ANALYSIS OF THE TENSILE STRENGTH OF 100% WOOL YARN FROM DIFFERENT CLIMATIC AREAS

OANA Dorina[1], OANA Ioan Pavel[1]

[1] University of Oradea, Faculty of Energy Engineering and Industrial Management, Department of Textile -Leather and Industrial Management, B. Ştefănescu Delavrancea street, no. 4410058, Oradea, Romania
E-Mail:oanaioanpavel@yahoo.com

Corresponding author: Oana, Ioan Pavel, E-mail: oanaioanpavel@yahoo.com

Abstract: *One of the basic conditions required of yarns is to have enough tensile strength to allow them to be turned into textiles and also to give the final product durability. During processing, threads are subjected to various unavoidable forms of mechanical stress, simple or compounded, but the amount of stress can be kept under control by adjusting the corresponding operating parameters (speed, gauges, push force on the cylinders of the rolling train etc.). The values of the operating parameters of the spinning operation are set so as to obtain uniform products in large scale production, but also to ensure the preservation of the properties of the fibers and yarns, for further processing. To this end we analyzed the tensile strength of three batches of 100% wool yarn meant for knitting, from three different geo-climatic areas. These are fine woolen yarn of 25 tex and torque of 620 twists/meter. The study of the tensile strength was carried out using a Uster R Tensojet 4 (UTj4) tension meter, analyzing ten samples of 500 m from each batch. The statistical and mathematical processing of the data obtained after analyzing the samples indicated that the yarns from South Africa have better tensile strength and a lower mechanical impedance variation coefficient than yarns from Asia and England.*

Key words: *yarns, tension meter, tensile strength, variation coefficient, fineness*

1. INTRODUCTION

The most frequent type of stress that the yarn endures during processing and during use of the finished products is traction. Tensile stress always causes a deformation along the stress line [1].

Basically, the traction forces to which yarn is subjected during processing or use are most often lower than shear stress, however they can cause pronounced, irreversible deformation. Such deformations occur even after the first application of stress, or more visible after exposure to repeated stress. In both cases their size depends on the duration of the stress [2].

Each type of yarn is characterized by a specific behavior when subjected to traction, a behavior which needs to be studied and understood very well, to avoid partial or total destruction of the yarn before it is used in the finished product [3]. Also, knowledge of all aspects of yarn behavior when subjected to tensile stress allows for determining the most appropriate fiber mixture, to provide the finished product the properties required by the intended use of the product [1].

Although there is no generally valid correlation between tensile strength and other characteristics that measure the behavior of yarn under tensile stress, strength and elongation at break are and will remain key indicators for assessing the quality of yarns [4].

The tensile strength is measured by the size of the shearing force, or by specific indicators, and by specific resistance, toughness and breaking length, and mechanical work of shear [1]. For yarns of the same type and the same structure, the size of the shear force is dependent on the thickness of the yarns analyzed, so their use makes it possible to compare the tensile strength of yarns of different thickness. Any body under the action of sufficiently great tensile forces, will deform by increasing size in the direction of the force. This phenomenon is known as elongation.

2. CONTENT

The wool fibers, as all other types of hair, are multicellular fibers which, from morphological point of view, are made up of three main structural parts, or three cell layers, distinct from each other: the cuticular layer, the cortical layer which is the part that forms the core of the wool fiber (about 85% of the fiber's volume), and the medullary layer which is inside the fiber and only in thick wool.

Wool, as an organic material, belongs to the class of proteins, the keratin family being characterized by a high physico-mechanical, chemical and biochemical strength.

From an elasticity point of view, fleece ranks second after polyamide fibers. In wool's case, its elasticity gives the products made of it softness and wear resistance during use. Tensional properties of wool are determined by the morphological structure of the fiber, the quality of the wool and the test conditions.

The tensile strength of the wool yarn is its property to endure certain levels of external stress. Tensile strength is expressed in cN and depends on the diameter of the yarn from a physical point of view, and on the temperature in terms of the heat treatments to which it is subjected (bleaching, dyeing, etc.).

Tenacity is the ratio betweeen the breaking strength and the length density, or denier, expressed in tex (T_{tex} or T_{den}). Although the tenacity of wool yarns is generally low, the resistance to wear of wool clothing products is much higher than that of some products made of fibers with higher tensile strength, due to a good structural stability and a good resistance to repeated stress.

Elongation at shear point varies depending on the fineness of the constituent fibers. The shear force and tensile strength do not fully reflect the behavior of yarns (or fibers) to tensile stresses. For a more complete characterization, stress-elongation diagrams are used. During stress, variation in force depending on deformation can be represented graphically, as a curve, using for this purpose dynamometers equipped with recording devices (the Tensojet 4 Uster dynamometer). Charts thus obtained are called stress-elongation diagrams.

The shearing mechanical work is the mechanical work required to deform the yarn (or fiber) to the point of shearing and is equivalent to the area delimited by the curve, the abscissa and the parallel to the ordinate starting from the shearing point, and is measured in cN·cm.

The shearing mechanical work L(WorK) is obtained from the relationship[5]:

$$L = f \cdot F_r \cdot \Delta l_r \quad (cN \cdot cm) \qquad \textbf{(1)}$$

Where: f – is the shearing factor;
F_r – is the shearing force (cN);
Δl_r – is the elongation at shearing (cm).

The shearing mechanical work factor is a dimensionless value that indicates the capacity for deformation of a thread.

Tensile strength is one of the basic features of the yarn, because it influences the behavior of yarns in processing (weaving preparation, weaving or knitting), determining the technological parameters of the equipments and their productivity. Also, yarn tensile strength is a qualitative characteristic, because the yarn's quality and the quality of the product made from it depend on its value. [6]

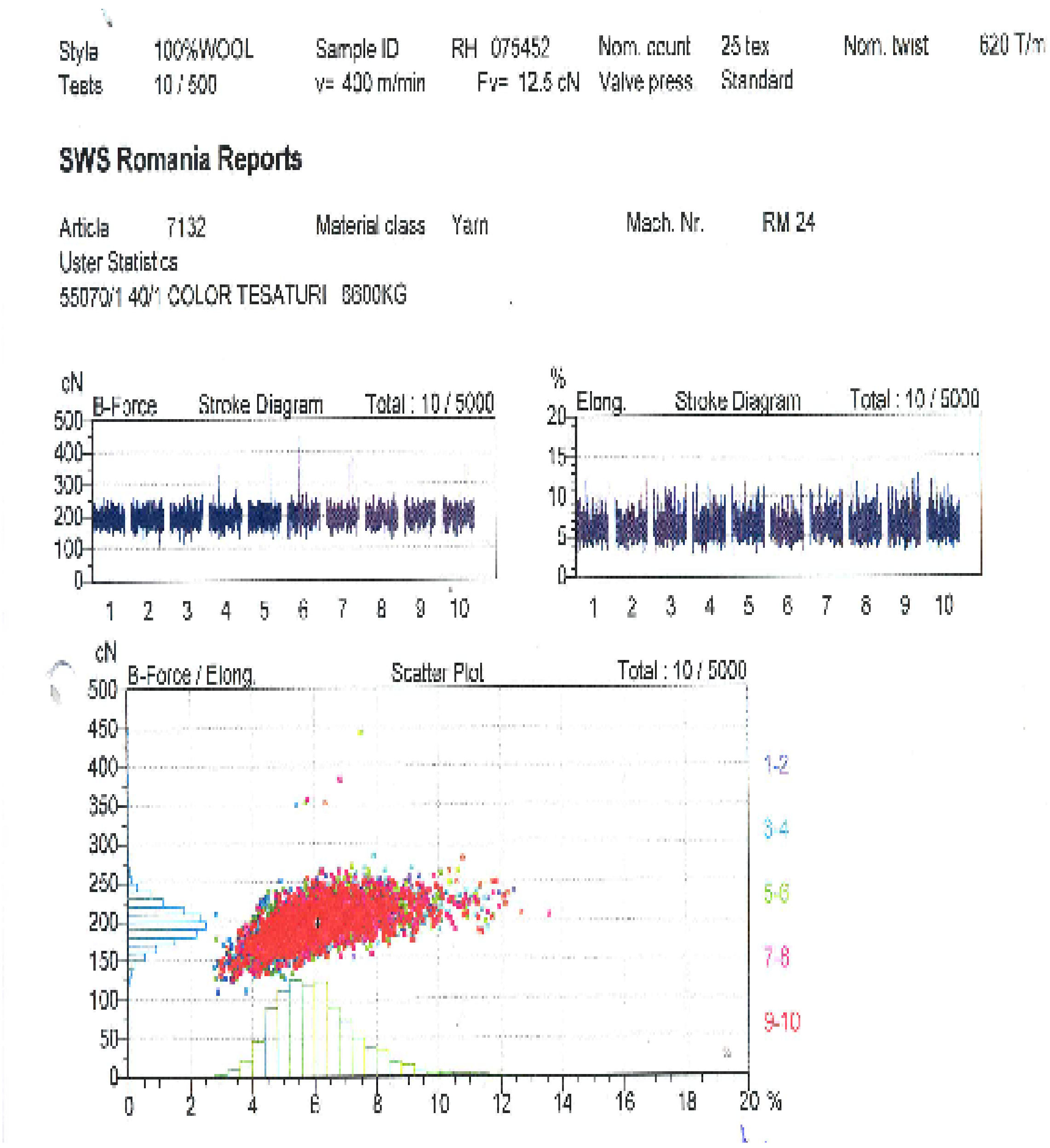

Fig. 1*: The stress-elongation diagrams for Batch I originating from Asia*

For these reasons, the parameters analyzed were those which assess tear resistance, using the Tensojet 4 Uster R (UTj4) machine, obtaining the shearing force, the shearing mechanical work,

shearing elongation and tenacity. The study was performed on three batches of 100% wool yarn from three different geo-climatic areas.
Batch I (55070) – originating from Asia
Batch II (55330) – originating from South Africa
Batch III (55621) – originating from England
These yarns, meant for knitting, have a fineness of 25 tex and torque of 620 twists/ meter. Testing was carried out on 10 samples of 500 m from each yarn batch.
Analysis and the machine F_2

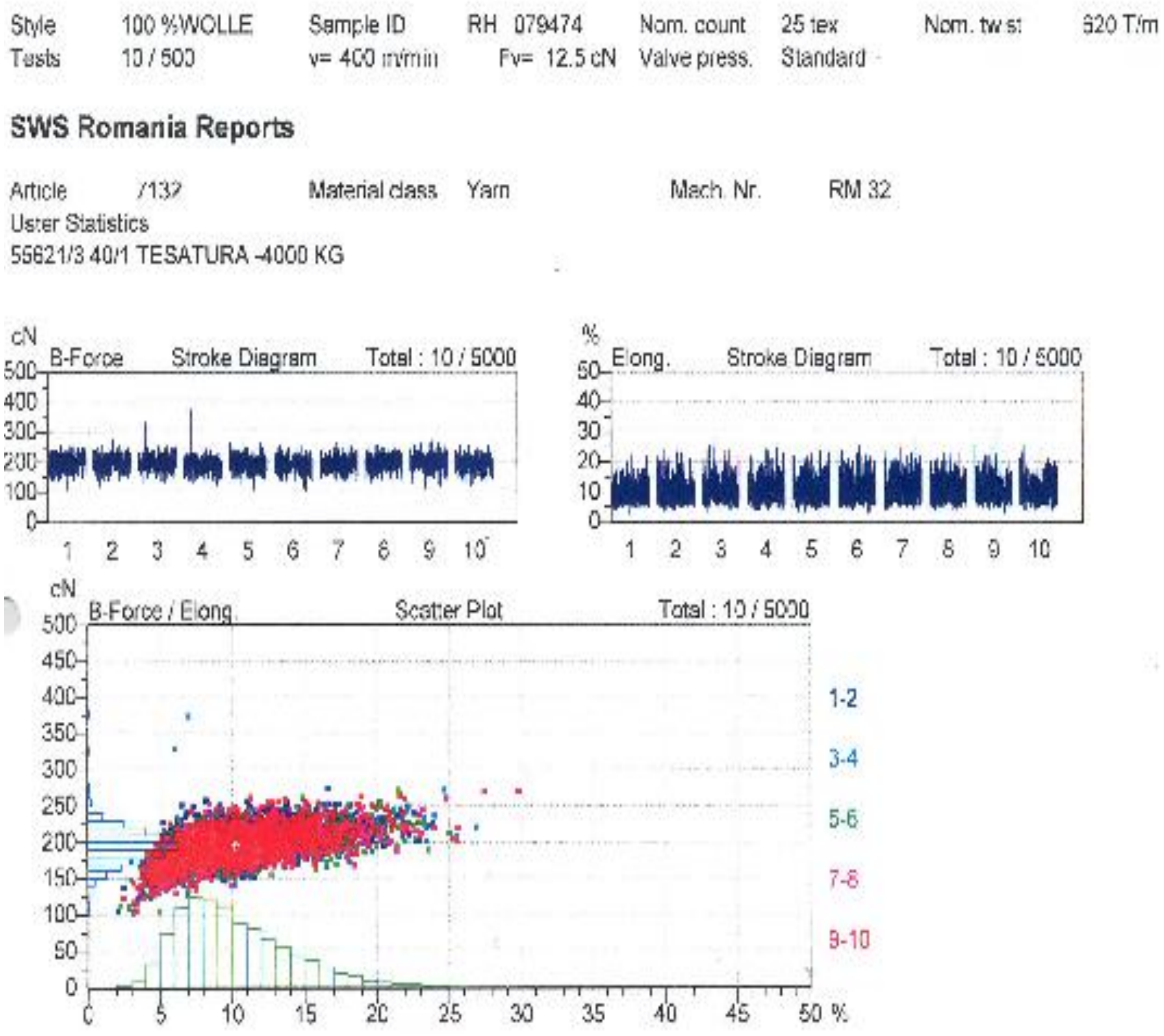

***Fig. 2**: The stress-elongation diagrams for Batch II originating from South Africa*

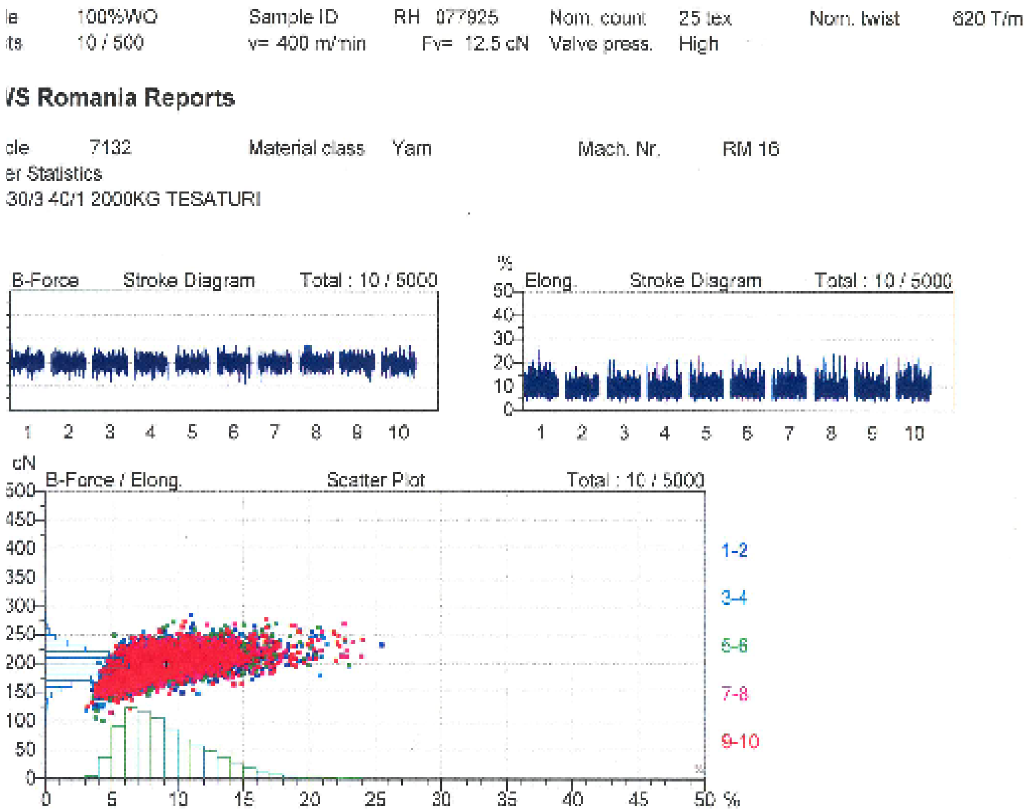

***Fig. 3**: The stress-elongation diagrams for BatchIII originating from England*

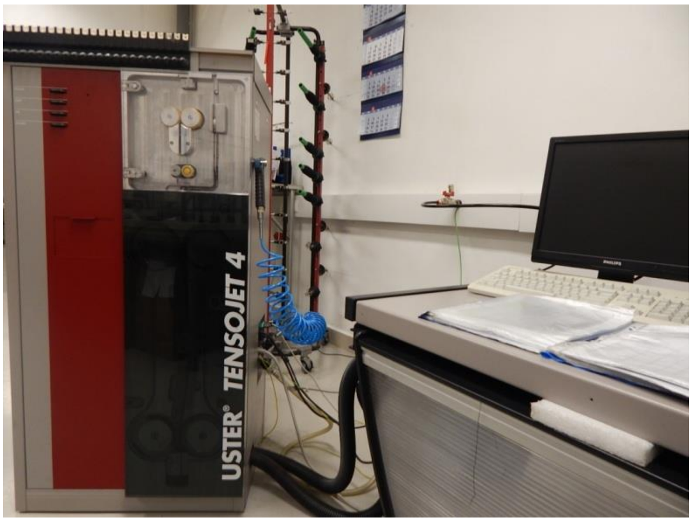

***Fig. 4:** The Tensojet 4 Uster dynamometer*

3. CONCLUSIONS

Based on the study conducted on three batches of wool yarn and the processing of the statistical and mathematical data produced by the Uster R Tensojet 4 machine, we found that woolen yarn from South Africa are high quality, with a better tensile strength and lower mechanical strength variation coefficient than yarns from Asia and England.
Tensional properties of the wool yarns are determined by the morphological structure of the fiber and wool quality, which are influenced by geo-climatic conditions, which also influence the degree of unevenness in terms of tensile strength.

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