TEKA. COMMISSION OF MOTORIZATION AND ENERGETICS IN AGRICULTURE – 2012, Vol. 12, No.4, 190-195

Experimental measurement complex running gear for research and of interaction conditions rolling stock

Volodymir Nozhenko[1], Nikolai Gorbunov[1], Sergey Mokroysov[2], Vycheslav Chernikov[1], Maxim Kovtanez[1], Rostislav Demin[3]

[1]Volodymyr Dahl East-Ukrainian National University, Lugansk, Ukraine
[2]Scientific and production center "TRANSMASH"
[3]State Enterprise "State scientific and research center of Railway Transport of Ukraine"

S u m m a r y . The processes occurring in the contact wheel and rail, depends on the work of railway rolling stock. Energy consumption is realized in touch "wheel-rail", and efficient use of this energy depends mainly on the friction on the rail. The article describes the testing equipment enables the investigation of the condition of the chassis and the interaction of the newly created and operated by the Department of rolling stock Railway East-Ukrainian National University. Dal in the laboratory "Friction and lubrication in the drive locomotives"
K e y w o r d s : rail vehicle, test bench, the clutch, the friction coefficient

INTRODUCTION

Evaluation of such technical systems, as rail vehicle, - a very complex task. To solve it, you need not only to select and evaluate the basic properties of the vehicle, such as speed, power, durability, indicators of dynamics, traction and so on, but also to combine them into a single consolidated index. For an objective assessment necessary to determine the factors which may assess the rail vehicle. Given that the primary of function transport is ensuring carrying capacity of freight transportation and high comfort of passenger transportation. It is advisable implement assess by traction and by dynamic qualities (fig. 1). At the same time the clutch wheel the locomotive with rails has a significant effect for traction and dynamic quality of the locomotive.

The problem of friction on the rail is one of the most vital for rail transport [Golybenko A., Kostyukevich A., Tsyganovskiy I., Nozhenko V. 2011, Gorbunov N., Kostyukevich A., Kravchenko K., Kovtanets M. 2011, Poole W. 2008]. The above problem is complex and the solution should be based on research in the area of contact interaction of solids with the features of the state of the contact surfaces (moisture, lubricant on the surface, abrasive particles, etc.), as well as in physics and surface chemistry.

The large number of influencing factors (physical, chemical, electrical, etc.) on the coupling quality of the locomotive creates difficulties in the theoretical description of processes in tribocontact, which led to widespread development of experimental methods.

The most reliable information for the newly created and exploited railway vehicles in assessing characterization of interacting pairs of friction materials and their conjugation provide experimental methods [Isaev I., 1988, Buhanchenko S.E. 2005, Prudnikov M.I. 2009, Churkin A.V. 2008, Luzhnov Y.M. 1978, Burstow M.C. 2006], implemented by:

- on physical and mathematical models in the laboratory;
- on roller rig with the field units of rolling stock;

- during field tests in operational conditions..

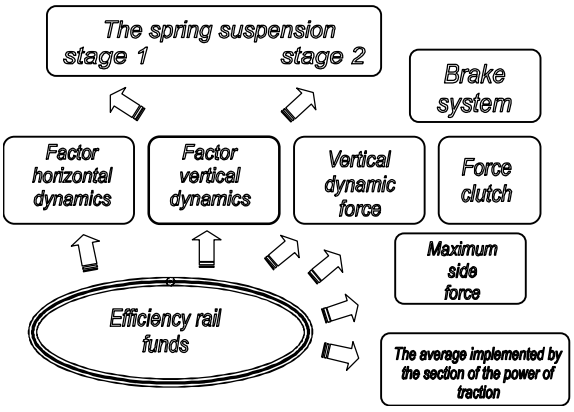

Fig. 1. Factors that assess the effectiveness of rail vehicles

Existing test bench allow you to study the process of friction on the rail in the laboratory. But the only complexity that can be difficult to reproduce in the laboratory - this is the real rail pollution rail those products that and to the extent that exist in different parts of the road. Therefore, for this type of measurement there are machines of friction, tribometer.

Based on the test bench «Friction machine», developed at the department of railway transport Volodymyr Dahl East-Ukrainian National University created automatically measuring and simulator test bench (AMSTB) for study the frictional properties of the contact "wheel-rail" [Kostyukevich A., Gorbunov M., Kovtanez M., Noghenko V., Chernikov V., Tsyganovskiy I.,2011, Kostyukevich A.I. 1991, Kostyukevich A., Gorbunov M., Kravchenko K., Popov C., Nozgenko V., Kovtanets M., 2010], which allows to solve the problems, which presented in fig. 2.

Automatically measuring and simulator test bench for the study of frictional contact properties "wheel-rail" consists of orienting and measuring unit. Block scheme shown in fig. 3.

Processing of the results of experiments conducted using software developed by the authors, which allows to process signals received.

According to the results of experimental studies based on the data from the encoders and tensor amplifier software system that incorporates a mathematical model, which allows to obtain the dependence of the coefficient of rolling friction sliding on the temperature in the contact "wheel-rail."

According to the results of experimental studies on the effect of activating surfaces implemented friction offered:

- way to increase friction on the rail, which consists of passing an electric current through the contact "wheel-rail". This is achieved by control the heating of the contact area due to the relatively high current density, increasing plastic deformation and, consequently, an increase in the contact area, which is especially important when emergency braking to improve traffic safety. The advantage of this method is the ability to increase adhesion without the use of traditional sand, which promotes in increased wear of wheel sets and pollution ballast;

- way to increase friction on the rail [Golybenko O., Gorbunov M., Kachyra O., Kostyukevich A., Kravchenko K., Popov C.,Krisanov M., 2009, Gorbunov N.I., Kravchenko E.A., Lewandowski V.A., Nesterenko V.I., Kovtanets M.V., Nozhenko V.S., 2010, Gorbunov N., Kovtanets M., Kravchenko E., Krysanov M., 2010, Gorbunov M.I., Kostiukevych O.I., Kovtanets N.V. , Kravchenko K.O., 2010], which is abrasive

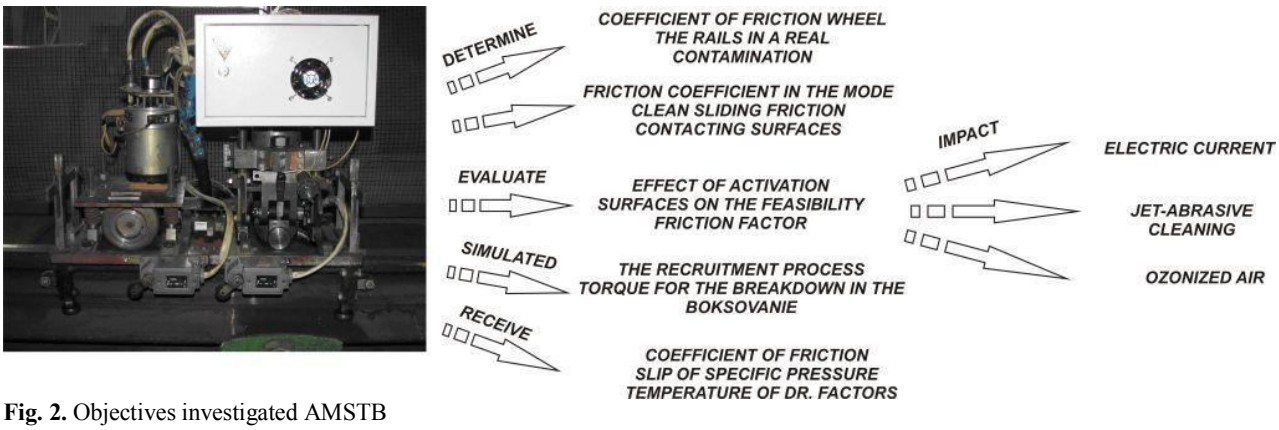

Fig. 2. Objectives investigated AMSTB

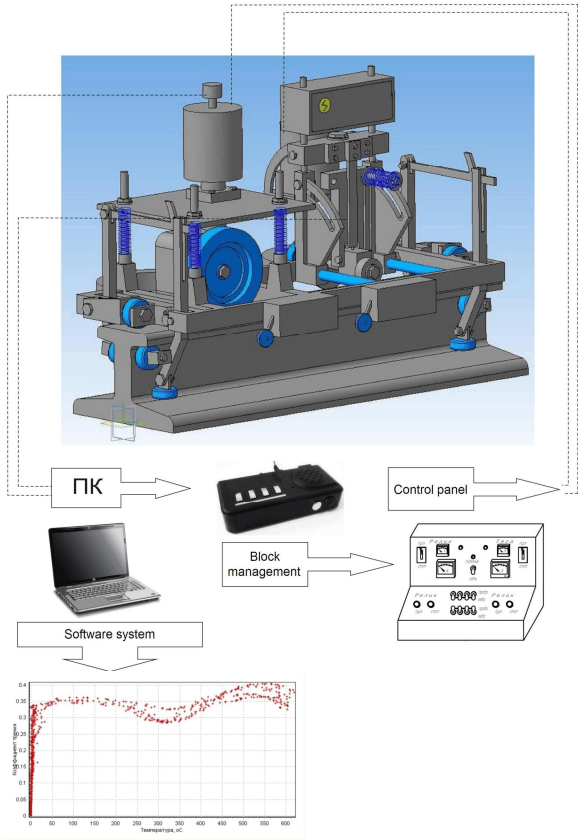

Fig. 3. The basic block scheme of the AMSTB for the study of frictional contact properties "wheel-rail"

blasting the rail surface (or wheelset and rail), the implementation of which the abrasive action of compressed air under high pressure acts as a cleanser and embedded in the surface layer of the rail, clears it from surface contamination, produce or cleaning or microcutting or sharzhirovanie surface. After cleaning, the proposed method corresponds to the rail surface purity, setting international standards ISO 8501-1:2007 (SA1, SA2, SA2.5, SA3). The advantage of this method is not just about cleaning tribocontact from surface dirt, and creation the effective surface roughness (by increasing the contact area of the wheel-rail), which leads to a significant increase in adhesion, but also in the ease of use, low cost of abrasive material, reducing resistance to the movement of trains over the traditional way of the feed sand, where sand gets on wheels composition, increasing by 12-20% resistance to the movement of trains [Osenin Y.I., Marchenko D.M., Shvedchikova I.A., 1997];

- way to reduce the friction "crest wheel-rail", which consists in the supply of ozonated air, which control the destruction of the surface contamination, and, thanks to the diffusion of atoms in the metal surface ozone, control the impurity concentration in the surface layers, which leads to the formation of oxides iron Fe_3O_4. The advantage of this method is that it is environmentally friendly, and efficient supply material to the desired surface, unlike conventional designs: systems with liquid lubricants have a high cost, instability lubrication properties, depending on the temperature, the higher the probability of hitting the wheel rolling on a track with a rail , solid lubricants pencils have low adhesion, high cost, fixed costs pencil regardless of whether the two-point contact.

The processes occurring in the contact interacting wheel and rail, depending on the whole efficiency of traction rolling stock. One of the important factors that determine the power consumption in the contact area is the coefficient of friction. According to the molecular-mechanical theory of friction coefficient of friction decreases with increasing load on the wheelset and speed, as evidenced by numerous experimental data. In addition, the friction coefficient is influenced by many additional factors, such as the type of rolling stock, track structure, weather conditions, presence of contaminants on the wheels and rails.

The analysis of the basic methods of increasing the friction coefficient showed that these include, first, the method of mechanical, thermo-mechanical, chemical, electrical discharge, plasma, etc. cleaning surfaces, and secondly, the methods of increasing the actual contact area by changing the geometric parameters of the contact surfaces, and, third, the means and the feeder in the contact zone of abrasive materials.

To determine the experimental dependences of the friction on the rail on factors such as the stiffness of rail, angle of attack, the vertical load handling, material and condition of the wheels and the rail, dynamic forces in contact, at the department of railway transport Volodymyr Dahl East-Ukrainian National University designed test bench "wheel-rail"[Gorbunov M.I., Kashura O.L., Spiryahin V.I., Kostyukevich M.I., Mikheyev A.S., 2003] (fig. 4), which allows us to study the implementation of the cohesive forces during acceleration, and slippage in straight and curved track sections.

The experimental setup is designed so that eliminates the effect of adverse factors observed in the full-scale test of locomotives, the process of adhesion and conduct the study of friction coefficient in contact, close to reality, to the different modes of motion. It also allows you to simulate the vertical oscillations of the rail, changing the characteristics of rail base, the

transverse vibrations of the rail, subsidence the rail in the vertical plane.

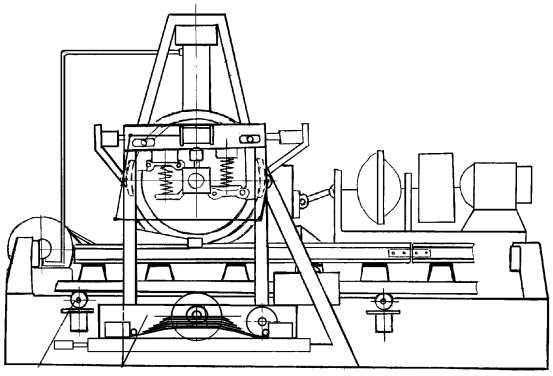

Fig. 4. Overview of the test bench for the study of friction on the rail

Another way to study the actual processes that occur while driving on the rail track at different rates, and, above all, under the power of the dynamic loads on the chassis elements is the simulation of field crews on roller rig which also performed studies of the effect of elastic and damping characteristics in motion.

Full-scale stand "roller rig" designed for the study of a new method of non-contact motion wheel flange wheelsets in straight and curved sections of track (fig. 5).

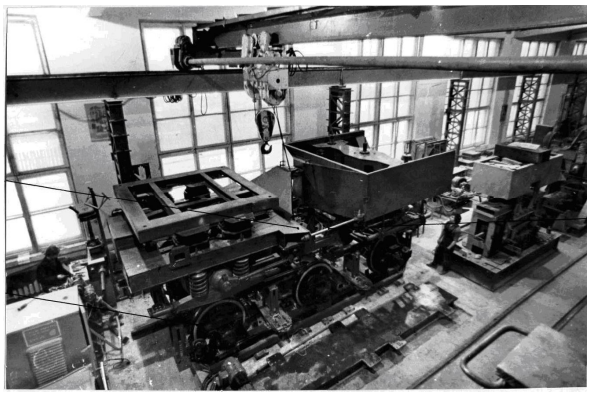

Fig. 5. General view of the bench area

Road wheels are stand in rotation from the rotating wheels of the crew, equipped with individual electric motors for all four wheels. Transmission from each motor to its wheels - V-belt, which significantly reduce the noise level in laboratory bench tests.

To study the transmission curve sections of track on the stand are simulated curves areas by curving the upper frame trolley stand, consisting of two parts, with the help of special actuators. In this case, wheel sets are shifted relative to the rails. This offset is fixed sensors located above the rails. After reaching the maximum displacement of wheelsets sensors generate and send a signal to the special power of the drive to start a reverse bias of wheel sets, which prevents convergence of wheel sets with rollers. On the right upper frame trolley stand provides simulation turn roll and lateral movement, the passage of carts curve sections of track. These displacements and returns to its normal position by means of special actuators.

Important in the design stage is to study the effect of various design changes due to the car body and a choice of values for which the dynamic qualities of locomotives would be satisfactory in a given speed range. This is explained by the fact that the locomotives 2TE116, 2TE121 between car body and bogies fitted combined rubber-metal bearings, carries an elastic mass separation truck and car body and provide lateral displacement and angular rotation relative to the car body have large variations in mechanical properties. As you know the mechanical properties of parts made of rubber hardness depends connection car body and bogie frame, which is one of the main characteristics that define the dynamic qualities of locomotives. Test bench, as shown in fig. 6, allows for field testing support for a shift in the oscillation frequency ranges from 0 to 3 Hz and amplitudes of the oscillations from 0 to 0.4 m in the harmonic loading in symmetric and asymmetric (with the introduction of the static component of deformation) cycles.

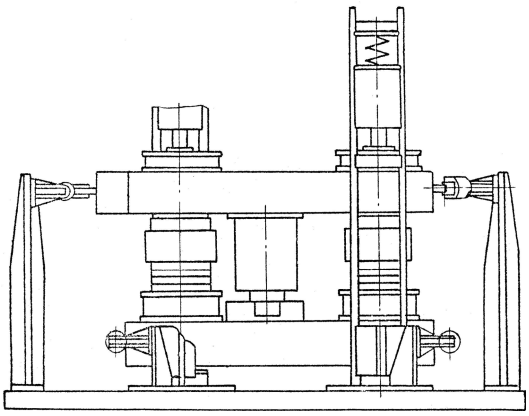

Fig. 6. General view of the test bench for testing car body with trolleys

On the test bench has to evaluate the dynamic properties of the set of ITR depending on the frequency of deformation and the oscillation amplitude.

Experimental studies to determine the resistance forces and moments acting in the supporting-return units in turn applies to carriage performed four test bench.

If necessary, test bench simulates:

- the dynamic fitting into the locomotive into curves track sections, accompanied by a car body of the locomotive and relates the change in the load bearing, pressure reducing valves alter the loading towers, located on either side of the longitudinal axis of the truck at the same distance by changing the pressure in the hydraulic cylinders;

- galloping carts and sales traction, pressure reducing valves dropping pressure in hydraulic cylinders, creating a difference in load bearing front and rear facing carts.

CONCLUSIONS

Experimental and measurement system for investigating the carriage and the terms of engagement of the rolling stock ensure a complete set of test chassis rail vehicle with the theoretical and practical problems of creating new technology. It reduces a series of studies of the newly created and existing rolling stock, increases the accuracy of the results and their reliability, improves the quality and information content of experimental studies.

The advantage of an experimental measurement system for investigating the carriage and the terms of engagement of the rolling stock is:

- easy management of frictional contact conditions, by controlled delivery of test substances into contact;

- possibility to simulation traction, braking, slippage;

- possibility study of contamination on a real rail.

REFERENCES

1. **Buhanchenko S.E. 2005.:** An automated system for tribological tests of structural materials and lubricants under static and dynamic conditions PhD, Tomsk Polytechnic University,187 p.
2. **Poole, W. 2008.:** Guidance on Wheel/Rail Low Adhesion Measurement, Rail Safety and Standards Board, GM/GN2642, Londen.
3. **Churkin A.V. 2008.:** An automated system for the study of frictional properties of surfaces with anisotropic roughness PhD, Udmurt State University, 178p.
4. **Burstow M.C. 2006.:** Rolling Contact Fatigue Laboratory Testing, February 2006, Rail Safety and Standards Board, AEATR-ES-2004-907 Issue 1, Londen.
5. **Golybenko A., Kostyukevich A., Tsyganovskiy I., Nozhenko V. 2011.**: The influence of a rail lateral bending on the stress – strain state of a wheel-tail contact, TEKA Komisji Motoryzacji i Energetyki Rolnictwa VXC, p. 78-84.
6. **Golybenko O., Gorbunov M., Kachyra O., Kostyukevich A., Kravchenko K., Popov C.,Krisanov M., 2009.:** bulletin № 6 20.08.2009 Patent for useful model № 48516, cl. V61S 15/00. Method of improving adhesion in the contact wheel with rail.
7. **Gorbunov M.I., Kostiukevych O.I., Kovtanets N.V., Kravchenko K.O., 2010.:** Increasing friction wheels rail by sandblasting cleaning their contact Transportation and Logistics: II Ukrainian scientific-practical conference of young scientists and students, 13 - 14 October 2010, Donetsk, pp. 166 - 169.
8. **Gorbunov N., Kostyukevich A., Kravchenko K., Kovtanets M. 2011**.: Influyense of operational factors on redistribution of wheel pairs wertical loads upon rails, TEKA Komisji Motoryzacji i Energetyki Rolnictwa VXC, p. 92-98.
9. **Gorbunov N., Kovtanets M., Kravchenko E., Krysanov M., 2010.:** Increased coupling as the engine clutch control interaction "wheel-rail", Proc. 1 stud. scient. conf. "Innovative technologies for rail transport", 23 - 25 September, Lugansk, pp. 46 - 49.
10. **Gorbunov N.I., Kravchenko E.A., Lewandowski V.A., Nesterenko V.I., Kovtanets M.V., Nozhenko V.S., 2010.:** Ways to solve the problem of increasing the towing and dynamic qualities of locomotives, Int. inf. scient. and tech. J. "Lokomotivinform», № 5, pp. 38-41.
11. **Isaev I., 1988.:** Improvement of experimental studies traction locomotives and rail, Railways of the world, № 10. – p. 2 – 10.
12. **Kostyukevich A., Gorbunov M., Kovtanez M., Noghenko V., Chernikov V., Tsyganovskiy I.,2011.:** bulletin №24 26.12.2011, Patent for useful model № 65999. Machine to determine the friction properties of friction contact "wheel-rail".
13. **Kostyukevich A., Gorbunov M., Kravchenko K., Popov C., Nozgenko V., Kovtanets M., 2010**.: Automated measurement and modeling bench unit "machine friction" for the study of frictional contact properties "wheel-rail", Sat. scientific papers X Intern. Conf. "Tribology and Reliability", Saint Petersburg, 165 – 174 p.
14. **Kostyukevich A.I., 1991.:** Numerical and experimental identification process traction locomotives with rails PhD, Lugansk, East-Ukrainian National University named after Volodymyr Dahl, 214 p.
15. **Luzhnov Y.M. 1978**.: Physical and patterns traction locomotives with rails PhD, 355 p.
16. **Osenin Y.I., Marchenko D.M., Shvedchikova I.A., 1997.:** Friction interaction with rail wheels, Lugansk, 228 p.

17. **Prudnikov M.I. 2009.:** Development of the normalized method and automated testing friction machines PhD, Bryansk State Technical University, 201 p.
18. **Gorbunov M.I., Kashura O.L., Spiryahin V.I., Kostyukevich M.I., Mikheyev A.S., 2003.:** Stand for research traction wheels with rail and test items axle spring suspension and rolling stock, Patent for useful model № 52970 A., Lugansk.

ЭКСПЕРИМЕНТАЛЬНО-ИЗМЕРИТЕЛЬНЫЙ КОМПЛЕКС ДЛЯ ИССЛЕДОВАНИЙ ХОДОВОЙ ЧАСТИ И УСЛОВИЙ ВЗАИМОДЕЙСТВИЯ ПОДВИЖНОГО СОСТАВА

Владимир Ноженко, Николай Горбунов, Сергей Мокроусов, Вячеслав Черников, Максим Ковтанец, Ростислав Демин

А н н о т а ц и я . От процессов, происходящих в контакте колеса и рельса, зависит работа подвижного состава железных дорог. Потребляемая энергия реализуется в контакте «колесо-рельс», а эффективное использование этой энергии зависит в основном от сцепления колеса с рельсом. В статье описано стендовое оборудование позволяющее исследовать ходовой части и условие взаимодействия вновь создаваемого и эксплуатируемого подвижного состава на кафедре железнодорожного транспорта Восточноукраинского национального университета им. В. Даля в лаборатории «Трение и смазка в приводах локомотивов».
К л ю ч е в ы е с л о в а *:* подвижной состав, стендовая установка, сцепление, коэффициент трения.