

## ANNOTATION

dissertation work of Bukayev Yeldar Zakharovich on the topic: «Improvement the ecology of sawn limestone production by recycling waste into innovative construction materials», submitted for the degree of Doctor of Philosophy (PhD) in the educational program 8D05201 (6D060800) – Ecology

### **Assessment of the current state of the scientific or scientific-technological problem being solved**

The Republic of Kazakhstan has significant resources of deposits of building stone of various rocks. Large deposits of shell limestone are concentrated in Western Kazakhstan. Currently, quarries are being actively developed and this building material is being mined.

The priority areas of scientific work identified by the Head of State Kassym-Zhomart Kemelovich Tokayev include the protection and rational use of natural resources. New strategies and scientific research in this area are becoming key in the light of sustainable development and environmental safety, which is relevant for the current state and development prospects of the Republic of Kazakhstan.

The main drawback of the problem of developing shell limestone deposits is the large loss of business stone associated with both the mining process and the geological nature of the occurrence of productive layers of stone. Waste accumulates in large quantities in dumps, and, carried by the wind, creates air pollution in nearby areas well above the CTL, harming the population and the environment.

One of the ways to increase the efficiency of development of limestone-shell deposits, in accordance with GOST 4001-2013 "Wall stones from rocks. Specifications" is the use of waste, which reaches 40-50% and more of the total production of business stone. There is a different use of waste in chemical production, cement production, and cosmetology, but the accumulation of waste is ultimately faster than their use due to insufficient use of this material.

The creation of an effective technology for the manufacture of building materials from shell limestone waste in a polymer-cement composition with mineral additives will make the accumulated waste a popular production raw material, thereby eliminating the existing critical air and environmental pollution.

### **Basis and basis for topic development**

The basis for the development of the topic of dissertation work is an initiative project conducted at the Caspian University of Technology and Engineering named after Sh. Yessenov (state registration number 0118RKIO426), the responsible executor of which is this PhD candidate.

The dissertation work was carried out within the framework of the state grant of the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan "Zhas Galym" No. AP22686399 "Reduction of

environmental impact by using sawed limestone production waste in new building materials".

### **Justification of the need for research work**

The rationale for the need for research is to address the issue of reducing the critical content of limestone dust in the air of settlements close to quarries, contributing to an increase in respiratory diseases, a decrease in the efficiency of solar and wind generation of electricity polluting pastures, which causes significant social tension in the region.

This can be achieved by creating a construction material demanded by the market with a low cost of production based on shell limestone waste, which will make it possible to eliminate the accumulated dumps of fine dust that create an unacceptable environmental threat to the environment and the population in the foreseeable future.

### **Information on the planned scientific and technical level of development, patent research and conclusions from them**

The planned scientific and technical development includes theoretical substantiation and practical confirmation of the effectiveness of the proposed new technology for creating a building material based on a polymer-cement composition from shell limestone waste formed during the extraction of sawn building stone.

The scientific and technical level of development is confirmed by the use of modern methods of research and analysis of literary data and patent materials in the field of building stone mining; more efficient use of deposit reserves owing to production of novel polymer-cement composition materials from shell limestone extraction wastes.

The patent search, in the direction of creating new technologies for the manufacture of building materials based on a polymer-cement composition and shell limestone, and their research, showed the absence of analogues of patented works close to the proposed technical solution.

Disclosed is a composition and technology of making construction material from limestone shell rock wastes and an aqueous solution of a polymer-cement composition. This method makes it possible to obtain materials with improved operational properties.

As a result of research, a patent was obtained for the utility model No. 4370 "Polymer cement composition" published 25.10.2019, bulletin No. 43 in the RSE "National Institute of Intellectual Property" of the Ministry of Justice of the Republic of Kazakhstan.

### **Information on metrological support of the dissertation**

Research on the topic of the dissertation was carried out using existing instruments and equipment. Experiments were carried out using instrumentation for measuring weight characteristics, pressure and temperature, which passed metrological verification.

The studies used qualified equipment to test the strength of building materials. The results of the work are based on proven engineering calculation methods and mathematical modeling. The repeatability of experimental data and theoretical calculations is confirmed by test and production verification reports.

### **Topic relevance**

At the present stage of economic and social development of the Republic of Kazakhstan, a special place is occupied by the problem of rational and integrated use of natural raw materials and fuel and energy resources. The saturation of production with modern technology, and the intensive pace of mining, has increased the number of technogenic impacts on the natural environment.

Half of the developed limestone deposits produce stones with a strength of up to 15 kg/cm<sup>2</sup>, which is reflected in the relatively low yield of standard stone, at best 70% of the volume of the developed rock, with an average yield of stone of about 50%. Half of the developed limestone deposits produce stones with a strength of up to 15 kg/cm<sup>2</sup>, which is reflected in the relatively low yield of standard stone, at best 70% of the volume of the developed rock, with an average yield of stone of about 50%.

The development of a waste-free technology for processing all types of limestone waste, with the production of new plasticized material, will reduce the cost of the main production of quarries, will help reduce the accumulated waste and improve the environmental situation.

In this regard, the problems of an integrated and systematic approach to the disposal of waste from the extraction of shell limestone are of particular importance.

Research uses a comprehensive research method. The work is represented by a combination of theoretical and experimental studies.

**The scientific novelty of the topic** is the development of new materials based on sawn stone-limestone waste, polyacrylamide components, cement-water composition for the production of construction products of low cost and with improved consumer properties and technology for their manufacture.

**The purpose of the research** is to improve the ecology of sawn stone-limestone production by intensive processing of its waste as a result of the development of innovative building materials with high performance on their basis.

**Object of research:** Sawn stone waste at quarries for the extraction of shell limestone.

**Research subject:** Improving the ecology of sawn stone-limestone production through the processing of waste into innovative building materials.

**Research objectives, their place in the performance of research work as a whole:**

- analysis and assessment of environmental impact of shell limestone production;

- study of the processes of creating new materials from limestone-shell rock waste during the extraction of sawn building stone;
- development of a new technology for the production of building materials from sawn limestone shell stone waste;
- substantiation of technical and economic efficiency of the method of processing limestone-shell rock wastes;
- preparation of process regulations for manufacture of polymer-cement composition from sawn stone wastes.

The main studies were carried out in the laboratories of the Department of Ecology and Geology and at the Research Institute of the Caspian University of Technology and Engineering named after Sh. Yessenov, as well as in the construction companies «Shell Stone» LLP and «FirmaFial» LLP (Aktau).

### **Methodological basis of research**

The results of the study are obtained on the basis of theoretical and practical provisions of experimental chemistry and physics, as well as the theory of experimental planning and statistical data processing. Experimental studies were carried out on existing equipment using original methods, modern measuring equipment, as well as methods of mathematical and physical modeling.

### **Scientific novelty of work**

The following new scientific results were obtained in the work:

- improved quality of polymer-cement composition and reduced consumption of materials and water, in developed composition of new material containing: portland cement, aqueous solution of polyacrylamide, white spirit and hardening accelerator, where wastes of sawn limestone-shell stone are used as filler;
- a connection has been established between the water absorption of limestone aggregate and the water demand of the resulting mixture, described by a mathematical relationship that allows determining the water content of the mixture from the fractional distribution of the initial mixture;
- it has been experimentally established that with a decrease in the size of the filler fractions, their water absorption also decreases. For screening with fraction size up to 5 mm varies within 4.3-7.15% weight.

### **Provisions submitted for protection:**

- environmental assessment of sawn limestone production in Mangistau region of the Republic of Kazakhstan;
- innovative composition of polymer-cement composition, which includes portland cement, water solution of polymer, white spirit and hardening accelerator based on aluminium chloride, water solution of polyacrylamide, wastes of shell limestone as filler, which improves quality of obtained material and reduces consumption of cement and water;
- formalized dependences of water absorption of limestone aggregate on water demand of the mortar mixture within the limits of 4.13-7.15% (170-190

l/m<sup>3</sup>), obtained experimentally, which makes it possible to calculate the flow rate of the required water according to the fractional composition of the initial mixture.

- technology of production of innovative material for production of construction products based on limestone-shell cutting wastes.

- substantiation of the influence of chemical interaction of cement paste with carbonate aggregate, which increases the adhesion of materials, as a result of which the strength of products based on limestone screening increases by more than one and a half times, in contrast to the use of quartz sand.

#### **Practical significance of the work:**

The proposed technology makes it possible to use waste from quarry facilities as efficiently as possible with obtaining construction material with improved properties (plasticity, mobility of the mixture, strength and water-repellent properties) with significantly lower consumption of cement (2 times) and polymer (3 times).

The use of local limestones as a filler for the manufacture of building products (wall stone, paving slabs, facing panels) makes it possible to obtain products with a lower bulk weight and increased heat and sound insulation qualities, the use of which, in buildings and structures, ensures an overall reduction in their cost by reducing the own weight of structures, reducing transportation costs, material and labor costs.

According to the results of the study, a patent was obtained for the utility model No. 4370 "Polymer cement composition" published 25.10.2019, bulletin No. 43 in the RSE "National Institute of Intellectual Property" of the Ministry of Justice of the Republic of Kazakhstan, a technological regulation was prepared for the manufacture of a polymer cement composition from limestone shell waste.

The results of the study were transferred for use in the production of the stone processing enterprise «FirmaFial» LLP (Kazakhstan) and used in the educational process in the preparation of bachelors in the educational program 6B05201 - "Ecology" at the Caspian University of Technology and Engineering named after Sh. Yessenov.

**The author's personal contribution to science** consists in setting the goal and objectives of research, developing compositions of a polymer-cement composition on porous aggregates using shell limestone waste, creating complex additives that regulate the physical and technical properties of the polymer-cement composition, as well as developing technological regulations for the manufacture of a polymer-cement composition based on sawn building stone waste from shell limestone. All the results of the work were obtained by the author independently.

#### **Approbation of work.**

The main provisions of the dissertation and the results of the study were reported and discussed at the International Scientific and Practical Conference "Development of Science and Technology in the Development of the Subsoil of

Kazakhstan" dedicated to the 90th anniversary of academician Sh. Yessenov (Aktau, 2017); International Scientific and Practical Conference "Arctic: Modern Approaches to Industrial and Environmental Safety in the Oil and Gas Sector" (Tyumen, 2019); International Scientific and Practical Conference "Global Science - 2019" (Orsk, 2020), XXXIII International Scientific and Practical Conference "Fundamental and Applied Scientific Research: Topical Issues, Achievements and Innovations" (Penza, 2020), Proceedings of Satpayev Readings "Satpayev Readings - 2020" (Almaty, 2020); III International Book Edition of the countries of the Commonwealth of Independent States "BEST YOUNG SCIENTIST – 2021" (April, 2021).

**Publications.** The main results of the dissertation are published in 18 publications, including 1 article in a scientific journal indexed in the Scopus database; 6 articles in journals recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan (CQASHE MSHE RK); 4 articles in scientific journals of the Russian Federation; 7 publications at international conferences, of which 3 are foreign; and also received a patent for a utility model registered in the RSE "National Institute of Intellectual Property" of the Ministry of Justice of the Republic of Kazakhstan.

**Structure and scope of work.** The dissertation consists of an introduction, four sections, conclusions for each section and a conclusion set out on 145 pages. It contains 34 figures, 26 tables, 134 used sources and 7 appendices.

The dissertation was carried out at the Department of Ecology and Geology of the Caspian University of Technology and Engineering named after Sh. Yessenov.