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THE WAYS TO ENSURE A RATIONAL LOAD DISTRIBUTION ON THE BEARINGS BY CREATING AN AXLE BOX

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Long-term experience of operation on the railways of Ukraine cylindrical roller bearings shows that they have insufficient reliability. The actual durability of the railway axle bearings is much lower than the calculated one. The reason for this is an uneven load distribution between the rolling elements and along the forming rollers [1, 2]. The peculiarity of the construction of the axle box of the freight car and the connection zone with the side frame of the bogie consists in the fact that during operation it is inevitable to wear both the body of the axle box and the axle frame of the side frame of the bogie. At the same time, significant gaps appear in the joints of the case of the axle box and the side frame. During the movement, this leads to running of the side frames and overloading one of the boxes, which causes uneven loading of the frame of the axle unit. This, in turn, leads to a distortion of the axle bearings and, as a consequence, to a decrease in durability.

Many scientists have for decades paid attention to the reliability of the roller bearings for railway axle boxess. Thus, fundamentals of the theory of calculation of durability of rolling bearings have been proposed. Weibull [3] in 1939 and was further developed in the works of A. Palmgren and G. Lundberg [5]. But the application of this theory in relation to railway axle box cylindrical bearings yields results which differ significantly from data exploitation. So, according to [6] average bearing life should exceed 40 years; in fact, it does not exceed 10 years [4].

According to [6] estimated service life of roller bearing depends on the basic dynamic load rating and equivalent load applied to the bearings. To Refine the results, enter number of correction factors that take into account the influence of the lubricant and the working conditions of the axle unit.

The value of the dynamic load capacity is based on calculations or tests of the bearing manufacturers.

Equivalent load acting on the bearings is determined by the following formula:

$$P_e = (X \cdot V \cdot F_r + Y \cdot F_a)\, K_T \cdot K_B, \quad (1)$$

where X, Y – are the coefficients of respectively the radial and axial loads, V – coefficient of rotation, F_r – radial load, kN, F_a– axial load, kN, K_T – temperature coefficient, K_B– factor of safety (dynamic).

In [5] to calculate the equivalent load offered to accept the assumption that in operation the axial forces do not exist and buxom nodes, they do not act, so the formula to determine the equivalent load will be as follows:

$$P_e = F_r \cdot K_T \cdot K_б, \quad (2)$$

But in the case of railway axle box bearings, this is not true

It is assumed that axle node loaded by the classical scheme: the most loaded is the upper roller, the center of which is located in the direction of the radial load acting on the bearing, and the load on the other rollers are reduced in proportion to the cosine of the angle between the guide force and the straight line connecting the center of the roller with the bearing center.

It should be noted that when considering the issue of increasing the durability of the bearings, the main focus is directly on improving the design of bearings by making changes to the geometry of the rolling elements and bearing rings and the manufacturing techniques of the bearings themselves. The choice of the rational form of contact between the side frame of the trolley and the case of the axle box remained outside the field of view of the researchers.

To ensure uniform distribution of loads optimizing the design of the axle boxes in the future can solve the problem of insufficient reliability of axle box bearing units of freight cars.

One of the main tasks during the commissioning of axle box assemblies was to ensure their interchangeability with the axle box nodes on sliding bearings. It is the requirement of interchangeability has led to the construction of the first cargo roller axle boxes had a number of elements of the

transitional type. However, the designers have taken steps that highlight the features of roller bearings, namely high rigidity, small gaps etc.

Another direction of improving the design of the axle boxes is the use of elastic elements. In the early 80-ies of XX century was the design of axle unit with elastic strip located between the adapter and the outer ring. There is a structure made with two rectangular lugs on the edges of the arch in the area of the load rollers. These tides are found along the length of the body and are the bearing surfaces to transmit load from the side frame. But these proposals for changes in structures axle box node has not received further development. The disadvantage of these designs has increased the complexity of manufacturing, lack of strength of the new elements and the appearance in these elements additional sources of stress concentration.

In this way, the issue of ensuring an even distribution of loads due to the optimization of the construction of the axle box is insufficiently studied and can solve the contemporary problem of the axle box bearing units of freight cars.

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