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EVALUATION OF DEFORMATION PROPERTIES OF HIGHLY ELASTIC KNITTED FABRICS IN SPORTSWEAR DESIGN

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Abstract: The article analyzes the modern range of compression materials, highlighting key factors such as the elasticity, deformation, and abrasion resistance properties of the materials. In the process of designing compression sportswear, selecting fabric samples and conducting tests to determine their mechanical properties is of significant scientific and practical importance. As a result of experimental studies, the elongation of materials was studied, and special testing equipment of the YG026A-III and YG026T models was used to assess the deformation properties. The deformation properties were evaluated, and elongation diagrams were provided, which will help improve the methods used to determine the operational characteristics of materials.

Keywords: elastic fabrics, compression sportswear, tensile strength, compression pressure, deformation.

Introduction. Currently, there is an increasing demand for compression clothing with improved ergonomic and operational characteristics for athletes, healthcare professionals, and individuals leading an active lifestyle. Compression garments offer functions such as enhancing blood circulation, reducing muscle fatigue, and preventing injuries by applying pressure to the human muscle system. In addition, the comfort and long-term wearability of these garments are also crucial factors. Today, most compression clothing has certain shortcomings in terms of breathability, elasticity, and hygienic requirements, which makes their further improvement a pressing issue. Therefore, creating a technology for producing compression sportswear with high operational characteristics is an important scientific and practical task [1].

To achieve and maintain optimal athletic form, athletes frequently use various strategies to aid in recovery and enhance performance. In recent years, compression sportswear that covers the entire body has become popular during training and competitions in various sports. Compression garments are used to: 1) increase the physiological parameters of muscle tissue during exercise and physical training: strength, power, endurance; improve circulation; reduce resistance from the environment (air, water) during high-speed sports; correct body shape; thermoregulation; protect joints and tendons from injuries and strains; 2) accelerate recovery and reduce muscle pain during training and rest periods.

The primary function of compression sportswear for general training is to provide a comfortable environment for athletes during training [2]. Literature analysis shows that compression sportswear helps supply oxygen to muscles during tension and slows down the accumulation of lactic acid. Athletes highly value compression garments for strengthening muscles, reducing vibrations, and decreasing the risk of micro-injuries. Compression garments support the calf muscles, reduce pressure in the calf, and provide protection against excess load in cold conditions, giving athletes a sense of safe movement. During challenging workouts or after long-distance events, compression serves as a preventive measure. The most popular compression sportswear includes t-shirts, leggings, shorts, tops, sleeves, knee and elbow braces, calf supports, and more. The continuous growth of the compression sportswear market leads to rapid advancements in materials, designs, and manufacturing methods [7].

In the design of such sportswear, it is crucial to select elastic materials suited to the specific sport. Several key properties of elastic materials must be considered in this process.

In recent years, the most common reasons for the rejection of some sportswear include:

- Inability to withstand high physical activity and extreme climatic conditions
- Loss of elasticity after multiple uses
- Fading of colors
- Tearing or thinning of the fabric due to excessive friction in areas such as the knees and elbows.

From a design perspective, sportswear must be well-constructed, with sturdy seams, and resistant to wear in high-friction areas. The materials used for the garments should be selected based on their elastic and viscous properties, and deformation characteristics are essential to understand when evaluating the material's performance in a given situation. It is important for compression clothing to retain its shape and characteristics throughout the duration of its use. Therefore, in addition to testing materials according to established standards, scientific research should focus on the stability of elastic and viscous properties to ensure that the garments maintain their form over time [8].

Methods.

Among the elastic-viscoelastic characteristics of elongation in textile materials, the most important for garment design are as follows:

1. Extension – defined as the relative change in the length of the sample under the applied load.

2. Elasticity – the ratio of the total deformation to the initial deformation expressed as a percentage. During active physical training with rapid, high-amplitude movements, the material must return to its original dimensions at the same rate in order to maintain contact with the body’s surface.

3. Residual Deformation – the relative increase in the material’s dimensions after the removal of the applied load, which defines the residual deformation of the material.

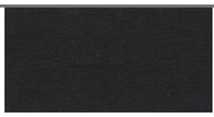
When designing body-compressing garments, it is essential to select, order, and use materials based on their deformation characteristics.

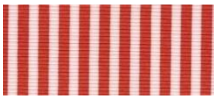
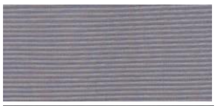
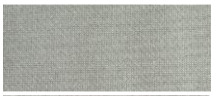
The "Textile Industry Engineering" faculty at Namangan State Technical University has sufficient laboratory equipment for studying the physical-mechanical properties of high-elasticity knitted materials in its educational-scientific laboratory.

Results. Thus, to study the fiber composition, surface density, and structural characteristics of knitted fabrics, commonly used samples for compression sportswear production were selected. Experimental studies were conducted on 15 different types of material samples to determine the deformation properties of elastic materials. The physical-mechanical properties of the fabrics obtained from the research are presented in Table 1. The evaluation of the deformation characteristics of the fabrics was carried out using the specialized testing equipment of type YG026A-III (Figure 1).

Figure 1. YG026A-III equipment

Table 1.

№	Samples	Appearance of the fabric	Fiber content of fabrics (%)	Surface density,	Fabric thickness	A group of items
1	Sample 1		Cotton-95, PU-5	195,5	0,45	T-shirt and tank top
2	Sample 2		Cotton-92, PU-8	200,1	0,6	T-shirt and tank top
3	Sample 3		Cotton-95, PU-5	212,2	0,5	T-shirt and tank top

4	Sample 4		Cotton-97, PU-3	169,9	0,6	T-shirt and tank top
5	Sample 5		Cotton-90, PU-10	175,7	0,75	T-shirt and tank top
6	Sample 6		Cotton-95, PU-5	165,4	0,5	Sports underwear
7	Sample 7		Viscose-90, PU-10	196,5	0,8	T-shirt and tank top
8	Sample 8		Cotton-95, PU-5	415,4	1,0	Sports suit
9	Sample 9		Cotton-92, PU-8	182,4	0,6	Sports underwear
10	Sample 10		Cotton-95, PU-5	171,1	0,5	Sports underwear
11	Sample 11		Cotton-95, PU-5	231,4	0,6	T-shirt and tank top
12	Sample 12		PE- 92 PU-8	185,2	0,5	Sports suit
13	Sample 13		PE-94 PU-6	180,4	0,5	T-shirt and tank top
14	Sample 14		PE-94 PU-4	311,3	0,8	Sports suit
15	Sample 15		PE-96 PU-4	430,4	0,8	Sports suit

Note: Abbreviations used in the table: PL-polyester fiber, PU-polyurethane fiber.

Discussions. In the framework of experimental research, the tensile strength, deformation stability, and abrasion resistance properties of elastic knitted materials were evaluated. The tensile strength of the samples in both the width and length directions was determined using the YG026T universal testing machine, and this process was conducted in accordance with standard methods [12].

The results presented in Table 2 show that the tensile strength, engagement degree, and abrasion resistance were assessed through the number of cycles of resistance. To determine the deformation characteristics of the knitted fabrics, tests were carried out under a load equal to 5% of the breaking strength, in both the width and length directions. This method is an important criterion for assessing the material's stability under operating conditions [7].

Table 2. Mechanical Properties of Elastic Knitted Fabrics

№	Tensile strength		Elongation at break		Engagement		Number of cycles resistant to abrasion
	By length (N)	By width (N)	By length	By width	By length	By width	
Sample 1	332,2	315,2	216,8	265,1	4	3	23000
Sample 2	176,8	75,8	67,66	261,74	3	4	16000
Sample 3	331,8	174,8	116,8	326,44	3	2	24500
Sample 4	247,8	253,8	133,44	225,4	4	4	19000
Sample 5	200	275,4	242,12	144,54	3	5	16500
Sample 6	432,2	224,2	143,66	323,04	5	3	28500
Sample 7	125,2	114	152,12	195,14	2	3	15000
Sample 8	206,4	661,2	125,96	84,7	4	5	17500
Sample 9	238	215	149,36	276,32	2	3	20500
Sample 10	365,8	207	117,78	312,2	3	4	19500
Sample 11	180,6	82,4	79,2	210,5	2	2	14500
Sample 12	206,7	70,8	135,4	196,2	2	3	16500
Sample 13	135,1	101,2	102,4	148,3	2	2	15500
Sample 14	306,9	86,5	157,4	198,7	3	2	17500
Sample 15	116,3	68,7	96,5	202,4	2	2	16500

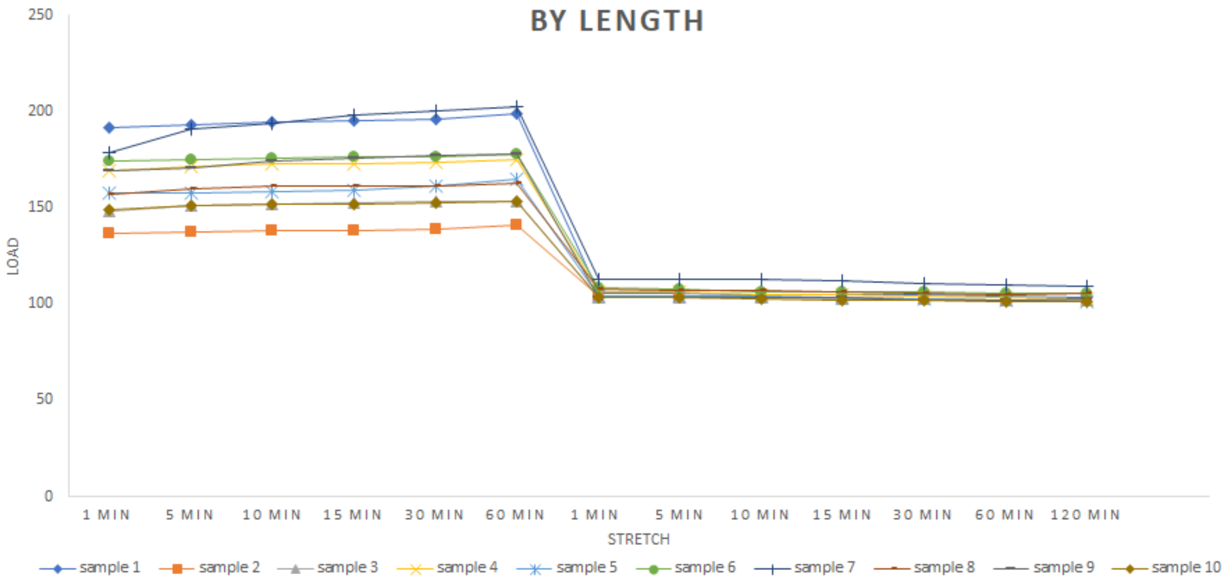


Figure 2. Chart of elongation by length of various woven knitted fabrics

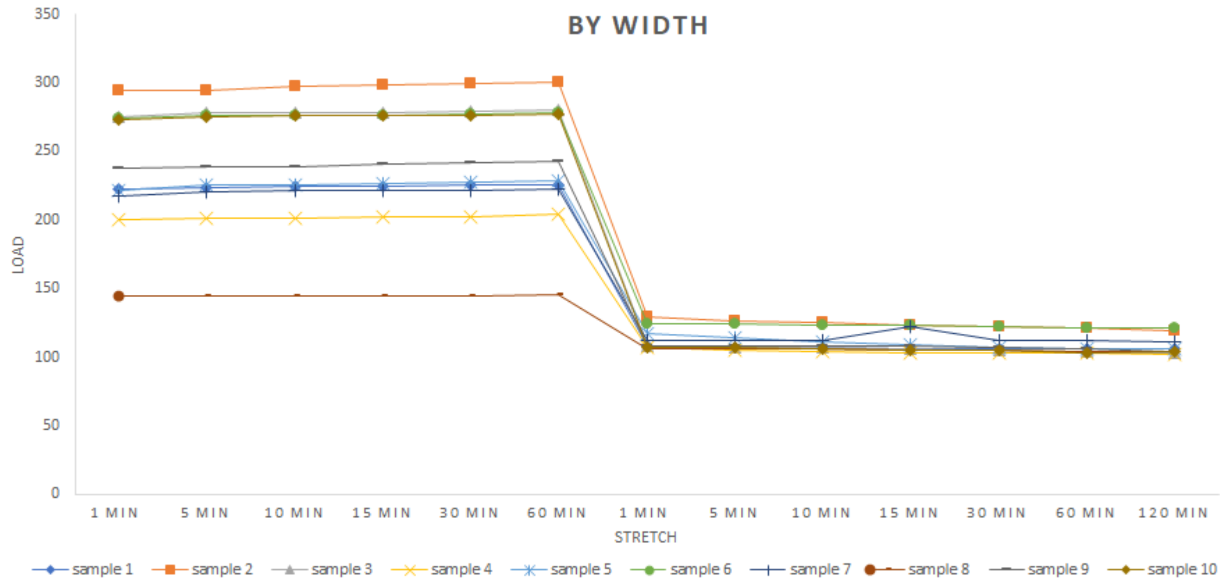


Figure 3. A diagram of the widthwise elongation of various woven knitted fabrics

Conclusions. The results show that, using the available knitting equipment, the fabric with a composition of 95% cotton and 5% polyurethane, and a surface density of 171.1 g/m², meets the required deformation properties. This material can be used to produce compression sportswear with high functional parameters. To increase consumer demand, it is necessary to conduct a broader user survey and make greater use of raw materials with higher linear density. The current technology is universal, primarily enabling the production of a variety of compression items. Furthermore, this product range has high demand and, with seamless longitudinal knitting, can compete with imported analogs. [9][10]

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