reliability; friction damper; rolling stock; railway

Aleksander GOLYBENKO, Larysa GUBACHEVA*, Aleksander ANDREEV
East-Ukrainian National University named after V. Dal
Molodyozhny block, 20a, Lugansk, 91034, Ukraine
Sergey MOKROUSOV, Valerii SHCHERBAKOV
SPA "Transhmash"
str. Frunze, 127-a, Lugansk, 91000, Ukraine
**Corresponding author*. E-mail: gubacheva@snu.edu.ua

PERSPECTIVE METHOD TO GUARANTEE THE RELIABILITY FOR THE ROLLING STOCK OF THE RAILWAY

Summary. The design method how to increase the reliability of the railroad underframe frictional dampers has been given. The new design for frictional wedge has been suggested, it helps to decrease both the wear of friction wedge and the deterioration of the connected with shpinton sleeve.

ПЕРСПЕКТИВНЫЙ МЕТОД ОБЕСПЕЧЕНИЯ НАДЕЖНОСТИ ПОДВИЖНОГО СОСТАВА ЖЕЛЕЗНЫХ ДОРОГ

Аннотация. Предложены конструктивные методы повышения надежности фрикционных демпферов. Новая конструкция фрикционного сухаря позволит уменьшить как износ фрикционного сухаря, так и износ втулки шпинтона.

1. INTRODUCTION

Increase of profitability and competitiveness of railway transportation in many respects depends on an opportunity of its adaptation to a modern tendency of development of global transport system as a whole, which is characterized by raising average and maximal speeds of movement of vehicles.

Alongside with advantages of internal-economical character, the decision of this problem will allow to improve the investment attractiveness of Ukraine, as the states capable to provide an effective railway communication between the European Union and the countries of Transcaucasian, Central Asia and the Far East by means of transit transport corridors. Achievement of the set object assumes radical qualitative transformation of a railway transformation of Ukraine, including, first of all, track and locomotive facilities, and cargo Carriage Park also. The prime and urgent tasks are modernization of outdated rolling stock of railways and creation of the new rolling stock, satisfying the modern requirements on parameters of operational properties and reliability.

Operating experience of railway transportation has shown that mobile mating units are the least reliable elements of rolling stock underframe part. The reason of it are complex conditions of their operation characterized by a high level of working temperature, frequency of interaction and the stressed state of contact area of working elements, and influence of climatic factors also. The consequence is deterioration of stability of operational characteristics both mobile mating units and a rolling stock as a whole. First of all, it concerns frictional dampers, responsible which are for leveling

of high-frequency oscillations of spring superstructure, which are displayed with the rise of movement speed for rolling stock.

2. THE ANALYSIS OF CONDITIONS OF OPERATION FOR PASSENGER CAR UNDERFRAME AND THE CAUSES OF REDUCTION IN STABILITY OF WORK

Increase of traffic safety is the main task at designing and operation of rolling stock which is used in extremely complex and severe conditions. The large distances, high daily average runs a wide range of change of climatic conditions and other features of their work of rolling stock demand the creation of highly reliable constructions with big safety margins of such important units, as oscillation dampers. The investigations, which have been carried out by many authors [1-4], have shown that the heightened wear of parts, impacts in work, possible seizures and significant instability of friction coefficient are usually characteristic for the frictional dampers and these factors are principal causes for reduction of the general operation reliability. Main factors of instability are violation of manufacturing techniques of frictional elements, deviations of the sizes of separate parts and imperfection of a structural design with big sensitivity to change of friction coefficient.

In the article the problem of increase of operational reliability of the main friction pair frictional damper of oscillations of the passenger carriages, which are used in heavy conditions of operation is accomplished due to constructive change of geometry for the main friction pair and technology of its manufacturing.

Basic elements of the frictional oscillation damper [5] are the shpinton sleeve, which together with six frictional slide blocks forms the main friction pair. Moving in the process of oscillations of the running part of the carriage, the frictional blocks are retained against the shpinton sleeve 1 by special conical rings, lower of which through the rubber shock-absorber acts on a wing of an axle box, and inner spring acts on the upper ring.

The conditions of operation of friction pair are as follows:

- pressure of friction surfaces – no more than 2 MPa;
- speed of relative sliding of pairs – 0,1-0,2 m/s;
- duration of one cycle of loading– 0,2-0,4 s;
- hourly average number of loading - 200-1500 cycles.

The analysis of operational conditions of underframe of the passenger car has shown that the principal cause of deterioration of operational parameters of a train is wear of the mobile mating units connected with a change of geometry of mating surfaces. It is established, that change of geometry of matting units leads to a change of force characteristics of damping devices, to increase of displacements and acceleration of car body, to the raised wear of running parts and autocoupling devices, and also to the increase of stressed state in a frame of the carriage.

The investigation of the reasons of wear of mobile mating is made by the example of passenger car frictional damper. The investigation of units (528 units), taking place in operation, with the use metallographic methods have allowed to establish the reasons of catastrophic wear. The principal cause of intensive wear and violation of stability of damper characteristics consists of the local overheat of separate sites of the middle link (the shpinton sleeve), resulting in dripping and tearing out of the metal. It leads to the change of structure of the metal with formation of ferrite network on borders of grains, to decrease in wear resistance and formation of wear out on a working surface [6].

The basic parameter of reliability such as probability of non-failure operation was used for comparative estimation of the variants of constructions. These parameters were determined on the results of train tests with use of a special method of statistical processing [7], at which the normal law of distribution was determined by two-parametrical functions of distribution of random variable – by density of distribution and function of distribution. The function of distribution determines the probability of non-failure operation P(t).

It is established, that the most worn elements of the frictional damper at run of the car, for example, of order of 400 thousand per km were the shpinton sleeve (P(t) = 0,805) because of the wear and

frictional blocks (P(t) = 0,965) because of broken edges. New constructive decisions of the main pair friction and selection of new materials are necessary for increase of wear resistance of these links

The obtained dependence of wear on time of tests of the typical model and modernized design with block from new materials oxafen (оксафен [11]) are resulted in work [8]. 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 μm/hr, and in a pair with a block from oxafen – 0,24 μm/hr. Speed of wearing of the typical model of block makes 0,465 μm/hr, and from oxafen – no more than 0,29 μm/hr, this has allowed to receive the increase of wear resistance more than in 2 – 2.5 times.

Now consider the new design solutions of the main friction pair.

3. NEW CONSTRUCTIVE DECISION OF THE MAIN FRICTION PAIR

Besides of the analysis connected with the term of operation it is shown that the serviceability for dampers depends on not only from speed of wear for the main friction pair, but also of its geometry. The most vulnerable part is the shpinton sleeve.

To prevent the disastrous wear of frictional pair, the new construction of the friction block is offered [9-10]. It allows to reduce both wear of the friction block, and wear of the shpinton sleeve.

The construction of the friction block is shown on fig. 1, where main surface of friction is executed with perforations, filled by the special composite mass with anti frictional characteristics for ensuring the smoothing of the roughness of the shpinton sleeve surfaces and reduction of the wear.

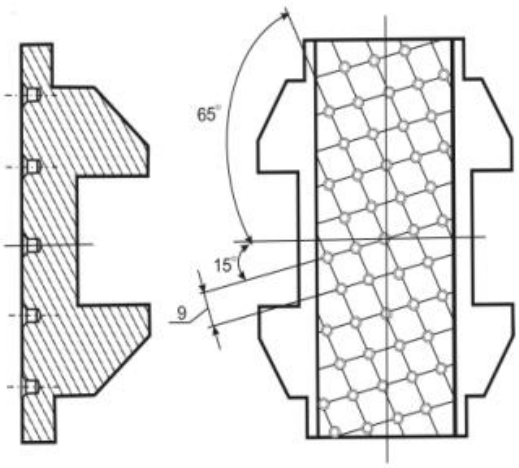

Fig. 1. The friction block with perforations on the main friction surface, filled by the composite mass
Рис. 1. Фрикционный сухарь с перфорациями на главной поверхности трения, заполненные композиционной массой

4. RESULTS OF RESEARCH

The stand tests of the wear of the main frictional pair have been carried out by Lugansk Testing Centre "Transsert" (Ukraine) on the testing stand for tests of frictional dampers (the certificate of accreditations UA 6.001.T.174). The investigations were conducted on the batch for one truck- 8 shpinton sleeves with six surfaces and 48 friction blocks.

The value of the wear of the friction blocks and shpinton sleeve was determined as weight difference before test and after test at operating time of 200 hours with different frequency of

vibrations (0,5 - 2 Hz) and displacements (up to 5 mm). The comparison of the wear results were conducted for the frictional pair «steel on steel» (standard) and for the pair « steel- composite mass» (the new construction).

The wear of details of the frictional blocks is represented on a fig. 2, where the surfaces of wearing are indicated by pointers:

• on a fig 2*a*, - metallic block,
• on a fig. 2*b* – metallic shpinton sleeve,
• on a fig. 2*c* – block from composite mass.

The conducted comparative tests of model-based prototype have shown:

1. The pair of friction «steel on steel»:
   - the value of force on the damper rod was increased as the wear value was increasing;
   - the scorings on the shpinton sleeve and friction block had appeared;
   - an external temperature of the sleeve in zone of the contact when functioning(working) on frequency of 1 Hz made 60^0-80^0 C;
   - the mass wear of the friction block after tests - 0,5-1,17 g;
   - the mass wear of the shpinton sleeve after tests - up to 2 g.
2. The pair of friction «steel - composite mass»:
   - the force on the damper rod remained stable;
   - the scorings on the shpinton sleeve and friction block did not exist;
   - an external temperature of the sleeve in zone of the contact when functioning on frequency of 0,5 Hz practically did not differ from shop temperature, the temperature at working on frequency of 1 Hz was on 10^0-15^0 above shop one;
   - the wear of the friction blocks and the shpinton sleeve - up to 0,2 g.

The results allow to draw a conclusion about advantages of the new construction of the friction blocks.

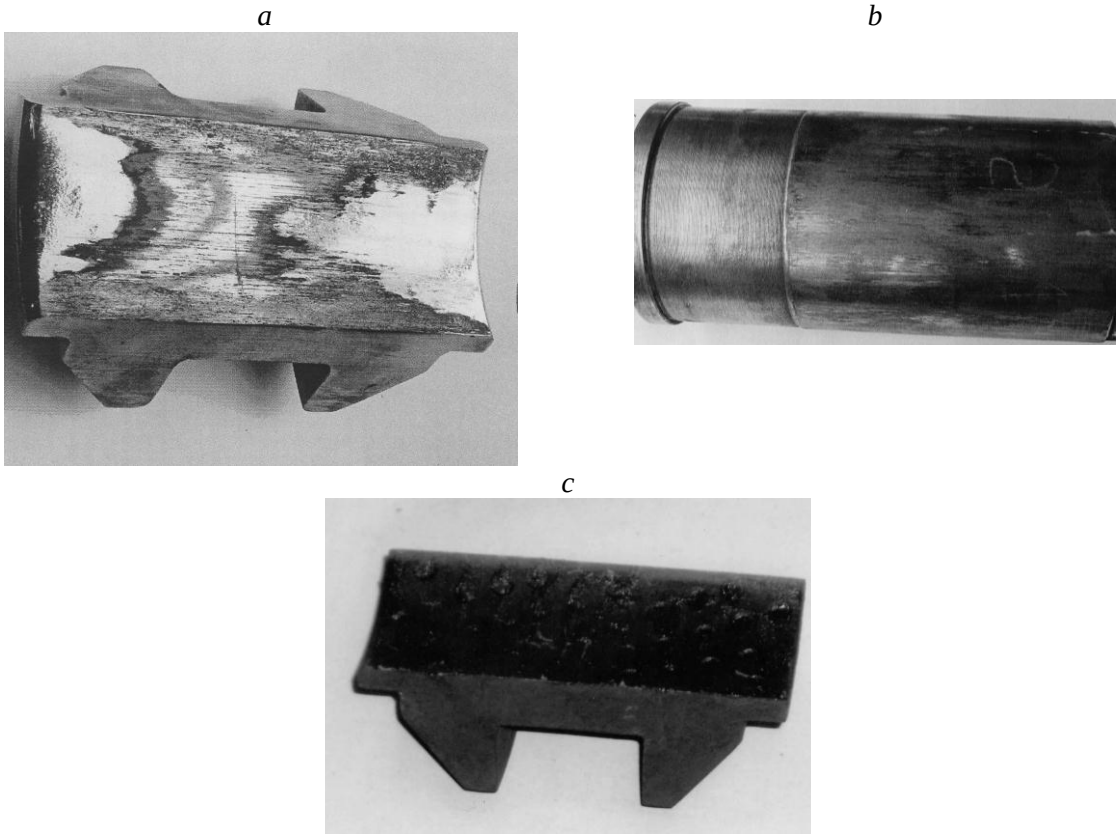

Fig. 2. Wear of details of frictional blocks and shpinton sleeve
Рис. 2. Изнашивание деталей фрикционных сухарей и втулки шпинтона

5. SUMMARY

1. The conducted investigations on study of the wear of main frictional pair have allowed to ascertain the reasons of instable operation of the frictional damper, that is displayed in local overheat of the separate sections of the shpinton sleeve surface. It causes dripping and breaking away the metal, and, as a result, brings to reduction of wear resistance.
2. The engineering methods of increasing the operating reliability by way of perforations of main friction surface and their filling by the composite mass have been proposed , that have allowed substantially to reduce the wear of the main friction pair.

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