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Study the state of deformation of fibers with variable properties

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Abstract. The method for calculating the tensile and compressive strength of certain fiber systems with different structures in terms of layer thickness was presented. The laws of influence of various parameters, which become invisible in stretching, have been established on the description of two-layer yarn interaction. It was found that the tension (pressure) compressing the fiber in the center of the thread has a maximum value, it increases significantly with the increase of the angle of attack, which leads to an uneven distribution along the radius of the thread. In a two-layer yarn formed from two fiber systems with different mechanical characteristics, the degree of compression of the fibers depends significantly on the ratio. It was expected that the fiber maturity index decreased in the outer layer, and the pressure between the fibers increased as the thickness of the inner layer increased. All the fibers in the two-layer yarn are in a sliding state, and as this indicator increases, starting from the center of the yarn, the fibers begin to be in tight contact with each other, the length of which depends on the radius of the inner layer, the bending angle, and the ratio of the Young's modulus of the fibers of the two-layer yarn. It was observed that the fibers in the thread layer are in tight contact with each other at the value of the angle of sag

1. Introduction

In the world, secondary material resources from the weaving and knitting industry account for 25% of the total raw materials. Currently, as a result of the development of scientific and technical distribution in the world, the increase in the assortment of products, the amount of secondary material resources is increasing. As a result, these secondary material resources are causing environmental pollution as a result of waste disposal. For this, the production of low-cost quality finished products is currently important due to the creation of new technologies with low waste in their processing based on the effective use of secondary material resources [1].

In our Republic, at present, comprehensive measures are being implemented to develop resurstejamkor techniques and technologies that will allow to expand the range of special clothing fabrics, reduce labor and energy consumption, save resources, and effectively use various fibers. On the development strategy of the new Uzbekistan for 2022-2026, including "...modernization and rapid development of the textile industry, consistent development of textile production and significant increase in export potential...", which defined important tasks. In the implementation of these tasks, it is important to create technically and technologically modernized machines in the production of a new assortment of special clothespins, including on the basis of the effective use of secondary material resources of various compositions in the rope thread [2].

In the world, an increase in the standard of living of the population is achieved due to an exponential increase in gross product due to non-renewable natural resources. Only 2% of them are used in the form of finished products for consumption, while the remaining 98% pollute the environment in the form of waste and waste. Therefore, urgent and drastic measures must be taken to reduce the consumption of non-renewable resources and environmental pollution. The most important direction in this regard is the reuse of production secondary material resources, which is the acquisition of a finished product that significantly reduces the use of Natural Resources and, consequently, environmental pollution. Since the secondary material is 2-3 times less than the amount of work and energy spent on resource processing, in the process of using modern technological equipment of the light industry, it reduces the release of harmful substances into the atmosphere to a minimum, and part of them completely recovers production

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waste. However, these environmentally friendly technologies are very expensive and cannot radically solve environmental problems [3-5].

In order to evaluate the cocktail properties in the composition of tin thread, formed from fibers with different properties in terms of their consistency, it is necessary to take into account their mutual location in the structure of the tin thread, the method of spinning and the speed condition of technological machines. From the results of the study, it became known that during the issuance of tension, the process of straightening the fibers in the structure of the thread and combining them will be inconsistent, the property of which will depend on the degree of attachment of the thread to the loop. As a result, gradually the value of radial tension increases in the transverse cross section of the Calva thread, which leads to an increase in the product's bikrity indicator in the stretch. The screw is located on the lines, as the angle of bending increases, the ripeness indicator of the fibers also increases, and after a certain period of time this indicator acquires its maximum value, and then gradually begins to decrease. In this case, a kalava thread microstructure of different composition, associated with the presence of fibers with different mechanical characteristics, and a change in a large range of certain magnitudes characteristic for the deformation of this kalava thread (for example, breaking force) in the form of a complex of several elements, has a simple deformation law, but a real kalava thread with different constants allows [6,7].

2. Methods

In this research work, issues related to the occurrence of a zone of slip of fibers in relation to the calave thread or the absence of their mutual slip are investigated. Consider a two-additive calave thread, where the mechanical properties of the cross-section vary in thickness based on the uniformity law, assuming that the length of the calave thread on the winchymon line is the same in each layer. In the case when the cross-displacement of fibers passing through an arbitrary point of the cross-section of the calave thread, located on the screw line, is not irregular, its deformation is determined by the following formula [8, 9].

$$0<\theta<\theta_1, (0<r<r_1) \text{ when } \varepsilon_f=\varepsilon_{1f}=\varepsilon_{1y}[\cos^2\theta-\nu_1\sin^2\theta)] \quad (1)$$

$$\theta_1<\theta<\theta_2\ (r_1<r<R) \text{ when } \varepsilon_f=\varepsilon_{2f}=\varepsilon_{2y}[\cos^2\theta-\nu_2\sin^2\theta)] \quad (2)$$

where ε_{1y} and ε_{2y} is the deformation of the thread in each layer, ν_1 and ν_2 is the Puasson coefficient for each thread.

$$\cos\theta=h/\sqrt{h^2+4\pi^2r^2},\ \theta_1=\arccos[h/\sqrt{h^2+4\pi^2r_1^2}],\ \theta_2=\arccos[h/\sqrt{h^2+4\pi^2R^2}]$$

where: h - calave thread length, r - respectively, from the center of the calave thread to the fiber in question, r_1 and R - internal and calave thread radii. If the fiber is located on the surface of the kalava thread, y then it can be assumed $\theta=\alpha$ that (here is the angle at α which the kalava thread is threaded). Let's say X_i the fiber is affected by tension and G_i pressure (compressive stresses) in the arrow yshnalish. The linear deformation of the fiber under the influence of these forces is based on the Guk law following [8, 40-42 b.] defined by the formula

$$\varepsilon_{if}=\frac{X_i}{E_{if}}-\frac{2\nu_{if}}{E_{if}}(-G_i) \quad (i=1,2) \quad (3)$$

E_{if} and ν_{if} is the Yung modulus and Puassona quotient on each inner ($i=1$) and ($i=2$) outer layers of the fiber. Comparing the formulas (1), (2) and (3), we determine the relationship between Voltage $X_i=x_iE_{if}\varepsilon_{iy}$ and $G_i=g_iE_{if}\varepsilon_{iy}$ pressure

$$G_1=g_1E_{1f}\varepsilon_{1y} \quad (4)$$

$$G_2=g_2E_{2f}\varepsilon_{2y}=g_2kE_{1f}\varepsilon_{1y},\ k=E_{2f}\varepsilon_{2y}/E_{1f}\varepsilon_{1f}$$

$$0<\theta<\theta_1,\ (0<r<r_1) \text{ when } x_1=\cos^2\theta-\nu_1\sin^2\theta-2\nu_1g_1 \quad (5)$$

$$\theta_1<\theta<\theta_2\ (r_1<r<R) \text{ when } x_2=\cos^2\theta-\nu_2\sin^2\theta-2\nu_2g_2 \quad (6)$$

Verda function [8, 40-42 B.]- the science of ishga corresponds to the formula of smell:

$$g_i=\frac{1+\nu_{iy}}{1+2\nu_{if}}\cdot\frac{c^2}{u^2}\left(1-u^{1+2\nu_{if}}\right)-\nu_{iy}\frac{1-u^{2\nu_{if1}-1}}{2\nu_{if}-1} \quad (7)$$

Where $u = \cos\theta$, $c = \cos\beta$, ν_{1y} and ν_{2y} are the Puasson coefficients for a kalava thread.

To represent the compressive stress (pressure) in the received signs [9]- we use the following formulas presented in the scientific work:

$$0<\theta<\theta_1,\ (0<r<r_1) \text{ when } \frac{G_1}{E_{1f}\varepsilon_{1y}} = g_1 = (\cos^2\theta - \nu_{1y}\sin^2\theta)\frac{(r_1^2 - r^2)\cos^2\beta\sin^2\beta}{2(r^2\sin^2\beta + R^2\cos^2\beta)}$$

$$+k(\cos^2\theta_1 - \nu_{2y}\sin^2\theta_1)\frac{(R^2 - r_1^2)\cos^2\beta\sin^2\beta}{2(r^2\sin^2\beta + R^2\cos^2\beta)} \tag{8}$$

$$\theta_1<\theta<\beta\ (r_1<r<R) \text{ when, } \frac{G_2}{E_{1f}\varepsilon_{1y}} = g_2 = k(\cos^2\theta - \nu_{2y}\sin^2\theta)\frac{(R^2 - r^2)\cos^2\beta\sin^2\beta}{2(r^2\sin^2\beta + R^2\cos^2\beta)} \tag{9}$$

Calculations are performed according to the (8) - formula.

3. Results

The distribution curves for the fiber compressing $g = G/E_{1f}\varepsilon_{1y}$ [$G = G_1\ (0<\bar{r}<\bar{r}_1)$, $G = G_2\ (\bar{r}_1<\bar{r}<1)$] force on the Yung modulus E_{1f} (inner layer) and E_{2f} (outer layer), the two - layer calava thread thickness, which are different and have value $k = E_{2f}\varepsilon_{2y}/E_{1f}\varepsilon_{1y}$ and $\bar{r}_1 = r_1/R_1$ angle of attachment, are shown in Figure 1.

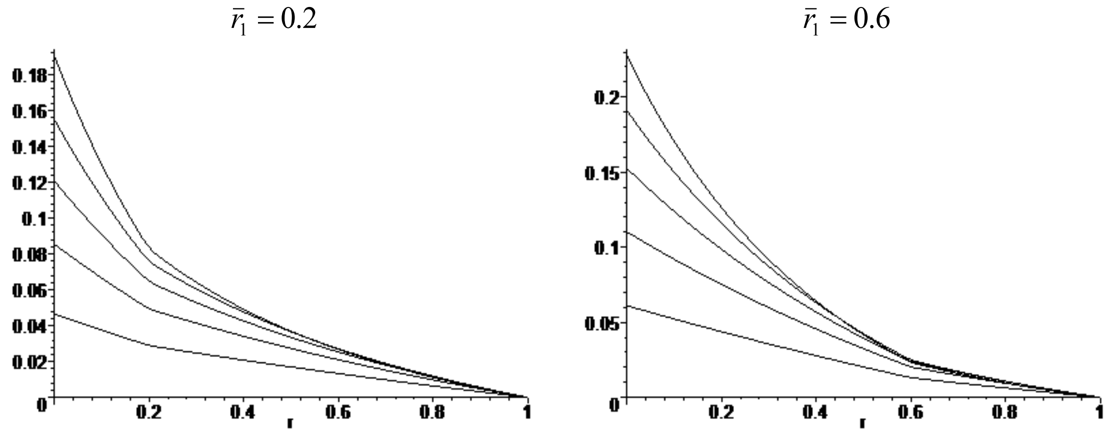

Fig. 1. $k = E_{2f}\varepsilon_{2y}/E_{1f}\varepsilon_{1f} = 0.5$ when, $\bar{r}_1 = r_1/R$ different ratios of values and β at the following different values of the angles of hearing: $1-\beta=10^0$, $2-\beta=20^0$, $3-\beta=30^0$, $4-\beta=40^0$, $5-\beta=50^0$ $\bar{r}_1 = 0.2$ ($E_{1f}\varepsilon_{1y}$ is related to) fiber compactor $g = G/E_{1f}\varepsilon_{1y}$ voltage $\bar{r} = r/R$ radius distribution curve

It appears that the fiber compressing forces (pressure) will have a maximum value at the center of the coil thread, increasing significantly as the angle value increases, which, in turn, leads to an uneven distribution of pressure along the coil thread radius. when, as the inner layer thickness increases, the maximum value of pressure increases, while when, on the contrary, the pressure decreases in the center of the Calva thread [10-23].

Thus, Figure 2 shows that the degree of compressibility of the fibers in a tin thread with different mechanical descriptions, formed from two different mixed fibers $k = E_{2f}\varepsilon_{2y}/E_{1f}\varepsilon_{1y}, k<1$ will significantly depend on the ratio. in the case of, the fiber maturation decreases in the outer layer, the pressure between the fibers increases as the thickness indicator of the inner layer increases. With a decrease in fiber maturation ($k>1$) in the inner layer, there is a decrease in pressure in the layers of the Calva thread, which causes an uneven distribution of tension along the Calva thread neck.

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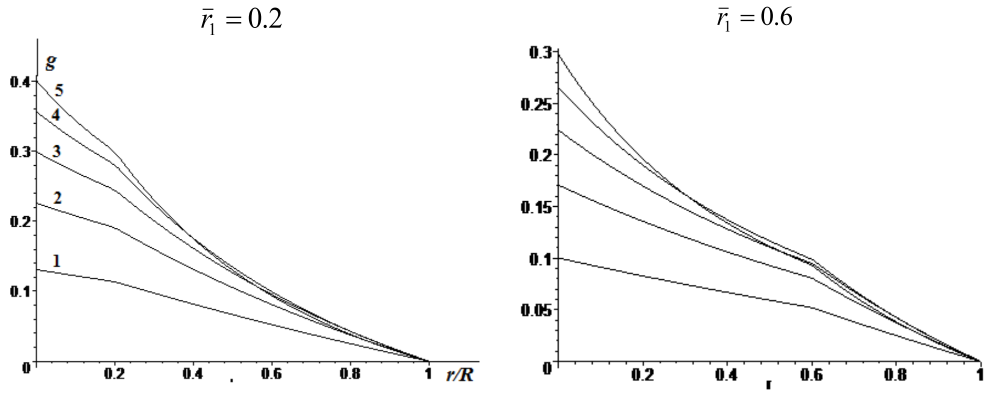

Fig. 2. $k = E_{2f}\varepsilon_{2y} / E_{1f}\varepsilon_{1f} = 2$ which consists of, $\bar{r}_1 = r_1 / R$ different ratios of values and β different values of the rowing angles: $1-\beta = 10^0$, $2-\beta = 20^0$, $3-\beta = 30^0$, $4-\beta = 40^0$, $5-\beta = 50^0$ for ($E_{1f}\varepsilon_{1y}$ is related to) fiber compactor $g = G / E_{1f}\varepsilon_{1y}$ voltage $\bar{r} = r / R$ radius distribution curve

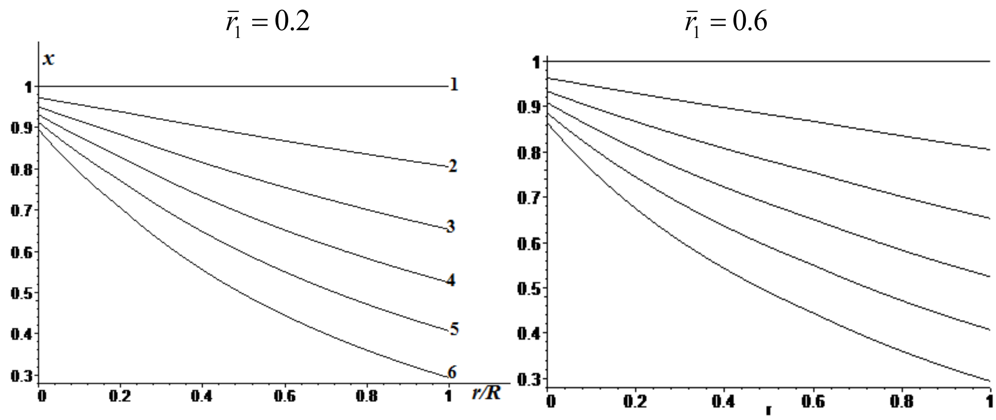

Fig. 3. $\bar{r}_1 = r_1 / R$ ratio and β different values of the angle of attachment: $1-\beta = 0^0$, $2-\beta = 10^0$, $3-\beta = 20^0$, $4-\beta = 30^0$, $5-\beta = 40^0$, $6-\beta = 50^0$ for $k = E_{2f}\varepsilon_{2y} / E_{1f}\varepsilon_{1f} = 0.5$ in the case that consists of, ($E_{1f}\varepsilon_{1y}$) $x = X / E_{1f}\varepsilon_{1y}$ fiber, which are related to $\bar{r} = r / R$ the distribution curve of the stretching voltage over the radius

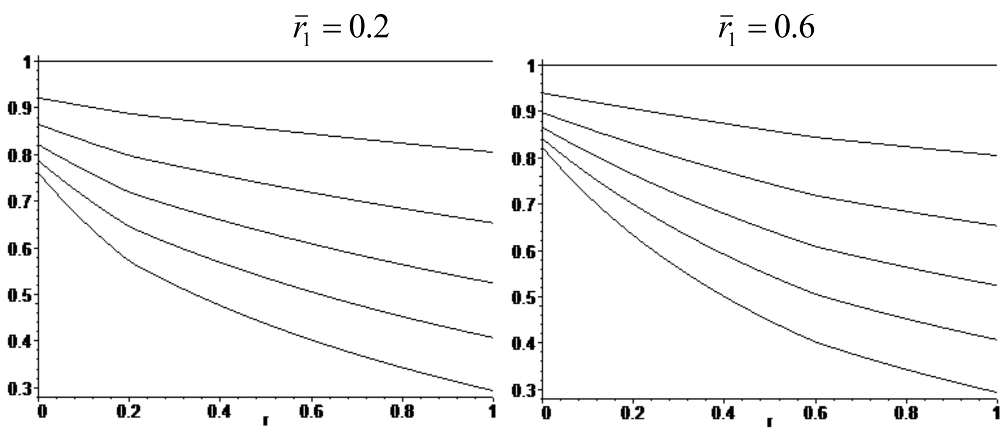

Fig. 4. $k = E_{2f}\varepsilon_{2y} / E_{1f}\varepsilon_{1f} = 2$ in the case that consists of $\bar{r}_1 = r_1 / R$ ratio and hearing β different values of the angle: $1-\beta = 0^0$, $2-\beta = 10^0$, $3-\beta = 20^0$, $4-\beta = 30^0$, $5-\beta = 40^0$, $6-\beta = 50^0$ for ($E_{1f}\varepsilon_{1y}$) $x = X / E_{1f}\varepsilon_{1y}$ fiber, which are related to $\bar{r} = r / R$ the distribution curve of the stretching voltage over the radius

β different values of the angle and $k = E_{2f}\varepsilon_{2y} / E_{1f}\varepsilon_{1f}$ $\bar{r}_1 = r_1 / R$ kalava thread in proportions $\bar{r} = r / R$ the stretching force by Radius is $x = X / E_{1f}\varepsilon_{1y}$ [$X = X_2$ $(\bar{r}_1 < \bar{r} < 1)$]distribution curves along the axis are described (Figure 2).

The analysis of the curves showed that in this case, the fibers located in the center of the Calva thread will have a high stretchability and β when the angle value is high, the elongation factor is significantly reduced as the stretching force approaches its surface (Figures 3 and 4).

3.1 Determination of fiber stretching and gluing zones when rowing two-layer kava strands

We determine the stretching force and friction value of one fiber according to the following formula [8, 9].

$0 < r < r_1$ when, the stretching force consists of:

$$F_{чўзиш} = F_1 = \pi r_0^2 E_{1f}\varepsilon_y x_1,\ F_{тр} = F_{1тр} = 2\pi r_0 l_f \mu E_{1f}\varepsilon_y g_1;$$

$$r_1 < r < R \text{ when,}\quad F_{чўзиш} = F_2 = \pi r_0^2 E_2 \varepsilon_y x_2,\ F_{тр} = F_{2тр} = 2\pi r_0 l_f \mu E_{2f}\varepsilon_y g_2$$

Here μ - coefficient of friction between fibers, $l_f = h / \cos\theta$ - fiber length, $L_b = 2\pi r_0$, r_0 - the quoted radius of the fiber. In the case where there is a sliding zone where the stretching force is equal to the frictional force of the fish, the fibers are straightened, and this condition is written in the following form for the fiber located at a distance from the center of the yarn:

Here μ - the coefficient of friction between the fibers, $l_f = h / \cos\theta$ - the length of the fiber, $L_b = 2\pi r_0$, r_0 - the quoted radius of the fiber. In the case where there is a slip zone where the stretching force is equal to the friction $F_{иш}$ force, the fibers are straightened, and this condition is written as follows for the fiber located at r_p distance from the center of the coil thread:

$$r = r_p \text{ when, } F_{тор} \geq \quad F_{иш} \tag{10}$$

We include the following function:

$$0 < r < r_1 \text{ when, } y = y_1 = x_1(r, \theta(r,\beta)) - ag_i(r, \theta(r,\beta)) / \cos(r,\beta)$$

$$r_1 < r < R \text{ when, } y = y_2 = x_1(r, \theta(r,\beta)) - ag_2(r, \theta(r,\beta)) / \cos(r,\beta)$$

Here: $\theta(r,\beta) = \arccos[\frac{1}{\sqrt{1+\bar{r}^2 tg^2\beta}}]$, $\bar{r} = r / R$

(10) it follows from the condition that the value of the indicators for the range occurs $y_i \geq 0$, respectively, in the inner $y_1 \geq 0$ and ($y_2 \geq 0$) outer layers, a single fiber slip occurs. $y_i \leq 0$ at these values satisfying the condition, the slip will not be inconsistent. When recording the values of the angle of β attachment and dimensionless parameters a, the boundaries of these zones are determined $r = r_{ip}$ by the following equation:

$$y(r_p, \beta_0, a_0) = 0$$

in this $0 \leq r_p \leq R$ it is necessary to choose the root that satisfies the condition.

To calculate $5^0 \leq \beta \leq 60^0$ that is, we accept. The calculations showed that if, respectively $a < 4$ and $a < 3$ if accepted, y without $k = 0.5$, and $k = 2$ for r_1 / R depending on the ratio, $\beta \leq 60^0$ for all values of the angle $y_i(r, \beta, a) \geq 0$ the condition is met.

In this case, all the fibers in the layer of the kalava thread will be in a sliding state. $a \geq 4$ and $a > 3$ at the time of its existence, a hard twisting (contact) zone of fibers appears in the Matrix, β with an increase in the angle of attachment, its length also increases. a calculations for the indicator $\varepsilon_{1y} = \varepsilon_{2y}$ in the case of, dimensionless this $\bar{r} = r / R$, a, $\bar{r}_p = r_p / R$ carried out with the inclusion of sizes.

The data presented in the table may lead to such consequences as $a = \mu h / r_0 \le 1$ when, μ - at small values of the coefficient of friction or the winding step path or an increase in the radius of the fibers, all fibers of the double-layer Calva thread are in a state of slip, with an increase in this indicator, starting at the center of the Calva thread, it is observed that the fibers are in tight contact with each other.

The length of this zone is equal to that of the inner layer r_1 length (R belongs to), eavesdropping angle β and kalava will depend on the ratio of the wool modulus of the fibers located in different layers of the thread. In this case, in the case in question, the angle of the earring is $\beta \le 5^0$ at the value of the fiber in the kalava thread layer is not in the contact of mutual stiffness.

$k = 0.5$

$\bar{r}_1 = 0.2$	Slippery zone $\bar{r}_p < \bar{r} < 1$					
a/β	1	3	5	7	9	11
5	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$
7	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$
10	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$
15	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$
20	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$
25	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.08<\bar{r}<1$
30	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.06<\bar{r}<1$	$0.22<\bar{r}<1$
40	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.06<\bar{r}<1$	$0.30<\bar{r}<1$	$0.43<\bar{r}<1$
50	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.17<\bar{r}<1$	$0.47<\bar{r}<1$	$0.56<\bar{r}<1$
60	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.17<\bar{r}<1$	$0.48<\bar{r}<1$	$0.60<\bar{r}<1$	$0.66<\bar{r}<1$
$\bar{r}_1 = 0.6$	Slippery zone $\bar{r}_p < \bar{r} < 1$, zone length $\bar{l} = l/R = 1-\bar{r}_p$					
β/a	1	3	5	7	9	11
5	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$
	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$
7	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$
	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$
10	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$
	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$
15	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.06<\bar{r}<1$
	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=0.94$
20	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.05<\bar{r}<1$	$0.27<\bar{r}<1$
	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=0.95$	$\bar{l}=0.73$
25	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.004<\bar{r}<1$	$0.28<\bar{r}<1$	$0.36<\bar{r}<1$
	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=0.72$	$\bar{l}=0.64.$
30	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.26<\bar{r}<1$	$0.36<\bar{r}<1$	$0.43<\bar{r}<1$
	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=0.74$	$\bar{l}=0.64$	$\bar{l}=0.52$
40	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.07<\bar{r}<1$	$0.41<\bar{r}<1$	$0.48<\bar{r}<1$	$0.53<\bar{r}<1$
	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=0,59$	$\bar{l}=0.52$	$\bar{l}=0.47$
50	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.38<\bar{r}<1$	$0.50<\bar{r}<1$	$0.54<\bar{r}<1$	$0.56<\bar{r}<1$
	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=0.62$	$\bar{l}=0.50$	$\bar{l}=0.46$	$\bar{l}=0.44$
60	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.49<\bar{r}<1$	$0.56<\bar{r}<1$	$0.59<\bar{r}<1$	$0.66<\bar{r}<1$
	$\bar{l}=1$	$\bar{l}=1$	$\bar{l}=0.51$	$\bar{l}=0.44$	$\bar{l}=0.41$	$\bar{l}=0.34$

It can also be observed that with an increase in the stiffness of the fibers of the outer layer, the zone of being in solid contact expands significantly. Let's say, $k = 2, \bar{r}_1 = 0.6, \ a = 11$ when, $5^0 < \beta < 60^0$ for angle values, all fibers of a two-layer Calva thread are in a mutual hardness contact.

$k = 2$

$\bar{r}_1 = 0.2$	Slippery zone $\bar{r}_p < \bar{r} < 1$					
β / a	1	3	5	7	9	11
5	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$
7	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$
10	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$
15	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$
20	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$
25	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.08<\bar{r}<1$
30	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.06<\bar{r}<1$	$0.22<\bar{r}<1$
40	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.06<\bar{r}<1$	$0.30<\bar{r}<1$	$0.43<\bar{r}<1$
50	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.17<\bar{r}<1$	$0.47<\bar{r}<1$	$0.56<\bar{r}<1$
60	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.17<\bar{r}<1$	$0.48<\bar{r}<1$	$0.60<\bar{r}<1$	$0.66<\bar{r}<1$
$\bar{r}_1 = 0.6$	Slippery zone $\bar{r}_p < \bar{r} < 1$					
β / a	1	3	5	7	9	11
5	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$
7	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.21<\bar{r}<1$
10	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.31<\bar{r}<1$	$0.46<\bar{r}<1$
15	$0<\bar{r}<1$	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.40<\bar{r}<1$	$0.55<\bar{r}<1$	$0.63<\bar{r}<1$
20	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.35<\bar{r}<1$	$0.56<\bar{r}<1$	$0.66<\bar{r}<1$	$0.72<\bar{r}<1$
25	$0<\bar{r}<1$	$0<\bar{r}<1$	$0.51<\bar{r}<1$	$0.64<\bar{r}<1$	$0.72<\bar{r}<1$	$0.77<\bar{r}<1$
30	$0<\bar{r}<1$	$0.26<\bar{r}<1$	$0.60<\bar{r}<1$	$0.70<\bar{r}<1$	$0.77<\bar{r}<1$	$0.81<\bar{r}<1$
40	$0<\bar{r}<1$	$0.52<\bar{r}<1$	$0.77<\bar{r}<1$	$0.77<\bar{r}<1$	$0.83<\bar{r}<1$	$0.86<\bar{r}<1$
50	$0<\bar{r}<1$	$0.61<\bar{r}<1$	$0.77<\bar{r}<1$	$0.83<\bar{r}<1$	$0.86<\bar{r}<1$	$0.89<\bar{r}<1$
60	$0<\bar{r}<1$	$0.69<\bar{r}<1$	$0.82<\bar{r}<1$	$0.86<\bar{r}<1$	$0.90<\bar{r}<1$	$0.92<\bar{r}<1$

4. Conclusion

1. A method for calculating the stretching and compressive strength of some fiber system with a different structure in terms of layer thickness was presented. The laws of influence of various indicators that would be inappropriate in stretching to the description of the two-layer Kalava thread interaction have been established.
2. It turned out that in this case, the fiber-compressing voltage (pressure) in the center of the coil thread will have a maximum value, the angle of attachment will increase significantly with an increase, which will lead to an uneven distribution of the coil over the radius of the thread. The degree of fiber compression in a two-layer coil thread formed from two fiber systems with different mechanical characteristics $k = E_{2f}\varepsilon_{2y} / E_{1f}\varepsilon_{1y}$ will depend significantly on the ratio. $k < 1$ when, in the outer layer, the ripeness indicator of the fibers decreases, as the thickness of the inner layer increases, the pressure between the fibers increases.

A decrease in fiber maturation in the inner layer ($k > 1$) results in a decrease in pressure between the layers of the Calva thread, which in turn may be one of the reasons for the uneven distribution of tension along the length of the Calva thread.

3. $a = \mu h / r_0 \le 1$ the causative double layer was assessed as affecting the formation of the slip zone of the Kalava thread. $a \le 1$ when, all the fibers contained in the two-layer Calva thread are in a state of slippage, and with this indicator increase, starting from the center of the Calva thread, the presence of fibers in mutual solid contact begins,

the length of which is the radius of the inner layer r_1, eavesdropping angle β and will depend on the Yung modulus ratio of the two layers of Kalava yarn fibers. Eavesdropping angle $\beta \leq 5^0$ at the value of the fiber in the kalava strand layer is not observed to be in cross-solid contact.

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