Thet Naing Myint

Corrosion-resistant composite cements

Abstract

Relevance of the research. At the present stage of development of the construction industry, one of the main tasks is to ensure the durability of structures, which can be achieved by protecting building structures from the corrosive effects of the environment. The growth of construction production requires a constant increase in output, the development and use of new effective building materials with high physical and mechanical properties, improved performance and durability. On a large scale, the search for the ways to improve the quality of cements and increase the production of cements while creating and implementing low-waste and waste-free technologies continues.

The most promising solution for creating corrosion-resistant concretes that ensure the durability of building structures is the use of effective composite binders in their compositions.

In Russia and other countries, sulfate-resistant cements are produced, which are used in the construction of facilities subject to the corrosive effects of mineralized waters. However, their production volumes are limited by the raw material base. In this regard, it is very important to develop corrosion-resistant cements based on clinkers of non-standard mineralogical composition.

The degree of development of the research. Destructive processes can develop in cement stone under the influence of the external environment. The greatest danger, according to the RILEM technical committee on durability, is primarily caused by the destruction of hardened cement from water containing sulfates and magnesium salts. Constant attention is paid to the problems of physical and chemical processes of corrosion and the corrosion resistance of cement stone. As a result of numerous studies by Russian and foreign scientists, it has been established that in order to ensure the stability of cement stone in various conditions, it is necessary to take into account its structure, which is determined by the material composition, the nature of the additives introduced, the mineralogical composition of Portland cement clinker, the granulometric composition of cement and its components.

Currently, sulfate-resistant Portland cement has been developed, which has clear requirements regarding its chemical and mineralogical composition, primarily limiting the C_3A content. To increase the corrosion resistance of cement stone, many researchers propose adding active mineral additives to the binder composition. The most effective additives, such as microsilica and metakaolin, can be added directly to the concrete mixture, but in a cement plant, due to their physical state, they are low-tech. Also, in many construction projects it is recommended to use additive-free sulfate-resistant Portland cement, and mineral additives, as a rule, reduce the strength properties of the binder. Recently, to improve the manufacturability of introducing additives, as well as to increase the strength of cement stone, sulfated clinkers have been proposed: sulfoaluminate and sulfoaluminoferrite. When their minerals hydrate, ettringite is formed, which is a prerequisite for increasing the sulfate resistance of cement stone. In this regard, the development of corrosion-resistant cements using ordinary Portland cement clinkers in combination with sulfated clinkers requires in-depth scientific research in order to obtain technologically advanced composite cement with optimal mineralogical composition, dispersity, as well as the creation on its basis of a highly effective material that ensures corrosion resistance and durability of building structures .

The purpose of the research is the development of corrosion-resistant composite cements under conditions of sulfate and chloride aggression (sea water) based on Portland cement clinker of irregular composition and sulfated clinkers.

This goal is achieved by solving the following main **tasks**:

1. Determination of the influence of dispersity of sulfated clinkers (sulfoaluminate and sulfoalumoferritic) on the formation of the structure of cement stone during hardening under normal conditions and in corrosive environments.
2. Substantiation of the choice of sulfated clinkers, which provide the maximum indicators of the performance properties of the binder and to develop effective compositions of corrosion-resistant composite cements.
3. Development of recommendations on the optimal material composition and dispersion of corrosion-resistant composite cements.

4. Conducting industrial testing of the results obtained with the release of pilot batches of cements.

Scientific novelty. A complex of physicochemical methods proved the possibility of obtaining corrosion-resistant composite cements based on Portland cement clinkers of non-standardized composition by introducing sulfated clinkers into their composition, such as sulfoaluminate and sulfoaluminoferritic clinker. It is shown that in the developed composite cements with specific surface area SSA= 300-350 m^2/kg, obtained by joint grinding of sulfated clinkers and portland cement clinker of irregular composition, sulfated minerals are distributed in fine fractions. This contributes to an increase in their hydraulic activity in the composition of cement and, together, accelerates the processes of its hydration and hardening, which contributes to the formation of a large number of finely crystalline crystalline hydrates that are stable during long-term hardening and in water, and when exposed to an aggressive environment. It has been established that due to the formation of fine-crystalline ettringite crystalline hydrates (l = 5–10 μm), a dense, low-porous cement stone (p = 15–17%) with increased strength (R_s > 40 MPa) is formed, which leads to increased corrosion resistance of cement stone (K_s > 1.0). It is shown that the introduction of the developed composite binders into the composition of fine-grained concrete makes it possible to increase the water resistance of concrete by 2-3 grades (from W6 to W12).

Theoretical and practical significance of the research. Theoretical ideas about the structure formation of Portland cement in the presence of sulfated minerals have been supplemented, which ensure the early formation of ettringite phases that are stable when exposed to aggressive media on the cement stone and ensure the formation of a dense corrosion-resistant cement stone.

Composite binders based on Portland cement clinker of irregular composition and sulfated clinkers with increased corrosion resistance (K_s >1.0) have been developed.

The optimal compositions of corrosion-resistant composite cement with the content of Portland cement clinker of non-standardized composition in the amount of 80-90% are determined. sulfated clinkers - 5 - 10% and gypsum - 5 - 10%.

It has been established that the use of sulfated clinkers provides high density (reduction of stone porosity by more than two times) and stone strength (increase in compressive strength by 80-100%) during long-term hardening in an aggressive environment.

Rational areas of application of corrosion-resistant composite cement are determined, it is shown that when hardening in sea water for more than 200 days, the resistance coefficient is close to unity, which allows us to recommend them for the construction of port facilities and facilities in the coastal marine zone.

Basic provisions for defense.

- the results of experimental studies of the influence of dispersion of sulfoaluminate and sulfoaluminoferritic clinkers on the formation of the structure of cement stone during hardening under normal conditions and in corrosive environments;

- scientific substantiation of the choice of sulphated clinkers, providing the maximum performance and corrosion properties of composite cement;

- developed compositions of composite cements based on Portland cement clinker of non-standardized composition and sulfated clinkers with increased corrosion resistance;

- established patterns of influence of sulfated clinkers of various compositions on the technical properties of cement stone;

- developed recommendations for optimizing the material composition and dispersion of corrosion-resistant composite cements.