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MODIFIED CONCRETE FOR THE CONSTRUCTION OF MODERN ROADS

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Abstract

Uzagalnyuyuchi result doslidzhen naukovtsiv at the Branch tehnologiї monolitnogo betonuvannya svidchit scho priskorennya tverdnennya concrete vimagaє new pidhodu to stvorennya tsementnoї matritsi, the basis yakogo Je regulyuvannya Process strukturoutvorennya on mikro- i nanostructured rivnyah scho dozvolyaє zabezpechiti pidvischennya funktsionalnih characteristics that will ultimately novi for the warehouse that yakisno vidminni behind the structure and power of construction materials.

Keywords: *high-strength concrete, fast-setting concrete, mineral additives, industrial waste.*

Introduction

Analysis of trends in global development of the construction industry shows the need to increase the level of use of concrete for industrial, residential and road construction [1-4]. Widespread use of concrete in construction is due to its universal structural and physical properties, which provide high strength, fire resistance, ability to withstand external influences and ensure the durability of erected buildings and structures.

The need for modern building materials in the practice of modern construction production both for the construction of new high-quality buildings and structures, and for the repair and efficiency of existing infrastructure is constantly growing [5-7]. Such materials should be characterized by high functionality, energy efficiency, environmental friendliness, affordability, durability, be cost-effective in the structure of the life cycle of construction projects [8-9].

The main part

Intensive methods of building construction require modern technologies that would reduce energy resources, increase the efficiency of construction work in different temperature conditions, reduce the production cycle. Given that in the conditions of monolithic construction hardening of concrete is carried out without application or with restriction of heat treatment, the obligatory condition of high-speed technology is use of fast-hardening binders with reception of high durability of concrete mix in one - two days. to reduce the weight of products and structures, save concrete, steel and reduce costs [10].

A promising area of implementation of fast-setting high-strength concrete is the development and repair of road infrastructure that will ensure speed, safety and comfort of traffic with increasing traffic loads [11-12]. The development of road infrastructure, which involves the construction of modern highways with high transport and operational characteristics and rapid repair of the transport network, requires the use of fast-setting road concrete that meets the requirements of difficult operating conditions [13]. Such concretes for road and monolithic technologies should be characterized by high mobility of concrete mix for its quality laying and fast set of durability for maintenance of necessary rates of construction in various temperature conditions.

An important criterion for any type of construction is the speed of work, which speeds up the flow of funds. The development of composite fast-setting concrete with the use of man-made industrial waste makes it possible to significantly reduce the duration of construction and reduce the use of natural raw materials [11-14]. The economic effect of the development of fast-setting concrete is determined by reduced material consumption, reduced energy and labor costs and the use of man-made waste, significant increase in durability, and, consequently, increase the service life and reduce operating costs associated with buildings and structures and repairs , made possible by ensuring high performance of concrete [12-15]

A promising direction in the creation of high-strength materials based on cement is the use of ultrafine additives, applying the principles of forming a high-strength structure based on ultra-dense packaging [16-17]. Nowadays, additives of metacaolin, microsilica, fly ash and others are widely used as concrete modifiers. When they are introduced into the composition of concrete at the micro level, there is self-compaction and significant improvement of physical and mechanical characteristics of concrete [18-19].

It should be noted that the use of one-component additives is not always technologically and economically justified. The main disadvantage of monoadditives is the manifestation of their negative properties, in addition to the positive effect on the characteristics of concrete and mortar. In particular, some additives increase mobility, while reducing strength, others help to reduce the freezing point of water and increase water resistance, however, cause corrosion of steel and accelerated hardening of cement paste. A possible way to reduce the negative impact of monoadditives is the introduction of an additional component that can reduce or eliminate the negative effect of monoadditives. The action of complex additives is additive, and sometimes synergistic, which can not only enhance the main effect of the additive, but also neutralize its negative side effect [20].

Special properties of complex additives allow to regulate speed of hardening of cement dough and at the same time to change mobility of system, structure of cement stone and its operational characteristics. Of considerable practical interest is the use of additives containing plasticizer and inorganic electrolyte [21-22]. The obtained effect is due to the formation in these conditions of a homogeneous submicroporous structure with the most uniform distribution in its volume of the solid phase.

By increasing the dispersion of microsilica to nanoscale, significantly accelerates hydration processes due to the fact that the particles play the role of nucleation centers for the formation of denser particles C-S-H. The formation of the phase C-S-H is not limited to anything, and tumors fill the pore space. The large number of crystallization centers is the reason for accelerating the hydration process of cement [23].

The main feature of dispersed additives of micro- and nanosilicon is the facilitation of the nucleation process, as their particles are practically isomorphic with the products of neoplasms. The growth of crystals of neoplasms in the area with dislocations becomes energetically advantageous due to the appearance of an additional surface for the deposition of hydration products [24].

Acceleration of the hydration reaction of cement with the introduction of nanosilicon is caused by the high specific surface area of particles and their reactivity [25]. However, the size of the specific surface of the particles must be optimal, because its increase leads to an increase in water consumption and accelerate the hardening time. Researchers have found that the strength of the cement mortar with the introduction of nanosilicon in the amount of 5% leads to an increase in strength by 64% after 1 day of curing and 35% after 28 days compared to control compositions [26].

The concept of developing high-performance composites for various functional purposes with regulated properties requires a systematic study of the cement matrix in a wide range of recipe solutions at all stages of crystallization and structure formation. The use of ultrafine additives, nanoparticles characterized by high uncompensated surface energy and can significantly change the physicochemical interactions in concrete, playing the role of catalysts or crystallization centers depending on the chemical composition of the surface and concentration, allows nanotechnological approaches to structure and formation of properties projects in the volume of the curing system [27-28].

The main task of nanomodification is to control the process of forming the structure of the material from the nanoscale to the macrostructure of the concrete mixture and the kinetics of the whole spectrum of chemical reactions that accompany the curing process. Thus, using nanodisperse modifiers, you can control the kinetics of the interaction between cement and mixing water and achieve maximum positive effects at the stages: dissolution of cement grains, obtaining a given rheology; colloidation, ensuring the necessary preservation of mobility over time; crystallization, strengthening the heterophase boundaries of the contact zones and, thus, increasing the strength, water and frost resistance of concrete. The complex of physicochemical interactions in the structure of cement stone at the nanoscale creates the possibility of changing hydration reactions, revealing new patterns for understanding the nature of hydrate phases, as well as the development of high-performance concrete, which ensures controlled and environmentally friendly concrete production.

Conclusions

Based on a detailed and comprehensive analysis of scientific literature sources and patent materials of domestic and foreign scientists dedicated to the development of modified multicomponent binders and fast-curing building composites based on them, as well as nanomodification of cementitious matrix structure, it is possible to conclude high early and brand strength, density, deformable properties, frost resistance. This will purposefully manage the manufacturability and kinetics of structure formation, intensify the initial stages of hardening and create a strong and monolithic concrete structure with high rheological and physico-mechanical properties that determine their durability and a wide range of applications. Analysis of known patterns of structure of building materials allows to hypothesize the possibility of developing high-strength concretes for structural materials with regulated construction and technical properties due to purposeful management and control of early structure formation and formation of cementitious matrix structure by complex multilevel modification at micro- and nanostructure. mineral additives containing superplasticizers, ultrafine mineral additives and small doses of nanodispersed materials.

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