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Technogenic Waste Based on Iron Quartzites – Raw Materials for Mixed Cements

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Annotation: The article presents the results of research on the use of technogenic waste from the enrichment of unoxidized ferruginous quartzites as a mineral filler for mixed cements. It has been established that the introduction of waste into cement in an amount of up to 30% leads to an increase in compressive strength by 23%. With a further increase in waste dosage, the strength decreases sharply. With an increase in waste content, a denser composite structure with pronounced overgrowing of pores is formed. During the joint grinding of cement particles and waste, their mechanochemical activation occurs, which leads to the formation of calcium ferrites.

Key words: industrial waste, ferruginous quartzites, mixed cements, strength, microstructure.

INTRODUCTION

Today in the world, with the development of the construction industry, the need for cement is also increasing. In increasing construction volumes, cement is one of the resources available at the price of finished objects, which is achieved through cost reduction due to the use in construction of modern high-quality building materials and products with lower energy intensity and improved characteristics. In this regard, the production of effective cements based on technogenic waste is of particular importance.

On a global scale, special attention is paid to the development of new cement compositions, and the most important task of research in this direction is the development of compositions of new composite additives based on technogenic waste for composite Portland cements. When developing composite additives and, based on them, new compositions of highly effective composite Portland cements, in this direction it is necessary to substantiate a number of the following scientific decisions, in particular: development of new methods for the production of effective types of construction products based on composite additives; development of new compositions for the production of nanocements using secondary raw materials; increasing the strength of concrete using sulfate-resistant cements; optimization of the composition of raw materials when producing energy-saving clinkers and cements; modernization of technologies for the production of white and decorative Portland cements; to increase the production volume of additive cements, the use of alternative sources of active mineral additives and filler additives.

RESEARCH MATERIALS AND METHODS

The Republic is implementing large-scale activities for the production of high-quality cements aimed at meeting the demand for cement, modernizing the economy and creating new production capacities. The Action Strategy for the Development of the Country's Economy defines the tasks of “development of industries, modernization and diversification of industry, practical application of low-consumption energy-saving technologies, development of the cement industry, production of import-substituting and export-oriented products” [1]. In this regard, scientific research aimed at developing new compositions of composite additives based on technogenic waste and new compositions of effective cements using them is of utmost importance.

The problem of rational use of natural resources is a pressing issue of our time. One of the most important areas of resource-saving activities is the development of new effective technologies for the recycling of industrial waste, among which special attention should be paid to waste from the mining and metallurgical cycle, which makes up a significant share of the total volume of waste. Most of this type of waste is stored, thereby occupying thousands of hectares of fertile land, poisoning groundwater, the atmosphere and, of course, causing immeasurable harm to human health.

Currently, such waste from the mining and metallurgical cycle as slag, sludge, dust, tailings from wet magnetic separation of ferruginous quartzites, technogenic sands have largely found their application in the construction materials industry and are actively used as mineral fillers for the production of binders [1-3]. There is no experience in using flotation enrichment waste of unoxidized ferruginous quartzites as fillers for mixed cements, and therefore the task is to study the possibility of their use in this direction. In the foreseeable future, priority will belong to mixed cements and composite binders, which requires experimental and theoretical research and establishing the possibility of using waste in the direction of optimizing the compositions of mixed cements, studying the processes of their structure formation and the physical and mechanical properties of the resulting cements. Waste from the enrichment of unoxidized ferruginous quartzites from the Navoi Mining and Processing Plant, discharged into the tailings pond, is characterized by a high dispersion of 250 m2/kg. Analysis of the chemical composition of the waste indicates that the content of silicon oxide in average samples is over 54%, iron oxide is more than 41%, and the content of other oxides, present in small quantities, determines the possibility of their use as a mineral filler in the preparation of mixed cements.

RESEARCH RESULT

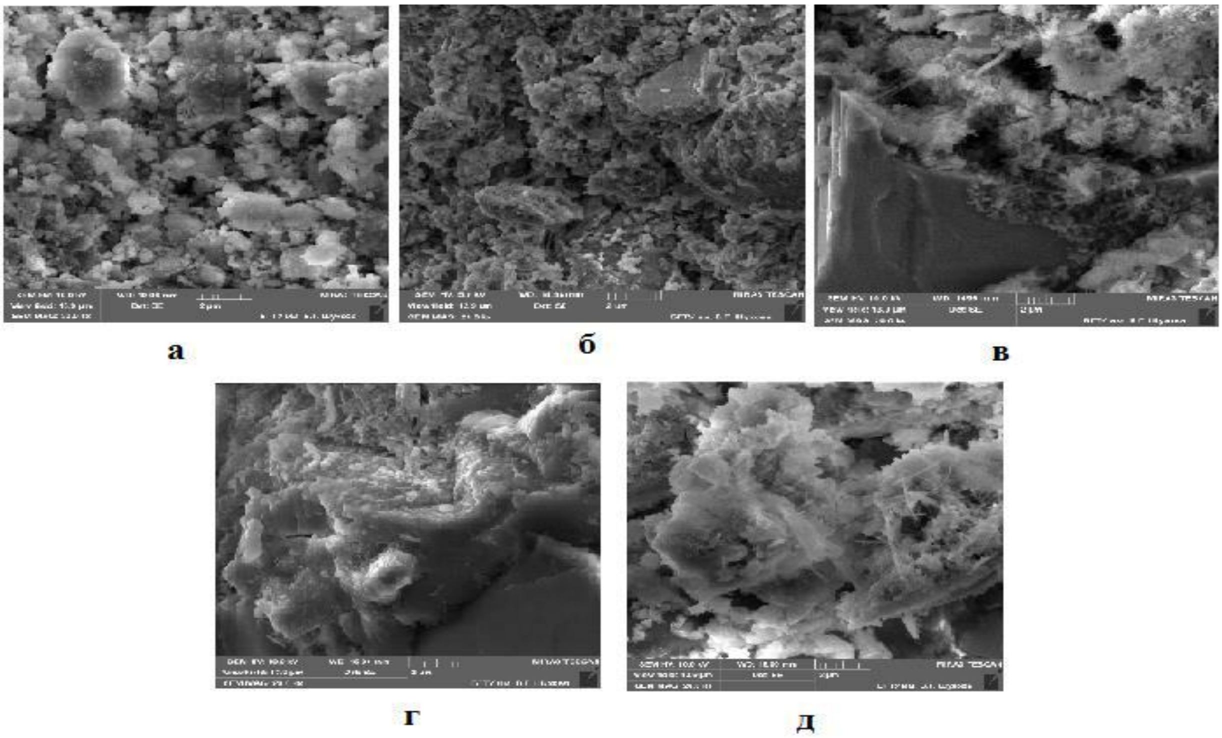
To obtain mixed cements, Belgorod cement CEM I 42,5H was used, which meets the requirements of GOST 31108-2003 “General construction cements. Technical conditions”, waste from the enrichment of unoxidized ferruginous quartzites from the Mikhailovsky mining and processing plant was used as a mineral filler.

In order to study the effect and establish the optimal amount of introducing waste into cements, waste was introduced into the mixtures in various dosages from 5 to 50%, respectively, varying the amount of cement from 95 to 50%. Co-grinding of the raw material mixtures was carried out in a laboratory porcelain mill until the specific surface of the powder reached 300 m2/kg. To study the physical and mechanical characteristics of mixed cements of various compositions, cube samples measuring 30x30x30 mm were molded, 3 samples of each composition for different test periods. Samples were tested at the age of 7 and 28 days. normal hardening. The compressive strength values of the resulting mixed cements exceed the tensile strength values of cement. When introducing waste into cement in an amount of 5%, the strength increases by 15%, when introducing waste from 10% to 20%, the strength increases by 22%, and when introducing 30% waste, the strength reaches 85.03 MPa, which exceeds the strength of cement by 23 %. With a further increase in the dosage of waste into cements in the amount of 40% and 50%, the compressive strength of the resulting mixed cements drops sharply, which is associated with an overdose of mineral filler and, as a consequence, softening of the structure of the composites.

Comparing the diffraction patterns of mixed cements with different waste contents, it should be noted that an increase in waste content leads to an increase in the content of beta quartz in the compositions.

With increasing waste content, a denser composite structure is formed with a pronounced overgrowing of pores, with the formation of a dense gel-like mass consisting of hydrate formations of cement in amorphous and crystalline form with nuclei of relict clinker grains and pores of various sizes (pic. 1).

Spectral analysis shows that calcium ferrites are present in the point spectra studied, indicating that when cement and waste particles are crushed together, their mechanochemical activation occurs. For crystals, the development of destruction leads to the beginning of amorphization of the surface layers, with a simultaneous increase in their chemical activity.



Pic.1. Microphotographs of the fracture surface at the age of 28 days (x 20,000):

a – hydrated additive-free cement, b – mixed cement,

Containing 5% waste, c – mixed cement containing 10% waste, d – mixed cement containing 20% waste, e – mixed cement containing 30% waste.

During the grinding of minerals, as a result of the destruction of the substance, the formation of uncompensated atomic bonds occurs on the surface of dispersion particles capable of chemical interaction. As various studies have shown, when the components of a mixture are crushed together, it becomes possible for certain solid-phase reactions to occur between particles of solid substances.

The research results obtained indicate the mechanochemical activation of mixed cement particles resulting from the joint grinding of waste and cement.

Studies of the microstructure of chipped surfaces of samples of mixed hydrated cements using a Tescan MIRA 3 LMU scanning electron microscope revealed differences in their microstructures.

CONCLUSION

Thus, the use of technogenic raw materials will make it possible to rationally use expensive, energy-intensive clinker, and solve the important environmental problem of recycling waste from the enrichment of unoxidized ferruginous quartzites, which occupy large storage areas and have a detrimental effect on the environment and human health.

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