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The effect of super plasticizer on the pore structure and the strength of the contact zone between old and new concrete

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ABSTRACT: The article presents the results of experimental studies to identify changes in the characteristics and strength depending on the number of super plasticizers FREM C-3 and the duration of interruptions in concreting. The introduction of plasticizing material in the composition of new concrete in an amount of from 0.3 to 1.5% provides increased strength and improved structure of the contact zone of concrete masonry at different times.

KEY WORDS: contact zone, old concrete, new concrete, strength, super plasticizer, pore structure, average size indicator, vertical molding, horizontal molding.

I.INTRODUCTION

In the construction and reconstruction of social and transport infrastructure, concrete and reinforced concrete structures are widely used. During the operation of these structures in buildings and structures, mechanical loads and an external aggressive environment affect them. During the repair process, their damaged parts are usually covered with a new concrete mixture. At the same time, physical and mechanical properties were repaired and contact zones between old and new concrete were built.
Concrete with freshly laid (new), reducing their strength characteristics and performance in general.
Naturally, in the conditions of construction of various structures, depending on the solution, contact zones between previously built old and newly complex new concrete, a question arises in practical works, which often causes certain difficulties.
In this regard, the lowest requirements are required, and the bond between the concrete at the same time of masonry is sharply reduced, the income is up to 30-40% of normal strength [1]. In addition, there is an opinion that concrete on normal cement cannot be used due to significant requirements for its quality. If in some cases this is possible, then 3-4 hours have already passed, as completely unsuitable.

II.RELATED WORKS

A lot of scientific research was carried out to study contact zones and develop effective methods of technological solutions that ensure the joint work of old and new concrete layers. It contradicts each other that opinions and conclusions contradict each other. In particular, in some literary sources it is noted that the properties of concrete layers in the contact zones are due to the properties of cement, as well as ambient temperature, and that a new concrete layer should be expanded before the beginning of the hardness of the previous concrete [2,3]. But, in the opinion of AA Gvozdev, S. P. Vasiliev, S. S. Dmitriev, interruptions in the laying of old and new concrete layers (up to 1 year) do not affect the properties of contact zones [4]. In accordance with the requirements of regulatory documents [5, 6] and recommendations [7, 8] it is shown that concrete in working conditions must have a strength of at least 1.5 MPa in order to adhere well in old concrete. vibrators) that can damage an old concrete surface.
Great impact on strength. In addressing these issues Gvozdev A.A. [9], Golishev A.B., [10] Ginzburg Ts.G. [11], Gorchakov G.I. [12], Dzhigit S.G., Rodin Yu.L. P., Dzhigit D.G. [13], Mikhailov N.V., Urev Y.V. [14], Mikulsky V.G., Igonin Yu.I. [15], Dolev A.A., [16] Latypov V.A.M. [17], Kremneva E.G. [18], and other scientists have conducted effective research.
In scientific research Gvozdeva A.A. [9] It is emphasized that the method of brushing an old concrete surface is an effective way to increase the strength of the contact zone.

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Under the guidance of Gorchakov G.I. [12], a group of scientists carried out complex experimental - theoretical studies, during which, in order to expand the adhesion surface of the contact zone, methods were proposed for treating the old concrete surface with sand and shot peening.

Based on the results of experimental studies on the repair of old concrete of the brand 40–70MPa EG Kremneva and E.V. Khamenyuk [18] came to the conclusion that the strength of the contact zone does not depend on the strength of the old concrete, vibration of the new concrete mixture laid on the old concrete can slightly increase the strength of the contact zones.

The proposed chemical treatment of the surface of old concrete with acid [19], the use of colloidal cement glue [20], the addition of latex, various resins to the composition of new concrete [21,22,23], allows to increase the strength of contact zones to a certain extent. But for the organization of technological processes when applying these methods, additional funds are required. In addition, some of them can negatively affect human health and the environment.

There is confusion in the literature on the effect of surface humidity on the strength of contact zones. V.G. Mikulsky, JI.A. [Igonin [15] believe that to completely hydrate cement and maintain an adsorption bond, it is necessary to maintain 100% moisture on the surface of old concrete. But, as a result of studies on brand concrete from 200 to 600 V.E. Leirich wa I.F. Belov [23] concluded that the wet surface of old concrete, on the contrary, leads to a decrease in strength. This decrease depends on the density of the old concrete and the water-cement ratio of the new concrete. It is recommended to dry the surfaces of concrete of high strength grade-500 and more before laying new concrete.

In the scientific literature, information on the study of the porosity of the contact zone of old and new concrete is missing. However, such structural properties as water resistance, frost resistance and corrosion resistance depend on the porous structure of the contact zones.

Therefore, one of the urgent problems in construction is to increase the reliability of the contact zone of old and new concrete in concrete and reinforced concrete structures.

III. PURPOSE OF THE STUDY

This study sets the task of identifying the causes that contribute to the deterioration of concrete adhesion in the joints, to determine the degree of influence of these factors on the monolithic structure of ordinary and modified concrete with super plasticizers.

IV.RESEARCH METHODS

The study was carried out on prism samples with dimensions of 4x4x16 cm molded from fine-grained concrete with a composition of 1: 3 with W / C = 0.5 prepared on Portland cement “Kuvasaycement” grade 400 (GOST 10178-85), the setting time of which is -5 hours 10 minutes, setting time -8.00 hours and fine-grained gravel of the Fayzabadsky quarry (Uzbekistan). As modifying additives used FREM C-3 -additive with plasticizing action, Belarusian production. According to the effectiveness of the plasticizing action, it belongs to the plasticizers of group I (STB1112-98).

For identical test conditions to real conditions, the samples were molded in horizontal and vertical positions.

The first half of the samples (4x4x4cm) was molded immediately after preparation of the concrete mixture, and the second half was filled with concrete mixture after 2, 6, 12, 24, 72, and a 168-hour break.

After storing the samples in normal hardening chambers for 28 days, the parameters of the pore structure (average pore sizes λ), as well as the tensile strength under bending on the MII-100 device were determined.

V.RESULTS AND DISCUSSIONS

The results of the tests are presented in the table.

Figures 1 and 2 show the kinetics curves of the set strength of the contact zone of old and new concrete when using FREM C-3 plasticizer.

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Table

Dependence of strength (a) and pore structure indices (b) of the contact zone of old and new concrete on the amount of FREM C-3 plasticizer and the duration of the molding break.

a)

№ composition	The amount of additives,% by weight of the binder	The duration of the break laying new concrete, hour						
		0	2	6	12	24	72	168
		The tensile strength in bending, in% compared to the whole sample						
1 (cont.)	0	100	101/102,1	99,7/101,2	96,1/98,5	84,1/88,3	67,5/70,7	59,4/63,2
2	0,30	102,3	102,8/104,4	102,1/104,1	101,7/103,9	99,2/100,3	84,4/91,5	71,7/73,4
3	0,60	104,7	104,9/105,5	104,5/105,6	103,8/102,8	102,3/99,8	86,2/93,0	73,3/74,5
4	0,90	105,4	105,9/107,1	105,6/106,4	104,2/105,3	103,6/104,4	87,1/96,7	74,6/76,3
5	1,2	105,3	105,7/106,5	105,5/106,0	104,0/104,6	103,4/103,8	87,2/95,1	74,2/75,6
6	1,5	105,2	105,0/105,8	104,5/105,2	103,7/104,1	103,0/103,7	87,0/94,3	74,0/75,1

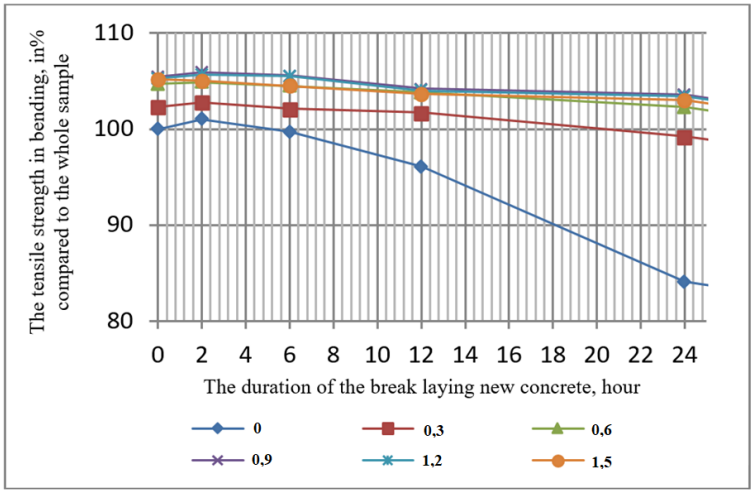
Note: in the denominator, the value of the vertical molding samples; in the numerator is the value of the horizontal molding samples.

b)

№ composition	Amount of additives,% of the mass of binder	Duration of a break in laying new concrete, hours						
		0	2	6	12	24	72	168
		The average pore size λ						
1 (control)	0	0,41	0,42/0,40	0,41/0,40	0,43/0,40	0,46/0,44	0,63/0,60	0,82/0,80
2	0,30	0,40	0,40/0,39	0,40/0,38	0,42/0,39	0,44/0,43	0,62/0,61	0,80/0,78
3	0,60	0,39	0,39/0,37	0,41/0,40	0,44/0,42	0,46/0,43	0,64/0,63	0,82/0,80
4	0,90	0,37	0,39/0,36	0,42/0,39	0,43/0,41	0,43/0,42	0,67/0,65	0,84/0,82
5	1,2	0,38	0,40/0,35	0,43/0,40	0,44/0,41	0,43/0,43	0,66/0,65	0,85/0,84
6	1,5	0,38	0,41/0,38	0,42/0,41	0,46/0,43	0,47/0,43	0,67/0,66	0,86/0,85

Note: in the denominator, the value of the vertical molding samples; in the numerator is the value of the horizontal molding samples.

a)



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b)

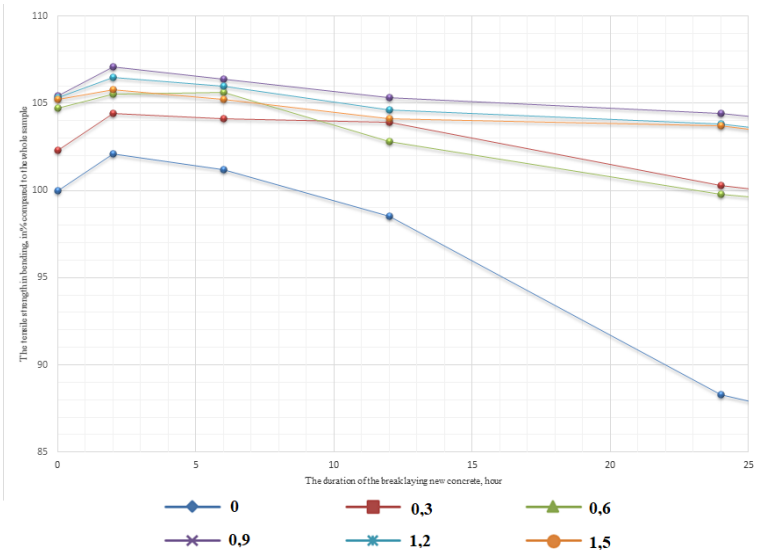
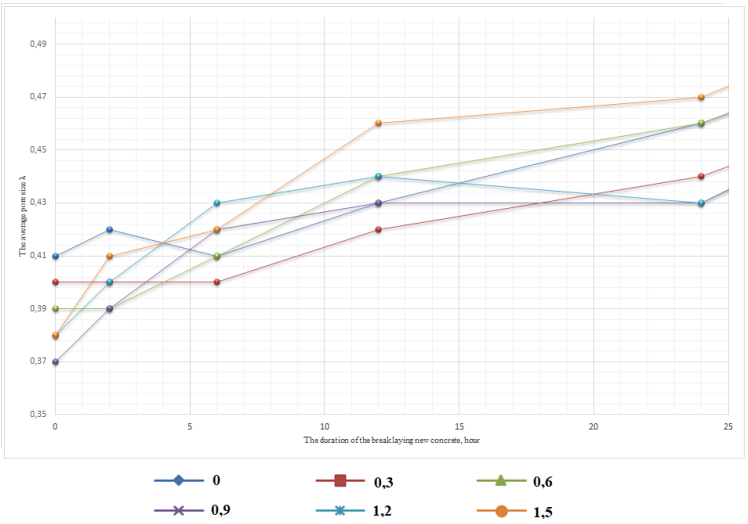


Fig. 1 Dependence of the contact zone strength of old and new concrete on the amount of FREM C-3 plasticizer and the duration of the molding break.
a - samples of horizontal molding. b - samples of vertical molding.

a)



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b)

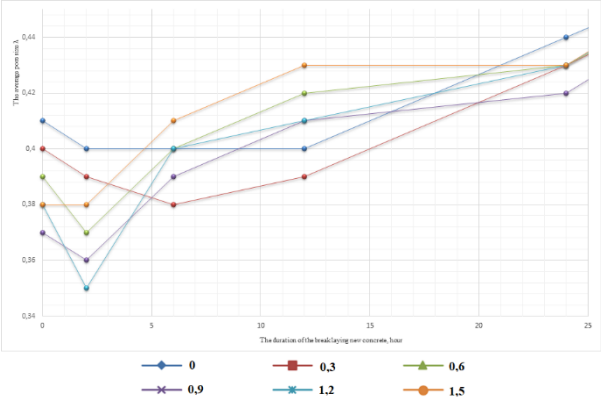

Fig. 2. Dependence of the average pore size index λ of the contact zone of old and new concrete on the amount of FREM C-3 plasticizer and the duration of the molding break.
a - samples of horizontal molding. b - samples of vertical molding.

The test results showed that due to the introduction of plasticizing additives in an amount of from 0.3 to 1.5%, it provides an increase in strength and an improvement in the pore structure of the contact zone of samples of both horizontal and vertical molding in all curing periods. In the first hours of hardening, due to the introduction of super plasticizer, a significant increase in strength and a decrease in the average pore size of the contact zone were observed, which are associated with the plasticizing effects of FREM C-3. The decrease in strength and the deterioration of the pore structure of the contact zone occurs only after a 24-hour break in laying new concrete. This is explained by the extension of the setting time of the cement used in the new concrete due to the introduction of plasticizing additives [24]. The most optimal dosage of super plasticizer providing the best strength and finely porous structure of the contact zone was 0.9%. It should be noted about the differences in strength values and the average pore size of the contact zone of the samples of vertical and horizontal moldings. In the first case, in the process of compaction on the surface of old concrete, cement slurry is formed, which fundamentally differs from the main one in chemical and physical composition. Practical without any astringent. This foamy liquid usually consists of a mixture of free lime in cement, dusty substances contained in aggregates, as well as excessively burned cement particles, which practically have no binding properties and, therefore, adversely affect the strength and porous structure of the contact zone between old and new concrete.

VI.CONCLUSION

The results of the study indicate that the strength and quality of the pore structure of the contact zone is always lower than the strength of the monolithic part of concrete, and the longer the gaps in the laying of old and new concrete, the lower the strength of the contact zone, the larger the pore size.
The introduction of FREM C-3 super plasticizer into the composition of newly laid concrete in an amount of 0.3 to 1.5% helps to increase the strength and improve the pore structure of the contact zone with previously laid concrete. The decrease in strength and the deterioration of the pore structure of the contact zone depends on the amount of additive added, the setting time of the cement used and occurs only after a 24-hour break in laying new concrete.

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