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THE RESEARCH OF THE INFLUENCE OF THE COMPOSITION OF COMPONENTS ON THE MECHANICAL PROPERTIES OF STRUCTURAL POLYMER WEAR-RESISTANT MATERIALS FROM THERMOSETS

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Abstract: *This article presents the research results of effect of the composite material composition based on a thermos reactive binder using the Angren kaolin filler brand AKT-10. The composition possibilities optimizing and the composite material properties are considered for using in the lever brake system of railway transport using as modifying additives – soot containing waste from the Uz-Kor Gas Chemical production enterprise. The mechanical properties of composite materials were researched in order to use them for the manufacture of the "bushing" part used in the suspension of brake lever transmission of the railcar side frame.*
Keywords: *Epoxy resin, hardener, fiberglass, kaolin, soot waste.*

INTRODUCTION. The main directions of economic and social development of the railways of Uzbekistan provide for the widespread introduction of composite materials in railcar building, which reduce the material intensity of structures, save energy, labor costs, improve the quality, reliability and durability of products. To solve these problems, research is needed to determine and predict the technical performance the durability of composite materials, taking into account the effects of the surrounding environment and contacting media, deformation and other factors, including the wear resistance of the composite material. In this regard, we selected for research a bushing part used for the lever brake system of railway transport, where it is inserted on the side frame for suspension of pads, passenger and freight railcars, including subway cars.

The bushings of the trolleys side frames brackets, in which the holes for the triangle suspension rollers are designed by more than 1 mm during depot repairs, and during major repairs, regardless of wear, are replaced. When installing new fiber bushings, select them according to three standard sizes (diameter 45. 46. 47 mm) with a gap of no more than 1 mm. Currently, phenoplasts are widely used in car building for the manufacture of such bushings - a variety of plastics based on phenol-formaldehyde resins [1]. These materials are particularly durable and highly resistant to various influences. But, during the production of phenoplast bushings, free phenol, formaldehyde and dust are released. Phenol is a harmful substance for a healthy person. Therefore, in the production of bushings, hung safety measures are required.

Another of the materials to achieve the effect of the technical essence is a bushing made of a composite material containing a fibrous filler in the form of a mixture of polyoxadiazole and cotton fibers, an anti-adhesive in the form of zinc stearate and or calcium stearate, a binder in the form of phenol-formaldehyde or cresol-formaldehyde resin. In addition, the material of the well–known bushing includes an adhesive - polyvinyl acetate or polyvinyl butyral and a powder filler silicon oxide [2].

This bushing is made of two layers and consists of an inner sliding working layer and an outer damping layer. And this complicates the manufacturing technology, during operation, the stratification of its parts is possible. Based on the literature review, we identified the need to develop compositions for composite materials used in railway transport. At the same time, the use of local raw materials and environmentally friendly technologies is not a little important.

MATERIAL AND METHODS. The research objective is to obtain high-quality bushings using local raw materials, increasing the service life, simplifying the manufacturing process and reducing harmful emissions into the environment during its manufacture. Technical result, which allows solving this problem, is increase of service life of bushing due to increase of its technical characteristics, which is achieved by qualitative and quantitative ratio of components included into bushing material. In this regard, we propose the use of epoxydiane resin ED-20 filled with both dispersed (AKT-10) and fibrous filler (glass fiber) as a polymer binder. Compositions also included plasticizer-dibutylphthalate (DBP) and polyethylene polyamine hardener (PEPA). The components used are shown in Table 1.

Table 1

Composite material components

№		Weight, gr	Weight part,%
1	Epoxy resin (ED-20)	50	60
2	PEP Hardener	5	6
3	Fiberglass	3	4
4	Angren Kaolin (ACT–10)	20	25
5	Waste soot	4	5

For making the bushing, we take epoxy resin (ED-20), add the PEP hardener and mix the mixture to a homogeneous state of the mixture, add the Angren kaolin (ACT–10) and soot waste at the same time and mix it to a homogeneous state. After that, we mix it with fiberglass until the fiber is completely wetted. Then the obtained composition was loaded into molds of the required sizes, ensuring the production of bushings. The bushing drawing is shown in Figure 1.

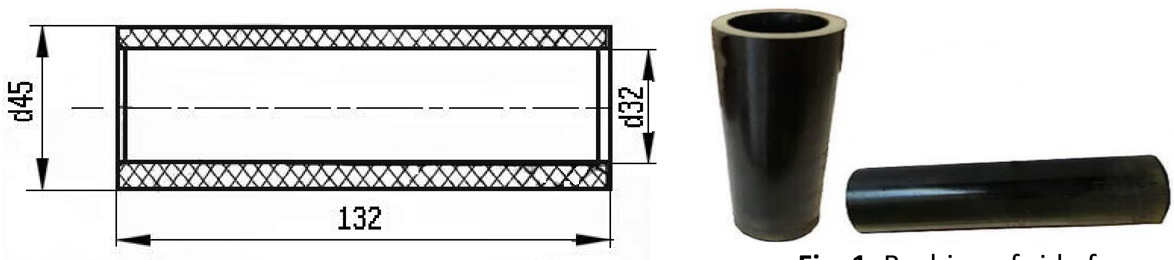

Fig. 1. Bushing of side frame bracket with dimensions.

To ensure the required operational properties of the bushings, tests were carried out for bending stress, destructive stress during compression and tension, impact strength, water absorption and softening temperature of materials. The bending stress σ_f, MPa, is calculated by the formula [3]

$$\sigma_f = \frac{3FL}{2b \cdot h^2}, \quad (1)$$

where, F is the applied load, N;

L - distance between supports, mm;

b - width of the sample, mm;

h is the thickness of the sample, mm.

The dependence of stresses and strains under tension are the most widely published mechanical properties for comparing materials. For resins with fiberglass filler, it is recommended to carry out tests of type "B", at a speed of 5 mm/min. [4]. The test is carried out on a machine that, when the sample is stretched, must provide load measurement with an error of no more than 1% of the measured value and a constant clip extension speed within the limits required by this standard. The strength values (σ) in MPa (N/mm^2) are calculated by the formulas:

tensile strength ($\sigma_{рм}$) $$\sigma_{рм} = \frac{F_{рм}}{A_0} \quad (2)$$

disruption strength ($\sigma_{рр}$) $$\sigma_{рр} = \frac{F_{рр}}{A_0} \quad (3)$$

tensile yield strength ($\sigma_{рт}$) $$\sigma_{рт} = -\frac{F_{рт}}{A_0} \quad (4)$$

conditional yield strength ($\sigma_{рту}$) $$\sigma_{рту} = \frac{F_{рту}}{A_0} \quad (5)$$

where, $F_{рм}$ is the maximum load during the tensile test, N;

$F_{рр}$ - the load at which the sample disrupted, N;

$F_{рт}$ - tensile load when the yield strength is reached, N;

$F_{рту}$ - tensile load when the conditional yield strength is reached, N;

A_0 is the initial cross-section of the sample, mm.?

The method of determining the impact strength by Sharpie for polymer composite materials is carried out on samples with and without incision. Its essence is the use of two supports when testing a polymer, and the pendulum has to strike exactly between them. During the inspection of the material for the tendency to brittle destruction, it is possible to identify the unsuitability of the material to work under certain conditions [5]. The Sharpie impact strength of the sample without incision a_n or a_{cU}, kJ/ m^2, is calculated by the formula

$$a = \frac{A_n}{b \cdot h} \cdot 10^3 \quad (6)$$

where, a_n or a_{cU}, kJ/m2;

A_n- the impact energy spent on the destruction of the sample without incision, J;

b – width of the sample, mm;

h is the thickness of the sample, mm.

The water absorption of samples by mass (W) as a percentage is calculated by the formula [6]:

$$W = \frac{m_1 - m_2}{m_1} \cdot 100\% \quad (7)$$

Where: m_1 is the mass of the sample saturated with water, g;

m_2 is the mass of the sample dried to a constant mass, g.

The softening temperature was determined by Vic [7]. The method was used in 50 load 50 N; the rate of temperature increase 50 ° C / h. A comparative analysis of the technical characteristics of the obtained material with the known material U-301-07 is given in Table 2.

Table.2

Technical characteristics of materials

No	Key indicators	U-301-07	New material
1	Colour	From light brown to dark brown	Black
2	Bending stress at maximum load, MPa, not less	70	40
3	Water absorption, %	7	1
4	Sharpie impact strength on samples without incision, J/m2, not less	6	0,06
5	Destructive tensile stress, MPa	28-30	6
6	Softening and working capacity temperature, °C	60	70

RESULTS AND DISCUSSION. The proposed set of essential features informs the obtained new properties that allow solving the task, namely, increasing the service life of the brushing of the lever brake system of railway transport, simplifying the manufacturing process and reducing harmful emissions into the environment during its manufacture. The implementation of the brushing of lever brake system of railway transport from a composite material containing fiberglass as fibrous filler allows increasing the wear resistance of the brushing, eliminating corrosion, which in turn increases the service life of the brushing.

The implementation of the brushing of lever brake system of railway transport from a composite material containing Angren (AKT–10) as an anti-adhesive, is an anti-adhesive additive, facilitates production processes, and prevents the material from sticking to the mold. The chemical composition of the kaolin brand ACT-10 of the production enterprise LLC "Angren-Kaolin" is given in Table 3.

Table.3

Chemical composition of kaolin brand AKT-10

Chemical composition, (%)												
GV	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	P_2O_5	BaO	MnO	SO_3
2,82	88,2	7,42	0,36	0,28	0,12	0,03	0,03	0,41	0,02	< 0,01	< 0,01	none

The implementation of the brushing of lever brake system of railway transport from a composite material containing epoxy resin (ED-20) with PEP as a binder makes it possible to simplify the process of manufacturing the brushing, in addition increases the strength and anti-friction properties, which further increases the service life of the brushing.

The implementation of the brushing of lever brake system of railway transport from a composite material containing soot waste as a solid lubricant, which is an antifriction additive, reduces the coefficient of friction and reduces the wear of the friction surfaces, which again increases the service life of the sleeve. Soot is a lubricant that works effectively in a humid media. It contains water molecules, which ensures easy relative sliding. In this regard, the properties of the material are weakened in vacuum. Thus, graphite has a low coefficient of friction in a humid media (0.04) and increased (0.3) in vacuum.

CONCLUSION. It is shown that the addition of 4% fibrous fiberglass filler is not significantly sufficient to achieve the bending strength of the present material. It is recommended to increase the concentration of fibrous filler in the next experiments. It was found that the water absorption of the obtained material is 7 times less than that of a material which is made from a cotton product based on phenol-formaldehyde resin. The softening temperature of the obtained new material is slightly higher than that of the present material due to the plasticization of the composition with a carbon-containing waste from oil refining containing carbon-containing oligomers with a molecular weight of 250-450.

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