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Study on the Influence of Tensional Properties on the Quality of Textile Materials

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Abstract

The problem of analyzing the quality of yarns and the structure of textile materialson the mechanical properties it is mainly in the following situations: in the technological manufacturing process after the textile product has been made or in the cutting phase, especially in the case of using yarns with increased elasticity or in the wearing process when the material is subjected to mechanical stress-strain. Most deformations due to the structure of the textile material make it more or less extensible and elastic in case of repeated mechanical stress. The ability of textile materials to deform under mechanical stress, especially tensile stress, is dependent on their elastic properties. Other factors that influence the deformation capacity of the textile material are represented by the gauges, stifness, contraction of the textile yarns. The study of the mechanical properties of textile structures under diferent strain rates is very important for the actual engineering design of the finished product. The elimination of latent stresses from the raw textile material is carried out during their finishing operations. It was found that the change in tensile properties is due to the differences in the structure of the material, applying the same finishing process. It has also been demonstrated that the existing tensions in the textile material are completely eliminated after wearing, following complex stress. The paper presents the influence of tensional properties on the quality of textile materials and the interpretation of stress-strain diagrams through different mathematical models.

Keywords: Quality Yarns, Elasticity, Structure Parameters, Stress-Strain Diagram.

Introduction

A confident understanding of knitted behaviour and characteristics are vital in the design and development of a functional garment. Textile materials have evolved in recent times and knit play a significant role in the development of sportswear industry [1]. Three-dimensional knit can be used to manufacture the complex structural shape and high energy absorption composite due to its excellent deformability [2]. Thus value of pattern design curves should be calculated using regression equations that each of them consists of the sum of characteristics that influence a pattern shape [3]. There has been increasing interest in the mechanical behavior of knitted materials, due to the wide range of applications they can be utilized in [4].

In general, woven, non-woven, braided and knitted fabrics can be distinguished according to their method of fabrication. Among them, knitted fabrics, which are produced by intermeshing loops of yarns using knitting needles, have so far the most modest percentage for usage in technical applications, even though they are widely utilized for outerwear, such as dresses and sportswear due to their excellent formability [5]. However, due to the advancement in knitting technology as well as the availability of high-performance fibers such as carbon, glass and aramid, knitted fabrics are gaining more and more interest in different innovative applications. For example, smart fibers are used as the base material for active knitted actuators or shape memory alloy (SMA) fibers are knitted into garments to create the shape changing cloths [6]. In addition, knitted textiles are also the materials of choice in biomaterials because of their high flexibility and low tendency to fray.

Moreover, in the composite materials industry, the utilization of knitted fabrics as preforms was considered skeptically because of their relatively low stiffness and strength originating from their low fiber volume fraction [7]. Nevertheless, the curved nature of the knitted loops manifests itself in the outstanding drapability of the resultant knitted fabrics, which catches the attention of composite materials engineers. The yarns tensile and elongation properties play a phenomenal role in the quality of the end products. This special property enables knitted fabric to be utilized in forming complex and deeply curved composite components [8].

In the evolution of own control structure arises need for investments in production processes to assist the organization in its various decision-making levels. New technologies in textile companies caused the need to invest in development, improvement of quality controls and standards certifications [9]. In this sense making the product more competitive in the market, it makes it necessary to adapt to processes and management. Knowledge of the full course of the stress–strain curves is more desirable, since it provides the whole information about the behavior of stresses under various levels of strains [10].

Beside the yarn and fabrics strength and breaking extension, there are other useful parameters which can be computed from the stress–strain curves [11]. They are work of rupture or toughness, secant modulus or stiffness, Initial Young's Modulus. The work of rupture or toughness measures the ability of the yarn to absorb energy and as a consequence, withstand a sudden shock. Secant modulus or stiffness is the ratio of change in stress to change in strain between two points of zero and breaking stress. The Initial Young's Modulus is a measure of the force required to produce a small extension and hence it determined the initial resistance to extension [12].

Experimental Part

The structural, physical and mechanical characteristics of the yarns influence the structure and properties of knitwear in the processing, wearing or maintenance processes and motivate the prescription by standards and their testing by appropriate methods [13].

To study the physical and mechanical properties, 10 knitwear samples were subjected to tests described in table 1.

Table 1: Description of the Knit Samples Under Study

Finesse of the knitting machine	Finesse of yarn	Knitting structures	Course density /50 mm	Wale density /50 mm
7 E	2x42 tex	Rib 1:1 with displacement	21	11,5
			20,5	12
			21	12
			22	11
			21	10,5
7E	4x24 tex	Rib 1:1 with displacement	24	13,5
			24,5	14
			25	14
			24	14,5
			24	14

The problem of the dimensional stability of the knitted is extensively researched. The knitted structures have elastic structures, this being a reason for which dimensional stability will always be a topical theme. The jersey structures, due to the distribution of the platinum loop in the knit plane, due to the relatively small number of yarn-yarn contact points that cause the threads to slide into the structure, due to the spiral of the tubular footage structure, is among those whose dimensional stability is difficult to control [14].

The technical characteristics of the yarns, the technical characteristics of the knitting machines and the technological parameters of the knitting machine are the elements which will be correlated in order to obtain structures with minimum dimensional changes [15].

Results and Discussion

To determine the tensile properties of the knitted samples under study, longitudinal and transverse tests were performed using the electronic dynamometer, these being made according to the SR EN ISO 2062 standard. The values are presented in Fig. 1.

Also, the dimensional stability of the textile materials was analyzed for the variants under study, following the degree in which the respective material keeps its initial dimensions. The dimensional variation of knitwear is determined especially by the redistribution of tensions in the material following the knitting and finishing process, and by the moisture-thermal treatments applied to it [16].

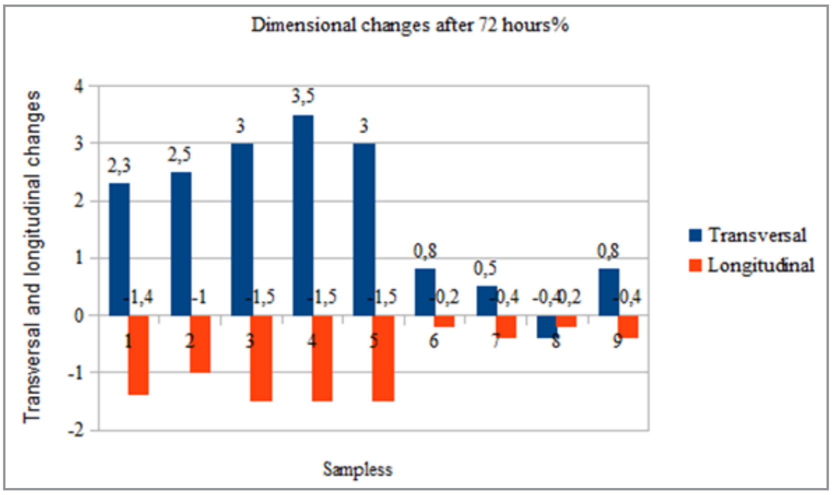

Figure 1: Dimensional Changes for the Knit Options in the Study

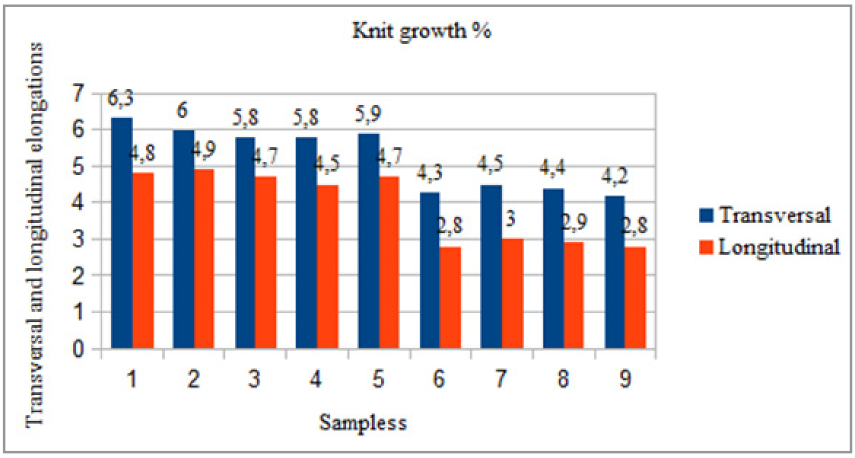

Figure 2: The Elongation Remains in the Two Directions for the Samples in the Study

The dimensions of the knitwear under study, namely the length and width, were measured immediately after removal from the machine, after 24, 48 and 72 hours to see the dimensional changes over time. Figure 1 and 2 shows their dimensional changes in transverse and longitudinal directions. It was found that the dimensional changes in the longitudinal direction tend to greater contractions, the fineness of the yarn having an important role in their production [17].

Likewise, other more important factors that determine or contribute to or influence the dimensional stability of knitwear can be: structural characteristics, yarn tension during winding, fineness of the yarn, fineness of the knitting machine. The knitted variants subjected to research were tested on the electronic dynamometer according to STAS SR EN ISO 2062. Thus, following the tensile stresses of the tricot variants, it was observed that they are generally characterized by a curve similar to the one in figure 3.

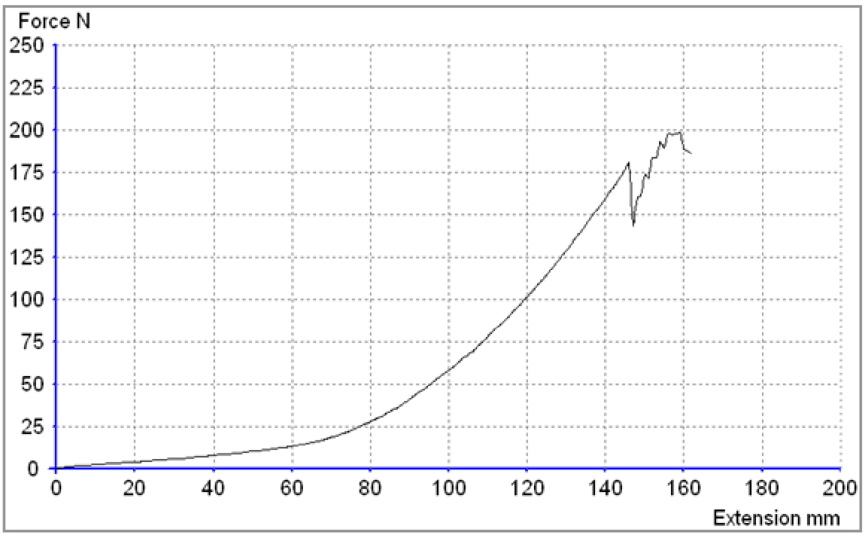

Figure 3: Stress-Strain Curve for Variant 4 in the Direction of the Row of Stitches

The tensional properties of the materials are determined by the fibrous composition, the structural model and the processing technological parameters and represent a resulting characteristic, which reflects the transfer of the tensional properties in the fiber-yarn-knitting sense, through the value of the transfer coefficients. The stress-strain diagrams for the samples under study are shown in figure 4.

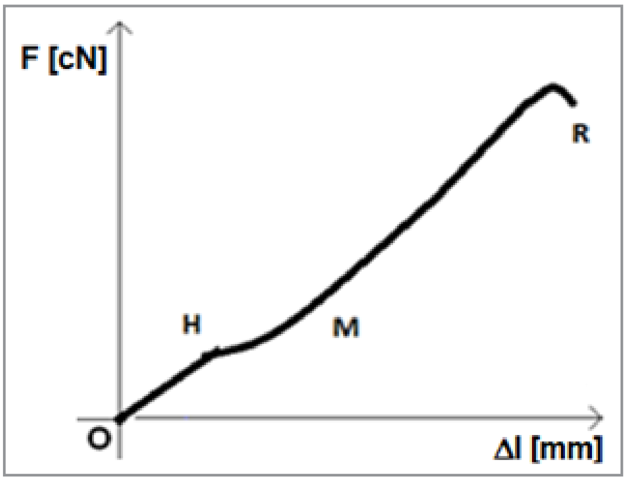

Figure 4: Model of Stress-Strain Diagrams

The stress-strain curves have many practical benefits in the fields of weave research and technology. Graphic interpretation:
- The force graph starts from the origin of the coordinate axes, point O representing the area where no force acts on the material;
- Zone OH is a line segment, and represents the zone of proportionality, point H being the end of the zone of proportionality;
- The HM area includes both an elastic and plastic area segment;
- The MR zone is a segment of a straight line, in which the material behaves as an inelastic solid subject to deformation, towards breaking; point M represents the beginning of this
areas of rupture;
- The force graph ends at point R, breaking point of the sample;
- The segment OH passes through the origin O of the axes can be described by the equation: where represents the slope of the line;
- The MR segment can be described by a d2 line that has a higher slope than the OH segment described by the d1 line and can be expressed by the equation where.

Understanding stress-strain diagrams is relevant to global aspects of the deformation process. These diagrams allow the determination of the values for tensile strength and elongation at break corresponding to the proportionality point [18].

The inhomogeneity of the mixture influences the shape/shape of the stress-strain curves, the appearance of which reveals the dependence on the nature of the component fibers as well as the dependence on the technological processing process or the spinning system used; at the same force, the fibers elongate differently, which leads to uneven tensions inside the thread with implications in the appearance of the product. In order to obtain knitted structures with adequate dimensional stability, this means within ±2%, it is necessary that the dimensional changes during the relaxation periods after knitting and chemical finishing being minimum. For this, all the processes to be applied will be conducted with appropriate and uniform tensions throughout the technological flow. The twist direction of the yarn and the spinning process influences the dimensional stability through internal stresses that can be introduced into the structure or through the spirality of the tubular knit feature [19].

The relaxation periods of 72 hours should be strictly respected, folded and under standard atmospheric conditions, both after knitting and after chemical finishing. During relaxation, the internal tensions introduced into the structures are balanced and the shape of the stiches changes in an absolutely random manner [20].

Knitting density influences both dimensional stability and requires the feasible finishing process to be adopted as well as its parameters. These parameters are correlated with the dimensional stability obtained after finishing. The knitted is one of the aspects with a particular influence on the dimensional stability of the knitwear. The structure is determined either by the aesthetic aspects or by the functional aspects of the designed product [21].

Conclusions

By resting, the knit changes dimensionally over time, immediately after removing it from the machine, there are essential changes in the knit in both directions, followed by slower changes. In the stage after knitting up to the cut, the period in which the knit is relaxed and then after the cut until it is made, we must take into account the way to store the knits, an operation that can affect the dimensions of the knit in the case of improper sewing [22].

The study of the mechanical properties of textile structures under diferent strain rates is very important for the actual engineering design of the finished product.

On the characteristics of dimensional stability a large influenced the residual elongation, the degree of elasticity to the mechanical tensile stress, allowed and the stability of some correct technologies in both mechanical processing and finishing processes.

The tensile properties of yarns play a vital role in the manufacturing and quality of the end products. Knowledge of the Stress–

Strain curves is more desirable, since it provides the whole information about the behavior of stresses under various levels of strains.

The behavior of the Stress–Strain curve of spun yarns is not only a function of the nature and structural arrangement of the constituent fibers in the yarns; the variation of rate of straining and gauge length also play a key role in defining the characteristics of stress-strain curves. In fitting the stress-strain curves, it is usual to plot the stress vertically and strain horizontally.

The first part of the stress-strain curve, starting at zero stress and strain, is fairly straight indicating a linear relationship between the stress and the strain.

After relaxation of the knits after being removed from the knitting machine, it can be noticed that there are generally elongations in the stitch course direction and contractions in the stitch courses in vertical direction [23].

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