STRENGTH OF CONCRETE WITH VARIOUS COMPOSITIONS AND SUPERPLASTICIZER ADDITIVES

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ANNOTATION

The influence of LEVELCON additives on the formation of the structure and strength properties of concrete using local building materials has been determined through experimental research. It has been established that the use of such additives contributes to the formation of a dense structure at the microstructure level of cement stone and, consequently, the concrete itself. As a result of this influence, there is a consistent increase in the compressive and tensile strength of concrete with commonly used binding agent consumption.

Keywords: *structure, additive, concrete, testing, strength, superplasticizer, result, analysis.*

INTRODUCTION

Concrete is currently one of the most widely used construction materials for building structures of various purposes. Concrete is a complex artificial composite material obtained by the hardening of a mixture of binding agents, aggregates, and water. It possesses various unique properties, making it suitable for a wide range of operating conditions and applications due to its relatively low cost. In addition to these characteristics, its production technology is readily available, local raw materials can be extensively used, it has low energy consumption, and it offers operational reliability and durability for both precast and monolithic reinforced concrete structures. Concrete

remains the primary structural material in modern construction, and there is no expectation of its replacement in the near future.

Modified concrete with the use of chemical additives allows achieving significant technical and economic benefits and enhancing concrete durability by substantially influencing the chemical processes of cement and concrete hydration and hardening. This, in turn, improves its technological properties. Various complex chemical additives, imported from abroad, are currently being used in our country. Therefore, it is expedient to conduct experimental research on concretes based on local raw materials to assess their suitability for wide application.

PROPERTIES OF MATERIALS AND TESTING METHODS

In the present study, Portland cement M 400 from the "Ahangaran Cement Plant" was used, which meets the requirements of GOST 10178-85 "Portland Cement and Slag Portland Cement. Technical Specifications."

According to the manufacturer's data, the normal density of the cement paste is 27%, and the specific surface area is 3500 cm²/g. The cement's strength activity on the testing day is 39.5 MPa.

As coarse aggregate for preparing the concrete mix, granite gravel with particle sizes of 5-20 mm from the Kuylyuk quarry was used, which meets the requirements of GOST 10260 [1].

The test results for the properties of the coarse aggregates are presented in Table 1.

Table 1

Granularity Composition of Aggregates		Bulk density, kg/m^3	Volume of intergranular voids, %	Water absorption (%) within	
Particle size, mm	Content in the mixture, %			1 hour	48 hours
5-10 10-20	30 70	1360	39	1,6	1,8

River quartz sand from the Kuylyuk quarry, complying with GOST 8736 [2], was used as fine aggregate. The test results for the sand are presented in Table 2.

Table 2

Specific gravity, t/m^3	Bulk density, kg/m^3	Residue in % by weight on sieves						Coefficient of fineness
		2,5	1,25	0,63	0,315	0,14	Passed through sieve	
2,62	1470	3,15	10,5	30,4	35,8	19,12	1,1	2,39

The task of these studies was to investigate the strength of modified concrete based on local construction materials with the complex additive LEVELCON, which provides a plasticizing effect without delaying the setting time of concrete mixes. Control samples of concrete without the additive were also used. The additive was introduced into the mixing water in an amount of 1% of the cement mass, which is considered optimal for many similar additives [4,5,6].

Two types of additives imported from Turkey were used in the experiments. The additive LEVELCON FX6-SR is a highly effective additive for maintaining the plasticity and workability of ready-mixed concrete based on a polycarboxylate hyperplasticizer with a high level of water absorption capacity. This additive does not contain chlorine and has increased resistance to aggressive chemicals. According to the manufacturer, the dosage of the additive is on average 0.6-2% of the cement weight. It retains plasticity even in high outdoor temperatures during the summer.

The LEVELCON PF 300 additive is intended for concrete used in the production of prefabricated reinforced concrete structures. This additive is a superplasticizer for a new generation of concrete, consisting of modified polymers based on polycarbonate ethers. It can be used for monolithic reinforced concrete, including concrete pouring in cold weather conditions. This additive reduces the water demand of the concrete mix.

It does not contain chlorine, and concrete with its use is resistant to the effects of aggressive chemicals.

When using this additive at an average dosage of 0.6-1.2% of the cement weight, the early strength of concrete increases due to the reduction in the water-cement ratio. According to the manufacturer's recommendations, the optimal dosage of these additives should be determined through preliminary experiments using local construction materials, taking into account the specific objectives.

In the selection and study of concrete strength, two main conditions were considered. First, it was aimed at achieving maximum strength of the cement mixture with the minimum possible consumption of coarse aggregate without compromising the concrete technology.

The second condition is to ensure the highest workability of the concrete mix at various commonly used consumption rates of binder and water-cement ratio with the optimal consumption (proportion) of aggregates. This is determined by the technology of the concrete mix to achieve the desired concrete strength.

Taking into account the above, the compositions of the studied concretes are presented in Table 3.

Table 3

Composition Code	Material Consumption per 1 m^3 of Concrete Mix, kg				Bulk density, kg/m^3
	Cement	Sand	Gravel	Water (L)	
Series A	360	850	1000	200	2410
Series B	425	815	950	210	2400
Series C	530	750	900	220	2400

RESULTS AND ANALYSIS

As known, the main characteristic of concrete is the strength of concrete cubes (in MPa), accepted with a coefficient of 0.95, taking into account possible

heterogeneity of samples from one batch - the compressive strength class of concrete (B).

According to current standards, the compressive strength class of concrete is the average value obtained as a result of testing cubic samples from one batch for compression, in quantities ranging from 2 to 6 cubes, in accordance with GOST 10180 [3].

The strength of each sample during testing was calculated with an accuracy of 0.1 MPa. The actual strength of the entire batch of concrete was determined as the average strength of a series of individual samples from one batch.

The strength characteristics of concrete largely depend on the ratio of ingredients in its composition:

- Cement
- Coarse aggregates
- Fine aggregates
- Water and additives

Concrete mixes were prepared in a laboratory concrete mixer with a volume of 63 liters. Experimental concrete cubes with dimensions of 10x10x10 cm were made from each series of concrete compositions, which were stored after demolding in laboratory conditions (humidity 60±10%, temperature 20±5°C). On the day of testing, the specimens were subjected to compression on a hydraulic press MIG-1000 (manufactured in the Russian Federation) with electronic control. Tensile splitting tests were conducted on a 30-ton press of the XNC-300 type (manufactured in the People's Republic of China).

The test results are provided in Tables 4 and 5.

The Influence of the LEVELCON FX6-SR Additive on the Strength of Concrete

Table 4

Concrete Composition Code	Concrete Age on the Day of Testing, days	Concrete Strength, MPa R_b^g (R_b)	Ratio of Concrete Strengths R_b^g/R_b
Series A	7	26,1 (19,4)	1,35
	14	- (23,1)	-
	28	36,8 (23,8)	1,55
Series B	7	37,5 (22,6)	1,66
	14	- (26,1)	-
	28	39,7 (30,2)	1,31
Series C	7	49,2 (30,0)	1,64
	14	- (19,4)	-
	28	52,7 (35,6)	1,48

Note: The values in parentheses represent the concrete strength without the additive.

Influence of LEVELCON PF-300 Additive on Concrete Strength

Table 5

Concrete Composition Code	Concrete Age on the Day of Testing, days	Concrete Strength, MPa R_b^g (R_b)	Ratio of Concrete Strengths R_b^g/R_b
Series A	7	27,0 (19,4)	1,39
	14	- (23,1)	-
	28	37,2 (23,8)	1,56
Series B	7	34,6 (22,6)	1,53
	14	- (26,1)	-
	28	40,1 (30,2)	1,33
Series C	7	35,3 (30,0)	1,18
	14	- (19,4)	-
	28	47,1 (35,6)	1,32

Note: Values in parentheses represent concrete strength without the additive.

As a result of the use of the studied additive, it is highly likely that there is rapid formation of the concrete structure, accompanied by the generation of cementitious

mineral components. This contributes to its self-compaction and increases the density and strength of the cement stone. Experimental data on the strength of cement stone and concrete [7, 8], as well as the results presented in Tables 4 and 5, support this conclusion. Analysis of this data reveals that at 7 days, the strength of concrete with the additive is 75-90% of the strength of concrete at 28 days.

The increase in tensile strength of concrete with the additive and without the additive at 28 days for concrete with LEVELCON FX6-SR additive was approximately 45% on average for all series, and for concrete with LEVELCON PF-300 additive, it was approximately 31% on average. This is considered positive from a technical efficiency perspective for the use of these additives in concrete.

CONCLUSION

Based on the new experimental data obtained, it has been established that the introduction of LEVELCON additives of two types into the composition of concrete mixtures contributes to an increase in the ultimate compressive and tensile strength of concrete by up to 60% and 45%, respectively. This is associated with reduced water demand, resulting in the formation of a dense structure in such concrete due to self-compaction.

As a result, the introduction of these additives can lead to an increase in the concrete strength class for both compression and tensile strength by one class. This can reduce the cost of concrete through savings on Portland cement and improve the performance characteristics of various building structures, whether made of precast or cast-in-place concrete.

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