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DEVELOPMENT OF OPTIMAL COMPOSITIONS AND RESEARCH OF PHYSICO-MECHANICAL PROPERTIES OF FINE-GRAINED CONCRETE

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ABSTRACT

The article presents the development of optimal compositions and the study of the physical and mechanical properties of fine-grained concrete.

Fine-grained concrete is obtained from a mixture of fine aggregate, cement and water in certain proportions. To increase economic efficiency and reduce the consumption of a binder, chemical and mineral additives are introduced into the composition of the concrete mixture. Technical requirements for materials for fine-grained concrete are given in GOST 26633–2015 [1].

As a fine aggregate, sand is used, consisting of grains 0.16–5 mm in size and having a density of more than 1.8 g/cm3. For the preparation of fine-grained concrete, natural sands are used, formed as a result of the natural destruction of rocks, as well as artificial sands obtained by crushing hard rocks and screenings.

Keywords: fine-grained concrete, fine aggregate, cement stone, sample, superplasticizer, strength.

The quality of sand used for the manufacture of concrete is determined by the mineral composition, grain composition and the content of harmful impurities. The aggregate should consist of grains of different fractions, while the grain composition of the aggregate is set on the basis of proven recommendations so that smaller grains are located in the voids between large ones. In concrete technology, plasticizing additives (superplasticizers) are most widely used, which improve the mobility of the concrete mix without increasing water content and reducing strength.

They also make it possible to reduce the water content without compromising the workability of concrete mixtures and to achieve an improvement in the basic properties of concrete or, for given concrete properties, to reduce the required consumption of a binder. Fine-grained concrete has increased flexural strength, water resistance and frost resistance. Samples of smaller sizes than for the usual one: cubes 3x3x3 cm, 5x5x5 cm, 7x7x7 cm and beams 4x4x16 cm (as when testing cement) [2].

As a result, to obtain equal-strength concrete and equally mobile concrete mixture in fine-grained concrete, the consumption of water and cement increases by 20–40% compared to

ordinary concrete. To reduce the consumption of cement, chemical additives, effective compaction of sandy concrete mixtures and coarse sands with an optimal grain composition should be used. In cement-sand mixtures with a high content of cement, it is useful to use plasticizers, superplasticizers and organomineral additives.

In accordance with the goal, the main direction of research is the selection of compositions of fine-grained concrete with the addition of mineral and chemical additives. The strength of concrete samples for bending and compression was determined on samples – beams 4x4x16 cm in size. A composition of 1:3 was chosen as a control composition. Figure 1 shows a graph of the strength development of the control composition and compositions with the addition of ash-slag. The consumption of components and the results of tests of samples of fine-grained concrete for flexural and compressive strength are shown in the figure.

Based on the results obtained, it can be concluded that the introduction of chemical additives leads to a significant decrease in the water-cement ratio, and in this regard, to an increase in strength indicators. For the plasticizer Polyplast R, the best results are typical with the introduction of an additive in the amount of 1% by weight of the binder, for the superplasticizer Polyplast R type 2 – in the amount of 1.5% by weight of the binder.

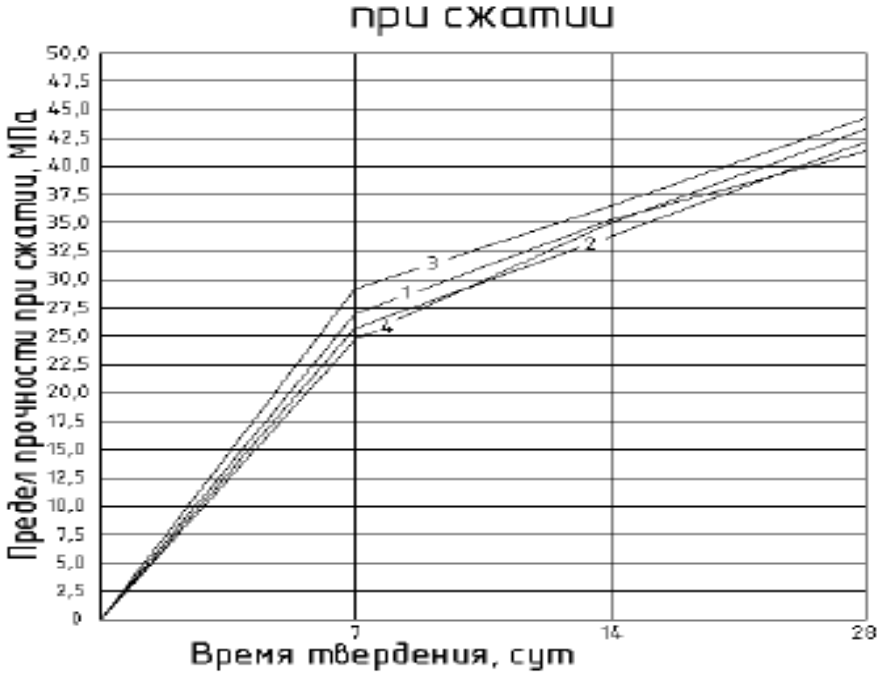

Figure 1 – Influence of ash-slag on the strength of fine-grained concrete: 1-control composition; 2-addition of ash-slag-5%; 3 – addition of ash-slag – 10%; 4-addition of ash-slag-15%.

As a result of the data obtained, it can be judged that the addition of ash-slag in an amount of 5–15% by weight of the binder has a significant effect on the strength characteristics. In compositions No. 2 and No. 4, ash-slag with a specific surface area of 2500 cm2/g was used. With an increase in the amount of ash-slag in the mortar mixture, the amount of the alkaline component added to the mixture also increases. This is due to the fact that ash-slag has a high adsorption capacity.

The introduction of fly ash and ash-slag as a mineral additive instead of part of the binder contributes to the pozzolanic process, in which amorphous silica (SiO2) is bound to lime formed

during the hydration of the binder as a result of the transition to low-basic hydrosilicates. The cement stone structure is compacted with fine particles that fill the space between the particles in the dough and the hydration products in the ash and slag stone, which in turn leads to an increase in the strength of fine-grained concrete [3, 4].

The greatest increase in compressive and bending strength is achieved by replacing ash-slag with 10% binder. We consider this dosage of ash-slag to be optimal and use it in the further selection of the composition of fine-grained concrete. Figure 2 shows a graph of the strength development of samples with the addition of the superplasticizer Polyplast R and the complex additive Polyplast R type 2.

Figure 2. Influence of chemical additives on the strength of fine-grained concrete: 1 - control composition, 5 - Polyplast R 0.5% additive, 6 - Polyplast R 1% additive, 7 - Polyplast R 1.5% additive,
8 - additive Poliplast R type 2-0.5%, 9 - additive Poliplast R type 2-1%,
10 - additive Polyplast R type 2 - 1.5%.

Based on the results of the data obtained, it can be concluded that the joint introduction of mineral and chemical additives into fine-grained concrete increases strength characteristics, reduces the water-cement ratio and porosity. The resulting mixture has increased workability and plasticity. The most optimal dosage of additives is 1–1.5%.

Based on the studies of the developed compositions of fine-grained concrete with the optimal dosage of mineral and chemical additives, the following conclusions were drawn:

As a result of studies of the obtained compositions of fine-grained concrete with a mineral additive, it was found that the introduction of ah-slag in an amount of 10% (composition No. 3) leads to an increase in strength compared to the control composition. The compressive strength of composition No. 3 was 44.05 MPa, which corresponds to class B30.

To impart plasticity and reduce W/C, plasticizing additives Polyplast R and Polyplast R type 2 were introduced into the compositions in an amount of 0.5% to 1.5% by weight of the binder. Compositions No. 6 and No. 10 became the best compositions as a result of the introduction of the additive, the compressive strength of the samples was 44.51 MPa and 44.82 MPa, which corresponds to class B35. These compositions can be recommended for the production of products from fine-grained concrete.

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