

ABSTRACT

of the dissertation on the topic "Production of concretes based on finely ground cement from phosphoric slag with modifying additives", submitted for the degree of Doctor of Philosophy (PhD) in the specialty 8D07340 – "Production of building materials, products and structures"

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Relevance of the work: The work assumes a high environmental and economic return from the organization of the production of finely ground cements, which consists not only in the creation of a new cheap binder, but also in the disposal of large-scale waste (metallurgical and phosphoric slags) of the Republic of Kazakhstan.

Based on the results, the work will minimize the harm caused to the environment by man-made industrial waste, reduce harmful emissions into the atmosphere, create jobs and improve the quality of life of the population as a whole. The main advantages of the developed technology of finely ground cements include:

- waste-free;
- saving stocks of valuable natural raw materials;
- the possibility of using a variety of man-made industrial waste and waste from non-metallic minerals as active binder components. At the same time, neither carbon dioxide nor dust is released into the atmosphere, as occurs in the production of Portland cement.

The purpose of the work: To organize the production of finely ground cement with modifying additives using industrial waste, including electrothermophosphoric slags with astringent properties, and to study the effect of this cement on the strength of concrete.

To achieve the purpose of the thesis, the following tasks are set:

- Analysis of the mineral resource base of the Republic of Kazakhstan, high-tonnage man-made waste (electrothermophosphoric slags, ash and slag waste from thermal power engineering, slags from non-ferrous metallurgy) in order to assess their technical suitability and economic feasibility of use as the second component of finely ground cement;
- Study of the shredding of man-made waste and optimization of the shredding technology in order to reduce energy consumption for this process. The choice of less energy-intensive technological schemes for obtaining goods;
- Optimization of the fractional composition and specific surface area of TMC in order to reduce the amount of cement from TMC-30 to TMC-70 and ensure brand strength values of 30Mpa - 70MPa in the cement market of Kazakhstan at a minimum cost. Development of high-strength TMC compounds;
- Study of the processes of structure formation during hydration of TMC, identification of new reactions and products of interaction of mechanically activated cement components;
- Development of the composition of fine-grained and heavy concrete based on TMC, determination of their technological and operational properties;

- Production of a pilot batch of raw materials and concretes based on it and determination of their properties.

Methods of achieving set goals:

- Organization of industrial production of finely ground cements based on phosphoric slag, which ensures the production of improved physical and mechanical properties and high-strength products.

- Development of complex technological bases for the production of finely ground cements based on electrothermophosphoric slags.

Object of research: cement with the addition of electrothermophosphoric slag and man-made industrial waste and concretes based on them.

Subject of the study: determination of the effectiveness of concretes based on finely ground cements obtained from phosphoric slag.

Scientific novelty:

- The optimal composition of mechanically activated finely ground cement based on phosphoric slag with modifying additives has been developed;

- The processes of hydration hardening and the features of the neoplasm of the resulting finely ground cement, which provides the necessary strength, have been studied.;

- The optimal composition of fine-grained and heavy concrete based on mechanically activated finely ground cement has been selected.

Scientific results submitted for protection:

- Technology of grinding of mechanically activated finely ground cements with optimal compositions and modification additives and methods of cement production;

- Optimal compositions of high-strength TMC in intermediate ratios of TMC-30 and TMC-70;

- Optimal composition of fine-grained and heavy concrete based on finely ground mechanically activated cements with modifying additives;

- The results of a study of the operational characteristics and compositions of hydration products of mechanically activated finely ground cement with a modifying additive;

- Production technology and economic efficiency of finely ground mechanically activated cements with modifying additives.

Practical value of the dissertation:

The scope of application of finely ground cements based on phosphoric slag with modifying additives has been expanded.

Formulations of finely ground cements based on phosphorous slag with modifying additives for various types of construction and concretes based on them have been developed.

The results of the conducted research were used in the development of an act of introduction into the production of finely ground cement from phosphoric slag with modifying additives for various types of construction.

Validity and reliability of scientific statements, conclusions and recommendations:

-the results of physico-chemical (X-ray phase, differential thermal analysis) studies of mechanically activated finely ground cements with a modifying additive, as well as the results of physico-mechanical and operational tests;

-the similarity of pilot tests of experimental work and results, as well as technologies for the production of mechanically activated finely ground cements with a modifying additive.

The relationship of work with research plans.

The work was carried out on the basis of grant financing on the topic No.0113RK00663 "Small-clinker finely ground cements based on large-tonnage industrial waste of the Republic of Kazakhstan", in the direction of grant financing of the most promising projects for commercialization of the results of scientific and (or) scientific and technical activities, included in the plan of JSC "Science Foundation" of the Ministry of Education and Science of the Republic of Kazakhstan on the topic No. AR15573148 "Organization of production of low-clinker finely ground cements based on industrial waste" of the State budget and program-oriented financing jointly with the Kazakh National Research Technical University named after K.I.Satpayev and the South Kazakhstan University named after M.Auezova was held in accordance with the theme BR21882292 "Integrated development of a sustainable construction industry: innovative technologies, production optimization, efficient use of resources and creation of a technology park".

The idea of dissertation research.

The field of scientific interests of the work is the development of the composition of various types of cements using high-tonnage industrial waste and natural non-metallic raw materials of the Republic of Kazakhstan. The work offers a solution to two urgent interrelated problems of the Republic of Kazakhstan, which are typical for many other countries. These are the problems of raw materials and ecology. The first is the saving of natural raw materials, the second is the disposal of man-made waste. The work is aimed at the release of goods and their production near multi-tonnage waste dumps.

Approbation of the work.

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

- Man-made raw materials for the production of composite silicate materials using energy-saving technology (article) *Journal of Composites Science*, 7,124 Volume 7, Issue 3, March 2023. Percentile 76% <https://doi:10.3390/jcs7030124> (Q1)

- Thermal insulating materials based on magnesium-containing technogenic raw materials (article) *Rasayan Journal of Chemistry* Volume 16 (1) , January - March 2023, pp.413-421; Percentile 34% <https://doi.org/10.31788/RJC.2021.1616927> (Q3)

- Cement-based concretes with low water requirements *Modern Materials Science: Topical Issues, Achievements and Innovations* Web of conferences 401,

01065 15 - 16 March, 2023. Percentile 22% <https://doi.org/10.1051/e3sconf/202340101065>

- Utilization of Anthropogenic and Natural Waste to Produce Construction Raw Materials (article) *Sustainability (Switzerland)* Volume 17, №2791 March 2025. Percentile 77%

<https://doi.org/10.3390/su17072791> (Q1)

- Studies on the Production of a Ground Silicate Composite Based on a Mineral Slag Binder with the Disposal of Industrial Waste (article) *Journal of Composites Science*, 9, 225

April 2025. Percentile 79% <https://doi.org/10.3390/jcs9050225> (Q1)

- Binding properties of synthesized CS glasses activated by alkaline components. (article) *Technobius*, 4(3) №0064 Astana, 2024. DOI: [10.54355/tbus/4.3.2024.0064](https://doi.org/10.54355/tbus/4.3.2024.0064)

- Использование техногенных отходов фосфорной промышленности в качестве сырья в дорожном строительстве (article) *Научный журнал «Вестник всеобщей науки и образования»*, №4 (2). Астана, 2022г. С. 170-174.

- Минерально-шлаковые вяжущие для получения грунто-карбонато бетонов (article) *Научный журнал «Вестник всеобщей науки и образования»*, №5 (3). Астана, 2023г. С. 3-6.

- О возможности утилизации техногенных отходов в качестве вторичного сырья (article) *Труды МНПК Modern scientific potential - 2024, Sheffield, February 28 - March 07.2024.* pp. 31-36.

- Свойства шлакощелочных вяжущих и бетонов с полифункциональной наномодифицирующей добавкой (article) *Труды МНПК «Качество. Технологии. Инновации»*, Новосибирск. 2024. С.110-116

- Малоклинкерные тонкомолотые цементы на основе крупнотоннажных промышленных отходов республики Казахстан (article) «Әуезов оқулары-23: Хакім Абайдың 180 жылдығына арналған Абай феномені және жаңа танымдық өрістер» ХҒТК еңбектері. Том 7. Шымкент, 2025ж. Б. 110-116.

- Ускорение твердения шлакощелочного бетона в гелиотермооснатках и его долговечность (article) *Труды МНПК «Интеграция науки, образования и предприятий при производстве современных строительных материалов и изделий»*. Самарканд, 2022 г., С. 45-48.

- Влияние природной полифункциональной наномодифицирующей добавки на свойства шлакощелочных вяжущих и бетонов на их основе (article) *Труды МНПК «Интеграция науки, образования и предприятий при производстве современных строительных материалов и изделий»*. Самарканд, 2022 г., С. 48-51.

- Straining cements based on expanding additives using industrial waste and concretes based on them (article) *"Industrial Technologies and Engineering"* ХК, Volume II Shymkent, Kazakhstan November 18.2023. pp.258-263.

- Expansion of vermiculite concentrate by thermal method and determination of the coefficient of expansion of vermiculite (article) "Industrial Technologies and Engineering"

XK, Volume II Shymkent, Kazakhstan November 18.2023. pp.263-265.

- Assessment of the effectiveness of decision making in justifying strengthening the capacity of railways of Uzbekistan in probabilistically-determined conditions "Industrial Technologies and Engineering" XK, Volume II Shymkent, Kazakhstan November 18.2023. pp.280-286.

- Features of calculation of reinforced concrete piles of agricultural buildings in aggressive ground conditions (article) "Industrial Technologies and Engineering" XK, Volume II Shymkent, Kazakhstan November 18.2023. pp.299-303.

- Азклинкерлі ұсақ ұнтақталған цемент және оны алудың тәсілі (патент) Патент на полезную модель. №8952, 29.03.2024ж.

Publication of the research results.

The main results of the dissertation work have been published in 15 scientific papers. Of these, 6 articles have been published in foreign journals included in the Scopus and Web of Science databases, 1 article has been published in scientific journals included in the list of publications 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. Received 1 patent for a utility model.

The structure and scope of the dissertation.

The structure of the thesis corresponds to the content and objectives of the research and consists of an introduction, 5 sections, a conclusion, and 2 appendices. The volume of the work is 98 pages, contains 25 figures and 40 tables.