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Research Article

POWDERED CONCRETES ON COMPOSITION BINDERS WITH APPLICATION OF TECHNOGENE RAW MATERIALS

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Abstract.

At present time the attention of scientists and engineers is attracted by wide-scale application of high-strength concretes differing from usual by increased content of cement stone, lesser bulkiness of grains, multi-component composition, increased specific surface of filler. In connection with this the preliminary study of conditions of high-strength concrete structure formation, the role of technological practices in this process and nature of structure impact on concrete quality. In article are considered aspect of designing of composition and technology of manufacturing of items on basis of powdered concrete, and also their actuality in contemporary construction. Results of determination of co,position and technology of high-strength powdered concretes with application of nanostructured modifiers that have diverse chemical and mineral composition and genesis are stated. The ability to reduce the binder's consumption by cost of introduction of technogene and organic raw materials into composition; provision of lower consumption of material resources and energy; application of non-toxic and fire safe materials, protection environment is established.

Key words: high-strength material, powdered concretes, nanostructured modifier, technogene raw materials.

Introduction. Today the attention o scientists and engineers is attracted by application of high-strength powdered concrete differing from usual by increased content of cement stone, lesser bulkiness of grains, multi-component composition, increased specific surface of filler [1-5]. Operational properties of this concrete to a great degree depend on properties of filler and water content.

Theoretical basis of high-quality composites creation is a new scientific direction, geonics, which applies results of research of geological processes and rocks for creation of materials of new generation [6-10].

Methods. Substantial impact on formation of powdered concrete structure is made by introduction of additions of new generation, such as carboxilate hyper-plasticizer – MF 1641, French hyper-plasticizer PREMIA 360 at its modification by water soluble products of carbon nanoclusters ("Astralenam C") etc., which regulates their quality characteristics. At present time is received the high-strength powdered concrete with strength B 100-120 [7-15]. It is known that empiric way of searching for further increase of concrete strength was always labor costly and lengthy. In connection with this the preliminary study of conditions of high-strength concrete structure formation, the role of technological practices in this process and nature of structure impact on concrete quality.

Positive results are given by multi-component composition of concrete – the number of components can reach 7-9 and more. At this the decisive impact on its properties is caused by quantity and quality of binding substance, quality of fillers (bulkiness of grains, granulometric composition, quality of surface, cavernosity, strength). At this the cost of finished material is significant.

An important source of increase of economic effectiveness of new generation powdered concretes production is the development of methods of structure optimization, promoting receiving of high degree of orderliness of elements composing it, production of binders with application of technogene products.

In researches were used mineral additions containing aluminous and carbonate component, and polymer typical – Melflux 2651, Melment, C-3, and also finely ground quarzite-sandstone, shales and amphibolites from produced rocks of Kursk Magnetic Anomaly (KMA). Application of complex organic-mineral additions, binding substances of wide nomenclature in concretes, where as siliceous component is applied the raw material of technogene origin in combination with super-plasticizers and hyper-plasticizers, is a future of contemporary concrete studies and concrete technology.

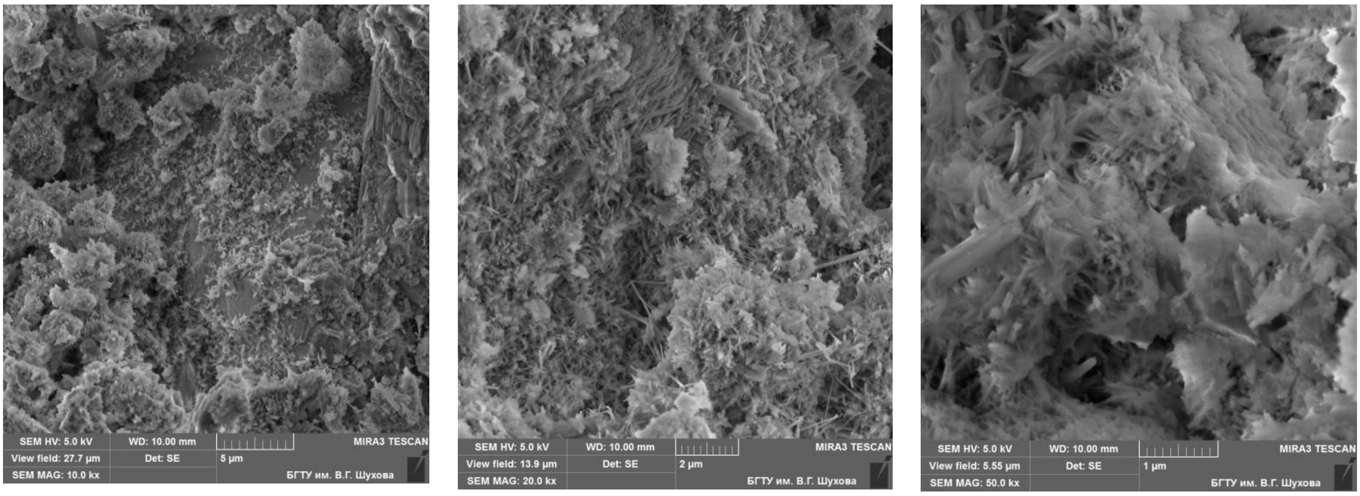
In spite of all positive characteristics, the cost of high-strength compounds and technology of works on their production is rather high, and dependently of particular conditions can exceed the cost of common binders in several times. On this basis the search for multi-tonnage mineral components, including of technogene origin that would not allow, without reduction of high construction-technical and aesthetic indexes, to increase the availability of application of new high-strength compositions, is important. In regard of high-strength and high-quality concretes are perspective complex additions, introduces in composition of mixture in form of water solution, powders and emulsions [15-19].

Processes of structure formation of composites with technogene components require their study and activation of works on optimization of compositions and structure of high-strength materials by cost of selection of proper proportion of new initial technogene products and management of structure formation processes. This would allow to receive high functional concretes at low material and energy costs for production.

Major part. Composition binder received at joint grinding with plasticizing addition has the most homogene dense structure, which is related to reduction of water-cement proportion. Same as in composite binder without plasticizer is observed the presence of dense formation in proximity of filer grains, in contact zones that provide minimal content of pores and micro-cracks. This is explained by specific of structure of nanostructure modifier (NSM), allowing the active formation of new formations by cost of use of water stored in pored of rock, and also significantly promoting formation of micro-structure of contact zones and all cement stone in general.

Introduction of NSM in cement system allows to increase the activity of binder up to 75.5 MPa. Growth of strength at introduction if NSM is explained by improvement (condensation) of stone cement structure,

Condensation and strengthening of structure is sripulated by growth of crystalline phase and replacement of water contacts between separate phases of new formation by crystalline contacts (Fig. 1).



a) ×10000 b) ×20000 c) ×50000

Figure 1. Micro-photo of cement stone on basis of powdered contact with addition of NSM.

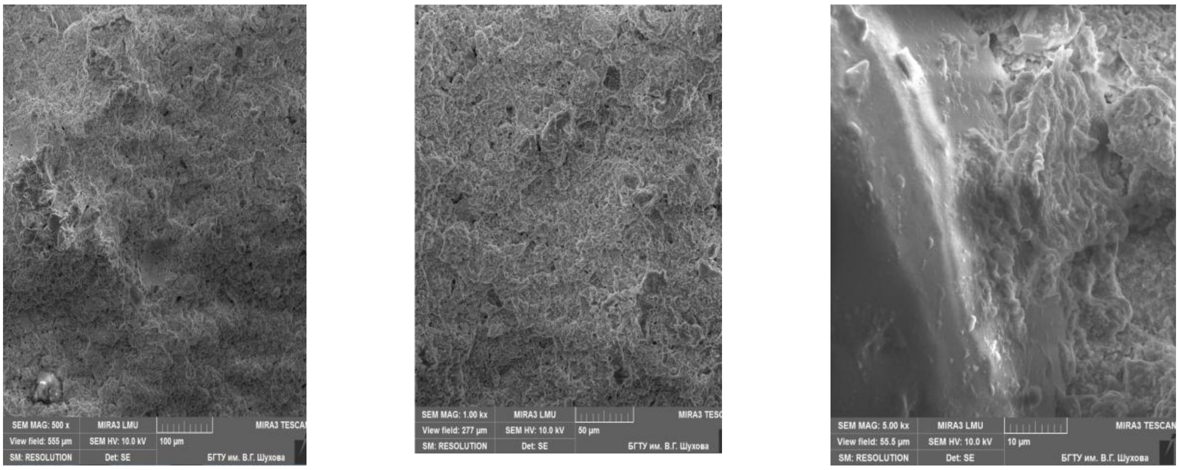
Hard frame of all binder samples is constructed of separate grains of NSM of technogene origin of diverse degree of dispersion ability with brightly expressed chemical contacts of interaction with new formations. At this, at bigger enlargement is visible that these particles are almost completely covered by products if hydration, because the particles of technogene raw materials are a good basics for formation of new formations germs, in result of which is a plentiful of globulas adhered to their surface (Figure 1). Beside that the smallest particles of filler, same as non-hydrated cement grains, are centers of crystallization. Structure of powdered concrete of optimal composition, received at joint grinding with plasticizing addition, is characterized by homogeneous dense structure (Figure 1). In general mass of products is observed the presence of dense formation in proximity of filer grains, in contact zones that provide minimal content of pores and micro-cracks. Specifics of NSM structure allowed the active formation of new formations by cost of use of water stored in pored of rock, and also significantly promoted formation of micro-structure of contact zones and all stone in general. This is confirmed by results of physical-mechanical tests according to which the strength limit at compression of this bonder is twice higher than the strength of cement without additions and equals 95 MPa. Microstructure of composite binder received at separate grinding and further mixing of components is also homogeneous, but differently from the previous one here is observed the intergrowth of needle-shaped crystals of length 1 nm (Figure 1 c), threading the whole amount of material structure, (Figure 1). Micro-cracks of 3...5 nm in length can be notices, which is explained by worse mechanic activation and diffusion of tuf and binder micro-particles. This leads to reduction of strength limit at compression for 8.4 MPa by comparison to binders received at joint grinding. Therefore, studying of micro-photographs of composite binders, prepared by different schemes of grinding, showed the following. Micro-structure of cement stone without NSM received at joint grinding, is more homogeneous, here is also observed the intergrowth of needle-shaped crystals, threading the amount if material structure (Figure 1), but in lesser quantity. In large quantity are present dense new formation in proximity of filler grains. As silicious component were selected micro-silicon, alum-containing addition, quartz sand applied at present time. This provided a significant increase of major construction-technical properties of concrete and construction items, that allowed ti decrease the weight of buildings and facilities, without reduction if their structural strength, stability and durability. This goal was achieved by condensation of structure, lessening of quantity of pores and micro-cracks. Th share of super-plasticizer Melflux 2651 was 0.9% of cement consumption. Cement consumption was reduced for ≈ 18 %. Freshly prepared mixture has an increased flowability and rheological activity, which allow to provide casting of concrete without forms, i.e. self-formation of items and construction of large square (poured floors, playgronds etc.).

Table 1. Indexes of construction-technical properties of powdered concrete

Name of index	Value
average density, kg/m3	2250

strength at compression, MPa	98
water retaining capacity, %	89.5
strength of cohesion with base, MPa	0.9
coefficient of construction quality	0.36
grade by water resistance, W	2
grade by frost resistance, F	300
wear capacity, kg/m^2	0.35
contraction	cracks are absent
coefficient of heat conduction, W/(m·K)	0.089

At 28-days term of solidifying it is distinct by a high degree of orderliness of grain constituent with high density (Figure 2).



a) x 500 b) x 1000 c) x 5000

Figure 2 – micro-structure of powdered concrete on basis of fine-grounded quarzite-sandstone.

Summary. In figure (at different enlargements) can be seen the degree of condensation of powdered concrete structure. Practically complete absence of pores in concrete is visible. This is received by cost of corrected composition of solidifying matrix, introduction of optimal quantities if finely disperse technogene products, their most dense packing and self-condensing effect of solidifying. Increase of structure density was observed with increasing effect within the time of solidifying. By this was preconditioned the receiving of high-strength concrete with improved physical-mechanical characteristics at application of complex additions. Within solidifying period occurs a range of changes in structure of forming concrete mixture in result of artificial contraction, lessening of porosity, exclusion of part of plastic deformations. At the end of solidifying period, when artificial stone reached its maximum density and, therefore, dynamic characteristics too, occurs the intense process of calcium hydroxide binding. In liquid phase is completing the postcompaction of grain compound with reaggregation of disperse particles.

In normative age the high strength of concrete with complex addition is explained by orderly grain structure. Within solidifying period occurs a range of changes in structure of forming concrete mixture in result of artificial contraction, lessening of porosity, exclusion of part of plastic deformations.

Conclusions. Therefore, model of structure formation in modified solidifying compositions, in which the principle of structure optimization is conducted, contained in creation of high degree of orderliness of composig elements and increase of adhesion of cement stone particles, is proposed. Received results allows to transfer to further improvement of high quality decorative concretes production. Application of methods of creation of model systems of high-strength solidifying compositions would allow to receive new data about the structure of material, abilities of improvement and management of processes of structure formation.

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