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Parameters of Choice and Calculation of Materials By The Guiding Composite Roller Mechanisms of Tape Conveyors

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Abstract: *The mechanism that makes the supporting rotational motion in the conveyor belts is considered a roller mechanism. In the case of mechanisms with guide rollers, the part that performs a smooth rotational movement is a bearing, and instead of this part (bearing), it is said about using a part that acts as a rotating sliding base and choosing materials. This means that the place where the belt is mounted on the conveyor is constantly dusty and watery, which leads to stagnation of bearings due to increased humidity, which leads to machine downtime. To solve this important problem, it is recommended to use a plastic and composite flexible material that is resistant to bending, friction, heating, acting as a sliding support, instead of a rolling bearing on the mechanisms of the guide rollers, which act as the basic rotational movement of the conveyor belt. For this, design work is carried out by studying the physicomechanical properties of these materials, and according to the results of scientific research it is recommended as an important innovation in production.*

Keywords: mechanism, roller, elasticity, friction, sliding, base, bullet, technology, analysis, energy

1. INTRODUCTION

In the world for the improvement of mechanical engineering, in particular the creation of structures and the development of methods for their calculation of resource-saving mechanisms and machines, large-scale studies are being conducted. Particular attention is paid to the use of these mechanisms in technological machines. One of the fundamental foundations for the further development of mechanical engineering is the intensification of research on the general theory of mechanisms and machines. The developed mechanical systems must ensure exact laws and trajectories of the movements of the working and executive bodies of technological machines (both in the plane and in space) due to the controllability of geometric, kinematic, dynamic parameters and system connections, which allows to expand their functional capabilities.

Since our republic gained independence, special attention has been removed on the development of mechanical engineering, the creation of resource-saving, highly efficient mechanisms of technological machines, in particular for the light and textile industries.

In particular, for example, take one of the largest enterprises in our country, the Navoi Mining and Metallurgical Combine. Here, transport nodes are considered a means of moving ores from one place to another. Rolling bearings perform uniform rotational motion in the rollers. Now, due to external factors, namely dust, water and moisture, the life of the rolling bearings is reduced. As a result, there is a stop of transport nodes due to jamming of the sliding bearings and damage to the belt due to high friction. This, of course, affects the rate of production.

Today, the main problem is the achievement of economic efficiency by replacing metals with high-strength composite plastic materials. In particular, in roller mechanisms of transport units, instead of rolling bearings, we can use plastic materials (graphitocaprolon) that are resistant to corrosion, friction and heating, which will act as a sliding support. First of all, we must know information about the structure of the internal structure of graphitocaprolone. Graphitocaprolone includes a mixture of filled (black) graphite. For this reason, the coefficient of friction of graphitocapralone is 2-3 times lower than polyamide 6 and the resistance to heating is higher relative to other capralons. The physicomechanical properties of graphitocapralone filled with graphite remain the same, with the exception of changes in dielectric properties.

2 METHODS AND RESULTS

When considering the physical properties of the material, the physical aspect of the interaction is studied during the relative motion of adjacent surfaces. When considering the mechanical properties of a material, the mechanics of interaction during friction of adjacent surfaces are studied. At the same time, such concepts as energy and momentum propagation, mechanical similarity during friction, relaxation vibrations, reverse friction, hydrodynamic equations, and other friction are connected and studied. The quality of the surface affects the fatigue wear of the part, resistance to corrosion and erosion, the strength of the tight joint and the reliability of the movable or stationary seal. Changes on the surface of the part can conditionally be divided into three classes:

– Change related to surface geometry
– Changes the surface layer of the material of the part.
– Changes associated with the appearance on the surface of the part of the film consisting of extraneous elements.

Even if the details in the drawings are shown in strict form with smooth lines, in fact their real shape is different from ideal. According to the scale and appearance of geometric irregularities of the part, three types of unevenness can be distinguished:

– macro geometrical (uniform);
– wave;
– microgeometric (rough);

To begin with, we study the physicomechanical properties of graphitocapralon. Firstly, to study the physicomechanical characteristics, we compare several grades of graphite capralon from which we learn such material parameters as density (kg / m³), working temperature (°C), melting point (°C), water absorption in (24 hours, %), The coefficient of thermal conductivity at room temperature (W / m, deg).

Table-1.
Physico-chemical properties of graphitocapralone

Name of indicator	**Graphitocaprolon (Gubakha) graphite-filled rods ny**	**Graphitocaprolon (China) rods extrusion of graphite filled ny**	**Graphite caprolon rods graphite filled ny**	**Graphitocaprolone (Anion) graphite plate filled ny**
Physical				
Density, kg / m³	1170	1140	1150	1170
Working temperature	from -40 to +100	from -40 to +95	from -40 to +95	from -40 to +100
Melting point, ° C	+220	+220	+220	+220
Water absorption in 24 hours,%	7–10	9	7	7 - 10
Density, kg / m³	1170	1140	1150	1170
Mechanical				
Tensile stress, MPa	75	75	75	75
Elongation at break,%	5	6	6	5
Steel friction coefficient	0.22	0.45	0.45	0.22
Hardness, MPa according to Brinell (when pressing a ball along Shore)	79–80	85	88	80

Above, we observe that graphitocaprolone is a solid and at the same time brittle material. That is, with external impacts, cracks can occur in graphitocapralone. To prevent this problem, we must cover the top layer of the material with a sleeve of composite elastic elements. As a result, we will relatively prevent damage to the material from external loads and impacts.

To do this, we must study the technological characteristics and brands of rubber from composite elastic elements. That is, we will choose such rubber brands as 3826MVS, 1338, 1847, 3825 MBCS, 7B–54MBC, 7IRP 13-46, 7IRP 13–48 and experimentally check for relative elongation. at break, Shore hardness, strength (kg / sm^2), stiffness coefficient (N / m)

Table-2.
Technological characteristics of the rubber brand

№	Rubber mark	Relative ext. at break	Shore Hardness	Strength (kg / sm^2)	Stiffness coefficient (N / m)
1.	3826MVS	25–300	60–75	80,0	$0{,}25\cdot10^4$
2.	1338	360	70–75	85,0	$0{,}28\cdot10^4$
3.	1847	550	80–85	75–80	$0{,}45\cdot10^4$

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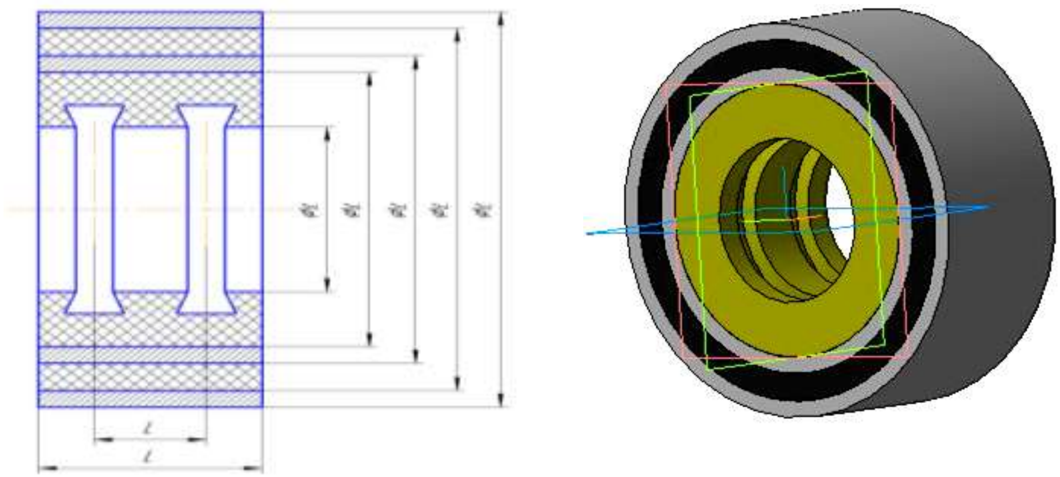
4.	3825 MBCS	120	85–90	80–90	$0{,}33{\cdot}10^4$
5.	7B-54MBC	130	75–80	90,0	$0{,}42{\cdot}10^4$
6.	7IRP 13–46	300–350	70–75	75–80	$0{,}25{\cdot}10^4$
7.	7IRP 13–48	150–200	90–95	90–95	$0{,}51{\cdot}10^4$

In the above table, according to technological characteristics, such as relative elongation. At break, Shore hardness, strength (kg / sm^2), stiffness coefficient (N / m) rubber grade 7IRP13-48 is suitable for our requirements. To manufacture this sleeve, we must draw a design drawing of this part [1].



Picture-1. Sliding Support (Roller mechanism)

The figure above shows that on the inner surface of our part two tracks in the form of a trapezoid are made for the part to work normally under sliding conditions. A viscous liquid in a certain amount is applied to these trapezoidal tracks. The thickness of the oil layer –*h* should be greater than the sum of the surface irregularities formed during processing, that is, the following conditions must be satisfied $h > R_z^1 + R_z$.

When the above conditions are met, the oil layer assumes external loads, as a result of which there is no surface contact and friction. And the coefficient of friction will be equal to $f = 0.001 - 0.005$. If the above conditions are not met, the coefficient of friction during dry friction will be equal to $f = 0.1 – 0.2$. Hence, due to dry friction, the wear-resistant durability of the sliding support (graphitocapralon) decreases. As soon as rotational motion occurs in the mechanisms of machines, friction also appears. As a result of this, in the bearings, gears and piston systems during friction, wear of the contacting surface occurs and power is lost. Therefore, in this case, friction is considered harmful. In brakes and clutches, friction is considered useful and therefore try to increase friction without going beyond the maximum allowable wear.

For mutual rotational motion in friction pairs, selecting the type of oil and adjusting the structure of the friction unit to the conditions contributes to the efficient operation of mechanisms and to increase the reliability and endurance of friction units. Elastic deformation occurs in the roller support due to the pulsed movement of the composite sliding support on a light plastic grate.

In the well-known methodology for calculating the moment of friction in a fifth-class rotational kinematic pair, two hypotheses are used [2, 3]. We use the first hypothesis according to the calculation scheme presented in Figure-2, taking into account the equilibrium conditions for the pressure force P_k and the projection of the friction force in the elementary contact zone on the axis of the op-amp.

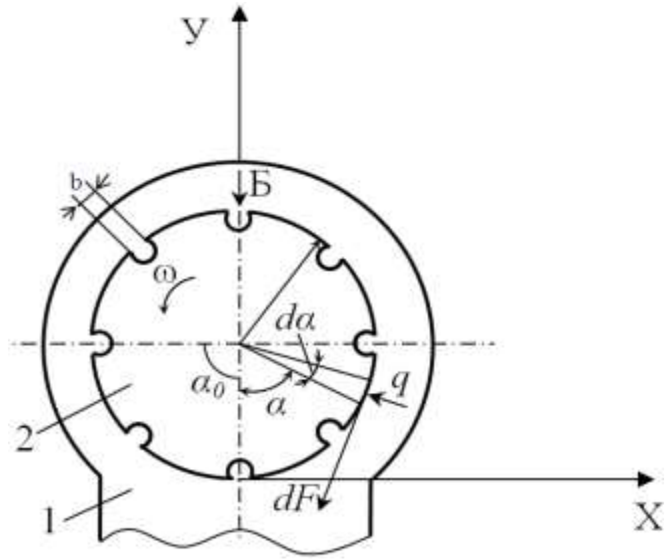
$$P = 2ql\left[r\sin\left(\frac{\pi}{2} - \frac{i}{2}\arcsin\frac{b}{r} \right) - \frac{ib}{2} \right] \tag{1}$$

Where, *q*-is the pressure force, *l*-is the length of the kinematic pair, *r*-is the radius of the cylinder, *i* - is the number of grooves, *b* - is the width of the groove.

It should be noted that the pressure force *P* from the force of the body weight, the journal on the axis (cylinder) mainly act in the girth zone π.

Taking into account the reaction force of the axle on the axis (cylinder), the moment from the friction force is calculated from the following expression

$$M_{mp} = fPr\frac{\frac{\pi}{2} - \frac{i}{2}\sin\frac{b}{r}}{\sin\left(\frac{\pi}{2} - \frac{i}{2}\sin\frac{b}{r}\right)} \quad (2)$$



1-axis (cylinder), 2-axle (housing)

Figure - 2. Design scheme for determining the moment of friction

Moreover $\sin\frac{b}{r} \approx \frac{b}{r}$, taking, and taking into account (1) and the coefficient "*a*" taking into account the degree of lubrication, we obtain

$$M_{mp} = 2fqalr\left[r\sin\left(\frac{\pi}{2} - \frac{ib}{2r}\right) - \frac{ib}{2}\right] \cdot \frac{\frac{\pi}{2} - \frac{ib}{2r}}{\sin\left(\frac{\pi}{2} - \frac{ib}{2r}\right)} \quad (3)$$

Where, *f* - is the coefficient of friction of steel over steel.

For a certain value of the force *P* - from the expression (1), we can calculate the value of *q*.

An analysis of formula (2) shows that in the absence of longitudinal grooves on the axis (cylinder), $b = 0$, then we have

$$M_{mp}^{/} = fPra\frac{\frac{\pi}{2}}{\sin\frac{\pi}{2}} \quad (4)$$

If the contact angle of the journal with the cylinder occurs at an angle α_0, then we have

$$M_{mp}^{//} = fPra\frac{\alpha_0}{\sin\alpha_0} \quad (5)$$

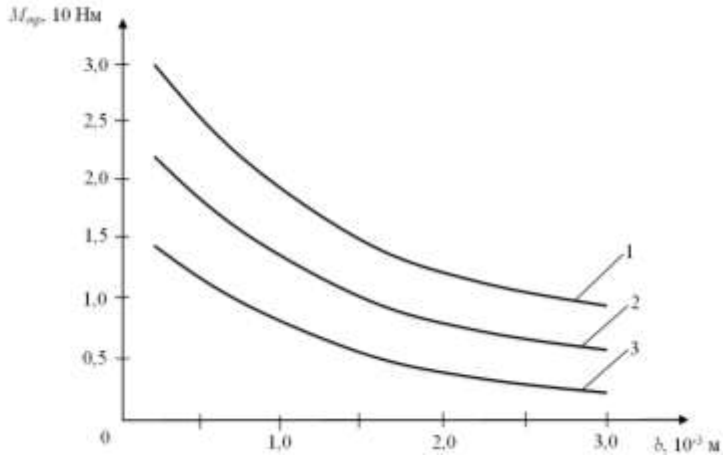
The resulting expression (4) corresponds to the well-known formula given in [4] according to the first hypothesis. It should be noted that expression (4) is a special case of formula (3) [4].

The initial data of the parameters of the fifth-class rotational kinematic pair are selected for the mechanisms and machines of the textile, light, cotton ginning industry and agricultural machines:

$P = (2.0 \div 6.0) \cdot 10^2$ N; $l = (1.0 \div 8.0) \cdot 10^{-2}$ m; $r = (1.0 \div 4.0) \cdot 10^{-2}$ m; $f = 0.05 \div 0.1$; $i = 8.0 \div 16.0$; $a = 0.4 \div 0.7$; $b = (0.5 \div 3.0) \cdot 10^{-3}$ m.

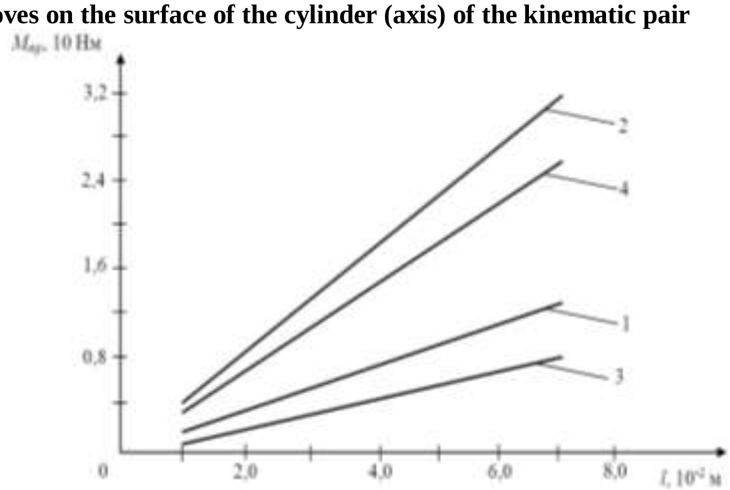
The recommended design of the rotational kinematic pair significantly reduces the moment from the friction forces, thereby increasing the life of the mechanism and the machine. At the same time, the design parameters and the external load influence the decrease in the moment from friction forces. Figure-3 shows the graphical dependence of the change in moment on friction forces on the variation of the width of the longitudinal grooves on the surface of the cylinder (axis) of the kinematic pair. It can be seen from them that an increase in the width of the grooves leads to a decrease in the MTR in a nonlinear regularity. This is because with increasing values of "b", the contact area of the surfaces of the kinematic pair also decreases. Moreover, an increase in the number of grooves significantly reduces the friction moment. So, when the width of the grooves increases from $0.5 \cdot 10^{-3}$ *m* to $3.0 \cdot 10^{-3}$ *m* at $i = 8.0$, the friction moment decreases from *30 Nm* to *9.9* Nm, and at $i = 16.0$ the value Mtr decreases from 14.5 Nm to 2.9 Nm. It is recommended to take $i = 10.0 \div 12.0$ and $b = (0.8 \div 2.0) \cdot 10^{-3}$ *m* for the considered machines and mechanisms of the mining and smelting plant to increase the resource of kinematic pairs up to 20%.

It is important to study the influence of the width and radius of the axis of the kinematic pair on the nature of the change in the moment of friction (see Figure-4). An increase in *r* and *l* proportionally increases the value of M_{tr} according to a linear regularity. Therefore, to reduce friction in the kinematic pair, it is advisable to reduce *r* and *l* to possible values [5].



1-at $i = 8.0$; 2-at $i = 12.0$; 3-at $i = 16.0$

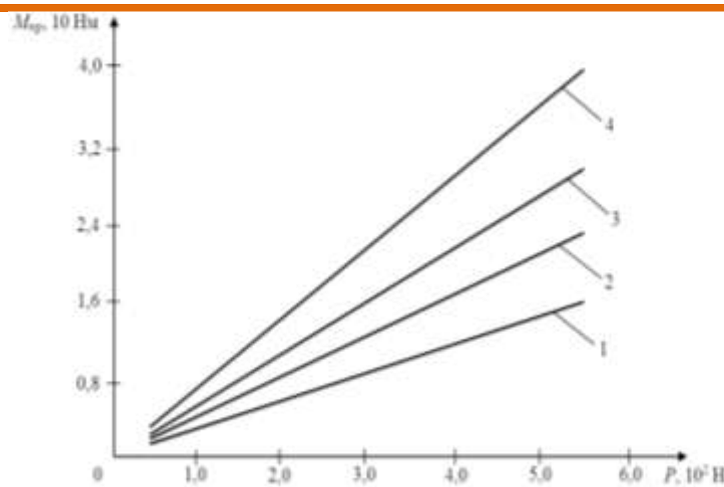
Figure -3. Graphic dependences of the change in the moment of friction force on the width of the longitudinal grooves on the surface of the cylinder (axis) of the kinematic pair



1, 3 for the proposed option; 2, 4-for the existing option
1, 2 - at $r = 4.0 \cdot 10^{-2}$ *m*; 2-at 1, 2-at $r = 3.0 \cdot 10^{-2}$ *m*

Figure -4. Comparative dependences of a change in moment on friction forces on a change in the length of rotational kinematic pairs

It should be noted that the load *P* in the main acts on the lower half of the surface of the cylinder, especially when *P* is formed from the weight of the trunnion. The greater the load *P*, the greater the value of M T_r. In this case, the grooves on the surface of the cylinder, not only reduces the contact area of the surfaces of the journal and cylinder, but also is a source of preservation and use of lubricant. The degree of lubrication is taken into account by the coefficient *"a"*. Figure-4 shows the graphical dependence of the change in the moment of friction on the change in the load *P* for varying degrees of lubrication of the rubbing surfaces. S_o, when the external load changes $(1.0 \div 8.0) \cdot 10^2$ *N*, the moment from the friction forces at $a = 0.70$ increases to *40.5 Nm* according to a linear law, and when the coefficient $a = 0.40$, M_{tr} increases only up to 15.4 Nm. Therefore, the recommended lubrication values are $a \leq (0.4 \div 0.5)$ [6].



1 at *a = 0.4*; 2-at *a = 0.5*; 3-at *a = 0.6*; 4-at *a = 0.7*

Fig. 5. Graphic dependences of the change in moment on the friction force in a kinematic pair with grooves in the cylinder (axis) on the increase in the load from the journal

Findings. Our material, which serves as a rotating sliding support, applied to the roller mechanism on the conveyor assembly, on the basis of the above scientific studies and a new design, give positive results. This, in turn, leads to an increase in the period of operation of mechanisms and the achievement of economic efficiency.

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