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ENGINEERING OF APPROPRIATE COMPOSITION OF CEMENT BINDING MATERIALS FOR CORROSION RESISTANT CONCRETE

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Abstract: *The increasing necessity for corrosion-resistant concrete is caused by the fact that the rate of aggressive environmental influence on building structures has recently significantly increased. This is the result of a violation of the ecological balance and violation of a number of requirements of the norms - low waterproofing ability of structures (basement walls, plinths, foundations), imperfection of a number of structural elements, including expansion joints, gutters, joining of the blind area to the building, absence or unsatisfactory operation of operational services. Reasons associated with the low quality of concrete or the low quality of construction work played an important role. All these reasons lead, in the end, to one form or another of corrosion of concrete*

Key Words: : *microfill, rotor, portland cement, micro damping, nitron, polyacrylate, micro-filler, cement stone.*

1. INTRODUCTION:

The quantitative and qualitative composition of any concrete, including corrosion-resistant, as you know, largely depends on the choice of composition engineering methodology. In this case, as a rule, the optimal structure should correspond to the optimal composition.

As a basic method of engineering of the appropriate composition of cement corrosion-resistant concrete in our studies, we adopted the general method in accordance with the provisions of the general theory of artificial building conglomerates (ISC), developed by professor I.A. Rybiev and his science school [1]. At the same time, appropriate structures correspond to improved quality indicators of materials in comparison with non-appropriate ones. This improved quality is due to the increased density, the minimum amount of liquid medium, the increased concentration of the solid phase, the minimum pore volumes in the contact zones and a number of other reasons, especially of an energy nature. A valuable advantage of appropriate structures is their similarity with each other, which is proved by a theorem in the theory of ISC. In particular, this means that the pattern revealed in relation to one material can be extended to others if their structures are appropriate.

The peculiarity of the general engineering method for ISC is that at the first stage of design, the greatest activity of the binder is established by the compressive strength (R*) at the optimum value of the water-binder ratio (W*/W). The desire for a comprehensive increase in the strength of a cement is justified for the reason that its quantity in the conglomerate depends on the strength of cement and the greater the strength, the more the consumption of the cement decreases. In accordance with the law of obligatory conformity of properties in the ISC theory, all strength, deformative, and other properties of a conglomerate are directly related to the same properties of a binder, and with optimal structures, their relationship is most fully manifested.

2. METHOD:

Scientists have proven [2] that the binder functions in the materials with a conglomerate type of structure in a binder. It has sufficient uniformity of composition and properties, with the necessary (appropriate) amount forms a uniform continuous spatial grid. By changing the properties of the binder, as the matrix part of the ISC, it is possible to directionally regulate and improve the properties of the conglomerate.

The dependence of the hydraulic activity of a Portland cement binder on its dispersion is extreme [3]. A linear dependence of the strength of Portland cement at a daily age on its dispersity was established [3].

But the intensification of cement hardening only by increasing its dispersion has a number of difficulties, which include a large consumption of process fuel and the deterioration of a number of construction and technical properties (increased shrinkage, tendency to crack formation, reduced frost resistance, etc.) [4].

3. DISCUSSION:

When establishing the optimal composition of a cement binder, the dependence of the strength of the binder on its water-binder ratio is determined under accepted technological conditions. Moreover, there are many such dependencies corresponding to different ratios of the constituents of the binder - Portland cement clinker, gypsum stone with varying dispersion within the established limits. But any of these dependences has an extreme of strength corresponding to a point with an optimal composition of normal or accelerated cement binder, which has an optimal structure with this production technology. For experimental determination of strength, a number of samples were prepared at different water-binding ratios [4]. In this case, the identified optimal technological parameters of mixing, compaction, hardening and other processing steps and their conformity to that accepted at the production site were taken into account.

Studies [4,5] suggested the preparation of a binder in the activator of periodic action with intensive mixing in a liquid medium. The dosed components are mixed with water for 30-60 seconds with an optimal speed of the rotor shaft, fixed in the range of 800-1000 min-1, and established during preliminary experiments from the dependence of the strength of cement stone on the intensity of mixing of the binder in the activator with different rotational speeds shaft.

4. ANALYSIS:

The cement test is sealed on a vibrating table with an amplitude of 0.3-0.6 mm with an oscillation frequency of 2900-3000 count / min for 15-20 seconds. Vibration is carried out without a load and with a load at a specific pressure on the surface of 0.3 MPa (imitation of vibration rails adopted at the factory).

Hardening of the samples is carried out under normal temperature and humidity conditions (T = 20 2 ° C and = 100%), as well as during heat treatment with a regime of 2 + 3 + 6 + 4 h at a temperature of T = 80 5 ° C. Preliminary studies [4] found that with this hardening mode, the binder gains up to 90% of brand strength.

Then, in the coordinate system, the extreme dependences of the compressive strengths of cement stone on the water-binder ratio were constructed for various specific surface of the binder (Fig. 1.2).

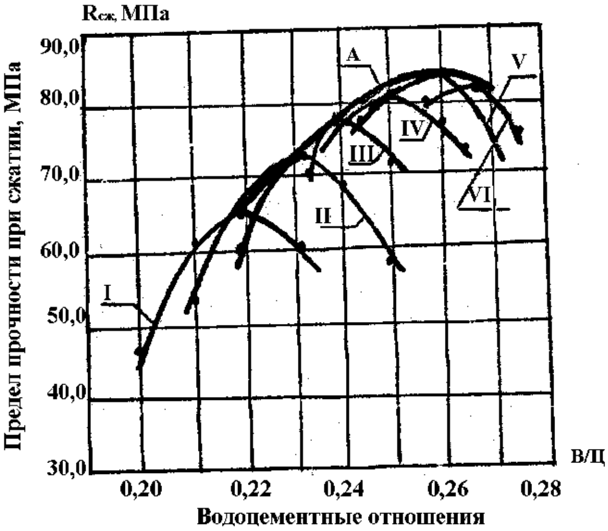

Fig. 1. The dependence of the compressive strength of cement stone on the water-cement ratio for various specific surface portland cement binder. Curve A - envelope of cement binders of optimal structure; the curve with indices I, II, III, IV, V, VI corresponds to the specific surface area (m2 / kg) of a Portland cement binder, respectively, at a grinding time of 30 ’, 45’, 60 ’, 90’, 120 ’, 180’. I - 280 m2 / kg; II - 320 m2 / kg; III - 370 m2 / kg; IV - 400 m2 / kg; V - 450 m2 / kg; VI - 520 m2 / kg /. (note: digital data taken from [4])

Extreme strengths (activity) correspond to the values of the compositions of the binder normal or accelerated hardening with the optimal structure of cement stone with the adopted technology, the modes of preparation and hardening of samples.

The regulation of the properties of cement binder in order to increase its strength is possible by changing the material composition, including the introduction of additional (modifying) substances.

Chemical additives (surfactants, dispersants, etc.) that allow you to control the processes of structure formation in binders and conglomerates, starting with solid-phase reactions in the grinding process, modify their properties [6].

Moreover, from a large number of currently known chemical additives, one is selected that exerts a multifunctional modifying effect on the grinding process and structure formation of cement systems.

The phenomenon of adsorption modification, established by P. A. Rebinder, is explained by the fact that when nuclei of future crystals appear, their surface is covered with surfactant molecules. In this case, the growth of the initial crystals slows down, but during the time during which the crystallization process takes place, they are formed in a very large amount in a unit volume. Reducing the size of the crystals always helps to improve the structural and mechanical properties of cement stone and concrete.

Of the chemical additives of the ionic type, which at the moment are the most expedient, are very stable cationic, upon dissociation of which a small anion and a cation with a long hydrocarbon chain are formed.

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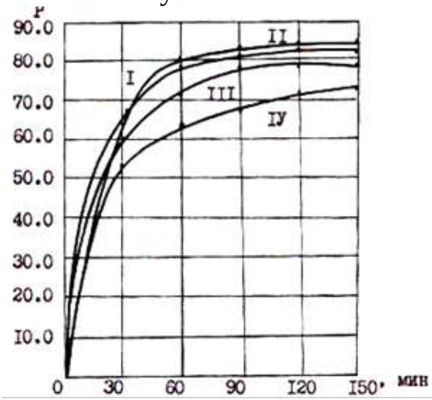
Of particular interest are cationic additives of water-soluble polymers, creating an additional structure in hardening cement stone. The spatial system of polymer films (membranes), which is formed inside a cement stone, increases its tensile strength and serves as a micro damping element that increases wear resistance, corrosion resistance and facilitates relaxation processes in the hardening system.

As a chemical additive, a water-soluble multifunctional acrylate additive was used - a waste product of the production of a nitron fiber, called K-9, which belongs to the group of hydrogels (gel polymers).

Studies [7] showed that gel polymers are involved in the process of structure formation, providing the last stage of hydration with a high degree of crystallization of the hydrated components of cement.

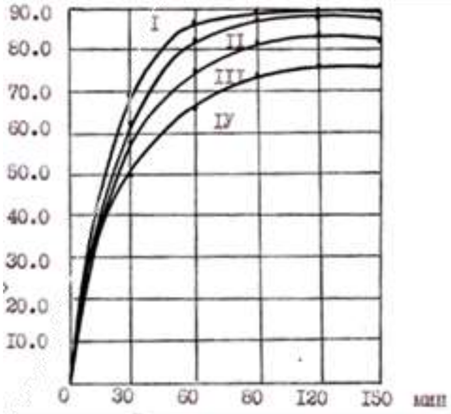
5. FINDINGS:

The studies performed by the authors on the modification of cement binder with K-9 polyacrylate confirmed the advisability of using this additive to increase its activity. The results are shown in Fig. 2,3.



Grinding time in minutes

Fig. 2. The dependence of the compressive strength of cement stone without the addition of K-9 on the grinding time: I - Portland cement; II - cement binder with 15% microfill (ash TPP); III - the same with 25% micro-filler (ash TPP); IV - the same with 40% microfill (ash TPP)



Grinding time in minutes

Fig. 3. The dependence of the compressive strength of cement stone with the addition of 0.002% K-9 on the grinding time: I - Portland cement; II - cement binder with 15% microfill (ash TPP); III - the same with 25% micro-filler (ash TPP); IV - the same with 40% microfill (ash TPP)

Analysis of the available data indicates an increase in the activity of cement binder in the presence of 0.002% K-9 additives by 15%.

6. RESULT:

The optimal compositions of cement binders obtained with different contents of micro-filler (ash TPP) according to [4] are shown in table 1.

Optimum cement binders Table 1

№	Components of cement-ash binder with an optimal grinding time of 45 min				Compressive strength, MPa, R* 28	W*/W
	Portland cement clinker, %	xx) gypsum block, %	Ash, %	xxx) additive K-9, %		
1	82,0	3	15	0,002	75,9[x)]	0,220

2	72,4	2,6	25	0,002	77,6 x)	0,225
3	57,9	2,1	40	0,002	67,2 x)	0,245
4	38,6	1,4	60	0,002	37,6 x)	0,285

x) tested halves of beams 4x4x4 cm in size (number of samples 3);
xx) the optimum amount of gypsum stone was found to be 3.5% by weight of Portland cement clinker;
xxx) the optimal amount of K-9 additive is determined by the weight of the binder.

7. CONCLUSION:

The performed design of the optimal compositions of cement binders for corrosion-resistant concrete according to the general method of the ISC theory allows us to determine the optimal region of structures with high quality characteristics in the range of water-binders and to select the most rational one from them [8].

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