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MATHEMATICAL MODEL OF THE INFLUENCE OF A GYMNAST'S STRENGTH ON CLOTHING FABRIC

RAYIMBERDIYEVA DILRABO

Senior teacher of Namangan Institute of Textile Industry
E-mail.: d.rayimberdiyeva78@gmail.com, phone.: (+99893) 938 20-97

NABIDJANOVA NARGIZA

Professor of Namangan Institute of Textile Industry
E-mail.: nabidjanova74@mail.ru, phone.: (+99893) 671 01-14

ISMAILOV NURULLA

Namangan Institute of Engineering and Technology (PhD)
E-mail.: Innnt027@gmail.com, phone.: (+99890) 214 72-44

Abstract:

Objective. This article discusses the impact of various forces that can arise during the movement of athletic girls in gymnastics clothes, the study of the stress-strain state, the types of fabric used for clothing, and the mathematical model of the force acting on it. Information about the values of the coefficients determined as a result of the actions is also discussed and highlighted.

Keywords: mathematical modeling, physical phenomena, learning, complex dynamic systems, multiplicity, parameters, gymnastics-clothing-environment, human body.

The developed mathematical model of the gymnasts' sportswear system makes it possible to develop a reasonable design and choose the materials of a set of clothes intended for use in conditions of human body movement. The developed mathematical system model "gymnast-clothing-environment" allows us to develop a rational design and selection of the material of a special fabric package designed for use in special conditions of the parameters of the area of movement of the gymnast's body. In world and domestic practice, computer mathematical modeling is widely and successfully used to solve such problems [3].

Mathematical modeling is a method of studying physical phenomena by constructing their mathematical models. So, when studying very complex dynamic systems and objects with a large number of parameters; they are non-linearly interconnected, it is difficult to get the dependence of output indicators on the influence of input, and even more so on changes in the parameters of the system itself. The way out of this situation was found by switching from mathematical models to simulation models. Computer modeling has a much greater potential for the study of complex objects and systems with nonlinear connections [4].

The solution of the problem involves searching for the parameters of gymnastic athletes' clothing and its materials that meet the requirements, and is aimed at determining the quantitative values of the parameters of clothing for gymnastics, taking into account the reaction of the human body to changes. in external conditions. The initial data include human biological characteristics, underwear parameters, sportswear parameters and environmental parameters. For simplicity of mathematical description, the "man-clothes-environment" system is presented as a multi-layered system. The main goal is to develop a mathematical model of clothing that works in the conditions of movement of a gymnast, to study the strength of the material. At the same time, the human body is considered as a deformed cylindrical body of limited dimensions, and clothing is considered as a soft shell. Then the problem under consideration is reduced to modeling deformations of a cylinder with a soft shell. This formulation of the problem allows us to study the state of stress-deformation of the gymnast's clothes, which may occur during the movements of the gymnast. Based on the table below, let's consider a mathematical model of the impact force on the fabric from which the clothes are made during the movement of the gymnast (Table 1).

A mathematical model of the influence of a gymnast on the fabric from which the clothes are made.

Table 1

Fabric with three different elasticity					
	removal (N)	Elongation when interrupted (mm)	Durability percentage (%)	Energy expended	Downtime (s)
Rhombus	62	199,7	99,85	3,1	59,93
Tour	254	172,4	86,35	10.9	51,82
Stretch network	113	78,1	39,05	2,9	23,44

The gymnast performs various movements. During movement, the force of movement is directed in different directions depending on the direction of movement, and during bending, the vector force of the human body, as well as the vector force of attraction of fabric materials, act in opposite directions. With good elasticity of fabric materials, the gymnast will be able to perform tricks with free movement perfectly. The figure shows examples of tricks performed by a gymnast.

a) b)

Figure 1. The tricks performed by a gymnast describe the directions of gravity opposite to the directional vector force acting on the fabric applied to the clothing in relation to the directional vector force in human movement

Based on Table 1, using the mathematical method of least squares, a mathematical model of the tensile strength and elongation (mm) of materials for various situations during the movement of the gymnast was created.

That is, we will use the formula $Y = A \cdot K^{\alpha} \cdot L^{\beta}$ (1) of the work performed as a result of the movement of the gymnast (taking into account the flexion of the joints, it is expressed in the form of the formula $Y = A \cdot K^{\alpha} \cdot L^{\beta} \cdot \cos\gamma$ (1 *), where the angle at which the joints are curved) [1,2].

Here

A - coefficient of work performed

α, β -unknown coefficients ($\alpha + \beta = 1$ sufficient to satisfy the condition)

K -Force in direction

L - tensile surface of the material (elasticity)

$\cos\gamma$ - angle when bending joints

(1) If we log both parts of the equation

$$\ln(y) = \ln A + \alpha \ln k + \beta \ln L \quad (2)$$

Let us write equation (2) as a function A, α, β .

$$\varphi(A, \alpha, \beta) = \sum_{i=1}^{n} (\ln(z) - (\ln A + \alpha \ln k + \beta \ln L))^2 \quad (3)$$

(2) Differentiate the equation and compose a system of equations

$$\begin{cases} \frac{d\varphi}{dA} = 0 \\ \frac{d\varphi}{d\alpha} = 0 \\ \frac{d\varphi}{d\beta} = 0 \end{cases} \quad (4)$$

Based on condition (4), we will create a system of A, α, β normal equations of three unknowns for calculating linear regression coefficients.

(5) we determine the unknown coefficients of A, α, β (angle γ) using the normal equation and compile the following table.

Table 2

№	K	L	Z	ln(k)	ln(l)	ln(z)	(ln(k))^2	(ln(l))^2	ln(x(u))*ln(y(u))	ln(z(x))*ln(z(z))	ln(z(u))*ln(z(z))
1	2	99,7	99,85	4,1	5,3	4,6	17,0	28,1	2,4	2,2	7,0
2	54	72,4	86,35	5,5	5,1	4,5	30,7	26,5	2,8	2,6	6,7
3	13	8,1	39,05	4,7	4,4	3,7	22,3	19,0	2,3	2,0	4,8
4	29	50,2	225,3	14,4	14,8	12,7	70,0	73,6	7,5	6,7	18,5

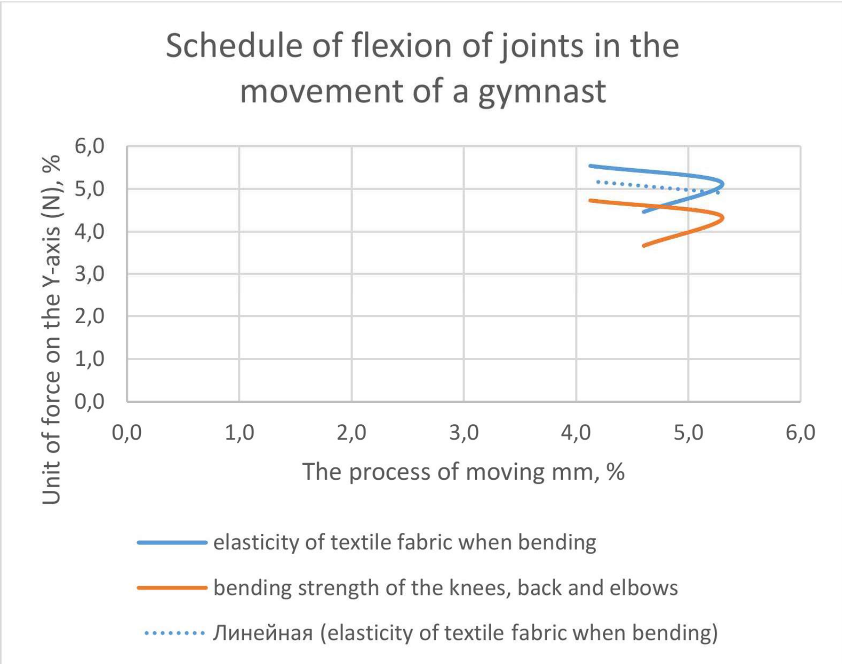

Figure 2. Figure 1 shows the graph (a) of the flexion of the gymnast's joint

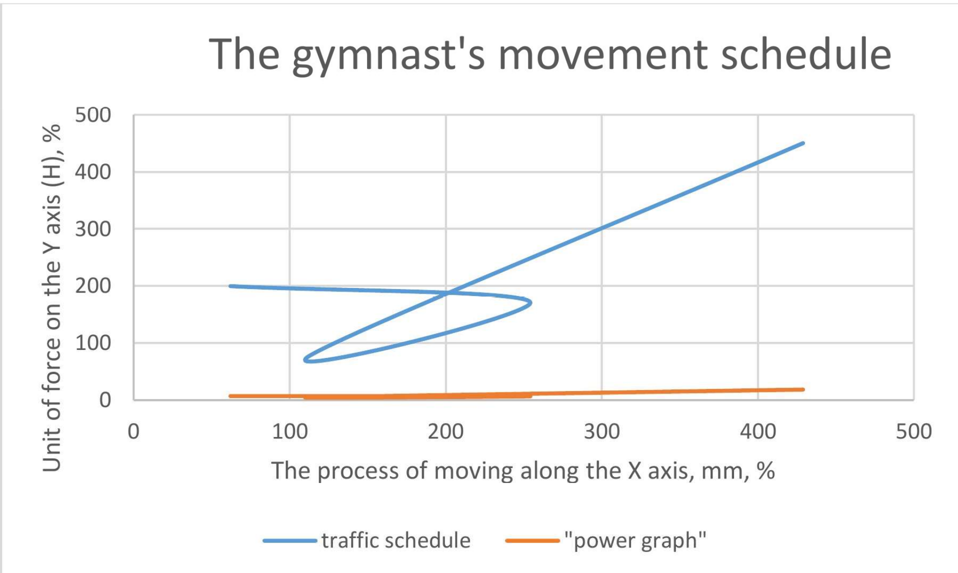

Figure 3. Graph (b) of the flexion of the gymnast's joints is shown in Fig. 1.

The value of certain coefficients as a result of actions is as follows:
A=1,305373. $\alpha = 1{,}03664$ $\beta = -0{,}03664$

The high elasticity of materials underlies the tricks performed by the gymnast during movement, based on the values obtained as a result of experiments.

Conclusion it is reasonable to say that the cloth placed on the gymnastic girls in various movements is based on a high level of resistance to the strong contrasts against the clothing force to the direction vector force in the human movement.

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MODELING OF STRENGTH RELIABILITY AND TRANSFORMATION OF A KNITTED LOOP AT THE LIMIT STATE OF THE STRUCTURE

GULYAEVA GULFIA

Associate professor of Tashkent Institute of Textile and Light Industry
E-mail.: uztextile@gmail.com, phone.: (+99890) 935 10-47

Abstract:

Objective. The aim of research is studying the mechanism of strength reliability and transformation of a knitted loop at the limit state of the structure. Comparative analysis of the transformation of the loop of various knitted fabrics, it is advisable to introduce the concept of the average coefficient of transformation of the loop ψ_{cp} was introduced.

Methods. The model of three-stage stretching of knitwear must be borne in mind that the increment of deformation is carried out due to the elongation of the thread on the scale of the loop structure, which occurs after the curved sections of the loop are straightened and the sliding (displacement) of the contact points between the mating loops is completed.

Results. Thus, the introduced loop transformation coefficient ψ can quantitatively characterize the degree of loop variability in the limit state, when the loop step and the height of the loop column take on the maximum possible values. On the other hand, this coefficient may indirectly reflect the mobility of the loop structure.

Conclusion. For the considered types of stitches (rib, satin stitch, interlock), of course, the highest mobility has plain (ψ_c = 1.456) and the lowest - interlock (0.617), which is explained by the peculiarity of the stitch structure. So, for example, interlock stitch, which is a derivative of an rib, has the largest set of external bonds ("saturation") among the stitches under consideration, which determines the relatively low mobility of the structure.

Keywords: knitwear, strength reliability, deformability, structure, knitwear deformation mechanism, transformation of the loop, loop transformation coefficient.

Introduction. Unlike weaved fabrics, where the structural elements for geometric models are described by relatively simple geometric constructions, in particular, intersecting straight lines (threads) at right angles, and are relatively constant, knitwear has a more complex geometric structure that is easily deformed under the action of an external load.

It is important to note that changes in the structural parameters of textile materials (knitwear, fabrics), including

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