

**Aleksander GOLUBENKO, Larysa GUBACHEVA\***  
East Ukrainian Volodymyr Dal National University  
Molodyozhny block 20A, 91034, Lugansk, Ukraine  
\*Corresponding author E-mail: gubacheva@snu.edu.ua

## **NEW DESIGN AND THE MANUFACTURING TECHNIQUES OF THE MAIN FRICTION PAIR OF FRICTIONAL DAMPERS**

**Summary.** The design of the main friction pair of the frictional oscillations damper of passenger car axle box stage suspension and its manufacturing techniques are described. The difference of the design of the main friction pair consists in replacement of a conical contact surface of the shpinton sleeve by a pyramidal surface as well as a cylindrical surface of the frictional slide block by a flat surface of the rectangular form. Technological ways of increase of strength and wear resistance were developed that allowed quantitatively to estimate a reserve of increase of strength and thermal wear resistance by methods of plastic deforming. With the purpose of increase of wear resistance and resource saving the new technology of producing the shpinton sleeve blank is offered by a method of cold die forging, and a frictional slide block – by hot die forging.

## **НОВАЯ КОНСТРУКЦИЯ И ТЕХНОЛОГИЯ ИЗГОТОВЛЕНИЯ ГЛАВНОЙ ПАРЫ ТРЕНИЯ ФРИКЦИОННЫХ ДЕМПФЕРОВ**

**Аннотация.** Описана конструкция главной пары трения фрикционного гасителя колебаний буксовой ступени подвески пассажирского вагона и технологии ее изготовления. Отличие главной пары трения состоит в замене конической контактной поверхности втулки шпинтона пирамидальной поверхностью, а цилиндрической поверхности фрикционного сухаря - плоской поверхностью прямоугольной формы. Разработаны технологические способы повышения прочности и износостойкости, позволяющие количественно оценить резерв повышения прочности и термической износостойкости методами пластического деформирования. С целью повышения износостойкости и ресурсосбережения предлагается новая технология получения заготовки втулки шпинтона методом холодной объемной штамповки, а фрикционного сухаря – горячей объемной штамповки.

### **1. THE ANALYSIS OF CONDITIONS OF OPERATION OF 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 a rolling stock which works in severe conditions. The big average daily runs, a wide range of changes of climatic conditions and other features of work require a creation of the designs with large reliability and durability margins of such important units, as oscillations dampers. The investigations which have been carried out by many authors, have shown [1-4], that the raised wear of details, shock loads, possible seizing and significant instability of friction coefficient are usually characteristic for work of the frictional dampers that is the principal cause of reduction in total reliability of the unit. Basic factors of

instability of friction coefficient are breach of manufacturing techniques of frictional elements, deviations of the sizes of separate details and imperfection of constructive execution with the big sensitivity to change of friction coefficient.

In given paper the problem of increase of operational reliability of the main friction pair of the frictional oscillations damper of the passenger carriages which are exploited in heavy conditions, is solved due to constructive change of geometry of the main friction pair and technology of its manufacturing.

The basic elements of the frictional oscillations damper are the shpinton sleeve 1 which together with six slide blocks 2 forms the main pair of friction (fig. 1). Moving during oscillations of undercarriage (running part) of the car the slide blocks 2 are pressed to the shpinton sleeve 1 by special conical rings 3, lower of which acts on the wing of the axle box through a rubber shock-absorber, and the upper ring is influenced with inner spring.

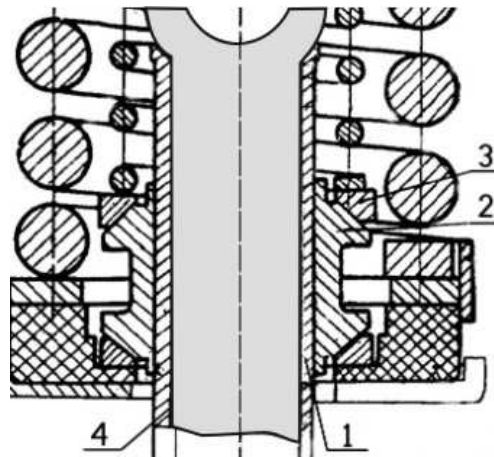


Fig. 1. The scheme of the frictional oscillation damper: 1 - shpinton sleeve, 2 - frictional slide blocks, 3 - conical rings, 4 - shpinton

Рис.1. Схема фрикционного гасителя колебаний: 1 - втулка шпинтона, 2 - фрикционный сухарь, 3 - кольца конусные, 4 - шпинтон

The known frictional oscillation damper of passenger car axle box stage suspension, described in works [5 - 8], have essential disadvantages which can be explained by figure (fig. 2).

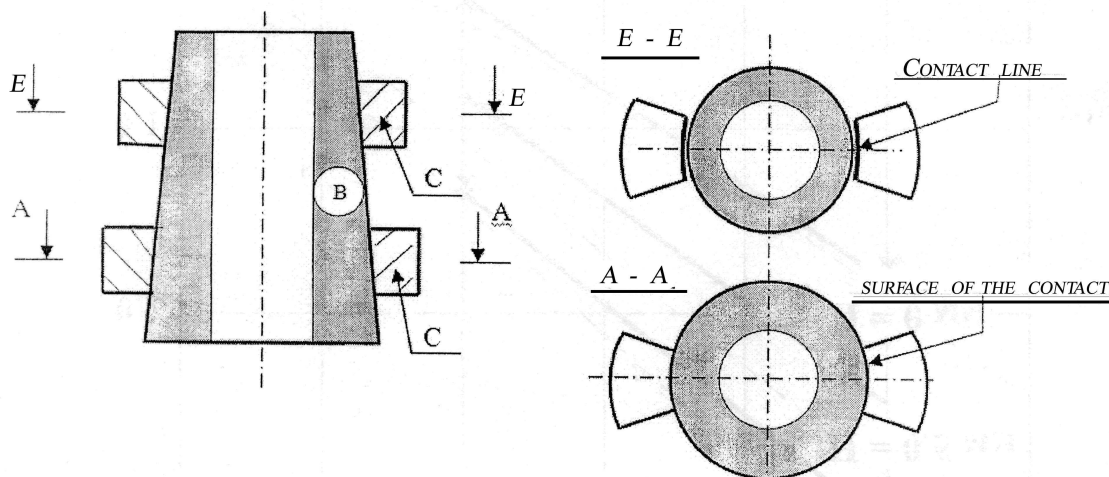


Fig. 2. The scheme of interaction of the frictional slide blocks (C) with the shpinton sleeve (B) (it is conditionally shown only two slide blocks from six)

Рис. 2. Схема взаимодействия сухарей (C) со втулкой (B) (условно показано лишь два сухаря из шести)

If the spring of the carriage of the car is loaded only statically (from weight of the car with passengers) and if the slide blocks are in the middle (or the lower part of the shpinton sleeve as it is shown in section A-A), the contact surfaces of the shpinton sleeve and frictional slide blocks coincide; as a result full fit of frictional slide blocks surfaces to the surfaces of the shpinton sleeve takes place.

But as soon as process of oscillation of the car relatively the carriage begins and there is compression of springs of the carriage from dynamic loads, the frictional slide blocks move relatively the shpinton sleeve upwards, and as the shpinton sleeve has the conical form, the contact of surfaces of the frictional slide blocks with the shpinton sleeve changes – it passes in linear, as it is shown on fig. 2 in section E-E.

Such essential change of contact conditions results in significant heating of the places of contact, leads of dripping, raised wear and necessity of premature replacement of the main friction pair (complete sets “the shpinton sleeve - the frictional slide blocks”). For this purpose the car needs to be put in a car shed, to lift it from the carriage, to replace carriages on to new ones. In the replaced carriages it is necessary to disassemble the suspensions, to take out the worn frictional slide blocks, to remove the shpinton sleeves and replace them on to new ones. It is very labour-consuming and expensive work which essentially reduces economical efficiency of use of carload park.

The analysis of operation conditions of the passenger car underframe has shown, that a principal cause of deterioration of operational parameters of a train is wear of the mobile integrations connected with change of geometry of integrated surfaces.

It is established, that change of geometry of mobile integrations results in change of force characteristics of damping devices, lead to increase of displacement and accelerations of car body, to the raised wear of running parts and autocoupling devices, and also to growth of stressed state in the carriage frame.

## 2. NEW GEOMETRY OF THE MAIN FRICTION PAIR AND TECHNOLOGY OF ITS MANUFACTURING

Mathematical modelling of contact interaction of the main friction pair, made by a finite-element method [9, 10], with the purpose of determination of contact and thermal stresses and distribution of thermal flows on surfaces of the integrated elements, has allowed to confirm necessity of change of geometry. As a result, it is offered to replace a cylindrical surface of friction of the shpinton sleeve on pyramidal one, for example, with six faces, and a cylindrical surface of the frictional slide blocks is offered to be replaced on flat surface of the rectangular form [11].

The offered change of the geometry and the form of contact gives very important operational advantages as wear of the working surfaces of the frictional slide blocks decreases by 50 % or more. Such change of a design of the frictional oscillation damper of passenger car axle box stage suspension enables to change essentially as well as the manufacturing techniques of the shpinton sleeve and the frictional slide blocks. The technology of production of the shpinton sleeve blank has been described in work [12], it has allowed to raise metal-utilization rate up to 0,67 against 0,3 on before used technology.

The scheme of interaction of frictional slide blocks (C) with the shpinton sleeve of new design (B) is shown on fig. 3.

On fig. 3 three kinds of frictional slide blocks are shown. A frictional slide block 1 is technological enough, but its contact surfaces  $K$ , which interacts with the basic rings, are insufficient for normal wearing process of pair “the frictional slide block – the ring”. This surface should be increased, as it is shown on fig. 3, position 2. And still the best to make as it is shown on fig. 3, position 3. The contact surface with a basic ring should be increased and simultaneously with increase of such contact surface we receive a draft which will provide easy extraction of a forging from a die impression.

According to old manufacturing methods it was supposed to manufacture six frictional slide blocks from one forging in the kind of a thick-walled ring which is produced on forging hammer with the help of drifting operation. The all surfaces of the slide block should be processed on turning and milling machine tools, and a basic surface should be finished by grinding. Thus, the metal-utilization factor made only 27 %.

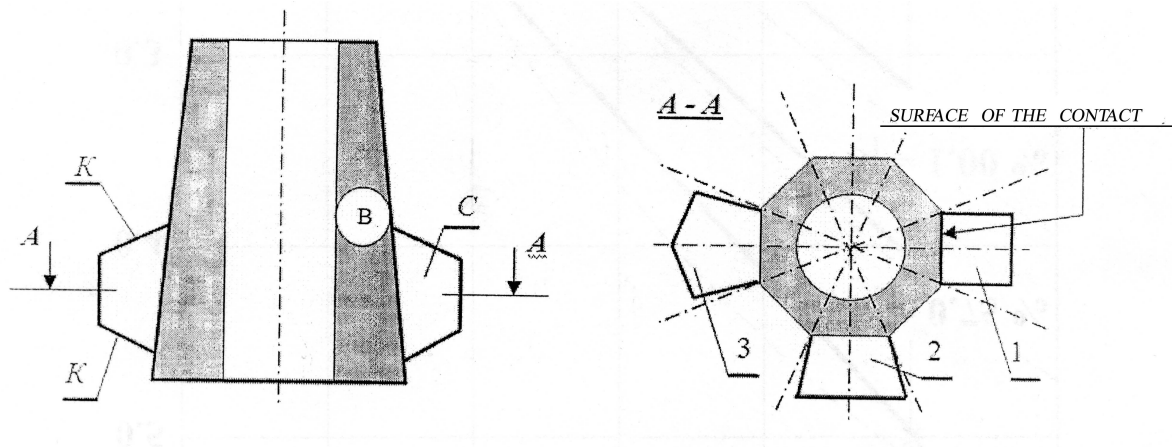


Fig. 3. The scheme of interaction of the frictional slide blocks (C) with the shpinton sleeve (B) of a new design (it is conditionally shown only three slide blocks from eight or six): 1 - rectangular, 2 – trapezoidal, 3 – a sector slide block

Рис. 3. Схема взаимодействия фрикционных сухарей (C) со втулкой шпинтона (B) новой конструкции (условно показано лишь три сухаря из восьми или шести): 1 – прямоугольный, 2 – трапециевидный, 3 – секторный сухарь

The new technology supposes hot die forging of forgings by the piece on die-forging hammer or on crank hot die-forging press. The technological process of hot die-forging of the frictional slide block according to new manufacturing techniques includes such operations:

- Cutting of the bar on piece blanks.
- Heating of the blanks in a gas furnace chamber (or in induction furnace).
- Die forging in roughing fullering impression.
- Die forging in finishing impression of hammer (or crank hot die-forging press).
- Trimming of flash on trimming press.
- Descaling in shot-blast chamber.
- Test and measuring operations.
- Machining.

The offered technology has allowed to determine the optimum sizes of frictional slide blocks, to reduce machining allowances on processing, to change essentially the circuit of processing. As a result it has allowed to raise the metal-utilization factor up to 85 %.

Certainly, manufacturing of such parts as a frictional slide block by die forging is not new in technology of hot die forging. But change of a design of the frictional oscillation damper of passenger car axle box stage suspension enabled to apply the new progressive metal-saving technology which provided essential technical and economical advantages.

### 3. CONCLUSIONS

The new design frictional damper has allowed:

- to provide uniform wear of friction surfaces and to prevent processes of dripping and seizing;
- to raise the reliability and to increase a run between repairs of the damper in 1,5 ... 2 times at the expense of improvement of metal structure and thermal durability of the working surfaces of integrations of the main friction pair;
- to reduce waste of expensive materials in 2,5 times at the expense of application of new resource-saving technologies of die forging.

**Literature**

1. Лукин В.В, Шадур Л.А, Котуранов В.Н, Хохлов А.А, Анисимов. П.С. М.: *Конструирование и расчет вагонов УМК МПС России*, 2000 - 731 с.
2. Челноков И. И.: *Гасители колебаний вагонов*. – М.: Трансжелдориздат, 1963. – 170с.
3. Соколов М.М., Варава В.И., Левит Г.М.: *Гасители колебаний подвижного состава: Справочник*. М.: Транспорт, 1985 - 216с
4. Войнов К.Н.: *Надежность вагонов* - М.: Транспорт,1989. – 112 с.
5. Губачева Л. А.: *Исследование изнашивания деталей фрикционного гасителя колебаний тележек пассажирских вагонов*. Новини науки Придніпров'я. – 2005, Вип.5., 31-35.
6. Gubacheva L.A., Naish N.M.: *Assurance of operate reliability of rolling stock* .Journal of Guangdong non-ferrous metals. – 2005, Vol. 15, No.2; 3, 200-212 с.
7. *Інструкція по утриманню, ремонту та випробуванню гасителів коливань локомотивів моторвагонного рухомого складу*. – Київ, 2003.
8. Федюшин Ю.М., Лобойко Л.М. та ін.: *Розробка, створення освоєння виробництва та впровадження сімейства моделей вітчизняних сучасних пасажирських вагонів для швидкісних перевезень*. Вісник Дніпропетровського національного університету залізничного транспорту. – Вип. 7, Дніпропетровськ, 2005.
9. Śladkowski A., Gubaczewa L., Basov G.: *Modelowanie ciernego tłumika drgan*. VI Konferencja Naukowa “Telematyka i Bezpieczenstwo Transportu”. – Katowice, Wydawnictwo Katedry Systemow Informatycznych Transportu Politechniki Slaskiej, 2006. – Т.2. – S. 173 – 186.
10. Śladkowski A., Gubachova L.: *Rozwiązanie problemu termosprężystości dla współpracy kontaktowej elementów ciernego tłumika drgań*. I Kongres Mechaniki Polskiej, Warszawa, 28–31 sierpnia 2007 r., S. 64.
11. Євстратов В.О., Губачева Л.О., Басов Г.Г.: *Фрикційний гаситель коливань буксового ступеня підвіски пасажирського вагона*. Патент України №7561, В61F5/12, Опубл. 15.06.2005, Бюл. № 6.
12. Євстратов В.О., Губачева Л.О.: *Спосіб виготовлення заготовки втулки шпінтона*. Патент України № 3595, G01N19/02, Опубл. 15. 12. 2004, Бюл. № 12.

Received 23.11.2007; accepted in revised form 14.12.2007