

## ANNOTATION

of the dissertation work of Yesserkegenova Bekzat Zhambylkyzy on the topic "Development of an automatic control system for bituminous crushed stone distribution with synchronous distribution of components"

for the degree of Doctor of Philosophy (PhD)

specialty 6D071200 – Mechanical Engineering.

**The main characteristic of the work.** In the dissertation work on the base of studying and analyzing existed types of surface treatment of roads and work conditions of bituminous crushed stone distributors with synchronous distribution of components, proposed and carried out a number of automatic control systems (ACS) by the process of bituminous crushed stone distributors (BCD) with original functional elements, including BCD with flat-wacated and spherical rotary distributors of crushed stone. Using elaborated ACS by the process of bituminous crushed stone distributors afford to provide steady dosed distribution of components on road surface in automatic mode and to improve the quality of rough layer of the roadway.

**The relevance of the work.** Surface treatment is widely used for providing required parameter of roughness and wear resistance of road ways' cover. For providing the quality of surface treatment the time between applying on the surface of road binder layer and further distribution of crushed stone shouldn't exceed one second. For synchronous distribution of binder and crushed stone used bituminous crushed stone distributors.

Adhesion's endurance of binder with roadbed and crushed stone with binder depend on accuracy of dosing and evenness of distributing these components. However, BCD's work is carried out in extreme conditions with rather influences on them destabilizing factors which carry to variation of their physical conditions. Technical and operational characteristics existed BCD are practically exhausted.

In these conditions presentation of BCD with its entry and exit characteristics as an object which is distributed by the concept of automatic control, allow to increase its work. This approach for considering BCD as a control object and making an automatic control system (ACS) on its base by the process BCD is proposed for the first time and unknown from the results of conducted patent-information research. For realization of these systems regular knots of BCD should be completed with main functional elements of ACS – measuring transducers and executive mechanisms.

Functioning bituminous crushed stone distributors equipped with ACS in automatic mode provide high effectiveness of surface treatment device. For realization of such approach to control the process of bituminous crushed stone distribution should be developed new systems with modernization on the base of regular knots of BCD and equip them with functional components, providing process of controlling.

For analyzing regularity happening with equipped systems of automatic control bituminous crushed stone distributors, should be studied functional conditions,

analysing and identification of main functional connection and mathematical dependences.

Thus, considering the above, the topic of the dissertation work is actual.

### **Results obtained due to dissertation research:**

- an analysis and classification of existing types and phases of surface treatment equipment were carried out and a new type of surface treatment equipment was proposed – a device of noise edge band (“Musical highway”), which novelty was protected by Pat.Kz №35402.
- On the base of preparation and distributing the main components – binder and crushed stone – two automatic control systems (ACS) for process of bituminous crushed stone distributors, which novelty was protected by Pat.Kz Пат.ПК №34113 и №34235.
- For combined flat-oscillating crushed stone distributor mathematical dependencies of the oscillation amplitude of the cantilever paddle blade on the variable and unchanging parameters of BCD units were obtained, achievement conditions of power cylinder’s effective work has been adduced.
- Modernized mixed-distributed device of bituminous crushed stone distributors (BCD) has been elaborated (Application №2021/0644.1) and technological regulation of BCD’s work with this device has been made.
- A new way of mixing multi-fractional crushed stone (Application №2021/0761.1), based on putting additional high frequency controlled influences on flat-oscillated distributor has been proposed.
- For the elaborated spherical crushed stone distributor, the dominant destabilizing factor was identified as an inaccuracy in mutual position of the gate regarding rotation trajectory of the drum located inside it.
- Mathematical relationships of the distance between the center of the drum and the center of the inner curved surface of the gate was obtained for all possible variants their mutual position.
- Modernized device with the spherical rotating crushed stone distributor has been elaborated (Pat.Kz №35539), automatically providing guaranteed gap between rotating components of distributor.
- Analysis of the closed spray control loop on the binder substrate on roadway have been carried out, activities on decreasing the speed of control influence in this control loop have been done.
- New technical means for metrological providing ACS’s work of bituminous crushed stone distribution process were elaborated: device for measuring inclination angle of chassis (Pat.Kz №35536).
- For filling the bodywork of BCD with multi-fractional crushed stone, a roller crusher has been worked out which provides crushing source stone material until fraction of cube form and required size, its novelty was defenced Pat.Kz №35068.

- Original in design device was elaborated (Pat. Kz №35494) for estimating quality of formed during surface treatment of rough layer on roadways by the method of direct measuring adhesion's ratio of automobile's wheel with road.

- On experimental stands efficiency of principle of crushed stone distribution used in units with flat-oscilating and spherical rotating distributors was confirmed. Parameters' dependence of distributors from variable controlled was obtained.

**Purpose of the work** – finding new approaches for improving effectiveness of bituminous crushed stone distributors' work at the expense of developing on their base an automatic control system for bituminous crushed stone distribution.

**Tasks of the work:**

- to justify the opportunity of constructing BCD's regular nodes by their modernization and equipping measuring converters and executive mechanisms of automatic control system (ACS) by process of bituminous crushed stone distribution;

- to elaborate new main elements and on their base - an automatic control system for bituminous crushed stone distribution

- to obtain mathematical dependance of ACS's main elements' variation from changing destabilizing disturbing influences on the process of bituminous crushed stone distribution;

- to check the efficiency of ACS's elements at experimental stands and to plan the ways of their developing.

**The object of research** is a process of bituminous crushed stone distribution with synchronous distribution of components on the base of equipped with ACS's additional elements of regular distributors.

**The subject of research** is ACS's main elements of controlled process of bituminous crushed stone distribution.

**The scientific novelty is**

- the representation of bituminous crushed stone distributors as the objects of automatic control;

- elaboration of two automatic control systems of bituminous crushed stone distribution's process, defended Pat.Kz №34113 and №34235;

- new technical solutions: changeable- distributing device (application 2021/0644.1), the way of mixing multi-fractional crushed stones (application 2021/0761.1), modernized device with spherical rotating distributors of crushed stone (Pat. Kz №35539), technical means of metrological support of ACS's work (Pat. Kz №35536), the roller crusher (Pat. Kz №35068), device of direct measuring adhesion's ratio of automobile's wheel with road (Pat. Kz №35494), new type of device for surface treatment (Pat. Kz 35402);

- mathematical dependance of ACS's main elements' variation for the process of bituminous crushed stone distribution from changing destabilizing disturbing influences;

- confirmation of efficiency of ACS's main elements at experimental stands.

**Practical significance** of the research is in

- opportunity of increasing effectiveness of bituminous crushed stone distribution process on the base of equipped with ACS's additional elements of regular distributors;
- using elaborated new ACS (four variants) and new technical solutions (ten objects);
- efficiency of main functional units, including flat-oscillating and sphere-rotating crushed stone distributors.

**The next scientific positions are represented for defence:**

- newly created two ACS for process of bituminous crushed stone distribution (2 patents Kz);
- new technical solutions on modernization of functional BCD units and main ACS elements (seven technical solutions, theirs novelty is confirmed by patents and applications on the research);
- mathematical dependance of ACS's main elements' variation from changing destabilizing disturbing influences for the process of bituminous crushed stone distribution;
- the results of checking the efficiency of ACS's elements at stands.

**Approbation of the work.** The results of the research were reported and discussed on V International scientific-practical conference "Increasing reliability and safety of transport constructions and communications" November, 27-28, 2019 (Saratov, RF)

**Publications.** On the topic of the dissertation 16 scientific works were published, including two articles in the journal, indexed in the Scopus database, 11 Kz patents for invention were obtained, 4 applications for proposal inventions were submitted, one article was published in the V International Scientific-practical conference's collection of works.

**Realization of researches' results.** Experimental models of flat-oscillating and sphere-rotating crush stone distributors have been accepted to use on polygon of PLR "Akmolapribor" (Astana city)

**Structure and volume of the dissertation.** The dissertation work consists of definitions, designations and reductions, introduction, 6 sections and conclusion, list of used resources and applications.

The work is outlined on 146 printed pages, includes 65\_ drawings, \_7\_tables, list of used resources from \_44\_names and \_3 applications.