

ANNOTATION

for a dissertation for the degree of Doctor of Philosophy (PhD) in the specialty 6D071300 – «Transport, transport equipment and technology»

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SELECTION, JUSTIFICATION AND MANUFACTURING OF MECHANISMS AND UNITS OF ROLLING RAILWAY STOCK TO INCREASE SPEED OF MOVEMENT

Assessment of the current state of the solved scientific or scientific and technological problem.

The value of transport, incl. railway transport in Kazakhstan is very large. More than 68% of the total freight turnover and more than 57% of the country's passenger traffic are accounted for by railways. At the same time, the share of passenger traffic annually is up to 20% (about 15 billion pkm) compared to the freight turnover of rail transport.

To date, the depreciation of the locomotive fleet of Kazakhstan is more than 75%, and passenger cars - 50%.

Accordingly, the renewal or modernization of the existing locomotive and wagon fleet will increase the speed of passenger traffic and improve the logistics of rail transportation.

All this is possible as a result of solving research problems by improving the design, design and manufacture of parts of assemblies and mechanisms using machine-building technologies.

Correspondence of the topic with the directions of the development of science or state programs. The dissertation work was carried out within the framework of the research work: Improving the dynamic qualities of the train through the introduction of pneumatic elastic elements.

Relevance of the topic. On an ongoing basis, incl. At the level of the Government of the Republic of Kazakhstan, the issue of organizing high-speed traffic between the cities of Kazakhstan is being worked out. To implement this ambitious project, it is necessary to develop the work of not only border stations in Kazakhstan, but also to strengthen all internal railway lines in order to increase capacity.

Given the growing interest of European and Asian states in the transit of their goods through the territory of Kazakhstan along the China-Europe route, the realization of the transit potential is also one of the priorities of the country's economic policy.

At the same time, it is considered especially relevant to improve passenger communication between cities by introducing high-speed passenger traffic. JSC «NC KTZ» constantly increases the speed of trains. From 2012 to 2017, the average speed on the network increased from 41.9 km/h to 44.2 km/h.

As the analysis of the annual financial resources allocated for the strengthening of the railway infrastructure shows, further reduction of the travel time requires more and more funds.

In 2010, in accordance with the instructions of the management of «NC KTZ» JSC, in order to prepare the main infrastructure for ensuring high-speed passenger traffic, an action plan was developed, which provided for implementation in 2 stages: with the organization of traffic at a speed of 140 km/h and until 2020 at a speed of 200 km/h. Until today, the speed of passenger traffic has not reached this intended goal.

With the existing structures of railway tracks in Kazakhstan, it is very difficult and relevant to compensate for the negative effect of centrifugal forces on curves, despite the presence of certain values of the elevation of the outer rail, which can compensate for the emerging centrifugal forces only up to a certain speed.

To do this, it is necessary to develop an approach that, with a minimum expenditure of time, effort and money, can reach an increase and acceleration of passenger traffic. This approach, and the only one, is the modernization of the design of mechanisms and machines of existing rolling stock, allowing to achieve the desired result.

Scientific substantiation of technical requirements for machines and mechanisms that provide high-speed movement, for their stable and economical design are relevant at the present stage. For some positions, solutions have not been found until recently.

This paper provides a solution to the issue related to ensuring high-speed traffic by modernizing the design of individual units and mechanisms of the existing locomotive and wagon fleet using mechanical engineering technology.

Thus, this paper presents options for solving the issue related to ensuring traffic speeds using large nodes and mechanisms of the Existing locomotive fleet and substations in the construction of fast railways in Kazakhstan. In particular, the study is aimed at finding opportunities with the use of structural components of mechanisms and assemblies of locomotives and passenger compartments in identifying their combination of characteristics.

Purpose of the study.

The aim of the work is to develop the design of individual mechanisms and assemblies, as well as their manufacturing technology to increase the speed of movement of locomotives and passenger train cars.

The object of the study is the mechanisms and components of a passenger train with high-speed movement.

The subject of the study is the improved design of units and mechanisms of railway transport, which allows to increase the speed of movement.

Research objectives.

In accordance with the goal in the dissertation work, the following **tasks** are solved:

- a comprehensive analysis of studies on the disorders of the rail track of the railway track under the influence of substations and vice versa, the processes of

oscillations in the nodes of locomotives occurring as a result of the dynamic impact of the rails and the under-rail foundation of the track;

- study of the possibility of passing high-speed passenger trains on the example of the Almaty-Astana section;

- research and improvement of the design of the nodes of the system of spring suspension of the rolling stock;

- research and improvement of the system of inclination during the movement of the rolling stock in a curve;

- design of the structure and manufacture of parts for mechanisms and assemblies of the locomotive and the carriage of the passenger substation.

Research methods. In theoretical studies, the provisions of fundamental and applied sciences are used: the theory of elasticity, the theory of mechanisms and machines, theoretical mechanics. In experimental studies, physical modeling of the motion of the rolling stock in curves, track deformations with the processing of experimental data by methods of probability theory and mathematical statistics were used.

Scientific provisions submitted for defense:

- systematized general patterns of interaction between the parameters of the railway track and the substation, allowing to make constructive decisions to improve their interaction;

- a modernized design of the spring suspension system, which allows reducing the impact of the rolling stock on the railway track through the use of an additional unit with pneumatic elements;

- created on the basis of kinematic synthesis, the design of the mechanism for turning the car body, which allows to increase the speed of the substation by adjusting the inclination of the car body when moving in a curve;

- justified elements of the design of the rack and pinion gear of the car body turning mechanism, as well as the technology for manufacturing the materials of its main parts.

Scientific novelty of the research:

- a systematic analysis of the established patterns of disorders of the rail track under the influence of substations and vice versa, dynamic processes in the nodes of locomotives and wagons, occurring as a result of the impact of rails and the under-rail foundation of the track, was carried out;

- a pneumatic spring suspension unit was developed and recommended for implementation for a specific series of a locomotive of the inventory fleet of Kazakhstan railways;

- substantiated and developed technical solutions and a method for calculating the structural elements of the car body turning mechanism for adjusting the inclined position;

- selected and substantiated design elements of the rack and pinion gear of the car body turning mechanism, as well as established technologies for manufacturing materials for its main parts.

The validity and reliability of scientific provisions, results and recommendations are based on the use of standard proven methods and research

methods, the use of physical laws, the high convergence of the results of theoretical and experimental data, using methods of statistical processing of experimental results with a high correlation index.

Practical significance of the work:

– the established patterns of the influence of the parameters of the under-rail base of the track and the developed mathematical models of the processes of oscillations of a diesel locomotive ensure the accuracy and reliability of the calculations of the necessary parameters for improving the mechanisms and units of railway transport;

- the methods used for designing the design of the mechanism for turning the car body and the locomotive spring suspension unit can serve as a method for calculating similar mechanisms and units of other types of locomotives and cars to increase their speed of movement;

– the method used for calculating the design of the gear-and-rack transmission of the car body turning mechanism, as well as the technology for their manufacture, ensure the reliability of the functioning of the roll compensation system for passenger cars during high-speed movement in a curve.

The results of the study were submitted for implementation in the production of the branch of «JSC NC KTZ Almaty branch of SE», and are used in the educational process in the preparation of students in the specialties "Engineering" and «Transport, transport equipment and technologies» of the Kazakh University of Railway Transport.

Applicant's personal contribution. The main results of the dissertation submitted for defense were processed and presented by the applicant personally, including the results of theoretical and experimental studies in the production activities of JSC «NC KTZ» for the reporting period, the devices and principles of operation and design of mechanisms and units of the substation, their individual technical characteristics.

Approbation of the results of dissertations. The main provisions of the dissertation and the results of the study were reported and discussed at scientific seminars of the Department of Transport Engineering, Mechanical Engineering and Standardization of the Kazakh University of Communications (2020-2022), as well as at the following conferences: International scientific and practical conference on the topic: «Innovative technologies on transport: education, science, practice» (Almaty, KazATK named after M. Tynyshpaev, 2018); International Scientific and Practical Conference «Transport of Eurasia of the 21st century: Modern digital technologies in the market of transport and logistics services» (KazATK named after M. Tynyshpaev, 2018); XV Międzynarodowej naukowo-praktycznej konferencji, «Nauka i Inowacja» (Przemyśl, Polska, 2019).

The results of this work are recommended by the department «Transport Engineering, Mechanical Engineering and Standardization» for the release of a textbook for students in the educational program «Transport Engineering and Technology» and university teachers.

Publications. The main results of the dissertation work were published in 19 publications, including 11 articles in journals recommended by the Committee for

Quality Assurance in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan; 3 articles in journals of the Scopus database, 2 articles in foreign scientific publications; 4 publications in International conferences, 1 of which is foreign.

Contribution of the dissertation student to the preparation of publications.

Drawing up plans for articles, writing sections, discussing research results and conclusions, designing articles:

1 Оценка влияния качественных показателей использования подвижного состава на себестоимость перевозок.

2 Жүк вагондары мен локомотивтердің түріне байланысты маршруттық тасымалдауды енгізудің тиімділігін бағалау.

Selection of materials for the review, writing a review and introduction, writing individual sections and their results, designing articles:

3 Mathematical and computer models in estimation of dynamic processes of vehicles.

4 Влияние пропуска поездов в различных условиях на участковую скорость.

5 Влияние системы тягового обеспечения на устойчивость и эффективность перевозочного процесса.

6 Тяговое обеспечение процесса преобразования блок-поездов.

7 Перспективы улучшения горизонтальной динамики локомотива.

8 Тепловоздардың тартымдық қасиеттерін жоғарылату.

9 Перспектива увеличения пропуска контейнерных поездов.

10 Оптимизация технико-технологических параметров работы станции и параметров грузовых поездов.

11 Перспективы внедрения высокоскоростного движения в Казахстане.

12 Способ оценки производительности формирования и пропуска соединенных грузовых поездов на железнодорожных участках.

13 Возбудители колебаний и вопросы возмущения подвижного состава от состояния пути.

14 Стендовые испытания пневматических элементов подвижного состава.

15 Модернизация локомотива с целью улучшения его динамических характеристик.

16 Вопросы улучшения динамических характеристик тягового подвижного состава.

17. Формирование состава на железнодорожном пути с различной колеей.

18 Adaptive frame of universal vehicle course.

19 Design of adaptive suspension for universal vehicle course.

The structure of the work. The dissertation consists of an introduction, four sections, a conclusion set out on 147 pages, contains 37 figures, 24 tables, 108 references and applications.

