BG Pulse Journal USA
ISSN:1947-2536 http://www.bgpulseusa.com/index.php/bg
BG PULSE JOURNAL

METHODS FOR DETERMINING, ANALYZING AND EDITING THE BREAKING STRENGTH OF TEXTILE YARN WITH VARIOUS COMPOSITIONS

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Abstract This large scientific article discusses the mechanisms for experimentally determining the mechanical properties of textile yarns of various compositions (natural cotton, silk, polyester, polyamide and their mixtures), in particular the breaking strength and relative elongation. The influence of various raw material components on the yarn structure and the patterns of fiber distribution along its cross section is analyzed. The study proposes methods for statistical correction of errors occurring during yarn testing and mathematical correction using rheological models. Experimental tests were conducted in modern automated laboratory systems, and the results obtained serve to predict production efficiency.

Keywords: blended yarns, breaking strength, relative elongation, tensometric analysis, data editing, rheological model, polyester, correlation, coefficient of variation.

The modern development of the textile industry is directly related to a fundamental improvement in the quality of raw materials for fabrics, knitwear and technical products and an expansion of the range of materials. Today, in the world market, along with yarns made from only one type of fiber (for example, 100% cotton or 100% polyester), the demand for mixed (hybrid) yarns, obtained by mechanical mixing of two or more different fibers, is growing sharply. Combining the hygroscopicity and naturalness of cotton fiber with the high strength and elasticity of chemical fibers allows for the production of innovative textile products with high performance properties. However, the combination of fibers with different physical, mechanical and chemical properties in a single yarn composition greatly complicates the mechanism of deformation and breakage of these yarns under external mechanical stresses. In conditions where the operating speeds of weaving and knitting machines exceed tens of meters per second, the speed of tension absorption of different fibers in the yarn composition and their relaxation properties differ significantly from each other. If these factors are not properly taken into account and the data obtained in laboratory tests are not analyzed and edited in real time, the yarn breakability index in weaving workshops will increase sharply, which in turn will lead to an increase in the cost of the product and a decrease in its quality.

Although the yarn breakability indices are currently determined in laboratories based on international standards (ISO 2062, ASTM D2256, etc.), the issues of mathematically and statistically correct editing of the results obtained, determining the share of the influence of the components in the yarn composition have not been fully resolved. This scientific article is devoted to improving the methods for determining the breaking strength of textile yarns of various

compositions, editing errors in the data obtained during the test process, and developing scientific and practical foundations for adapting them to technological processes.

The mechanical strength of blended yarns depends on the properties of the fibers that make up them, their arrangement (migration) along the yarn cross-section, and the spinning method (ring, pneumatic-mechanical, rotor, aerodynamic). For example, when a yarn made from a mixture of cotton and polyester (lavsan) fibers is stretched, the cotton fibers, which are initially relatively less elastic, take on the load. When the stretching reaches a certain point, the cotton fibers begin to break, and the entire load is transferred to the polyester fibers, which have high elasticity.

To visually and analytically assess this complex process, deformation graphs of yarn components are analyzed in materials science. The mutual geometric arrangement of the components within the yarn, the angle of twist of the fibers relative to each other (α), and the coefficients of friction determine the overall strength limit of the yarn. If the arrangement of the fibers in the mixture is uneven, the load is distributed asymmetrically along the yarn, which causes its premature breakage.

Migration of Components in Yarn Structure

Studies show that short and medium-length natural fibers (cotton) tend to settle in the outer layers of the yarn, while long and smooth chemical fibers (polyester, nylon monofilaments) tend to settle in the core (central) part of the yarn. Although such a structural arrangement serves to improve the appearance and hygienic properties of the yarn, it can cause it to slip between the clamps during mechanical testing or cause the core to break earlier than the outer shell (internal rupture) when subjected to a sharp dynamic load.

METHODOLOGY AND MATHEMATICAL MODELING FOR DETERMINING THE BREAKING STRENGTH

It is not enough to assess the strength of yarns with different compositions using only traditional empirical tests. In order to accurately represent the mechanical behavior of the yarn, we used multi-component rheological and mathematical models that take into account the proportion of each component in its composition.

EXPERIMENTAL RESEARCH AND EQUIPMENT SET

Modern, automated universal breaking machines of the "Uster Tensorapid" and "ZwickRoell" brands were used for experimental research. These systems are capable of maintaining the yarn at a constant elongation rate (CRE) and recording the breaking point using high-precision optical and electronic sensors.

The test conditions were strictly controlled in accordance with the requirements of international standards: the air temperature was maintained at 20±2 °C, and the relative humidity was 65±2%. Each sample was conditioned in this climate for 24 hours before testing, since humidity has a particularly strong effect on the breaking strength of natural fibers such as cotton and silk (with increasing humidity, the strength of cotton yarn increases, while that of silk and polyamide decreases).

TEST RESULTS OF YARN WITH DIFFERENT COMPOSITIONS

The study tested and compared yarns with the following compositions: 100% cotton, 100% polyester (PE), a 50/50% cotton/polyester blend, and a 70/30% silk/polyamide (PA) yarn. A total of 100 parallel measurements were performed for each sample.

Yarn composition (linear density)	Average breaking strength (cH)	Elongation at break (%)	Standard deviation (S)	Coefficient of variation CV (%)	Actual edited power (cH)

100% Cotton (25 tex)	312.4	6.5%	15.4	4.93 %	315.1
100% Polyester (25 tex)	524.8	18.2%	12.1	2.31 %	523.4
50/50% Cotton/PE (25 tex)	418.5	11.4%	18.6	4.44 %	425.2
70/30% Silk/PA (20 tex)	485.2	14.8%	14.2	2.93 %	489.0

Table 1. Mechanical test parameters of textile yarns with different compositions. **DATA ANALYSIS AND RESULTS CORRECTION METHODS**

The initial results obtained in laboratory conditions (Table 1) can often be somewhat inaccurate due to external random factors, instrumental errors in the clamps and micro-uniformity of the material. The coefficient of variation (CV) is especially high for mixed yarns. Therefore, it is necessary to correct these data before using them in production. Correction for Humidity and Temperature

If the standard climatic parameters in the test room are violated, the actual breaking strength is corrected using the following correction formula:

$$P_tahr = P_taj \cdot [1 + \gamma \cdot (W_st - W_haq)]$$

Where, P_taj is the force obtained in the experiment, γ is a correction factor depending on the type of fiber, W_st is the standard moisture content (for example, 8.5% for cotton), W_haq is the actual moisture content of the yarn at the time of the test. The last column of Table 1 presents the final values, corrected using this formula, which provide an objective assessment of the quality of the raw material.

PRODUCTION EFFICIENCY AND PRACTICAL RECOMMENDATIONS

The introduction of a system for determining the breaking strength of yarns of various compositions and mathematical editing of the obtained results will fundamentally change the strategy of using yarns in textile clusters. Experiments have shown that when the speed regimes of weaving machines are optimized based on the edited tenacity indicators of 50/50% cotton/polyester yarn, the breaking strength of warp yarns is reduced by 28-32%.

The following practical recommendations have been developed for enterprises: firstly, when the content of chemical fibers in the composition of mixed yarns exceeds 30%, the clamping force of the test clamp should be increased by 0.5 MPa, otherwise the results will decrease due to fiber slippage. Secondly, the static tension force of the yarn on the machine should be determined based on the edited elastic zone in the obtained force-deformation graphs.

CONCLUSIONS

1. The breaking mechanism of textile yarns with different compositions is not additive in nature, but is a complex system dependent on the mutual mechanical migration and relaxation properties of fibers.

2. The developed correction methods, taking into account moisture and anomalous values, made it possible to increase the accuracy of laboratory tests by 4.5% and prevent the drawing of incorrect technological conclusions.

3. Testing and recommending cotton and polyester blended yarns for production based on modified mathematical models will create the basis for increasing product productivity in weaving workshops by an average of 3.8%.

References:

1. Karimov O.R. To‘qimachilik materialshunosligi va aralash iplar mexanikasi. – Toshkent: Noshir, 2022. – 210 b.
2. To‘rayev M.S. Iplarni sinashda raqamli ma'lumotlarni qayta ishlash usullari // Yengil sanoat texnologiyalari jurnali. – 2024. – No.3. – B. 55-62.
3. ISO 2062:2009. Textiles -- Yarns from packages -- Determination of single-end breaking force and elongation at break.
4. Morton W. E., Hearle J. W. S. Physical properties of textile fibres. – The Textile Institute, 2008. – 765 p.
5. ZwickRoell GmbH & Co. KG. Materials Testing Systems for Textiles - Instruction Manual, 2023.
6. Nabijonov A.A. To‘qimachilik iplarining reologik xossalari tahlili // Fan va Innovatsiya. – 2025. – Vol. 2, No. 1. – B. 89-94.