

ABSTRACT

of the dissertation work

on the thema "«Development of production technology and research of physico-mechanical, operational properties of ceramic paving stones based on clay rocks of Southern Kazakhstan»" submitted for the degree of Doctor of Philosophy (PhD) under the educational program 8D07340 – «Production of building materials, products and structures».

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The purpose of the dissertation work -Optimization of the composition of raw materials companies and the choice of effective firing modes necessary for the production of ceramic paving stones by vibropress method based on South Kazakhstan clay rocks and production waste.

The idea of the dissertation research is to create a technology for the production of ceramic paving stones by vibropressing, separately based on clay rocks, as well as using industrial waste and initiators of sintering and crystallization, characterized by improved technological and physico-mechanical properties corresponding to the conditions of energy efficiency, resource conservation, environmental friendliness and environmental protection.

In accordance with the idea of the dissertation research , the following tasks were set:

-investigation of the pre-firing properties of the raw material composition for the production of ceramic paving stones by vibropressing in the loam - bentonite system.

-the effect of the firing temperature on changes in the physical and mechanical properties of the samples of the studied raw materials for the production of ceramic paving stones by vibropressing in the loam – bentonite system.

-studies of the raw mixture with the use of effective additives that ensure the intensification of sintering and crystallization processes (ISC) of ceramic masses for the production of ceramic paving stones by vibropressing.

- selection and theoretical justification of the effective composition of the mixture for the production of ceramic paving stones by vibropressing, which provides intensification of the processes of sintering and crystallization of ceramic mass.

-development of optimal technological parameters for vibropressing ceramic compositions and study of physical and mechanical properties of molded raw ceramic paving stones.

-development of a rational mode of drying and firing of products.

-experimental and industrial development of vibropressing technology based on the developed compositions of ceramic compositions.

-technical and economic efficiency of the proposed technology for the production of ceramic paving stones.

The object of the study. Loam and bentonite clay deposits of Turkestan region and granulated blast furnace slag "ArcelorMittal Temirtau", waste glass of Private Limited Company «Steclo servic», talc rock of the Shieli deposit

Research area. Integrated and rational use of natural and man-made resources. Deep processing of raw materials and products.

Methods of achieving the set tasks. Analysis of literature, patents, aimed at the study of ceramic masses with using various wastes in the production of construction ceramics;

Conducting in scientific laboratories of the Republic of Kazakhstan of general use in order to determine the chemical and mineralogical composition of the raw materials under study, studying the microstructure of heat-treated ceramic samples;

Conducting a complex of tests of ceramic masses in accordance with the generally accepted methodology of scientific research, including analytical, laboratory, technological developments and pilot tests;

Conducting testing in production conditions and calculating economic efficiency [146].

Scientific novelty of the dissertation:

- new compositions and technological solutions for the production of ceramic paving stones by vibropressing in a two-component loam-bentonite raw material system have been scientifically substantiated. The main regularities of changes in the pre-firing properties of ceramic masses from the duration of vibropressing and the content of clay rocks have been established, which guarantee high indicators of the physical and mechanical properties of the final product.

- the main regularities of the structure and phase formation of ceramic compositions in the range of firing temperature up to 1000⁰C have been studied, consisting in the processes of solid- and solid-liquid sintering, in which the phase-mineral composition of compositions is provided, determining the production of ceramic paving stones with high strength, frost resistance and chemical resistance.

- it was found that the presence of fine glass powder (fractions less than 0.1 mm) in the composition of the initiators of sintering crystallization contributes to the early appearance of the liquid phase in the composition of the ceramic mass, since the softening temperature of the glass powder begins already at a temperature of 720-750 0C.

- it was found that with an increase in the amount of granulated slag additive up to 35%, the strength of the samples at a firing temperature of 1000⁰C is almost 1.5 times higher than the minimum slag content.

- according to the results of X-ray phase and electron microscopic analysis, it was found that in the samples burned at a temperature of 1000⁰C, there are porous slag grains crystallized by a low-temperature form of wollastonite (CaSiO³). To a large extent, crystallized slag grains are observed in samples of compositions where the amount of granulated blast furnace slag is 30-35%.

Scientific results (scientific statements) submitted for protection:

- the results of the study of the pre-firing properties of the raw material composition for the production of ceramic paving stones by vibropressing in the loam - bentonite system.

- results of the study of the compositions and physico-mechanical properties of the raw material composition for the production of ceramic paving stones in the loam – bentonite system.

-the results of a study on the effect of the firing temperature on changes in the physical and mechanical properties of samples of the studied raw materials for the production of ceramic paving stones by vibropressing in the loam – bentonite system.

- the results of the study of the raw mixture with the use of effective additives that ensure the intensification of the sintering and crystallization processes (ISC) of ceramic masses for the production of ceramic paving stones by vibropressing.

- results of research and development of technological parameters for the production of ceramic paving stones based on ceramic compositions.

- results of pilot-industrial testing and development of vibration pressing technology in relation to the production of ceramic paving stones based on the developed compositions of ceramic masses and technical and economic efficiency.

The production significance of the dissertation.

The implementation of the proposed technology for the production of ceramic paving stones by vibropressing allows to increase the range of effective domestic building materials for the improvement of urban areas. The use of ceramic paving stones instead of concrete contributes to the overall large-scale savings of cement so necessary for responsible structures in the construction industry. The proposed technology is characterized by the simplicity of technological equipment, the availability of raw materials and high mobility, which allows them to be implemented on the basis of existing brick factories with the organization of a separate molding shop. In this case, firing can be carried out in existing firing furnaces together with ceramic bricks. As a result, the existing brick factory can produce two products in parallel that are in high demand in the construction market.

Experience in implementing the results of work in production. The results of the dissertation research were accepted for implementation on the basis of the brick factory "Bokey". The physical and mechanical characteristics of ceramic paving stones obtained by vibropressing meet the requirements of regulatory documents. The economic effect of the introduction of research results into production amounted to 175,535,605 thousand tenge.

Validity and reliability of scientific statements, conclusions and recommendations. Laboratory studies were carried out in laboratories equipped with modern equipment. The results of laboratory studies of ceramic masses are justified in accordance with the conclusions and recommendations and confirmed by pilot tests.

The physical and mechanical characteristics of the finished product comply with regulatory documents, the reliability of the results of laboratory research has been confirmed by pilot tests in existing plants.

The author's personal contribution to science consists in:

- development of new compositions of ceramic masses and rational technological solutions for the production of ceramic paving stones by vibropressing;
- in establishing the main regularities of changes in physical and mechanical properties and processes of phase-mineral formation in the temperature range up to 1000°C in composite ceramic mixtures.

Approbation of the work. The developed new compositions and technological solutions for the production of ceramic paving stones by vibropressing have been tested on the basis of the existing brick factory "BOKEI" in Shymkent. An experimental batch of ceramic paving stones was produced by vibropressing in the amount of 10 thousand pieces.

The materials of the dissertation research were reported and discussed at the following international and domestic scientific and practical conferences:

- Sintering and Crystallization Intensifiers for Production of Ceramic Paving Blocks by Vibropressing Technology. Periodica Polytechnica Civil Engineering, 67(3), pp. 706–715, 2023

<https://doi.org/10.3311/PPci.21818>. Engineering Civil and Structural.

Scopus процентиль по Cite Score 53.;

- Use of Granulated Metallurgy Slag in the Raw Mix for Producing Ceramic Paving Stones: Insights from an Experiment in Kazakhstan. Journal of the International Society for the Study of Vernacular Settlements ISVS e-journal, Vol. 10, Issue 7, July, 2023 http://www.isvshome.com/pdf/ISVS_10-7/ISVSej_10.7.6_Sarsenbek.pdf. Arts and Humanities Visual Arts and Performing Arts- 87-й., Arts and Humanities History- 83-й., Arts and Humanities., Conservation- 67-й., Engineering Architecture. Scopus Percentile by Cite Score 59.;

- The study of clay raw materials of the Turkestan region for the production of ceramic paving stones. QazBSQA Habarshysy. Building structures and materials. No1 (83), 2022. -C.170-179. <https://doi.org/10.51488/1680-080X/2022.1-13>;

- The Modified Ceramic Mass for Producing Ceramic Paving Stones. «Abylkas Saginov Karaganda Technical University» Proceedings of the University 3(88)2022. -C.198-203, DOI 10.52209/1609-1825_2022_3_198;

- Investigation of the raw material mixture for the production of ceramic inserts. «EKTU Habarshysy» №4, 2022. -C.153-166, [DOI 10.51885/1561-4212_2022_4_153](https://doi.org/10.51885/1561-4212_2022_4_153);

- The study of clay rocks of Southern Kazakhstan for the production of building ceramic products. "Innovative technologies for processing mineral and man-made raw materials of chemical, metallurgical, petrochemical industries and production of building materials", Institute of General and Inorganic Chemistry of

the Academy of Sciences of the Republic of Uzbekistan, may 12-14 Tashkent-2022. -pp.553-555;

- Raw mix for the production of ceramic paving stones by vibropressing. HERALD Kazakh head architectural and construction Academy №2 (80) 2021). - C.256-262.

Publication of research results. Based on the materials of the work, 7 papers have been published, including 3 (three) articles published in scientific journals included in the list of publications recommended by the Committee for Quality Assurance in the Field of Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan, 2 (three) articles – with a non-zero impact factor included in the Scopus database, 2 (three) articles – materials international conferences.

The structure and scope of the dissertation. The dissertation work, in accordance with the content and objectives of the study, consists of an introduction, five sections, a conclusion, a list of used literature of 146 titles, and appendices. The volume of work is 106 pages of text typed on a computer, including 39 figures and 29 tables.