

ABSTRACT
of the thesis on the topic:
" Development of the composition of monolithic concrete using chemical additives"
submitted for the degree of Doctor of Philosophy (PhD) in
OP 8D07305 – " Civil engineering and production of building materials and structures"

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Relevance of the topic. Improving the efficiency and quality of concrete and reinforced concrete is an actual issue and cannot be entirely successfully solved without the use of chemical admixtures in concrete technology. Currently, complex admixtures with a specific effect on the structure and properties of concrete are popular. In Kazakhstan, concrete with high strength and durability is not in demand enough. Still, the development of a market economy is beginning to change the current trend to the diametrically opposite side. The main emphasis in the development of concrete technology is not on saving any material, such as cement. Still, the production of high-quality competitive concretes includes concretes with high durability. To find a mortar, much attention is paid to the development of complex admixtures that allow to control of several properties of cement-based concretes simultaneously purposefully.

Recently, complex admixtures based on plasticizers and air-entraining admixtures have been widely used. These complex admixtures allow for the production of high-strength, high-quality concretes with a low water-to-cement ratio and capillary porosity.

The wide range of complex admixtures contributes to the improvement of the rheological and technological properties of concrete in different ways, but, as mentioned in several modern research, there is no complete understanding of their action mechanisms and exact rheological models.

The targeted formation of the structure of the cement stone, which is characterized by a low proportion of capillary pores and an increased content of hydrate neoplasms, makes obtaining high-strength and high-quality cement concrete possible. Modifying cement concrete with complex admixtures is the most accessible and simple way to significantly increase its efficiency, and it can be successfully used for these purposes.

In this regard, the production of complex admixtures based on plasticizers and air-entraining admixtures and the study of the features of their influence on the structure formation of cement compositions is an urgent and promising direction in the development of effective technologies for modified concrete, which are characterized by high performance and durability.

The formation of a given structure and properties of cement stone, the production of durable and high-strength heavy concrete modified with complex admixtures based on plasticizers and air-entraining admixtures is possible when analyzing the effect of

each component of the admixture and the features of their interaction on the structure formation of cement compositions.

The goal and objectives of the work

The main goal of the work is to develop a composition of ordinary concrete with complex chemical admixtures to achieve effective performance characteristics of concrete and the required properties.

In order to achieve the aim of the thesis, the following tasks are formulated:

1. To develop a composition of heavy concrete with a complex admixture based on plasticizer and air-entraining agent, conduct pilot tests of the research results, and optimize the concrete mixture composition;

2. Substantiate the effect of the complex admixture on the technological properties of the concrete mixture;

3. Investigate the physico-chemical processes occurring during the hydration and hardening of cement mixtures with the complex admixture;

4. Determine the effect of the admixture on the physical and mechanical properties and strength gain kinetics of heavy concrete;

5. Justify the possibility of producing modified heavy concrete with the admixture that enhances cement hydration by water accumulation and reduces capillary porosity;

6. Establish the combined effect of plasticizers and air-entrainers on the durability and porosity of cement-based compositions.

7. The study of the rheological properties of modified cement-sand mixtures, with the aim of understanding the impact of air entrapment on the flow behavior of these materials.

Research object

The object of research is concrete mixtures and cement mortars, which are high-strength concrete.

The subject of the study

The subject of the study is the composition and properties of monolithic concrete using various chemical admixtures that affect its physico-mechanical, operational, and rheological characteristics, such as compressive strength, durability, porosity, workability, water separation, and thixotropy.

Research novelty:

It has been established that the use of a complex admixture can improve the rheological properties of concrete mixtures during the process of liquefaction and thickening, depending on the plasticizing and air-entraining admixtures used. The conclusions were drawn based on the analysis of the results obtained.

New technical mortars containing complex chemical admixtures were substantiated, and formulas using these admixtures were developed to increase the durability of heavy concrete.

Using these admixtures improves the mechanical properties and porosity of concrete mixtures, making them more resistant to frost cycles. This allows for

optimizing the composition of the concrete mix and predicting its durability under conditions of repeated cycles in high humidity.

Research methodology

The methodological basis of the research is theoretical and empirical methods based on generalization, comparison, experiment, methods of a systematic approach.

Literature Review: Analyze existing studies and patents on chemical admixtures in concrete to identify trends and research gaps.

Rheological and technological testing: Measure workability, water absorption, yield stress, plastic viscosity, and shear thinning/thickening index of fresh concrete to assess the impact of admixtures. The rheological test was provided by the rotational rheometer with coaxial cylinders at different times after cement paste mixing using a specially selected shear rate mode during the time. The experimental rheological data were processed according to the Herschel-Bulkley model.

Mechanical and Durability Testing: Test compressive strength, freezing-thawing resistance, porosity, and resilience of hardened concrete samples.

Statistical Analysis: Analyze data to establish correlations between admixture properties and concrete performance.

Optimization: Develop an optimized mix design and recommendations for practical construction applications.

Practical value of the research findings

The work results are applicable in the design and construction of concrete and reinforced concrete monolithic structures.

Moreover, the complex admixtures with complex chemical admixtures can provide the production of concrete mixtures without water bleeding for different technical applications, such as concrete with high workability and concrete mixtures for 3D printing technology.

Approbation of the work

1 Akmaliev K., Tolegenova A., Jetpisbayeva A. Features of structure formation of polymercement stone. Proceeding of VI International annual conference «Industrial technologies and engineering», Volume I (2019) ШЫМКЕНТ, КАЗАХСТАН, с. 12-15.

2 Akmalaiuly K., Tolegenova A., COMPLEX CHEMICAL ADDITIVE FOR CONCRETE, Вестник КазНУ 2020 №5, 692-695 с. <https://official.satbayev.university/download/document/16739/%D0%92%D0%95%D0%A1%D0%A2%D0%9D%D0%98%D0%9A-2020%20%E2%84%965.pdf>

3 Tolegenova A.K., Akmalaiuly K., Skripkiunas G. Study of the effectiveness of the use of complex additives Master Rheobuild 1000 and Master Air 200, № 6 (2021): Известия НАН РК. Серия геологии и технических наук, с.141-146. <https://doi.org/10.32014/2021.2518-170X.130>.(Scopus Q3, Percentile 43%).

4 Tolegenova, Aigerim, Gintautas Skripkiunas, Lyudmyla Rishko, and Kenzhebek Akmalaiuly. 2022. "Both Plasticizing and Air-Entraining Effect on Cement-Based Material Porosity and Durability" Materials 15, no. 13: 4382. <https://www.mdpi.com/1996-1944/15/13/4382>(Scopus Q2, Percentile 64%).

5 А.К. Толегенова, А.С. Еспаева, З.Н. Алтаева, Исследование совместного влияния отходов добычи природного камня-ракушечника и химических добавок на технологические свойства бетонной смеси, Вестник КазГАСА 2(88) 2023 г. https://vestnik.kazgasa.kz/frontend/web/uploads/personal-documents/1687275342_G9FcWB.pdf

6 Tolegenova A., K. Akmalaiuly, Z. Altayeva, A. Yespayeva, Y. Kuldeyev, Influence of plasticizing and air-entraining admixtures on concrete properties, Вестник КазГАСА 4 (90) 2023 г. https://vestnik.kazgasa.kz/frontend/web/uploads/personal-documents/1703950212_RbhbeL.pdf

7 Tolegenova, Aigerim, Skripkiunas, Gintautas, Rishko, Lyudmyla, Akmalaiuly, Kenzhebek, Air-Entraining Effect on Rheological Properties of Cement-Based Mixtures, Advances in Materials Science and Engineering, 2024, 5018973, 16 pages, 2024. <https://doi.org/10.1155/2024/5018973> (Scopus Q2, Percentile 54%).

8 К.Акmalaiuly, А. Толегенова, G. Koshkombayeva, Corrosion Resistance of Reinforcement in Reinforced Concrete Products, Труды Университета №3 (96) 2024 (Вестник КапГТУ), 211-216 с. DOI 10.52209/1609-1825_2024_3_211 <http://tu.kstu.kz/archive/issue/103>

The structure of the dissertation. The dissertation consists of an introduction, four chapters, a conclusion, a list of references used, and 1 appendix.

The dissertation, following the content and objectives of the research, consists of an introduction, four sections, a conclusion, and a list of 108 references. The volume of the work is 100 pages of typewritten text, including 24 tables and 54 figures.