

## ABSTRACT

of thesis «**Methods of coordinate closure of automated milling cutters for the repair of track formation of road surfaces in conditions of high summer temperatures in Southern Kazakhstan**» submitted in candidacy for the PhD degree in **6D071300 – «Transport, transport equipment and technologies»** by **Kamzanov Nurbol Sadykanovich**

**General characteristics of the work.** In the work, based on mathematical calculation and simulation modeling, the theoretical foundations of the interaction of cutting elements of automated road cutters (ADF) for the repair of track formation of road surfaces with the use of coordinate closure and the use of modern scanning and navigation systems of the roadway in conditions of elevated summer temperatures in Southern Kazakhstan are discussed..

**Relevance of the research topic.** The road is exposed to various kinds of impacts of transport and weather and climatic factors during operation. The very first and most unprotected element of it, experiencing such effects, is an asphalt concrete coating. Practice has established that the main reason that has the greatest impact on reducing the quality of the roadway is called excess weight, the flow of cars that form a track, as well as the stress-strain state and service life of asphalt concrete road surfaces depend on elevated summer temperatures.

Rutting on highways is one of the main reasons leading to an increase in the risk of road accidents, reduces the comfort and economic efficiency of using highways.

Over the past more than twenty years, road equipment has been modified. Accordingly, the requirements for the technology of road surface profiling, including milling, should be revised, justified and supplemented.

The creation of the ADF made it possible to implement the operations of milling tracks and their flogging much easier and more efficiently as part of measures to repair highways and ensure road safety.

Therefore, improving the efficiency of road surface repair based on the use of coordinate closure of ADF is an urgent task.

To solve this problem, the order of transition from elastic (power) to rigid (coordinate) closure of the kinematic scheme of track milling has been developed, while taking into account the elasticity of the milling cutter-tool-coating (FIP) system when assigning milling allowance, and laser scanning of the coating profile has been applied.

The purpose of the work. The aim of the work is to increase the efficiency and expand the functionality of the use of coordinate closure of automated milling cutters, and the development of a new working body (RO) of a milling cutter for the repair of track formation of road surfaces in conditions of elevated summer temperatures in Southern Kazakhstan.

Research objectives. In accordance with the stated purpose of the study, the following tasks were solved:

- analyze existing processes and kinematic schemes for the repair of rutting of road surfaces and identify prevailing factors of various nature affecting the quality indicators of the road surface being repaired;
- perform an analysis of scientific, technical, patent literature and systematize patent information on the use of road cutters and determine ways to improve them based on the equations of patenting dynamics;
- to develop a new design of a road milling cutter for the repair of rutting in road surfaces, which makes it possible to increase the efficiency of the milling process of road surfaces;
- to establish the mathematical dependence of the milling of the track formation of the road surface with the possibility of switching to a digital model;
- to conduct bench experimental studies in order to develop methods for milling the rutting of road surfaces;
- to develop models of the milling process based on the coordinate closure of automated milling cutters for the repair of track formation of road surfaces;
- calculate the technical and economic efficiency of using a new road milling cutter rotor.

**The object of the study.** The object of the study is the RO ADF and methods of their coordinate closure for the repair of track formation of road surfaces in conditions of high, elevated summer temperatures in Southern Kazakhstan.

**Research methods.** The general methodology of research is determined by the construction of the relationship between the current problems of road safety, technology for the repair of track formation of road surfaces and the new constructive implementation of road cutters and their nodes working on this technology. The research was carried out using methods of theoretical mechanics, mechanical engineering technology, methods of using road construction machines, probability theory and mathematical statistics, experimental research and statistical data processing.

**The scientific novelty of the work is determined by the following provisions:**

- proposals have been developed for the selection of optimal methods of coordinate closure of automated milling cutters for the repair of track formation of road surfaces with dimensional and mechanical characteristics and layouts of road milling cutters;
- a new design of a road milling cutter for the repair of track formation of road surfaces has been developed, the novelty of which is confirmed by patent No. 35196 "Milling drum", authors Kulgildinov M.S., Kamzanov N.S. and others, Bull. No. 9 dated 09.07.2021.;
- a mathematical dependence of the milling of the track formation of road surfaces with the possibility of switching to a digital model has been developed;
- experimental studies have established the provisions of modeling the process of milling the pavement by force and coordinate closure and obtained regression equations describing the relationship of the parameters of this process.

**Practical value of the work.** It consists in the method of transition from elastic (force) closure to rigid (coordinate-kinematic) closure of the technological scheme of track milling, which allows not only to reduce the current average deviations of the height of the milled surfaces, but also their variations of deviations from the average.

The developed new design of the road milling cutter ensures that, in the process of milling the pavement, depending on the information obtained through laser technologies installed on road objects and from scanners installed on road milling cutters, the cylinder rods can be synchronously extended to the desired length, ensuring the removal of the asphalt concrete coating allowance until the defect is completely eliminated.

**The following main provisions are submitted for protection:**

- morphological classification of patents and the equation of patenting dynamics of road milling cutters, allowing to establish new trends in their improvement;

- a new design of a road milling cutter for the repair of rutting of road surfaces;

- mathematical dependence, with which you can assign the depth and other milling parameters, taking into account the elastic modulus of the track and the rigidity of the milling cutter-tool-coating system;

- method of transition from elastic (power) to rigid (coordinate) closure of the technological scheme of track milling;

- scanning and positioning technology that allows to create a fully functional ADF.

**Implementation of the results of the work.** The significance of the research results was confirmed by the acts of introduction into the enterprises «ҚАЗАҚАВТОЖОЛ» and «АЛМАТЫ ЖОЛДАРЫ» (Appendix A).

**Approbation of the work.** The results of the dissertation work were discussed and reported at:

- International Scientific and Practical Conference «Scientific Journal of the Modern Education & Research Institute» (Brussels, Belgium, 15.09.2019);

- International Scientific and practical Conference «Innovative technologies in transport: education, science, practice» (Almaty, 17.04.2020);

- During the passage of a foreign scientific internship in the interregional public organization of the city of Moscow «ПРОФЕССИОНАЛЬНЫЙ ИНЖЕНЕР», an experiment was conducted on the use of coordinate control in the working body of small-scale mechanization;

- Scientific and technical seminars of the Academy of Logistics and Transport and the Department of «Motor vehicles and life safety».

**Main publications:**

1. M.S. Kulgildinov, A.K. Kaukarov, N.S. Kamzanov, M.V. Taran, A. Zhauyt, B.M. Kulgildinov. Determination of kinematic and force parameters of the special bucket shovel for the development of large-block soils international journal of mechanical engineering and robotics research. International Journal of

Mechanical Engineering and Robotics Research. Vol. 9, No. 6, June 2020, pages 813-824. ISSN: 2278-0149 (Online).

2. R.A. Kozbagarov, K.A. Zhussupov, E.B. Kaliev, M.N. Yessengaliyev, A.V.Kochetkov, N.S. Kamzanov. Development of control suspension of attachment of a bulldozer. News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences, July-August 2020, 4(442), pages 166-174. ISSN: 2518-170X (Online), ISSN: 2224-5278 (Print).

3. R.A. Kozbagarov, M.V. Taran, K.A. Zhussupov, A.E. Kanazhanov, N.S. Kamzanov, A.V. Kochetkov. Increasing the efficiency of motor graders work on the basis of working elements perfection. News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences, January-February 2021, 1 (445), pages 98-105. ISSN: 2518-170X (Online), ISSN: 2224-5278 (Print).

4. R.A. Kozbagarov, N.S. Kamzanov, Sh.D. Akhmetova, K.A. Zhussupov, Zh.Kh. Dainova. Improving the methods of milling gauge on highways. News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences, May – June 2021, 3(447), pages 87-93. ISSN: 2518-170X (Online), ISSN: 2224-5278 (Print).

5. J.N. Kadyrov, N.S. Kamzanov, Z.R. Isabek, Milling drum. Patent No. 35091 for the invention.

6. J.N. Kadyrov, S.V. Li, E.A. Zhatkanbayeva, N.S. Kamzanov, etc. A device for cutting cracks in road surfaces. Patent No. 35118 for the invention.

7. M.S. Kulgildinov, J.N. Kadyrov, N.S. Kamzanov, etc. Milling drum. Patent No. 35196 for the invention.

**Structure and scope of work.** The dissertation work consists of an introduction, four sections and a conclusion set out on 124 pages of typewritten text, a list of 64 references, appendices on 21 pages and contains 12 tables and 52 figures.