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THE RESEARCH OF A PHASE COMPOSITION AND A MICROSTRUCTURE OF HYDRATED CEMENT BY MECHANOACTIVATED BONDING SUBSTANCE WITH AN ADDITIVE OF MICROSILICA

The physico-chemical methods of the research of hydrated cement by mechanoactivated bonding substance with organo-mineral additive (microsilica + C-3) was presented. It was explored the influence of the additive into the kinetics of formation lowly basic calcium hydrosilicate.

Key words: mechanical activation, organo-mineral additive, microsilica, silicate hydrate, pozzolanic reaction, X-ray phase analysis, microstructure, diffractograms

Наведено фізико-хімічні методи дослідження цементного каменю на механоактивованому в'яжучому з органо-мінеральною добавкою (мікрокремнезем+С-3). Виявлено вплив добавки на кінетику утворення низькоосновних гідросилікатів кальцію

Ключові слова: механоактивація, рентгенофазовий аналіз, цементний камінь, органо-мінеральна добавка, портландцемент, мікрокремнезем, гідратація, пуцоланова реакція, мікроструктура

The purpose of the researches was a realization of X-ray phase analysis and a research of microstructure of hydrated cement, the bonding substance of which was exposed to mechanical activation in specially made triboactivation. The microsilica in the quantity to 10 % and extra plasticizer - additive C-3 were taken into the bonding substance in the process of rapid mixing. The concentration C-3 made up 1 % mass of a bonding substance. There were the samples with hydrated cement analogous composition of the bonding substance which weren't exposed to mechanical activation and were prepared for a control.

The researches were realized there with a use of complex of modern methods of physico-chemical analysis with a goal of learning the processes of a formation of a phase composition and a microstructure of mechanoactivated hydrated cement with the additive of 10 % microsilica [1].

X-ray phase researches were realized by the method of powders by using the diffractometer DRONE-2.0 in view of SiKα radiation. Experimental samples are pounded in the agathic mortar until complete passing through the sieve № 008. The prepared sample was being drifted on the quartz cuvette with proportional layer, which had been previously greased with Vaseline. The cuvette was installed on the goniometric equipment GUR -5. The diffractograms were written down in the interval of angles 2 θ = 8-50^o by means of detector X-radiation, in the capacity of which was used the scintillation counter with a speed of counting 500 moment. /s.

The research of microstructure of prepared samples and photographing the chips of hydrated cement, hydrated by different conditions, were realized on bit-mapped electron microscope TESLA BS – 300 which gives a possibility for a direct research of a surface of solid objects. The bit-mapped electron microscope works in view of accelerating tensions to 30 kW. At the same time, the permission 20 nm is achieved. The electron-optical increase is 5-50000 times.

The analysis of diffractograms of hydrated cement in 28 days of maturing is evidence of formation the main characteristic phases of hydrates. During the process of mechanical activation the processes of hydration are considerably intensified that is confirmed by lowering of density of lines of unhydrated cement (d/n = 0, 26; 0,260; 0,217 nm), and also by increasing of the density of lines of calcium hydroxide (d /n = 0, 26; 0, 49 nm).

The insertion of microsilica is accompanied by some regular lowering of density of the lines of the main clinker minerals and by lowering of density of the lines $CaOH_2$ (d/n=0, 49; 0, 261nm). It's explained by active pozzolanic reaction among Portland cement and microsilica, (fig. 1).

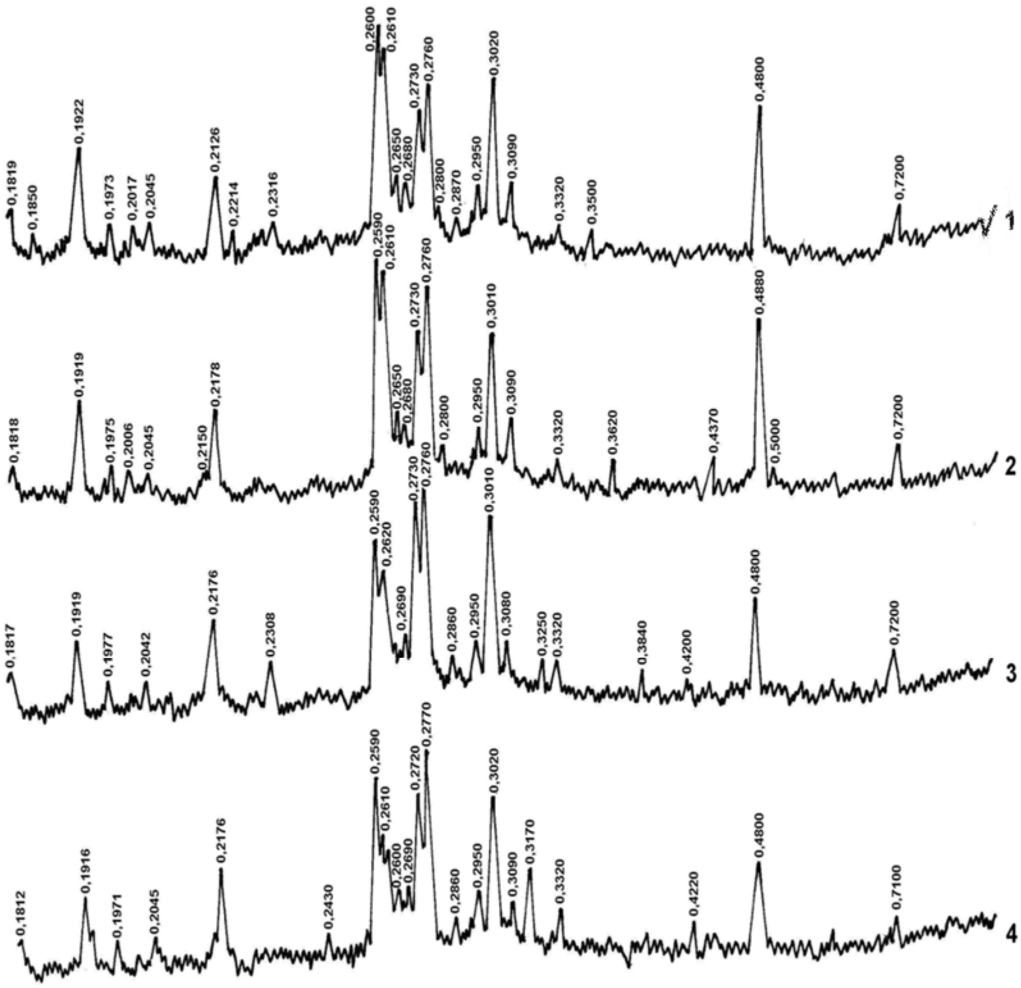
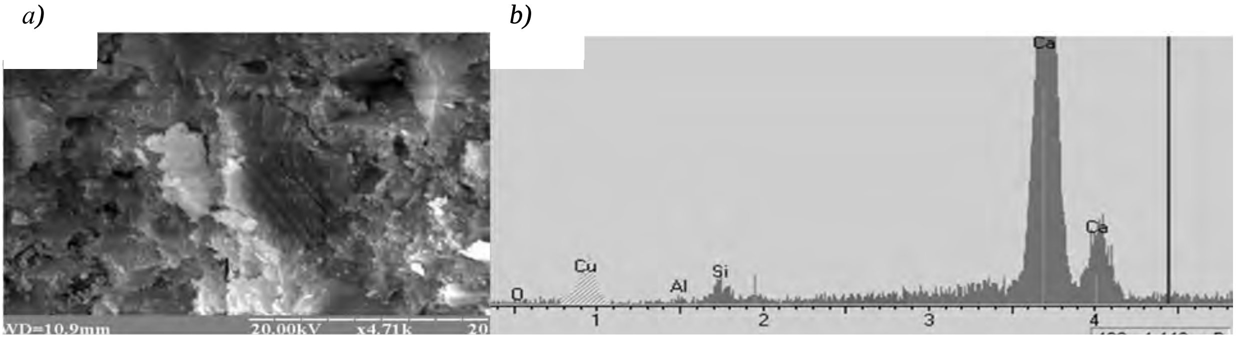


Fig. 1. The diffractograms of Portland cement stone on basis of:
1 - Portland cement without additives; 2 - mechanoactivated Portland cement without additives; 3 - Portland cement with 10 mas. % of microsilica; 4 - mechanoactivated Portland cement with 10 mas. % of microsilica

About the effectiveness of using the mechanical activation in the complex with additive of microsilica testify also the facts of microprobe analysis.

There is a part of compactly packed hexagonal aprons which are related to calcium hydroxide and which are observed on photomicrographies (fig. 2a).

a) *b)*



. Fig. 2. The microstructure (a) and the spectrum of characteristic X-radiation (b) from a surface of hydrated cement on basis of mechanoactivated Portland cement with additive 10 mas. % of microsilica.

Also it can be seen on the photomicrography a grain of microsilica which hasn't come yet into reaction with Ca $(OH)_2$ (fig.2a, b).

At the same time, a major part of inserted microsilica interreacts with Ca $(OH)_2$, producing a considerable quantity of crystals of calcium hydrosilicate.

Lowly fundamental C-S-H is crystallized in the form of needles, contributing to the formation of solid connections among the products of hydration of cement, raising the density and mechanical durability of stone. (fig. 3, b).

a) b)

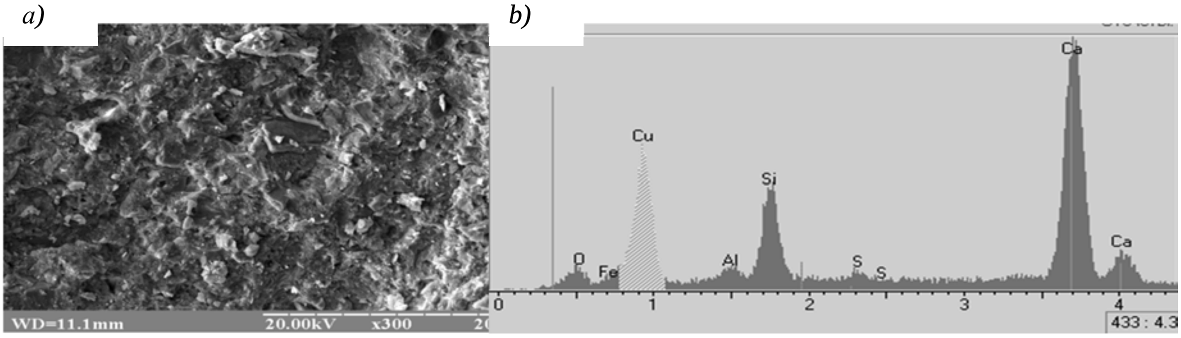


Fig. 3. The microstructure (a) and the spectrum of characteristic X-radiation (b) from a surface of hydrated cement on basis of mechanoactivated Portland cement with additive 10 mas. % of microsilica.

It was discovered that the insertion in Portland cement of organo-mineral additive with simultaneous mechanical activation of bonding substance allows regulating the processes of structure formation. The analysis of the diffractograms of hydrated cement shows that during the process of a mechanical activation the processes of hydration are considerably intensified , and the insertion of 10 % microsilica results in active pozzolanic reaction among Portland cement and microsilica.

The researches have shown that the mechanical activation of Portland cement with additive of microsilica changes a qualitative and quantitative composition of new formations that leads to change of conditions of the organization of structure of hydrated cement. For its turn, the change of a character of structure formation excites the change of attributes of solidifying compositions in comparison with cement compositions, received by usual technology.

It was explored that the insertion of microsilica in Portland cement leads to increasing of durability of hydrated cement in comparison with a control from 26 % to 40 % (according to terms of maturing), sch. 1.

Table 1

The influence of additive MS on the durability of hydrated cement

№	The composition of bonding substance, %,		Water binder ratio	The durability of hydrated cement MPa, at the age,					
				3 days		7 days		28 days	
	Portland-cement (PC)	Micro-silica (MS)		R of curve	R of pressure	R of curve	R of pressure	R of curve	R of pressure
1	100	0	0,35	5,08 4,1	17,1 12,2	6,7 5,3	25,2 18,4	10,9 8,1	50,8 36,8
2	97,5	2,5		5,8 4,3	19,3 14,6	7,7 5,6	27 20,4	11,5 8,3	58,0 42,9
3	95	5		6,1 4,7	21,2 16,6	8,0 6,0	28,8 21,5	11,6 8,51	64,4 46,8
4	92,5	7,5		6,58 5,06	22,8 17,2	9,7 7	31,1 23,8	13 9,5	75,1 53,2
5	90	10		7,02 5,4	23,4 18,2	10,8 7,8	34 26	14 10,1	85,7 61,3

Note: there are significances of durability of hydrated cement by mechanoactivated bonding substance above the line; also there is a significance of durability of control samples under the line (the bonding substance – unmechanoactivated Portland cement without additives of microsilica, C-3=0 %)

The mechanical activation accelerates a role of microsilica in bonding substance. In 28 – and day-time age the durability of hydrated cement by mechanoactivated bonding substance with additive of 10 % of microsilica is higher in 1, 4 in comparison with a control [2] . So that, it may be affirmed that directional structural modification leads to increasing of durability of consolidated cement compositions.

Conclusions

1. The insertion of microsilica in a composition of bonding substance contributes to the formation of solid connections among the products of hydration of cement that is confirmed by the facts on a formation of lowly basic calcium hydrosilicate.

2. The mechanical activation of grains of cement and microsilica assures the increase of mechanical characteristic of cement stone in diapason from 26 to 40%.

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ANALYSIS AND IMPLEMENTATION OF NEW MODELS OF FIRE FURNACES

This paper analyzes existing furnaces for fire testing of building constructions both in Ukraine and abroad. A new model of fire furnace was designed, which allows to test models of structural systems.

Key words: furnace for fire testing, the fire resistance of building construction.

Здійснено аналіз вогневих печей, що використовують для випробування будівельних конструкцій як в Україні, так і за кордоном. Розроблено нову модель печі, що дасть змогу проводити випробування моделей конструктивних систем.

Ключові слова: вогневі печі, вогнестійкість будівельних конструкцій.

Introduction

Determination of the fire resistance of different constructive systems is a complex and time-consuming scientific problem. One of the main methods for determining fire resistance, which gives accurate and reliable data about building's behavior during a fire, is a fire test: a full-scale imitation of the real fire in buildings or their fragments and tests in fire furnaces on building constructions of diminished size. The full-scale experiments provide the most accurate data about the behavior of a building during a fire, but they require significant economic and a labor costs. According to the difficult economic situation in Ukraine, this type of fire testing is not used. Therefore it is necessary to pay attention to the fire tests in furnaces on models of constructive systems, which give base for the development of numerical methods for determining the fire resistance.