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ANALYSIS OF THE PHYSICAL AND MECHANICAL PROPERTIES OF FABRICS WOVEN WITH PLAIN AND REP WEAVES

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Abstract

The physical and mechanical properties of the fabric samples obtained from the enterprise and the proposed ones were analyzed based on GOST 31307-2005 and GOST 3816-81 (ISO 811-81) standards.For this purpose, fabric samples woven in plain and reps weaves were taken from the WALTEX pneumatic weaving machine available at the weaving department of Home Textile NT Holding LLC, and experiments were conducted.

Keywords: Strength, Breaking force, Elongation, Deformation, Capillarity, Hygroscopicity, Air permeability, Plain weave Repp weave, Stretching, Moisture.

Introduction

The objective of the study to analyze the physical and mechanical properties of woven fabric samples based on GOST and ISO standards [1,2,3].

The tasks of the study: Studying the assortment of fabrics produced, Analyzing the weaving process, Conducting trial fabric weaving (experimental samples).

The breaking force of fabrics refers to the amount of force required to break the measured fabric samples mentioned above. It is denoted by the letter “P” and expressed in Newtons (N). The breaking force indicates the strength of the fabric [4,5].

The strength of fabrics depends on several factors such as:

– the fiber composition,
– the structure and linear density of the yarns used,
– the weave type,

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– the fabric density, and – the type of finishing applied.

The thicker and denser the yarns, the stronger the fabric becomes. Processes like calendaring and finishing can increase the fabric's strength, while treatments such as bleaching and dyeing may slightly reduce it [6].

In Figure 1, the histogram presents the measured breaking force values of the fabric samples.

The figure shows that the breaking force of fabrics woven with repp weave in both the warp and weft directions is higher than that of fabrics woven with plain weave in the same directions. This indicates that repp weave fabrics are stronger compared to plain weave fabrics.

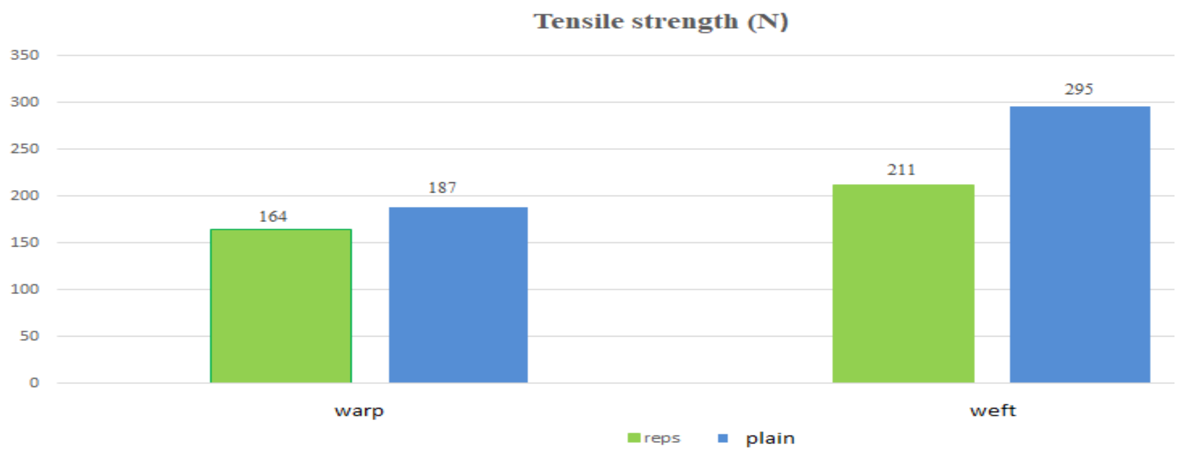

Fig.1 Analysis of the tensile strength of fabrics with plain and reps weaves

Along with determining the breaking force, the elongation at break of the samples was also identified.

Elongation at break refers to the difference between the initial length of the samples and their length when stretched until breaking. When this indicator is expressed in millimeters, it is called absolute elongation and denoted as "*Luz*." If the elongation is expressed as a percentage, it is referred to as relative elongation (en) and is calculated based on absolute elongation [7].

The amount of energy consumed to break the samples is the actual amount of work performed during breakage. To determine the breaking work, once the breaking force and elongation are known, the elongation diagram of the sample is recorded using the diagram-recording device of the tensile testing machine.

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Figure 2 presents the results of the fabric sample's elongation at break in the form of a histogram.

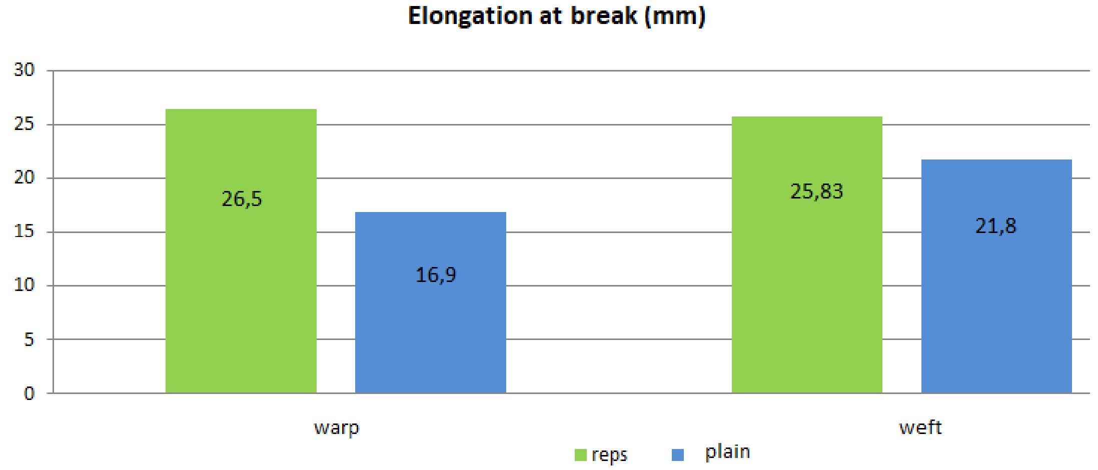

Fig.2. The result of the fabric sample's elongation at break

The results of the experiment conducted to determine the elongation at break of the fabrics showed that the elongation (in mm) in both warp and weft directions of the fabric woven with a reps weave is greater than that of the fabric woven with a plain weave. This can be explained as follows:

In plain weave, the yarns come into contact with each other at many points, which allows them to move more freely during the stretching process. However, in reps weave, some yarns appear on the surface, and their freedom of movement is more limited because they do not directly bear the load — this restricts deformation.

The ability of fabrics to allow the passage of air, water, gas, steam, dust, smoke, liquids, and radioactive rays is referred to as permeability. Air permeability is the ability of a sample to allow air to pass through it and is evaluated using the air permeability coefficient:

$$V_{\Delta r}\left(\frac{dm^3}{m^2 s}\right)$$

It indicates the amount of air (volume) that passes through 1 m² of surface area in 1 second under a known pressure difference**.** The experimental results on the air permeability properties of the fabrics woven with plain and reps weaves are presented in the form of a histogram.

As shown in the figure, the fabric woven with a reps weave demonstrates higher air permeability compared to the fabric woven with a plain weave.

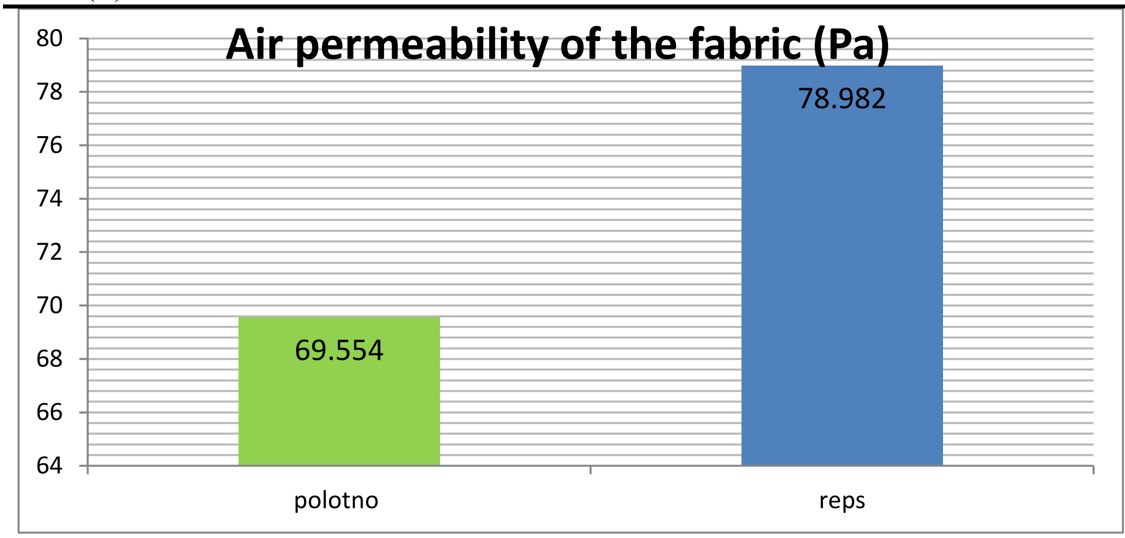

Fig.3. Air permeability of the fabric sample

"**Deformation of fabrics** is the process of change in the shape or size of fabrics under the influence of external forces (such as tension, compression, torsion, bending, etc.). The deformation process depends on the mechanical and elastic properties of the fabric, the structure and arrangement of the yarns, the type of weave, the elasticity of the fibers, and the strength of their bonding."

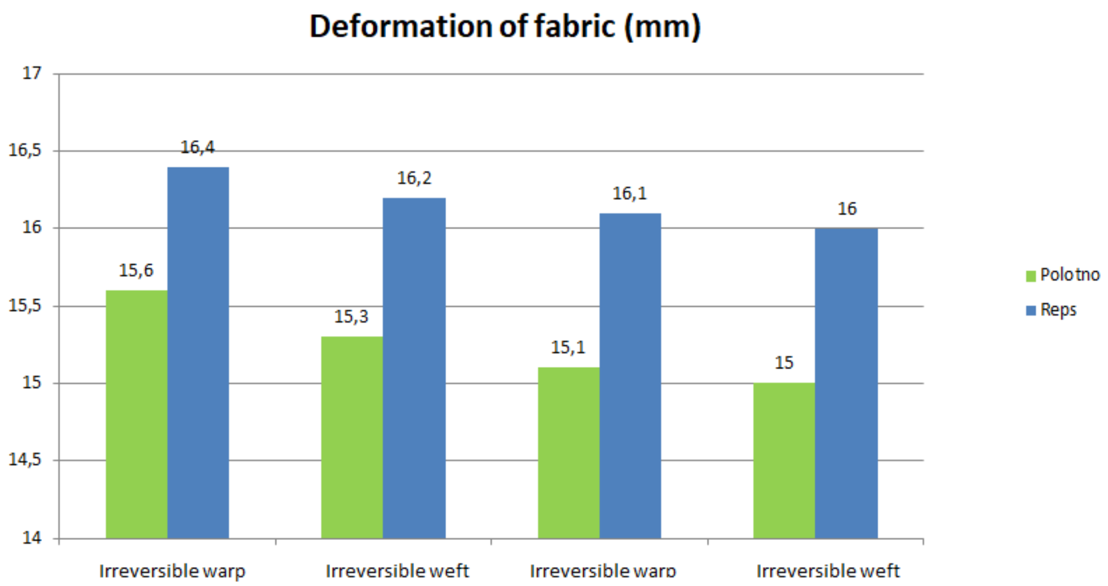

Fig.4 Deformation of fabric

Figure 4 shows the deformation of fabrics woven based on plain and reps weaves in the form of a histogram.

Elastic and plastic deformation of fabrics refers to changes in shape and size that occur when force (such as stretching, compression, or bending) is applied to the fabric structure. These deformations define the mechanical properties of the fabric and are of great importance in practical applications such as clothing, bedding, and technical textiles.

Table.1. Results of the study on determining the capillarity of grey woven fabrics made using plain and weft-faced reps weaves (in the weft direction)

Samples		Time of spent, min					
		5	10	15	20	25	30
reps	h(sm)	4,6	6,4	7,8	8,5	9,6	10,2
	h_1(sm)	4,2	6,8	7,5	8	9,8	10,8
	h_2(sm)	4,2	5,2	6,8	7,6	8,8	10,8
medium		4,3	6,13	7,36	8,03	9,4	10,6
minimum		4,2	5,2	6,8	7,6	8,8	10,2
maksimum		4,6	6,8	7,8	8,5	9,8	10,8
Plain	h(sm)	4,9	7,6	8,6	9,8	10,6	11,3
	h_1(sm)	5	7,8	8,8	9,5	10,8	11
	h_2(sm)	5,2	7,8	8,8	9,5	10,8	11,5
medium		4.2	4.5	5.3	5.6	6	9.8
minimum		4,9	7,6	8,6	9,5	10,6	11
maksimum		5,2	7,8	8,8	9,8	10,8	11,5

Capillarity is the phenomenon of liquid rising through capillary channels without the influence of external gravitational force. In fabrics, this occurs due to the movement of moisture through the microspaces (capillaries) between the yarns.

This histogram illustrates the results of a study conducted to investigate the **capillarity properties**—specifically the **height of moisture rise along the fiber direction**—of grey woven fabrics made with **plain and weft-faced reps weaves**, measured **in the weft direction**.

From the histogram, we can draw the following conclusions:

- The **capillary rise is consistently higher in fabrics with a plain weave**.

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- Over time, the height of moisture rise increases in both fabrics, but **the rise occurs more rapidly in the plain weave fabric**.
- After a **30-minute test**, moisture in the plain weave fabric rose to **10.6 cm**, whereas in the reps weave it reached **9.8 cm**—indicating **higher water absorption in the plain weave**.
- The **plain weave has a denser and more orderly structure**, with more and more stable inter-yarn voids (capillaries), which facilitates upward movement of liquid.
- In contrast, the **reps weave has a more relief-like (wavy) yarn arrangement**, a more textured surface, and an uneven density—this creates relatively greater resistance to liquid movement.
- Additionally, the capillaries in the plain weave structure may have **smaller diameters**, which increases capillary tension and allows the liquid to rise higher.
- Therefore, fabrics with **plain weave show superior capillarity compared to reps weave**, meaning they absorb and transport moisture more quickly and to greater heights.

This indicates that plain weave fabrics possess **better hygroscopicity**, making them more suitable for absorbent products such as **towels and bed linens**.

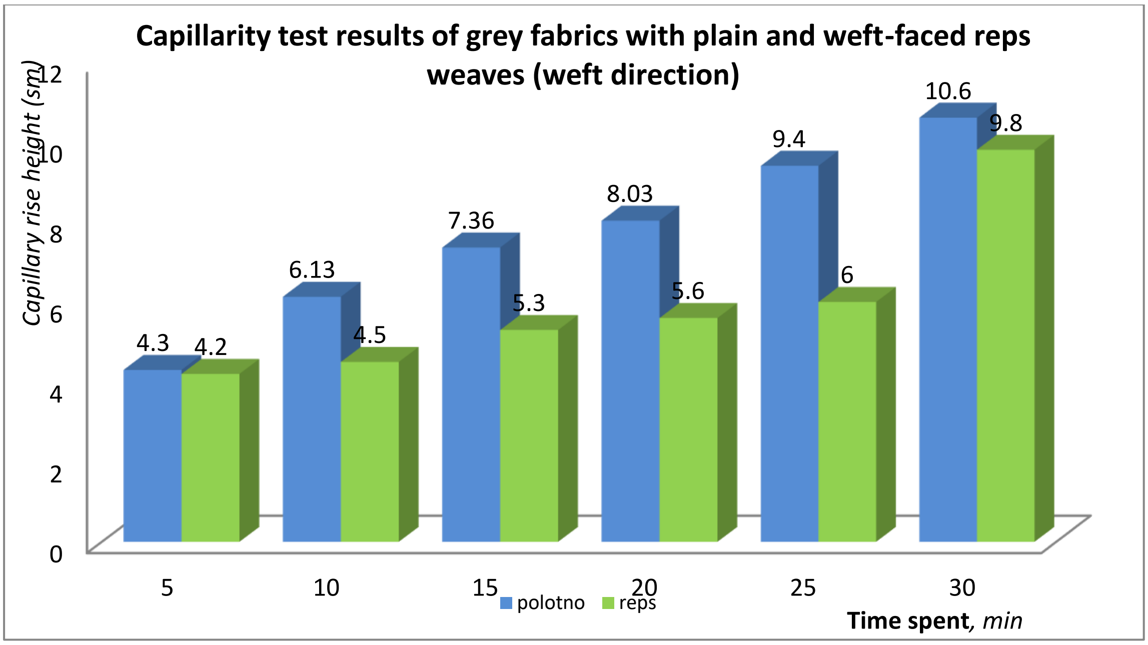

***Fig.5** Results of the study on determining the capillarity of grey woven fabrics with plain and weft-faced reps weaves (in the weft direction).*

Conclusion

Technological Indicators of Fabric Production on Pneumatic Weaving Machines in the Factory

The technological indicators of fabric production on pneumatic weaving machines at the factory were obtained. The recommended weave types for fabric production on these machines and their corresponding technological calculations were performed. Based on GOST 31307-2005 and GOST 3816-81 (ISO 811-81) standards, the experimental results of fabrics woven in plain and reps weaves were analyzed.

Pneumatic weaving machines play a crucial role in modern textile manufacturing due to their high efficiency, energy-saving capability, high-speed operation, and ability to produce high-quality fabrics. This is because the insertion of weft yarns using compressed air is carried out very quickly, which significantly increases production efficiency, reduces warp yarn breakage, and improves the fabric's quality indicators. These machines are also equipped with modern PLC (Programmable Logic Controller) systems and touchscreen interfaces for efficient operation and control.

In addition, pneumatic weaving machines allow for the production of a wide range of fabrics, including lightweight, air-permeable, dense, and high-quality textiles.

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