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PERSPECTIVE MATERIALS FOR FRICTIONAL PAIRS OF ROLLING STOCK

Summary. The opportunity of application of composite (chaotically - spatial) materials in the pairs of friction of axle box frictional dampers of passenger car truck is considered. The number of materials of a various composition for frictional interaction, ensuring a stable work of integrations in the period of the set term of service life, is investigated. The investigations of wear of elements of mobile integrations are carried out and the principal parameter of longevity of integrations (a speed of wearing) is determined. The recommendations on preferable application of the considered materials are given.

ПЕРСПЕКТИВНЫЕ МАТЕРИАЛЫ ДЛЯ ФРИКЦИОННЫХ ПАР ПОДВИЖНОГО СОСТАВА

Аннотация. Рассмотрена возможность применения (хаотически - пространственных) композиционных материалов в парах трения буксовых фрикционных демпферов пассажирских тележек. Исследован ряд материалов различного состава для фрикционного взаимодействия, обеспечивающих стабильную работу сопряжений в период заданного срока эксплуатации. Проведены исследования износа элементов подвижных сопряжений и определен основной показатель долговечности сопряжений - скорость изнашивания. Даны рекомендации по предпочтительному применению рассмотренных материалов.

1. THE ANALYSIS OF SERVICE CONDITIONS OF PASSENGER CARRIAGE UNDERFRAME IN THE CONDITIONS OF INCREASE OF SPEEDS OF MOTION

The up-to-date tendency of development of railway transport is growth of motion speeds of vehicles which creates essentially new operating conditions of structural materials in the mobile integrations of rail underframes. These conditions are characterized by the border-allowable values of their power, speed and temperature modes of operations, which result in the premature loss of strength of structural materials, reduce their wear resistance and decrease the reliability of mobile integrations [1-2].

The objective of the given work is the choice of materials for frictional interaction, ensuring a stable work of integrations in the period of the set service life.

For the decision of this task let us consider the main frictional pair of the frictional oscillation damper, which is exploited in heavy conditions of operation.

The main frictional pair is formed by the shpinton sleeve and six frictional blocks, made from steel 45, with superficial hardness more than 45 HRC and the admitted wear of main frictional pair less than 6 mm.

The investigations of wearing away of these pairs of friction and reliability parameters considered in works [3-6] have shown, that the increased wear of details, shock loads, possible seizing and considerable instability of friction coefficient, that is the causes of decreasing of general reliability of unit, are usually characteristic for work of frictional oscillation damper. The major factors of instability of friction coefficient are violation of manufacturing technology of frictional elements, a deviation of the sizes of separate details and imperfection of structural execution with a big sensitivity to the change of friction coefficient.

The analysis of conditions of operation of passenger car underframe has shown [7] that the principal cause of worsening of operating parameters of train is the wear of the mobile integrations related to the change of geometry of the mated surfaces. It is established that the change of geometry of mobile integrations result in change of power characteristics of damping devices, to the increase of displacements and accelerations of body, to the raised wear of running parts and auto-coupling devices, and also to growth of the stressed state in the frame of carriage underframe.

The mathematical simulation of contact interaction of main frictional pair carried out by the finite elements method [8, 9], with the purpose of determination of contact and thermal stresses and distributing of thermal flows on the surfaces of the mated elements, has allowed to confirm the necessity of search of new ways of taking away dissipative energy. One of such ways can be replacement of material of one of elements of main frictional pair.

2. PERSPECTIVE MATERIALS FOR MANUFACTURING THE ELEMENTS OF MAIN FRICTIONAL PAIR

Taking into account positive experience of application of polymeric materials as the details of mobile connections of passenger carriages, the decision was accepted to use a new composite material – oxafen (THAT 2256-001-73107036-2005) for manufacturing the frictional blocks.

The oxafen is processing on special technology at the equipment used now at the plant for production of inserts from fabric cloth-based laminate (textolite) [10]. The basic technical characteristics of material are presented in the table 1.

Tab.1

Characteristics	Textolite	Oxafen
Density, g/cm^3	1,3-1,4	1,3-1,4
Bending strength	147	120-210
Impact strength on Sharpi, kJ/m^2	36	35-60
The HB Hardness	275-294	350
Maximal temperature of exploitation, °C	150	250
Coefficient of linear thermal expansion at 80 °C, °C^{-1}	4·10-5	2,67·10-5
Friction coefficient: without lubrication	0,32	0,23
at lubrication by water	0,1	0,04
Wear (without lubrication), mm/hr	0,18	0,1
Wear at lubrication by water, mm/hr	0,12	0,05

It is visible from the resulted data, that the new material on density and bending strength is practically similar to textolite, but exceeds it on impact strength, on technical properties and maximally allowable temperature of reliable operation.

3. RESULTS OF EXPERIMENT AND THEIR DISCUSSION

Basis for the calculations of reliability parameters of main frictional pair as a weak link of the frictional damper of vibrations is establishment of functions of reliability of its elements. In the given work they were determined by statistical processing of results of supervisions at the bench tests after the wear of the shpinton sleeve, made from steel 45 with superficial hardness 42-45 HRC and the admitted wear less than 4 mm on the main surface of friction of the typical and modernized designs [5]. Performance data of the stand: vertical loading on every block from oxafen - 280 N, working stroke of blocks on a sleeve - 90 mm, number of double strokes of crank mechanism in a minute - 54.

The tests were conducted during 400 hours with average speed 0.16 m/s. Comparison on wear resistance was carried out at measuring through the equal intervals of time (80 hours) by middle linear size on the center. The investigations were conducted on a party for one car underframe – 8 shpinton sleeves and 48 frictional blocks.

The obtained dependences of wear on time of tests of the typical model and modernized design with block from oxafen are resulted in work [11].

The tests on a wear have shown that with the increase of number of cycles of work there are scorings on the surfaces of friction of blocks from composite materials. Such scorings can result in violation of stability of work of frictional pair and the frictional damper on the whole, but such phenomena are not observed on steel blocks for this period of time. At the same time on the steel shpinton sleeves at interaction with blocks from composite materials the reduction of their wear is noticed from 0,128 up to 0,096 mm for period of tests [11].

The parameter of longevity-speed of wearing- is used for an estimation of longevity of details in those cases, when by a basic factor causing the refusals, there is the process of wear. Speeds of wearing have been determined for the main frictional pair of "steel on steel" and for the pair of "oxafen on steel".

Speed of wearing of the typical sleeve with the typical block has made 0.32 $\mu m/hr$, and in a pair with a block from oxafen – 0.24 $\mu m/hr$.

Speed of wearing of the typical model of block makes 0.465 $\mu m/hr$, and from oxafen – 0.725 $\mu m/hr$, that specifies on reduction of wear resistance of the block from oxafen.

These results have allowed to draw the following conclusion - application of composite material of oxafen in the given design is possible at the change of its composition, in particular, of correlation of reinforcing components allowing to increase wear resistance of blocks.

Application of material with change of correlation of reinforcing elements has allowed to receive the increase of wear resistance more than in 2 – 2.5 times. Speed of wearing made no more than 0.29 $\mu m/hr$. The picture of wear of details of the frictional blocks is represented on a fig. 1, where the surfaces of wearing are indicated by pointers:

- on a fig 1a, - metallic block,
- on a fig. 1 *b* – block from oxafen.

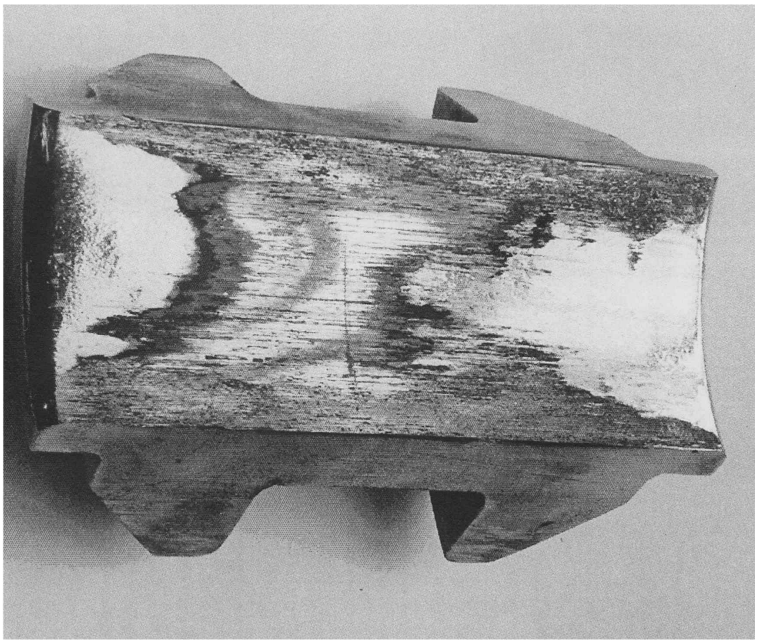
Measurements of coefficient of friction of rest were made on the special device, having a plane which is fluently inclined until a contraction of the block will not be noticed from a surface which it rests on. The coefficients of friction of rest on a steel surface for blocks from oxafen changes within the limits of 0.21…0.29, for steel – 0.23…0.36, that specifies on reduction of range of forces of friction and ensures possibility of more stable work of the blocks.

The received results allow to predict an opportunity of application of oxafen in the frictional mobile integrations of rail underframes.

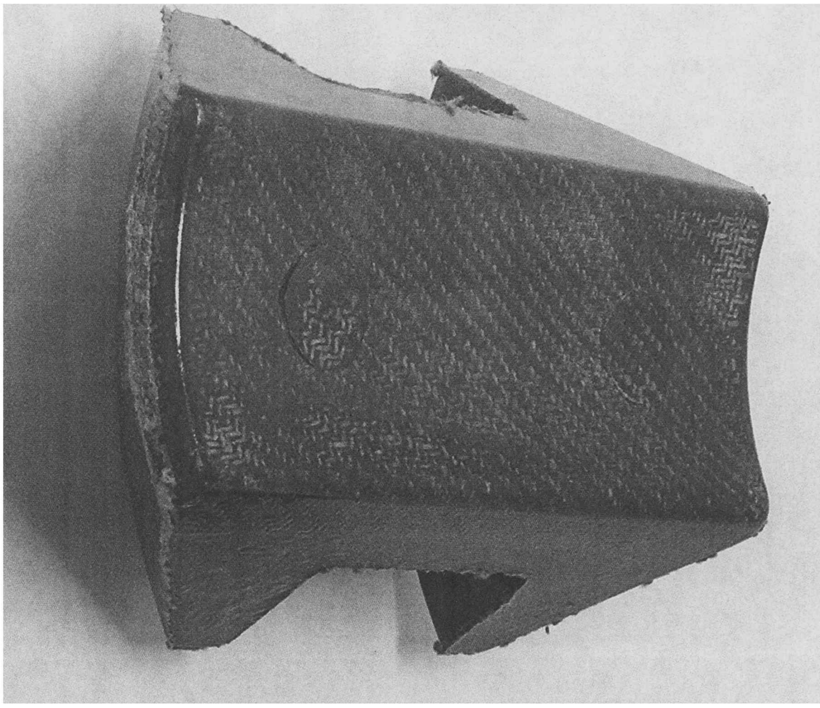
4. CONCLUSIONS

Application of material of oxafen with the changed correlation of reinforcing elements has allowed:

1. To decrease the wear of the shpinton sleeve for the account of polishing of the surface of sleeve by oxafen.
2. To increase wear resistance of the frictional blocks more than in 2.5 times.
3. To decrease the coefficient of friction of rest.
4. To exclude the phenomenon of corrosion of frictional blocks.



a



b

Fig.1. Picture of wear of details of frictional blocks
Рис. 1. Картина износа деталей фрикционных сухарей

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Received 2.03.2008; accepted in revised form 23.09.2008