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STUDY OF THE INFLUENCE OF CHEMICAL ADDITIVES ON THE PROPERTIES OF FINE-GRAINED CONCRETE

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ABSTRACT

The Republic of Kazakhstan has a huge territory, within which there is a large number of locations, where the lack of water for irrigation, satisfying the drinking needs of the population, livestock water and etc. You can resolve this situation by building special water-conducting facilities - channels intended for the transportation of water to the consumer from the water source. The problems arising from the operation of the channels are known for the past five thousand years, that is, throughout the history of hydraulic engineering. They lead to such environmental consequences as an increase in the level of groundwater. Warning, secondary soil salinization, acidification, soil squeezing etc. The root causes of these consequences are water losses from the filtering channel. The most effective solution to this problem is the device of various kinds of anti-filter clothing. One of these anti-filtering activities is the device of monolithic concrete facing.

Keywords: soil salinization, acidification, anti-filter clothing, monolithic concrete, chemical additives, fine-grained concrete.

INTRODUCTION

Currently, fine-grained concretes are found for the manufacture of reinforced concrete products and the construction of monolithic structures in hydrotechnical construction. The feasibility of their use is primarily determined by the lack of large aggregate in some areas of concrete. The use of local sands or fine waste of crushing rocks instead of the imported large aggregate allows you to achieve significant resource savings.

One of the ways to solve this problem is the use of affordable, cheap, often unclaimed local raw materials, to which you can attribute waste crushing rocks.

During the production of crushed stone from carbonate rocks on careers, a significant amount of sewing of crushing of particles of 0-5mm is formed, which are large sand along the grain composition. Opening is a waste production, occupy large warehouse areas and dumps. In addition, the storage of a significant amount of dispersed material causes environmental pollution.

At the outlet of crushing in the production of crushed stone, such parameters such as the size and strength of rock, production technology and the type of crushing equipment, an assortment of products are influenced. The volumes of sections of crushing at enterprises of non-metallic building materials are constantly growing. By increasing the requirements for the shape of the grains and increasing the production of small fractions of the crushed stone, the current output increase significantly.

Therefore, the development of alternative methods for utilization of crushing waste is an urgent task in the production of efficient building materials based on man-made production waste.

Thus, the use of fine-grained concrete based on cheap raw materials in the form of discraining production of rubble from carbonate rocks is the optimal technical solution, the implementation of which requires a number of studies in order to develop compositions and methods for the production of fine-grained concrete based on this technogenic raw material.

The absence of natural sands of proper quality for the preparation of concrete mixtures stimulates the use of sefs of crushing rocks in the composition of both ordinary heavy and fine-grained concrete. It should be noted that the main disadvantage of crushing drops is the high content of a dust fraction in them, which requires an increased consumption of cement in concrete and mortars. In the Kyzylorda region, the company engaged in the production of crushed stone from dolomites and limestone provide asphalt plants, plants for the production of reinforced concrete products and construction companies with their products and work consistently.

Low cost, the developed transport network allows you to consider crushing drops as affordable, local raw materials. Improving the forms of seeding grains, reduce the content of dust particles allows the creation of a raw material base in Kyzylorda, where there is no high-quality construction sand [3, 4, 5].

According to GOST 26633-2012 interstate standard. "Materials of construction non-metallic sections of crushing rocks in the production of crushed stone. Application conditions» materials from crushing sections are used in accordance with existing regulatory or technical documents as aggregates and fillers for concrete, construction solutions, dry construction mixtures, for the production of roofing, ceramic materials, preparation of mixtures with the device and coatings of automotive roads and airfields» materials from riddling of crushing are obtained in the form of sand, enriched sand, crushed stone and dust-like component.

The fine-grained concrete is used in the device of anti-filtered channels of channels and water bodies, the construction of various containers, in the manufacture of thin-walled panels of paving slabs, sealing the deformation seams of hydrotechnical structures, etc. For repairing hydrotechnical structures, airfield coatings, channel cladding can be used rapidly solid small-grained concrete based on liquid glass in combination with additives [2].

Currently, fine-grained concretes are one of the most sought-after types of building materials, which are used to build carriers and self-supporting structures, for thermal insulation and to protect building structures from the effects of the aggressive environment. In the development of technologies and the study of the properties of various types of fine-grained concrete, a great contribution was made by Yu. M. Bazhenov and his school, V. G. Batrakov, L. A. Alimov, V. V. Voronin, A. E. Shakin and others.

The fine-grained material structure, according to Yu. M. Bazhenova [1] has a number of advantages, among which you can call the following:

- the possibility of creating a finely disgraceful high-quality structure without large inclusions of a different structure;
- high thixotropy and ability to transform concrete mix;
- high manufacturability - the possibility of forming structures and products by casting, extrusion, pressing, stamping, spray and others;
- Easy transportability;
- the possibility of widespread use of dry mixes with a guarantee of high quality;
- the possibility of obtaining materials with various complexes of properties;
- obtaining special types of material: fibred concrete, ferrocement, decorative, electrically conductive, waterproofing and others;
- The ability to receive new architectural and structural solutions: thin-walled and layered structures, density variable products, hybrid structures;
- Multifunctionality of the material, i.e. the possibility on a certain cement and sand only due to the variation of the composition, the complex of additives and technological techniques to obtain construction, thermal insulation, waterproofing, decorative and other types of concrete;
- the possibility of widespread use of local materials and, as a rule, lower costs compared with classic coarse-grained concrete.

According to Yu. M. Bazhenova [1], the increased porosity of fine-grained concrete is due to the high specific surface of the aggregate, which increases the water consumption of the concrete mix, which contributes to the involvement in it with vibration to 3-6% air. In addition, the overall porosity of concrete is influenced by the water demand emptiness formed with the insufficient number of cement test, the absolute volume of which in fine-grained concrete should always be greater than in the usual one.

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Due to the absence of a large aggregate, a fine-grained mixture is more homogeneous and easily succumbed to various technological converts. This allows you to get products from it and the design of various purposes with a wide range of technical properties that are not always achievable when using large aggregate [9, 10].

Small-grained concrete was widely used in hydraulic construction. As aggregates for fine-grained concrete coatings, natural quartz and quartz-feldspathic sands are used, there are developments and experience in the use of other fine-grained aggregates. [11, 12]

EXPERIMENTAL PART

The experimental part of the work was performed using a number of standard methods.

When conducting experienced work, the dosing of cement and aggregates was carried out by weight, water and aqueous solutions according to the volume. The mixing of the mixture was performed manually.

The workability of cement-sand mixtures was determined by the cone flow diameter on the shaking table, according to GOST 310.4-84.

The sealing of sealless cement-sand mixtures was carried out on a laboratory vibrationboard with an amplitude of oscillations of 0.4 ... 0.5mm, a frequency of 50 Hz, under a prunes of 0.2 ... 0,3p. Sealing stipging cement-sand mixes on a laboratory vibrationboard with an amplitude of oscillations of 0.7 ... 0.8mm, a frequency of 50 Hz, under a long-range 10pc.

Long-term hardening of samples, as well as storing samples after thermal magazine treatment, was carried out at a temperature of 20 + 2 s in an environment with a humidity of 98%.

The determination of the strength of the samples was carried out according to the methods set forth in GOST 310.4-81 "Cements. Methods for determining the strength of bending and compression" and GOST 10180-2012 "Concretes. Methods for determining compressive strength and stretching."

The effect of chemical additives on the properties of fine-grained concrete was investigated by conducting relevant experiments. Chemical additives [2,9] in the concrete mixture were introduced with water indoor.

In the first part of the work, an influence on the properties of fine-grained concrete on the quartz sand of single additives C-3, LST, STB was investigated. The mixing of the concrete mix was performed manually. The mobility of the mixtures were within 11-12cm according to GOST 310.4-84. Samples tried in natural conditions.

Research results show that the introduction of the supplements of C-3, LST, STB led to a decrease in the water content in the concrete mixture from 205 to 168 ... 192 L/ m^3 and increased compression strength from 16 to

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18 ... 24 MPa aged 7 days and from 23 to 24 ... 33 mPa at the age of 28 days (Table-1).

The greatest effect was obtained using the S-3 and LST additive. The result of their introduction V/C decreased from 0.51 to 0.42 and 0.46, respectively. The use of STB additives had a minor effect on the properties of cement-sand mixtures.

Table-1. The effect of chemical additives on the properties of fine-grained concrete.

No	Consumption of materials kg/m^3			Additives,% of cement mass		V/C	Average density kg/m^3	Compressive strength, MPa aged	
	Cement	Sand	Water	Type	Number			7	28
1	400	1600	205	-	-	0,51	2200	16	23
2	400	1620	184	LST	0,2	0,46	2220	19	26
3	400	1640	168	C-3	0,5	0,42	2230	24	33
4	400	1610	192	STB	0,05	0,48	2210	17	24
5	400	1610	160	C-3, LST	0,5 0,15	0,40	2250	26	34
6	400	1640	170	C-3, STB	0,5 0,05	0,425	2240	19	33

In experiments used sand number №1.

In the second part of the experimental work, the effect on the properties of cement-sand mixtures of complex additives was investigated. As a result of the introduction of complex additives, the water content in the concrete mixture decreased to 160 ... 170 L/ m^3, compressive strength increased to 19 ... 26 mPa at the age of 7 days and up to 33 ... 34 mPa at the age of 28 days.

Table-2. Influence of the size and type of sand on the properties of fine-grained concrete.

No	Sand type	Consumption of materials kg/м^3			Additives, % of cement mass		V/C	Average density, kg/м^3	Compressive strength, MPa aged	
		Cement	Sand	Water	Type	Number			7	28
1	1	400	1600	200	-	-	0,5	2200	16	23
2	1	400	1610	160	C-3, LST	0,4 0,15	0,40	2250	28	36
3	2	400	1600	220	-	-	0,45	2200	14	19
4	2	400	1610	160	C-3, LST	0,5 0,15	0,43	2240	20	27
5	2	400	1600	210	-	-	0,545	2160	16	22
6	2	400	1610	170	C-3, LST	0,5 0,15	0,42	2180	26	33

In the production of fine-grained concrete, along with large sands can be used by medium and small sands. Typically, the fine-grained concretes obtained at the same time do not meet the requirements for strength and frost resistance. To verify the effect of additives on the properties of such concrete, a series of experiments was carried out using various sands.

The results of the experiments are presented in Table-2.

The results of the experiment show that the transition from large sand to the small leads to an increase in the water demand of the mixture from 160 ... 200 to 185 ... 220 L/ m^3 and reduce the strength of compression from 17 ... 28 to 14 ... 20 mPa aged 7 Day and from 24 ... 35 to 19 ... 27 mPa aged 28 days. At the same time, the strength of fine sand with an additive on fine sand is higher than that of the concrete without additives on medium sand, and at the middle sand concrete with the additive is higher than on large sand, but without the use of additives. That is, the use of a complex additive allows you to replace the sand smaller.

When applying the dolomite sand, the introduction of the supplements of C-3 + LST led to a decrease in water consumption and to increase compression strength. The introduction of said comprehensive additive allows to increase concrete strength by 1.5 times. At the same time, the effect of the use of additives in concrete on the dolomite sand is higher than on quartz sand.

Thus, the results of the studies have shown the effectiveness of the use of complex chemical additives in fine-grained concrete mixtures.

As the results of numerous studies show the basic properties of concrete depends on the consumption of cement. In order to study the effect of cement consumption on the properties of fine-grained concrete, cement M400 and dolomite sand were used. Two series of experiments were held. In the experiments of the first series, the mobility of the mixture was 11..12cm of the breaking cone on the shaking table, in the second series, the rigidity was 40 ... 48c.

Test results are presented in Table-3.

Table-3. The effect of cement consumption on the properties of fine-grained concrete.

No	Consumption of materials kg/m^3			Additives,% of cement mass		V/C	Cutting cone, cm; Stiffness, C.	Average density, kg / m^3	Compressive strength, MPa aged	
	Cement	Sand	Water	Type	Number				7	28
1	320	1610	210	-	-	0,66	11,8	2120	9	12,8
2	325	1625	170	C-3 LST	0,5 0,15	0,53	11,4	2140	11,2	16,4
3	400	1600	220	-	-	0,55	11,6	2140	15,4	21,6
4	400	1640	180	C-3 LST	0,5 0,15	0,45	11,0	2160	19,2	24,2
5	520	1560	240	-	-	0,46	11,8	2200	23,8	29,6
6	520	1580	195	C-3 LST	0,5 0,15	0,38	11,7	2220	28,2	38,6

The processing of test results of fine-grained concrete, made on various aggregates, made by the least squares method in accordance with [39], made it possible to obtain the following regression equations:

$$R_{28} = 17.8 \cdot \frac{Ц}{B} - 11{,}1 -$$ for quartz sand

$$R_{28} = 15{,}9 \cdot \frac{Ц}{B} - 6{,}9 -$$ for dolomite sand.

RESULTS AND DISCUSSIONS

In previously studies, the cost consumption was adopted on the basis of the analysis of literature data [6,7,8] for concrete mixtures. For specific cement sandy mixtures, the optimal dosage of chemical additives may differ from previously accepted values.

Therefore, studies were carried out based on the theory of experiment planning to optimize the compositions of chemical additives [13,14]. In particular, orthogonal second-order composite planning was used with two independent variables. As independent variables were adopted:

X_1 - C-3 plasticizing additive consumption, in % of cement mass;

X_2 - consumption of plasticizing additive LST, in% of the mass of cement;

Cement consumption in experiments was maintained permanent - 400kg/ m^3. The mobility of the concrete mixture due to changes in the initial water content was constantly maintained and drew 11 ... 12 cm on the cutting of the cone on the midwifeful table.

As the function of the response, the strength of concrete at the age of 28 days was determined.

Two series of experiences with experiment planning were implemented, in which the following additives were used:

1. C-3 + LST
2. C-3 + STB

Plans matrices and test results are presented in Tables 4 and 5. In experiments used sand number 1.

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Table-4. The matrix of the plan and the results of its implementation for the supplements of C-3 + LST.

No	Changes in variables				Compression strength, MPa
	Coded		natural		
	X_1	**X_2**	**X_1**	**X_2**	
1	-	-	0,3	0,1	28
2	+	-	0,7	0,1	32
3	-	+	0,3	0,2	28
4	+	+	0,5	0,2	30
5	0	0	0,7	0,15	36
6	+	0	0,3	0,15	33
7	-	0	0,3	0,15	32
8	0	+	0,5	0,2	33
9	0	-	0,5	0,1	34

$$У_1 = 36 - 4X_1^2 - 2X_2^2 - X_1 \cdot X_2$$

$$У_1 = 34 - 5X_1^2 - X_2^2 - X_1 \cdot X_2$$

The processing of experimental data made it possible to obtain the following regression equations, respectively, for each pair of additives:

1. C-3 + LST $У_1 = 36 - 4X_1^2 - 2X_2^2 - X_1 \cdot X_2$
2. C-3 + SBT $У_2 = 34 - 5X_1^2 - X_2^2 - X_1 \cdot X_2$

Table -5. The matrix of the plan and the results of its implementation for the supplements of C-3 + SBT.

No	Changes in variables				Compression strength, MPa
	Coded		natural		
	X_1	**X_2**	**X_1**	**X_2**	
1	-	-	0,3	0,03	26
2	+	-	0,7	0,03	31
3	-	+	0,3	0,07	28
4	+	+	0,5	0,07	28
5	0	0	0,7	0,05	34
6	+	0	0,3	0,05	31
7	-	0	0,3	0,05	31
8	0	+	0,5	0,07	30
9	0	-	0,5	0,03	32

Assessment of the adequacy of models, made using the Fisher's criterion confirmed their accuracy.

The graphs of the dependence of the strength of the concrete from the consumption of cement are given in Figures 1 a) and 1b).

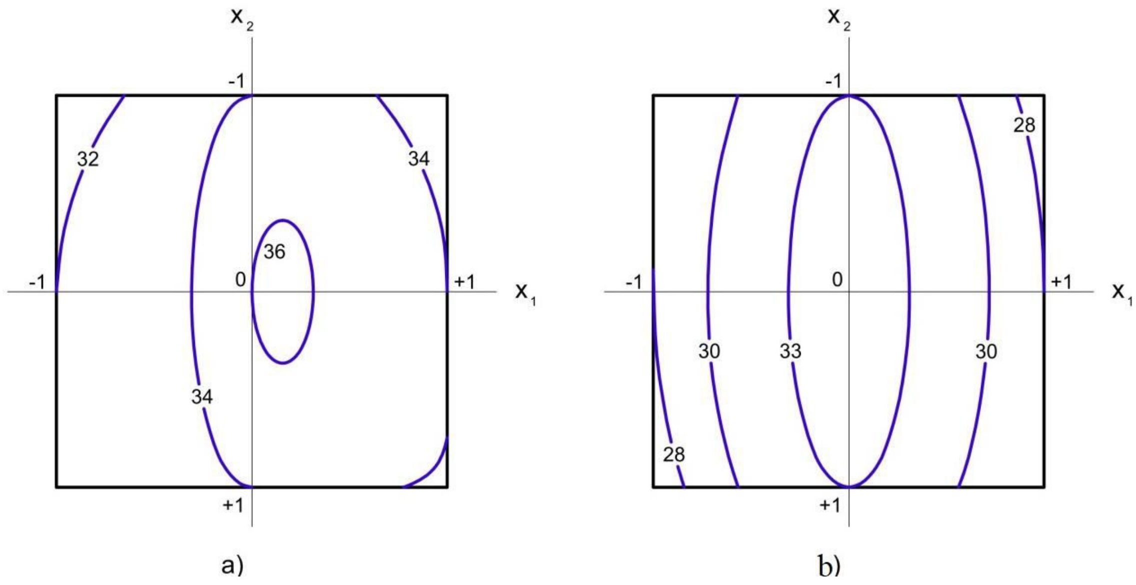

Figure-1. Insulating surfaces of the level of the dependence of concrete strength from the consumption of additives: a) C-3 + LST; b) C-3 + SBT.

CONCLUSIONS

Analyzing the obtained results, the following conclusions can be drawn:

a) The urgency of the studied fine-grained concrete is higher when using the complex supplement C-3 + LST than C-3 + SBT.

b) The optimal values of the introduction of each of the additives is: C-3 = 0.5%, LST = 0.15% and SBT = 0.05%.

The obtained equations can be used to design the compositions of fine-grained concrete cooked on similar materials.

The determination of the strength of the samples was carried out according to the methods set forth in GOST 310.4-81 "Cements. Methods for determining the strength of bending and compression" and GOST 10180-2012 "Concretes. Methods for determining compressive strength and stretching."

The effect of chemical additives on the properties of fine-grained concrete was investigated by conducting relevant experiments. Chemical additives in the concrete mixture were introduced with water indoor.

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Research results show that the introduction of the supplements of C-3, LST, STB led to a decrease in the water content in the concrete mixture from 205 to 168 ... 192 L/ m^3 and increased compression strength from 16 to 18 ... 24 MPa aged 7 days and from 23 to 24 ... 33 mPa at the age of 28 days.

The greatest effect was obtained using the S-3 and LST additive. The result of their introduction V/C decreased from 0.51 to 0.42 and 0.46, respectively. The use of STB additives had a minor effect on the properties of cement-sand mixtures.

Based on the analysis of the practice of construction and operation of monolithic cladding of irrigation channels, it can be concluded that it is necessary to improve the structures of cladding of irrigation channels and the methods of their construction.

The scientific analysis of the construction status of monolithic cladding channels determined the main purpose of this article and the objectives of the research.

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