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ANALYSIS OF EXPERIMENTAL DETERMINATION OF COEFFICIENT OF COUPLING BETWEEN WHEELS AND RAILS OF MASTER LOCOMOTIVES

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Abstract:

This article presents an analysis of the methods of determining the coefficient of friction between the wheel pair and the rail, which are the most responsible parts of the wheel motor unit of main locomotives, through experiments. As well as, the analysis of experimental studies by advanced scientists, including N. N. Menshutin, A. A. Rengevich and O. M. Yanson, is cited.

Keywords: wheel pair, rail, sliding, speed, coupling coefficient, main locomotive

INTRODUCTION. Increase of the friction coefficient in the sliding zone by O. M. Yanson, Candidate of Technical Sciences Lengrad Mining

In this article, the experimental methods of determining the coupling coefficient between a pair of wheels and a rail, which are the most responsible nodes and details of main locomotives, are analyzed.

In the processing of experimental data, N. N. Menshutin combined the first two branches of the coupling description into one conditionally growing branch, where $\psi_0 = \psi_A$ and $u_0 = u_A$ obtained [1]. He divided the network into two sections and proposed the following analytical relationships for them (movement without sand) (expressed a in percentages):

for the situation

$$K < 0{,}5 \; a = 0{,}28k \; ;$$

for the case

$$1 > K > 0{,}5$$

$$\alpha = \frac{0{,}155 + 0{,}196k}{3{,}5 - 3{,}36k}$$

When $k = 1$, $a = 2{,}5\%$, this u_A corresponds to the sliding speed, and when it is exceeded, the characteristic of the adhesion passes to the decreasing network. According to the experimental data, in fact, the condition k=1 corresponds to $a_0 = 1{,}2 - 1{,}4\%$.

From the formulas and experimental data, it is known that the current value of the friction coefficient when $a \le 0{,}14\%$, increases linearly with the increase of the sliding speed. When $a \ge 0{,}14\%$, the rate of growth of ψ slows down, and its value approaches the asymptotic ψ_0. In the interval from 0.8 to 1.4% of the values, the value of ψ increases from $0{,}95\psi_0$ to ψ_0 and maintains a constant value during the further increase of $a_A = 2{,}0 - 2{,}5\%$ [2].

When the sliding speed is u_A, the zone of complete or excessive sliding of the wheel along the rail begins, which is associated with a decrease in ψ. From the analysis of experimental data, it became clear that the dependence of the current value on $u_{изб}$ as ψ increases can be expressed by a simplified empirical formula as the final value increases up to $3 м/с$

$$\psi = \psi_A \frac{1}{1 + \chi_A (u - u_A)} ,$$

Where is the stiffness characteristic of the coupling at point $\chi_A -$ A Accordingly, the traction description is divided into two sections: the productive ($u \le u_A$)) and complete ($u > u_A$) slip sections of the wheels. For a complete slip section, the following stiffness parameter $\chi = \frac{d\psi}{\psi_A du} -$ is important; it determines the intensity of the decrease of ψ with the increase of limit slip velocity above u_A

Based on a large amount of experimental data [3], it was found that the size (value) of $\chi_À$ decreases with the increase of *v*

According to the data from foreign tests, it is possible to indirectly infer the decrease of χ_A value to approximately $0{,}25$ m/second when it is $\upsilon = 70 \div 90$ *km/s*

The effect of sanding under the wheel on the shape of the tread profile has been relatively fully studied only for the growing branch (branch) of the tread pattern.

In calculating the processes of development and cessation of wheel overslip, the decreasing branch of the slip description is of decisive importance, where the magnitude of χ is determined for it only by the excess slip speed $u_{изб}$ -. From this, it follows that in the case of movement with sand, if the following is obtained in the calculation method, it is possible to proceed from the description of simple movement in the calculations.

$$\psi_{хисоб} = 0{,}95\psi_{0макс}.$$

A comparison between the considered operational description and the test data from steam locomotives and diesel locomotives reveals that it is typical for any highway locomotive.

Based on laboratory studies conducted in CIS countries and abroad using models, it can be asserted that the thesis regarding the inaccuracy of judgments about the abrupt change in ψ characteristics during the transition from an increasing or intermediate station to a decreasing station has been substantiated. The descending branch of the description, constructed based on linear tests conducted from experiments, is represented by a solid curve in ,with its starting point at k=1. However, it's important to note that this point is where the description exhibits the highest rigidity: $\chi_A = \chi_{макс}$ as indicated in k=1[4].

In its initial segment, characterized by large values of χ but close to α_A, the curve is more steeply inclined, leading to larger values of α compared to those observed in experiments [5]. This disparity can be attributed to inaccuracies in measurement and data processing. Specifically, due to less precise methods of measuring wheel slippage in experiments, an experimental network of the slip description couldn't be obtained. Consequently, the values of χ derived from experiments [5] cannot be relied upon.

A comparison of the considered description of the operation with the data of tests carried out with steam locomotives and diesel locomotives shows that it is typical for any highway locomotive.

Based on the laboratory studies carried out on the basis of models in the CIS countries and abroad, it can be said that the thesis about the inaccuracy of the judgments about the jump change of the characteristics during the transition from an increasing or intermediate station to a decreasing station can be said to be proven. The descending branch of the description, built on the basis of the data of linear (line) tests carried out on the basis of experiments, is depicted in the form of a solid curve in k=1.

Prof. Experimental studies conducted by A.A.Rengevich on mine electric locomotives operating in both coal and ore mines (in the latter, high values of ψ_0)

1. The networks of the description of the connection are shown in the form of two curves with the following coordinates, intersecting at a point, $\psi_0 = \psi_A$ and $u_0 = u_A$.

2. Speed. $u_0 = 0{,}1 м/сек = const$

3. Characteristic hardness of the joint

$$\chi = \frac{0{,}03\sqrt{10\psi_0 - 0{,}7} - 0{,}016}{\psi_0}, \text{ (sek/m)} \qquad (2)$$

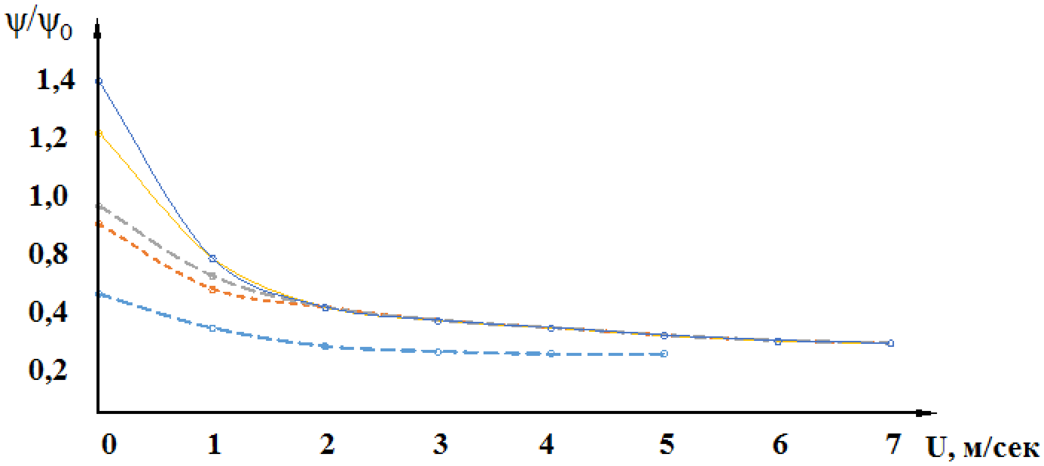

Figure 1. According to the conducted experiments, the change of the adhesion coefficient of the wheels in the full slip zone at speeds between 5 and 40 km/s.

______ - *when the sliding speed increases.*

_ _ _ _ _ - *when the sliding speed decreases.*

It follows from the formula that when $\psi_0 < 0{,}1$ we have $\chi > 0$, which is consistent with the increase in the full slip zone.

In conclusion, it can be said that the analysis of the methods of determining the coefficient of engagement between the wheel and the rail, which affects the torsional vibrations in the torsional gears of the main locomotives, shows that Prof. The method of measurements adopted in the researches of A. A. Rengevich is less accurate than the method of N. N. Menshutin.

The increase of the friction coefficient in the sliding zone was determined by O. M. Yanson, candidate of technical sciences, by conducting tests of a model of a mining electric locomotive at the Lengrad Mining Institute.

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