SELECTED ABSTRACTS OF D.SC. & PH.D. THESES SUBMITTED AT RUSSIAN TRANSPORT UNIVERSITIES

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Akashev, M. G. Refinement of the methodology for assessing the processes of interaction between cargo car wheels and rails using a strain gauge wheel set. Abstract of Ph.D. (Eng) thesis [*Utochnenie metodiki otsenki protsessov vzaimodeistviya koles gruzovogo vagona i relsov s primeneniem tenzometricheskoi kolesnoi pary. Avtoref. dis… kand. tekh. nauk*]. Moscow, RUT (MIIT) publ., 2023, 21 p.

Ensuring safety of railway traffic is an important problem, and the task of improving the methodology for assessing the processes of interaction between wheels and rails during features of a cargo car, considered in this thesis, is relevant.

The objective of the work is to improve the technology for assessing the condition of the track, as well as methods for assessing the impact of rolling stock on the track and the dynamic features of the rolling stock.

It has been established that the use of a strain-gauge wheel set provides sufficient accuracy and ample opportunities to perform long-term recordings of the forces of interaction between wheels and rails on a section of track of any length, necessary for the probabilistic analysis of these processes.

A finite element model of a strain-gauge wheel set of a cargo car was developed using the «Universal Mechanism» software package, which made it possible to perform calculations of its stress-strain state and determine the installation locations of strain gauges that make it possible to measure with the smallest errors the lateral and vertical forces at the points of contact of the wheels with the rails.

An object car was created, consisting of an empty tank car with an oncoming strain gauge wheel set, to identify dangerous sections of the track where there is a decrease in the safety factor of the wheel against derailment below the normalised value.

To test the identification of track sections that are dangerous due to wheel derailment conditions, field and operational tests of a specially formed experimental train were carried out, the latter consisted of a cargo car with a strain gauge wheel set, a track measuring car and a laboratory car with simultaneous recording of signals from all measuring devices.

A geometric-force method for assessing the condition of the track is proposed, which significantly complements the existing one, based on identifying deviations in the geometry of the rail track, since it allows one to determine sections of the track that are dangerous due to the conditions of derailment of the wheels of empty cars, which, according to existing standards, would be considered harmless for their movement.

Based on the results of experimental tests carried out on the railway network, a technology of a geometric-force method for assessing the state of the track has been developed and approved by JSC Russian Railways, which makes it possible to identify track sections in which the safety factor of the wheel against derailment decreases below the standard value of 1,3, set for cargo cars.

It is proposed that to determine the probabilistic characteristics of lateral forces, it is advisable to use a technique for isolating a random signal against a background of noise and represent their recording as a product of two random processes: telegraphic and modified.

The results obtained showed that the use of a strain-gauge wheel set and the wheel-rail interaction processes determined with its help makes it possible to refine the assessment of the state of the track and indicators of impact on the track.

The prospect for further development of the topic is improvement of the strain gauge wheel set, the development of new schemes and methods that allow taking into account the influence of additional factors on the accuracy of determining the forces of interaction between the wheel and the rail.

2.9.3. – Railway rolling, train traction and electrification.

The work was performed and defended at Russian University of Transport.

Grebennikov, N. V. Scientific basis for increasing the energy efficiency of autonomous locomotives with electric power transmission. Abstract of D.Sc. (Eng) thesis [*Nauchnie osnovy povysheniya energeticheskoi efffetivnosti avtonomnykh lokomotivov s elektricheskoi peredachei moshchnosti. Avtoref. dis… dok. tekh. nauk*]. Rostov-on-Don, RGUPS publ., 2023, 40 p.

Objective of the work is development of new scientifically based technical solutions, concepts of structure and operating modes of traction equipment of locomotives with electric power transmission, ensuring increased energy efficiency of operation, based on methods for processing recorded information by on-board systems of locomotives.

Based on the analysis of the current state of the problem of operating efficiency of autonomous locomotives, it has been established that the energy efficiency of locomotives is standardised only for the full power of the diesel generator set, and the operating efficiency is assessed by specific fuel consumption per unit of transportation work, and the lower is the load on the axle of the car, the greater is the specific diesel fuel consumption, and therefore increased energy efficiency, cannot be achieved solely through creation of new powerful locomotives, and special attention should be paid to the operating modes of locomotive traction equipment, which will allow the power characteristics to be adjusted to operating conditions.

Analytically, patterns have been established that make it possible to determine the efficiency of traction electrical equipment of locomotives, depending on the current and output/input power. It has been proven that voltage regulation leads to a significant reduction in the energy efficiency of traction electrical and electromechanical energy converters on autonomous locomotives with electric power transmission.

By applying the energy approach, a methodology has been developed and theoretically substantiated for assessing the energy efficiency of operating autonomous locomotives with electric power transmission based on the passport data of traction equipment and parameters obtained from locomotive recorders.

Based on the analysis of operational data, it was established that the diesel generator set of cargo, passenger and shunting locomotives operates for a long time with loads of less than 50 %, this necessitates the use of multi-diesel power plants for locomotives of all types of traffic. The operating conditions of electric power transmission elements are determined and the underutilisation of energy efficiency of energy conversion is revealed, especially in direct and alternating-direct current transmissions, due to the low power utilisation factor of the diesel generator set and electric power transmission in general.

By applying the developed methodology for assessing the energy efficiency of operating autonomous locomotives and analysing the results obtained, a concept for increasing energy efficiency has been developed, substantiated and formulated, which is based on the principle of scalability of the traction equipment used in an autonomous locomotive depending on operating conditions.

The use of the finite element method for carrying out traction calculations is theoretically justified, allowing for the expansion of existing methods for carrying out traction calculations in order

to construct optimal train trajectories taking into account the operating modes of traction equipment of autonomous locomotives.

The reliability and adequacy of the accepted scientific principles in development of a complex computer model of an autonomous locomotive with a modular structure of electric power transmission has been experimentally proven by comparing the theoretical results of calculations on a computer model and the results of experimental studies of the layout of the traction module of electric power transmission.

The theoretical and experimental results of the thesis research found practical application in development of a set of traction electrical equipment for electric power transmission of an autonomous locomotive. The use of the proposed concept of a modular structure of traction equipment together with brushless electric traction machines made it possible to provide the necessary traction characteristics with high efficiency values (for a shunting locomotive) of both the traction motor up to 94,6 % and the entire electric power transmission as a whole up to 85,4 %, which was confirmed on an experimental sample of a set of traction electrical equipment for electric power transmission of an autonomous locomotive.

The results were used to modernise the traction drive of the TGM6A series shunting diesel locomotive, which made it possible to obtain high traction and energy characteristics of the modernised TEMP-1tt diesel locomotive. Acceptance and qualification traction tests of the TEMP-1tt diesel locomotive confirmed diesel fuel savings of up to 30 % and an increase in productivity by 25 %.

2.9.3. – Railway rolling stock, train traction and electrification.

The work was performed and defended at Rostov State Transport University.

Mishkin, A. A. Increasing the efficiency of diesel locomotives by replacing part of the diesel fuel with hydrogen using an on-board aluminum-hydrogen generator. Ph.D. (Eng) thesis [*Povyshenie effektivnosti teplovozov putem zameshcheniya chasti dizelnogo topliva vodorodom s ispolzovaniem bortovogo alyumovodorodnogo generatora. Avtoref. dis…kand.tekh.nauk*]. Samara, SamGUPS publ., 2023, 24 p.

The objective of the thesis work was to increase the efficiency of locomotives by using an aluminum-hydrogen generator with development of technical and technological solutions for on-board hydrogen generation to transfer the operation of the power plant of a shunting diesel locomotive to a fuel-hydrogen mixture.

The analysis of the current state of the use of hydrogen as an additive and the main fuel for traction rolling stock showed that currently there is a problem with its effective use on locomotives, both from a technical point of view and from a safety point of view. It has been established that the most acceptable is the use of hydrogen as an additive to diesel fuel using on-board hydrogen production devices. It has been shown that the most effective method for on-board production of hydrogen on a diesel locomotive is the hydrolysis of aluminum.

The proposed methodology for calculating the energy characteristics of a mixed fuel based on diesel fuel and hydrogen makes it possible to determine the indicators of the operation of the power plant of a shunting diesel locomotive in different modes. Additionally, it makes it possible to establish the necessary quantitative additions of hydrogen according to the load characteristic, taking into account the mass flow rate of the hydrogen addition and the supplied heat from its combustion in the fuel-hydrogen mixture, as well as taking into account the power consumption for driving auxiliary equipment. It has been established that when replacing part of the diesel fuel with hydrogen during the operation of the locomotive power plant, it is optimal to use hydrogen additives from 1 % to 5 % at idle speed and at 1st, 2nd, 3rd positions of locomotive driver's controller (PKM), which makes it possible to increase the efficiency of the shunting diesel locomotive, based on the specifics and conditions of its operation in these modes, in which 70–90 % of the locomotive loading time is carried out.

The calculation of the components of the aluminum hydrolysis process based on the stoichiometric balance, and the identified model of the pattern of changes in the consumption of the required amount of hydrogen from the components of the hydrolysis process during the operation of the diesel locomotive power plant according to the load characteristic made it possible to determine the required amount of water, alkali and aluminum depending on the operating modes of the locomotive power plant. The required productivity of the on-board hydrogen production device was 0,09–0,91 kg/h with the established range of the required amount of aluminum (1,18–15,341 kg/h), water (1,877–24,395 kg/h) and alkali (1,389–18,054 kg/h) when the engine is operating at low load conditions (up to 3 PKM).

The developed algorithm for operation of the on-board system for producing and supplying hydrogen to the diesel engine of a locomotive and a set of patented technical means for generating hydrogen on board a shunting diesel locomotive can be adapted for replacement of part of the diesel fuel with hydrogen. This complex includes: a device for measuring indicator parameters in the cylinders of internal combustion engines, hydrogen generator (AHG) and an electronic control device for the joint supply of fuel and hydrogen additives. The developed and proposed technical solutions make it possible to use hydrogen as an additional fuel on locomotives according to the principle of «using hydrogen without hydrogen on board.» This, in turn, will allow us to move away from the use of on-board hydrogen storage systems, the operation of which is unsafe. The necessary requirements and measures have been formed to comply with the safe use of hydrogen during operation of a shunting diesel locomotive, which are aimed at reducing human factors and maximising the isolation of hydrogen from oxidizers.

Tests of the developed laboratory sample of AHG made it possible to establish the permissible temperature regime in the range of 60–70 °C, ensuring its optimal operation. The specific productivity for hydrogen was $8.95 \cdot 10^{-4}$ m^3 (m^2·s), the experimentally obtained hydrogen yield was 0,98–1,03 l/g. Experiments on the joint operation of the D-242 diesel engine and generator have shown a sufficient degree of development, which allows further research to test this technique on a diesel locomotive.

The resulting economic effect from the use of hydrogen produced and supplied as an additive to diesel fuel using the developed on-board AHG for one shunting diesel locomotive ChME3 amounted to 326024,19 rubles per year.

The scientific results of the thesis work can serve for technological, thermal and economic calculations when optimising and improving the operation of on-board devices (generators) for producing hydrogen for autonomous traction rolling stock.

2.9.3. – Railway rolling stock, train traction and electrification.

The work was performed and defended at Samara State Transport University.

Tsaplin, Ya. N. Improving the method for assessing the load-bearing capacity of rigid airfield pavements. Abstract of Ph.D. (Eng) thesis [*Sovershenstvovanie metod otsenki nesushchei sposobnosti zhestkikh aerodromnykh pokrytii. Avtoref. dis…kand. tekh.nauk*]. Moscow, MADI publ., 2023, 16 p.

The objective of the study was to develop a method for assessing the load-bearing capacity of rigid concrete and reinforced concrete pavements, based on taking into account the characteristics of modern aircraft and the actual stress-strain state of airfield pavements to determine their operating modes.

It was revealed that existing methods for assessing the load-bearing capacity of airfield pavements do not take into account the characteristics of modern aircraft and the stochastic nature of the characteristics of operated airfield pavements.

A methodology has been developed for classifying aircraft by bending moments in the pavement, taking into account the characteristics of aircraft in terms of force effects on the pavement and allowing for comparison of loads from aircraft with standard load categories.

A numerical experiment to test the strength of the soil foundation showed that heavy types of aircraft can cause unacceptable stresses in the soil foundation of the concrete pavement. It is recommended for class 1 aircraft to additionally calculate the strength of the soil base of concrete and reinforced concrete pavements.

Methods have been developed for planning and processing test results of concrete and reinforced concrete pavements to determine statistical characteristics: elastic characteristics of the slab, bed coefficient and cross-sectional rigidity of the slab.

The methodology for determining the load-bearing capacity of concrete and reinforced concrete pavements based on the results of full-scale tests, considering the characteristics of aircraft supports, has been improved.

A software package has been developed for assessing the bearing capacity of concrete and reinforced concrete pavements, taking into account the probabilistic and statistical variability of the basic arguments. It is recommended to use the programs in organisations involved in testing concrete and reinforced concrete pavements and assessing their load-bearing capacity.

The prospect for further development is to improve methods for assessing the bearing capacity of reinforced concrete monolithic and prefabricated airfield pavements, as well as asphalt concrete pavements.

2.1.8. – Design and construction of roads, metro, airfields, bridges and transport tunnels.

The work was performed at Moscow Automobile and Road Construction State Technical University (MADI), defended at Russian University of Transport. ●

NEW BOOKS ON TRANSPORT AND TRANSPORTATION

The list of titles in Russian is published in the first part of the issue.

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