PROPERTIES OF INFLUENCE OF POLYCARBOXYLATE SUPERPLASTICIZER AND BINARY MICROBRAKE-BASED ADDITIVES ON RHEOLOGICAL PROPERTIES OF CONCRETE MIXTURE

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Annotation This article presents the effect of the binary microwave and polycarboxylate superplastifier on the rheological properties of the concrete mixture. Studies have shown that the inclusion of a complex additive based on a binary microwave and superplastifier in the composition of a concrete crust increases the mobility, fluidity and viscosity of a concrete mixture.

Key words: concrete mixture, binary microwave, rheological properties, fluidity, viscosity, mobility.

Introduction. Certain requirements are imposed on its components in order to obtain non-compacting quality self-compacting mixture and high-quality and long-lasting concrete. The size of the fine aggregate should be 25 % of 0.125 mm particles and 75 % of 0.63 mm particles. Large filler is used in two different fractions in a certain ratio to ensure minimum voids (5-10 mm and 10-20 mm). At the same time, it is advisable to use a dispersive additive that does not affect the water requirement of the mixture [2-4].

It is known that according to the theory of polystructure [1], concrete belongs to composite building materials, which are characterized by a macrostructure. It is formed on the basis of hardening of a mixture of binder, microfiller, chemical modifier, small and large fractional fillers. Microfiller characterization, modifier additives, fine and coarse fillers, and manufacturing technology were considered as the main factors shaping the structure.

The study of the possibility of obtaining high-quality concrete with TsEMI 32.5N Portland cement based on polycarboxylate superplasticizer and binary microfiller and the possibility of obtaining high-quality concrete was carried out taking into account the above structure formation and technological factors.

Purpose and methods of research. In the research, TsEMI 32.5 N Portlandcement from the "Ohangarontsement" plant was used for the preparation of heavy concrete, new Angren TPP fly ash and limestone from the Muruntov mine were used as carbonate rock to obtain a complex microfiller (chemical composition is given in table 1).

Table 1
Chemical composition of the ash spark of the new Angren IES

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Type of microfiller	The composition of oxides, mas.%											
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	MnO	Na_2O	K_2O	SO_3	TiO_2	P_2O_5	n.n
New Angren IES ash spark	49,7	19,1	10,5	11,5	3,6	-	0,9	1,4	1,4	0,2	-	1,2

The mineral composition of the carbonate rock is presented in Table 2.

Table 2

Mineral composition of carbonate rock

Mineralogical composition (%)	Limestone (Muruntov)
Calcite	98
Quartz	2
Muscovite	-
Montmorillonite	-
Dolomite	-

It is advisable to use a superplasticizer to reduce the water requirement of cement systems and to provide its required rheology.

In the research work, the selection of the most optimal of the six superplasticizers most common in the building materials market of our republic was made (table 3). These experiments were carried out by measuring the spread of the cement mixture using a Hagerman cone. When preparing the samples, the water-cement ratio was taken as 0,27. The dose of superplasticizer in cement paste was 0.8 %. The time to measure the spread of the cone was determined after the mixing of the cement paste was completed. Mixing time was 6 minutes.

Table 3

Spreading of cement paste under the influence of different superlatifiers, mm

Start time of measurements, minutes	Melflux 1641 F (Germany)	Melflux 5581 F (German)	JK-02 (China)	POLIMIX (Uzbekistan)	Plv (FM) (Russia)	JK-08 (China)
0	280	350	250	350	130	250
5	370	370	260	370	120	260
25	380	350	240	370	100	240

Comparison of the obtained results with each other showed that it is appropriate to use the POLIMIX plasticizer based on polycarboxylate esters to achieve the highest values of cone spreading. Another positive aspect of using this chemical additive is that the superplasticizer replaces imports due to its local production and is cheap compared to other additives due to its low cost. Taking into account the above, a new generation of high-performance superplasticizers based on POLIMIX polycarboxylate esters from ARMENT CONSTRUCTION CHEMICALS was used as a chemical additive.

Technical parameters of POLIMIX polycarboxylate superplasticizer are listed in table 4.

Table 4

Technical specifications of POLIMIX superplasticizer

The main raw material	**Polycarboxylate**
Liquid color	Dark brown liquid
Density (at 20°C)	1,07 ± 0,02 g/sm^3
pH	4,2 ±1,0
The amount of chlorides	< 0,1 % by mass
The amount of alkalis	< 3,0 % by mass

The main rheological properties were determined according to viscosity, internal friction, bond viscosity and mobility [5, 6].

The obtained results and their discussion. In construction, concrete classes B15 and B30 based on TsEMI 32.5 N are widely used for the production of monolithic and prefabricated reinforced concrete products and structures. Therefore, first of all, the amount of raw materials received to study the control composition of these concretes was determined.

Calculations were made using EXCEL software and the obtained concrete compositions are presented in table 5.

Table 5

Control components of concrete

Concrete class	SA, sm	1 m^3 materials used for (kg)				
		cement	sand	flint	water	W/C
B15	P1 (1-4)	254	770	1153	190	0.75
B20	P1 (1-4)	293	737	1153	190	0.64
B30	P1 (1-4)	412	637	1153	190	0.46

Then, the mobility of concrete mixtures with the addition of POLIMIX superplasticizer and binary microsolidifier of the same composition was determined (Table 6).

Table 6

Control components of concrete

Concrete class	SA, sm	1 m^3 materials used for (kg)					
		cement	sand	flint	water	W/C	W/C, %
B15	P5 (>20)	254	770	1153	190	0.75	0.8
B20	P5 (>20)	293	737	1153	190	0.64	0.8
B30	P5 (>20)	412	637	1153	190	0.46	0.8

The analysis of the data in Table 6 shows that the addition of POLIMIX additive in the amount of 0.8 % of the cement mass to the control compositions, due to the hyperplasticizing effect of the modifier, it is possible to obtain self-compacting concrete mixtures with mobility >20 cm. The addition of 25 % of the binder based on SA and LP to the composition did not affect the values of cone subsidence at all (Table 7).

Table 7

Control components of concrete

Concrete class	SA, sm	1 m^3 materials used for (kg)						
		cement	M	sand	flint	water	W/C	W/C, %
B15	P5 (>20)	190	64	770	1153	190	0.75	0.8
B20	P5 (>20)	219	74	737	1153	190	0.64	0.8
B30	P5 (>20)	309	103	637	1153	190	0.46	0.8

It is known that the main rheological properties of the concrete mixture depend on three parameters: viscosity, internal friction and bonding [6].

In order to ensure fluidity of the mixture, it must overcome the shear limit due to bonding (clutch) and internal frictional forces. The greater the mobility of the mixture, the lower its viscosity. These three factors are independent of each other, and the flexibility is determined by their interaction.

For many years, the mobility of the concrete mixture has been determined experimentally by a simple and convenient method, cone slump. However, this method does not provide a direct relationship between the amount of cone subsidence and the formability of the concrete mixture. It is not always possible to correctly assess the amount of cone subsidence, the ability of the concrete mixture to settle into the mold and the ability to compact under the influence of vibration, since thixotropic changes are not taken into account when determining these technological properties [7, 8].

The study of the viscosity of the concrete mixture is based on the application of the methods of hydrodynamics of high-viscosity liquids. This, in turn, allows you to obtain calculated dependencies to identify them. Concrete mixture is considered as an incompressible fluid of high viscosity. The rheological properties of the concrete mixture flowing from the crack are determined based on the hydrodynamic equation according to [9, 11].

Studies on the effect of superplasticizer (SP) and binary microfillers on the viscosity of concrete mix

It was conducted in the self-compacting concrete compositions presented in Table 8. In studies, the dosage of additives is 0.4; 0.8; 1.2; 1.6 % of the mass of the binder, it was accepted as equal to.

The amount of binary microfiller is 25 % by mass of cement. The results of experimental studies are presented in Figures - 1, 2 and Table-8.

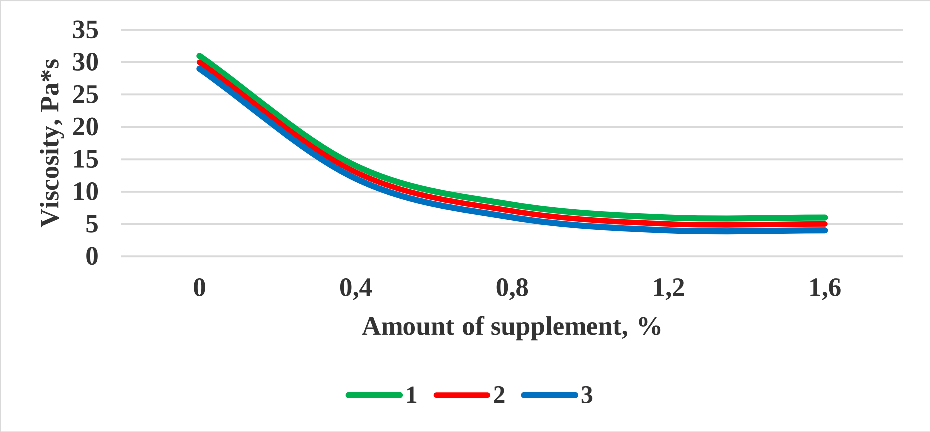

Figure 1. Effect of cement consumption and superplasticizer on the viscosity of the concrete mixture (the corresponding cement consumption of the 1,2,3-concrete mixture is 250, 290 and 410 kg/m3)

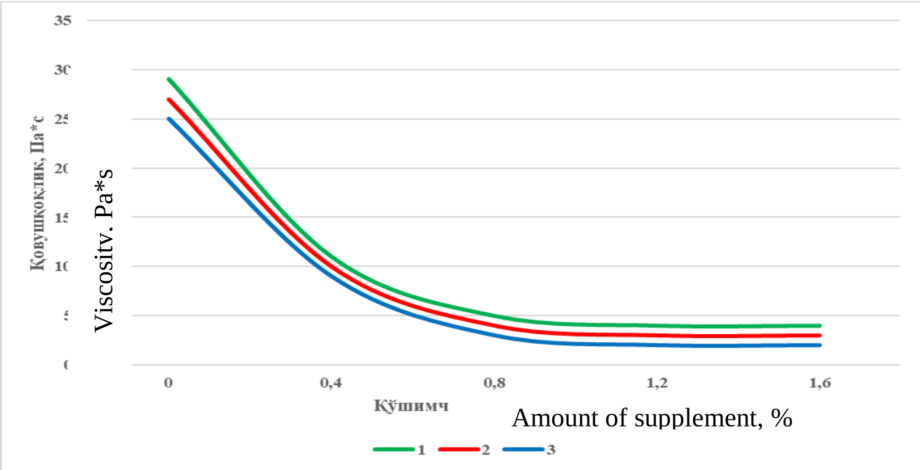

Figure 2. The effect of cement consumption, microfiller and superplasticizer on the viscosity of the concrete mixture (the corresponding consumption of cement and binary microfiller of the 1,2,3-concrete mixture is 190+64, 219+74 and 309+103 kg/m^3)

Analysis of the results showed that the viscosity of the concrete mixture naturally decreases with the increase in cement consumption and the content of the additive, especially when the dose of SP is 1.2 %, a significant decrease of 6-7 times was observed compared to the content without the additive.

The introduction of binary mineral microfiller reduces the viscosity of the concrete mixture by 8.5-9 times compared to the control composition when the consumption of SP is 0.8 % due to OK with a plasticizing effect.

The analysis of the obtained data shows that with an increase in the dosage of the additive, the viscosity naturally decreases and the workability of the concrete mixture increases. The introduction of a binary microfiller enhances these indicators.

Thus, it is sufficient to use 0.8 % SP to obtain a self-compacting concrete mixture with a binary mineral additive with a small viscosity value. Reducing the viscosity of the concrete mixture should help to significantly increase its flowability, which in turn requires experimental investigations.

Table 8

Rheological parameters of concrete mixture modified with POLIMIX SP and binary microfiller

№	Superplasticizer dosage, %	SA, sm	Leakage time T, min	Experimental viscosity $\eta x10^{-3}$, Паxc	Viscosity calculated by Einstein's formula $\eta мx10^{-3}$	Mobility $1/\eta\ 10^{-3}$
When cement consumption is 250 kg/m³						
1	0	4	99	2,9	2,8	0,37
2	0,4	13	50	1,5	1,5	0,71
3	0,8	18	26	0,8	0,8	1,38
4	1,2	22	19	0,6	0,5	1,91
5	1,6	24	15	0,5	0,4	2,44
When cement consumption is 290 kg/m³						
1	0	5	91	2,6	2,6	0,40
2	0,4	14	44	1,3	1,3	0,83
3	0,8	19	21	0,6	0,6	1,78
4	1,2	23	17	0,6	0,5	2,17
5	1,6	25	15	0,4	0,5	2,56
When cement consumption is 410 kg/m³						
1	0	6	88	2,5	2,5	0,42
2	0,4	15	38	1,1	1,1	0,95
3	0,8	19	16	0,5	0,5	2,22
4	1,2	23	15	0,4	0,4	2,5
5	1,6	25	13	0,3	0,3	2,86
When cement consumption is 190+65 kg/m³						
1	0	2	93	2,7	2,7	0,4
2	0,4	22	47	1,4	1,4	0,8
3	0,8	25	22	0,7	0,7	1,7
4	1,2	25	13	0,4	0,4	3,4
5	1,6	25	11	0,3	0,3	3,4
When cement consumption is 219+74 kg/m³						
1	0	2	89	2,6	2,6	0,5
2	0,4	22	41	1,2	1,2	0,95
3	0,8	25	18	0,5	0,5	2,1
4	1,2	25	10	0,3	0,3	3,8
5	1,6	25	8	0,3	0,3	4
Consumption of cement and binary microfiller 309+103 kg/m³						
1	0	2	80	2,4	2,4	0,5
2	0,4	22	33	1,0	0,9	1,1
3	0,8	25	16	0,5	0,5	2,6
4	1,2	25	9	0,3	0,3	4,1
5	1,6	25	8	0,3	0,3	4,4

One of the important properties of the concrete mixture of constructions built by the monolithic method is not only viscosity, but also fluidity and its change over time. For this reason, for the compositions listed in Tables 4.1-7, the change over time in the fluidity of the concrete mixture was studied (Fig. 3).

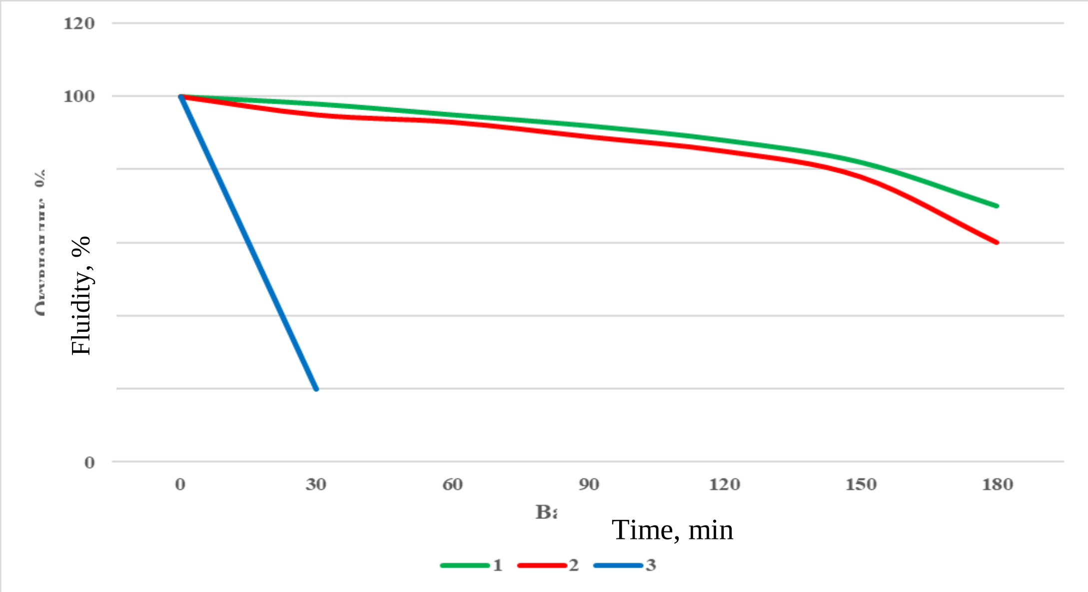

Figure 3. Changes in the fluidity of the concrete mixture over time
(1-Cement (309 kg)+binary microfiller (103 kg)+SP (0.8 %); 2-Cement (410 kg)+SP (1.0 %)); 3-Cement (410 kg))

The use of binary microfiller slightly increases the duration of flowability of the concrete mixture, which is due to the additional plasticizing properties of OK, and after 2 hours, the indicator decreased by 8-20 % compared to the beginning..

Conclusion. Thus, the use of SP and binary microfillers provides the required rheological properties of the concrete mixture, as well as the possibility of obtaining high-quality and long-lasting self-compacting concrete.

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