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Study of the physicochemical and physicomechanical properties of superplastic concrete of a new generation based on local raw materials

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ABSTRACT: A new generation superplasticizer based on local raw materials is the study of the newest concrete structure and the development of innovative technologies. The scientific significance of the research results is determined by the method of obtaining a highly effective superplasticizer, determined by the polymer change in the country and the optimal synthesis conditions based on polycarboxylates, and the law of increasing the plasticizing activity of complex additives can be used to obtain new plastic additives. The practical significance of the work is manifested in the definition of a superplasticizer, which can be used as a superplasticizer as a dispersant of the mineral suspension in the regulation of the rheological properties of concrete mixtures. This will increase the resistance of cement, reduce cement consumption by 10-15% and reduce the import of superplasticizer for concrete and concrete products.

KEYWORDS: Complex chemical additive, small and large fillers, superplasticizing additives, physical and chemical properties of concrete, stability and deformability.

I. INTRODUCTION

The relevance and relevance of the topic of the thesis. In the world in the field of construction is increasing the share of using new types of environmentally friendly materials, the use of efficient energy-saving technologies. In particular, in developed countries such as the USA, Germany, and Japan, certain successes have been achieved in the creation and production of new building materials, and on this basis the improvement of the physical condition of buildings and structures, and all this is very important in the construction of buildings and structures since their strength and stability is ensured. In this regard, special attention is paid to the development of compositions of new building materials, in particular wall materials based on local raw materials and the creation of energy-saving technologies for their production [1].
Research is being conducted in the world aimed at increasing the strength, durability and resistance to different climatic conditions of wall ceramic materials, in particular, the use of various burnable additives to porous the structure and reduce the average density in the firing process, optimize the structure of materials by introducing mineral additives, creating and improvement of energy efficient technologies for their production. In this regard, issues of developing effective wall ceramic products based on low-grade local raw materials and using industrial and agricultural wastes, creating energy-efficient production technologies for such products [2] are of great importance.
In the Republic of Uzbekistan in the field of the building materials industry, large-scale measures are being taken to deepen economic reforms and accelerate the development of the industry, to increase the production of new modern building materials, structures and products, and certain positive results have been achieved. The development strategy

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of the Republic of Uzbekistan for 2017–2021 sets a very important task, in particular, increasing the competitiveness of the national economy and reducing energy and resource consumption in the economy, and the widespread introduction of energy-saving technologies into production [3].

II. SIGNIFICANCE OF THE SYSTEM

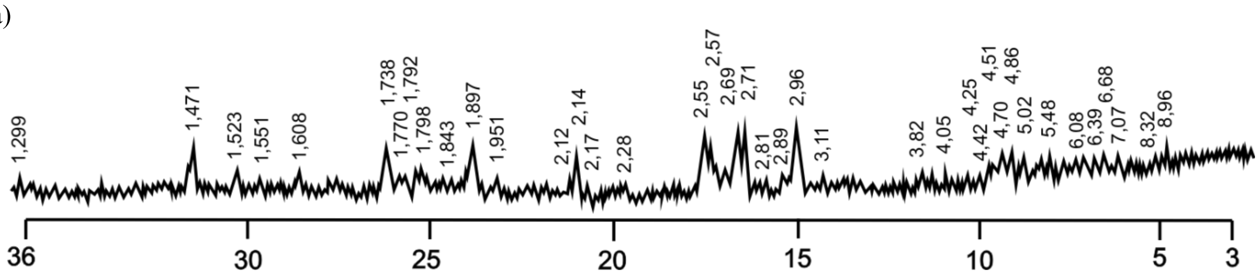
The scientific significance of the research results is determined by identifying the method of obtaining highly effective superplasticizers, chemical transformation of domestic polymers, as well as on the basis of polycarboxylates, optimal synthesis conditions are proposed, a pattern of increasing the plasticizing activity of complex additives is revealed, which can be used to obtain new plasticizing additives.
The practical significance of the work is to identify the production of superplasticizers, which can be used to control the rheological properties of concrete mixtures, as dispersant mineral suspensions.

III. LITERATURE SURVEY

The composition of the pore solution varies significantly depending on the ratio of clinker and sulphate agent in cement. This may depend on the nature and structure of the effective component in the superplasticizer, which affect the plasticizing effect of superplasticizers. This should also be taken into account when choosing Superplasticizer in order to achieve the optimal effect of plasticization, the initial and duration of plasticization of concrete [4].
Portland cement production makes a significant contribution to CO emissions. In order to reduce emissions of CO, limestone and slag mineral additives are the most promising and technologically and economically in the production of cement. For such cements, it is important to select a specific type and amount of plasticizer and evaluate what plasticizers affect the heat released during the hydration process. To achieve the objectives of the study, viscosity, conductivity and DSC analyzes of cement pastes with some plasticizers were determined. This study analyzes the effect of the amount of plasticizers based on polycarboxylate ether and modified lignosulfonate on the rheological properties and hydration processes of limestone, slag, and cement pastes. The use of polycarboxylate ester additive, unlike lignosulfonate additives, has a long-term effect on the viscosity of both cement paste and is less sensitive to mineral composition. The optimal amount of additives in the case of limestone cement is 1.25%, and in the case of slag cement is 0.3%. In cement limestone additives polycarboxylate ethers reduce total heat by 6% and lignosulfonates by 15% after 48 hours of hydration. In cement slag, polycarboxylates increase total heat by 4% and lignosulfonates by 2% after 48 hours of hydration. Exothermic profiles show that polycarboxylates continue to exoeffects in limestone to cement with a maximum time of 25%, and lignosulfonates by 40% in samples after 24 hours of hydration. In slag cement additives polycarboxylates continue exoeffects maximum time by 37% and lignosulfonates by 25% in samples after the same time of hydration [5].

IV. METHODOLOGY

The results of studies of x-ray phase analysis (XRF). The ratio of the intensity of crystalline phases to the total intensity of the diffractogram Jcr / Jobsch, equal to 0.29 arbitrary units, indicates the presence of a certain amount of the amorphous phase in the cement stone.
a)



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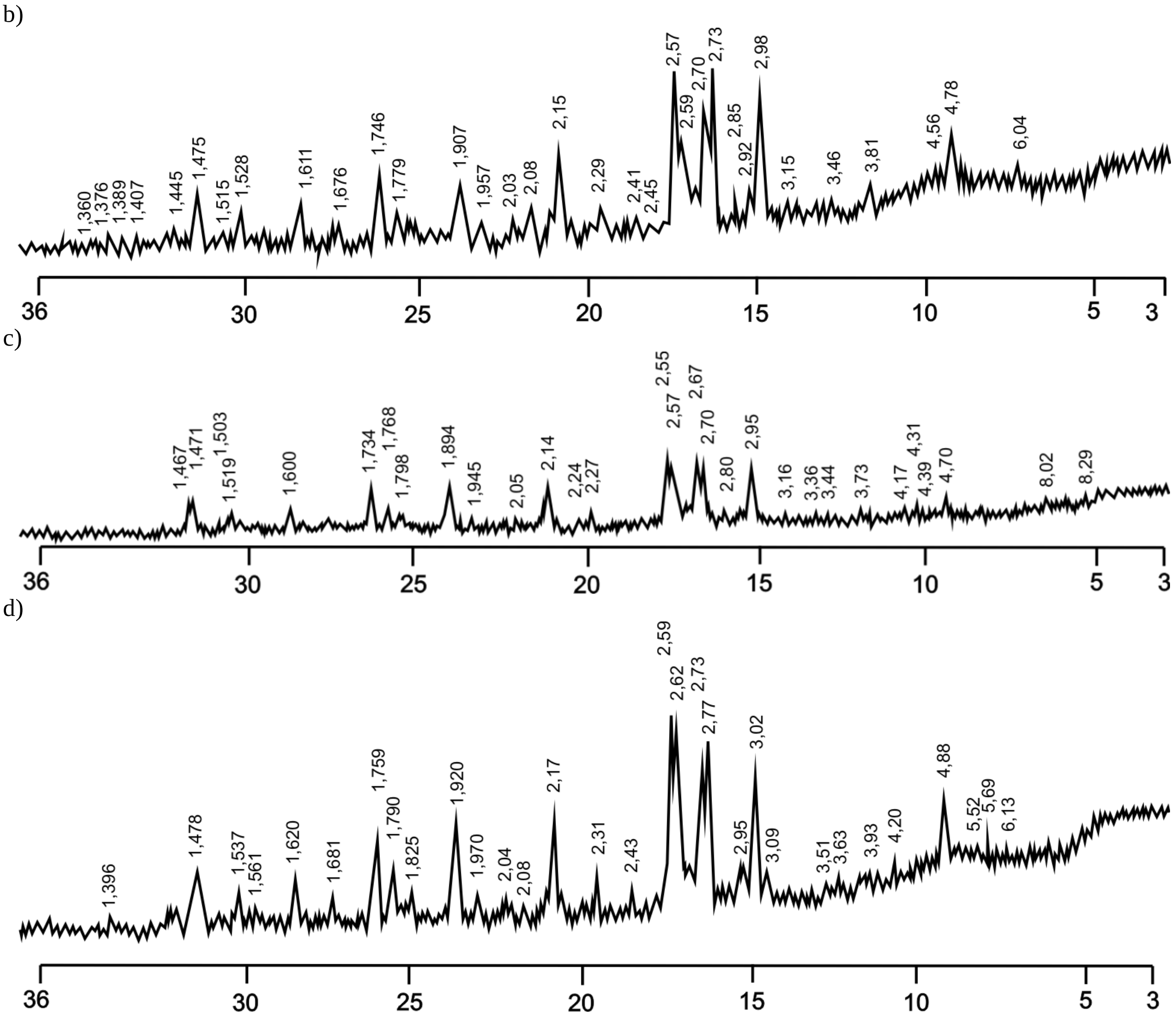

a) control; b) 0,2% SJ-1 superplasticizer; c) 0,5% SJ-1 superplasticizer; d) 1,0% super-plasticizer SJ-1.
Fig 1. X-ray curves of cement stone samples cured under natural conditions.

Figure 1 shows that on the control sample, which was hardened in natural conditions, there are diffraction reflections of non-hydrated portland cement clinker minerals, namely C3S - alite (3.95; 3,034; 2,778; 2,745; 2,609; 2,456; 2,323 Å), C2S - belite (4,426; 2,921; 2,778; 2,745; 2,609; 2,456; 2,186 Å), C4AF - celite (7.294 Å), C3A - tricalcium aluminate (2,694 Å) and hydrate new growths Ca (OH) 2 - calcium hydroxide (4,919; 3.113; 2,629; 2,456 Å) and 3Ca0 * A1203 * 3Ca804 * 31H20 - calcium hydrosulfophosphate (9.69; 5.492; 2.629; 2.456 Å). Interplanar distances are given in brackets.

On the diffractogram of the sample with the SJ-1 superplasticizer (Figure 1b, c, d), there are reduced peaks of Alita (3.034; 2.321 Å), belite (4.501 Å), celite (7.317 Å) and hydration products — a reduced peak of calcium hydroxide (4.921 ; 3.107, 2.627 Å), an increased peak of calcium hydrosulfonic aluminum (9.414 Å) and a peak of calcium hydrosilicate (8.224 Å). The extinction of tricalcium aluminate peak is observed. The decrease in the peak of calcium hydroxide is due to its binding to the sulfate components and the transition to gypsum and hydrosulfoaluminate. Crystallization occurs from a solution of calcium hydrosulphoaluminate in the liquid phase, as can be seen from the electronic images that fill the pores of the cement stone [6].

With a decrease in calcium hydroxide content, the possibility of the formation and existence of polybasic calcium hydroaluminates decreases. This circumstance prevents the formation of GSAC in the later periods of hardening.

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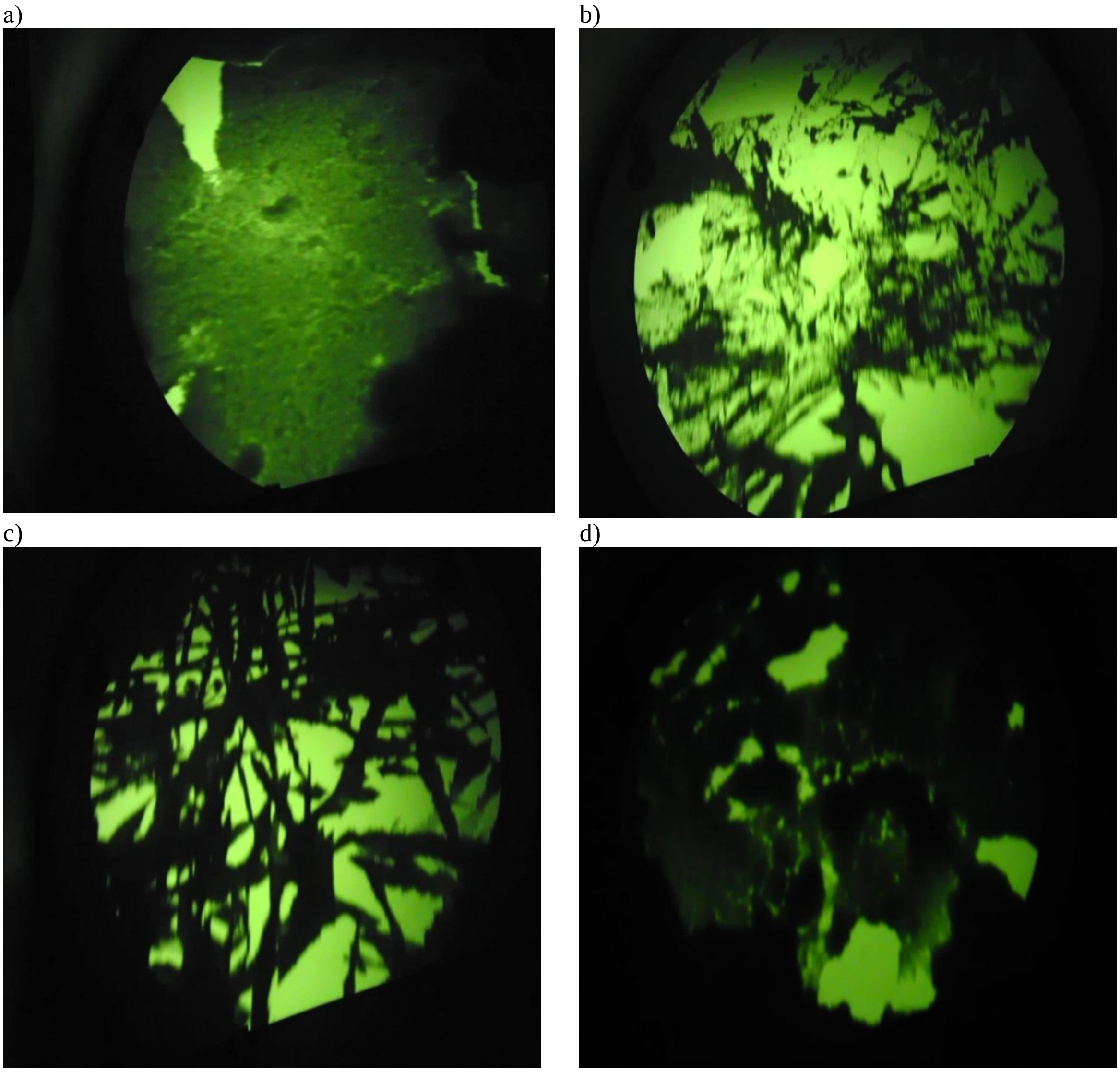
The resulting tumors, which crystallize in the presence of a complex additive in a finely dispersed form, clog the pores and capillaries of the Portland cement stone, compacting and strengthening its structure.

The results of electron microscopy studies

The phase composition of hydrated neoplasms of cement stone, made from dough of normal density on cement of the Akhangaran factory of the brand PC400 D20 with different content of superplasticizer, was studied by electron microscopy. Using electron microscopy methods, crystals of Portland cement minerals were studied after 28 days. hardening.

Figure 2 shows the complex structure of the cementing agent.



a) control without additives; b) 0.2% SJ-1 superplasticizer; c) 0.5% SJ-1 superplasticizer; d) 1.0% super-plasticizer SJ-1.

Fig 2. Electron microscopic images of cement stone samples.

In the main gel-like mass of neoplasms, needle-like crystals of ettringite are observed, filling the free cavities. Ettringitis neoplasms are formed in free volumes. On electron micrographs of cement stone samples with a complex additive, pores are filled with both gypsum and calcium hydrosulfoaluminate. Moreover, during autoclave treatment,

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the amount of hydrosulphaluminate becomes predominant. An increase in the concentration of calcium hydrosulfoaluminate and an increase in the specific surface of the hydration phases, both in the general structure of the cement stone and in the defective areas of the spatial skeleton, leads to the hardening of the material. the consequence of the fact that both gypsum and calcium hydrosulfate aluminate, when added with a superplasticizer, crystallize with the magnitude of the volume.

Conclusion. Thus, in samples with a superplasticizer, a deeper hydration of the silicate phase of cement occurs and an increase in mass loss with an increase in the duration of hydration is observed. It is established that the cement stones are highly crystallized by adding superplasticizer in large quantities.

It has been established, when studying the IR spectra of cement stones with the SJ-1 superplasticizer, good crystallization of calcium hydrosulphoaluminate, submicrocrystals of tobermorite hydrosilicates and the presence of hydroxyl hydroxysilicates of the xonotlite group.

The compaction and hardening of the structure of portland cement compositions in the initial stages of hardening is a consequence of the fact that calcium hydrosulfonic aluminate, with the addition of a superplasticizer, crystallizes with increasing volume.

Investigation of the physicomechanical properties of concrete with the SJ-1 superplasticizer. The introduction of the SJ-1 superplasticizer into the composition of concrete mixes significantly changes their properties. Superplasticizer increases the mobility of the concrete mix, improves workability properties, reduces water demand and others.

The introduction of superplasticizer reduces water-cement ratio, reducing water consumption leads to an increase in the strength characteristics of concrete, which opens up the possibility of obtaining high-strength concrete. This circumstance has a beneficial effect on the durability of concrete [7].

V. EXPERIMENTAL RESULTS

To study the effect of the SJ-1 superplasticizer amount and on the physicomechanical properties of concrete, Portland cement from Kyzylkumcement and Ahangarancement plants of the brands PC 400 DO and PC 400 D20 was used. The composition of the concrete factory JV LLC Binokor concrete service. The grade of concrete is M-200, the mobility of the mixture with a draft of a cone is 4-5 cm.

Analyzes of experimental studies of the rheological properties of cement mortar and concrete mixture showed that of the studied mixture compositions containing additives in the amount of 0.4 0.6 0.8 1.0% by weight of cement, the best indicators were obtained with an additive content of 0.8%.

On the basis of experiments to optimize the content of superplasticizer for the study of the physicomechanical properties of concrete, SJ-1 was taken in an amount of 0.8% by weight of cement.

For further experimental studies, samples of sizes 4x4x16 cm and 10x10x10 cm were made [8].

Samples after fabrication for curing were placed in a normal curing chamber. Samples were tested at an age of 1, 3, 7, 14, 28 days of normal hardening.

The second series of concrete samples were tested to determine the density and water absorption by weight. The test results are given in table 1., 2., and figure 3., 4. respectively.

Table 1 The dependence of the compressive strength and bending of fine-grained concrete on the content of the super-plasticizer SJ-1.

№	The mobility of the concrete mix OK cm	SJ-1 content, % by weight	Concrete strength in compression and bending (MPa) at the age, days.					
			1		7		28	
			R_{com}	R_{bend}	R_{com}	R_{bend}	R_{com}	R_{bend}
1	5,0	Control	5,8	1,1	14,4	3,4	16,3	3,5
2	5,0	0,4	4,8	1,0	12,4	3,0	16,0	3,4
3	4,7	0,6	5,4	1,0	12,9	2,5	18,2	4,1
4	4,5	0,8	6,9	1,2	15,1	3,2	21,0	4,2
5	4,7	1,0	5,4	1,1	14,4	2,7	16,8	3,8

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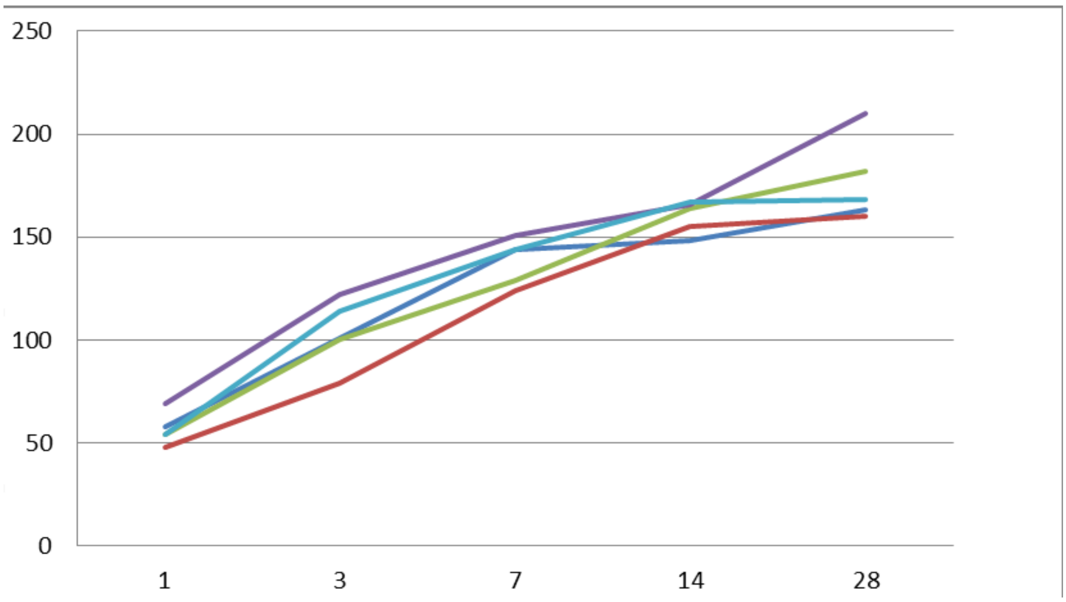
Table 2 The effect of the super-plasticizer SJ-1 on the physico-mechanical properties of fine-grained concrete.

№	Sample Name	Water absorption, % by weight	Average density kg/m^3	Strength of fine-grained concrete in compression and bending (MPa) at the age, days.					
				1		7		28	
				R_{com}	R_{bend}	R_{com}	R_{bend}	R_{com}	R_{bend}
1	Control.	7,4	2300	5,8 29,0	11,0	14,4 72,0	34,0	16,3 81,5	35,0
2	With the addition, the content of 0,4	7,1	2320	4,8 24,0	10,0	12,4 62,0	30,0	16,0 80,0	34,0
3	With the addition, the content of 0,6	7,3	2330	5,4 27,0	10,0	13,0 65,0	25,0	18,2 91,0	41,0
4	With the addition, the content of 0,8	7,0	2325	6,9 35,0	12,0	15,1 76,0	32,0	21,0 105,0	42,0
5	With additive content 1,0	7,4	2310	5,4 27,0	11,0	14,4 72,0	27,0	16,8 84,0	38,0

Note: Above the line is the average value of the strength indicators, below the line is the relative value of the indicator in% of controls.

From table 1 and 2 it can be seen that the management of the SJ-1 superplasticizer in the optimum amount in the concrete composition leads to an increase in its density and strength.



1-compressive strength of concrete without additives; 2-with the addition of SJ-1 in the amount of 0.4% by weight of cement; 3 with the addition of 0.6%; 4 - with the addition of 0.8%; 5 - with the addition of 1.0%, respectively.

Figure 1 The dependence of the compressive strength of fine-grained concrete on the content of the SJ-1 superplasticizer.

Analyzes of the conducted studies have shown that the density of concrete increases by 8–10%, and the water absorption decreases by 12–15% in comparison with the control compositions. At the same time, indicators of the properties of concrete with the addition of SJ-1 with a content of 0.8% of the additive are higher compared with the content of the additive 0.4; 0.6; 1.0 Accordingly, the super-plasticizer SJ-1 increases the strength of concrete in all periods of hardening. However, the greatest increase in strength in the first three days of hardening. This ensures high

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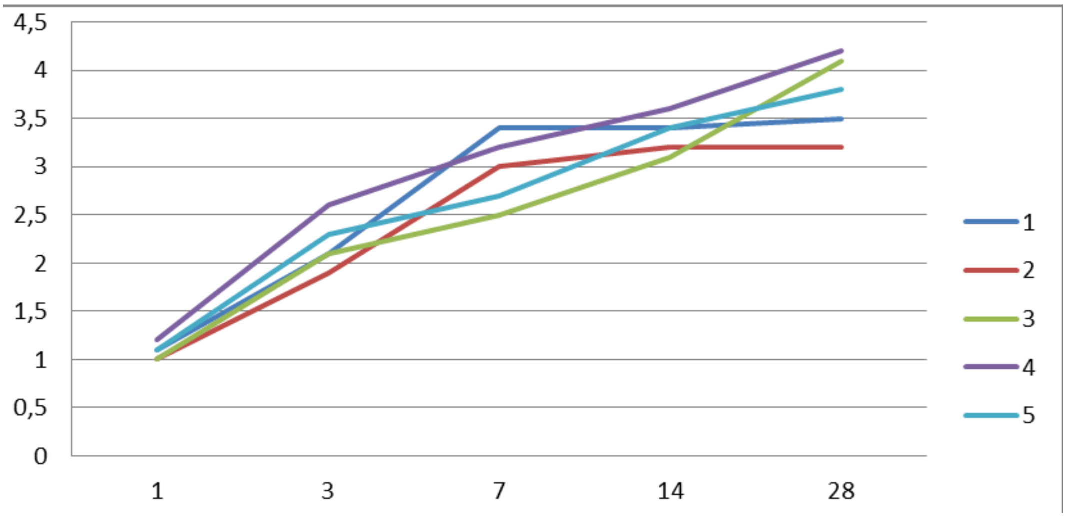
strength with the introduction of SJ-1 in an amount of 0.8. By the age of 7 days, the compressive strength with the addition of SJ-1 reaches 76% of the design strength of concrete.
The introduction of the SJ-1 superplasticizer into the concrete mix leads to a decrease in its water demand by 15–20% by weight. This increases the strength of concrete in compression and bending of about 20% of Figure 1; 2. Flexural strength of concrete at the age of 3 and 7 days with the addition of SJ-1 is significantly higher compared to the controls. Flexural strength of concrete with SJ-1 is 30% higher compared to control samples [9].



1 is the strength of concrete in bending without additives; 2-with the addition of SJ-1 in the amount of 0.4% by weight of cement; 3 with the addition of 0.6%; 4 - with the addition of 0.8%; 5 - with the addition of 1.0%.
Figure 2 The dependence of the bending strength of fine-grained concrete on the content of the super-plasticizer SJ-1.

Experimental studies to determine the effect of the SJ-1 superplasticizer on the physicomechanical, chemical and operational properties of concrete, as well as to identify the polyfunctional effect (plasticization, accelerated hardening at an early age, an increase in density) shows a high effect compared to the traditional superplasticizer.
Thus, according to the results of the conducted research, it was established that the super-plasticizer SJ-1 has the best effect on the physical and mechanical properties of concrete in an amount of 0.8% by weight of Portland cement [10].

VI. CONCLUSION AND FUTURE WORK

Superplasticizers were obtained, which were synthesized on the basis of local raw materials and secondary resources, have a positive effect. It was revealed that the obtained superplasticizing additives are proposed to be used in the range of 0.1–0.5% by weight of cement.
Superplasticizers based on polycarboxylate ethers have been developed, providing increased strength, water resistance, heavy structural concrete by reducing the water-cement ratio, the formation of stable hydrate phases of cement stone.
Installed high mobility, density and strength of cement composites with SJ-1. The optimal consumption of the SJ-1 is 0.2-0.4% by weight of the binder. At the same time, the consumption of mixing water decreases by 20–30%, which leads to an increase in grade strength by 15–20% at the age of 28 days. It should be noted that the introduction of the SJ-1 leads to an increase in the strength of cement composites early in the hardening stage. This leads to a simplification of the manufacture of composites.
With a flow rate of SJ-1 of the order of 0.2 and 0.4%, the mobility of the composites is of the order of 12 and 20 cm, respectively, while the sediment of the cone of the control composition is of the order of 6.0 cm.
Based on the experience of industrial implementation, it has been established that the use of superplasticizers under production conditions is expedient from an economic point of view by reducing the consumption of cement and avoiding expensive alternative ways to improve the water resistance of concrete.

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