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NON-AUTOCLAVED AERATED CONCRETE WITH MICROFILL AND ITS PROPERTIES

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Abstract
The paper shows the method of obtaining non-autoclaved aerated concrete with microfiller and complex gas-forming agent. The results of the conducted research on the developed technology of non-autoclaved aerated concrete production, establishment of dependence of basic properties of aerated concrete on the ratio of components in concrete are presented. Improvement of strength, thermal and deformation properties of non-autoclaved aerated concrete with microfiller and complex gas-forming agent based on aluminum powder and polymer additive is shown. It is established that during the manufacture of gas-ash concrete it is possible to observe the main regularities, which are expressed by the law of the general theory of artificial building conglomerates: the optimal structure corresponds to the complex of extreme properties - the most favorable properties of the conglomerate.

Keywords: microfiller, polymer additive, non-autoclaved aerated concrete, ratio of components, strength, thermal, deformation properties.

Introduction

At the moment in the country the issues of thermal protection of buildings and constructions are connected with the production of effective wall and thermal insulation materials, among which the important place is given to the known varieties of cellular concrete: non-autoclaved foam concrete and autoclaved aerated concrete [1].

At the same time, the existing experience of scientific and practical use of non-autoclaved cellular concrete in the country indicates that further development of their production and application should be carried out on the basis of solving the key problems in the technology of their production:

-significant reduction of moisture shrinkage of non-autoclaved concrete; - organization of industrial production of non-autoclaved materials with strength equal or exceeding the strength of autoclaved materials; - maximum use of industrial waste as the main raw material; - use of modern promising technologies of materials processing (helio-thermal processing) [2,3].

This will allow solving the issues of both waste utilization and reduction of production costs of commercial cellular concrete and cellular concrete products.

Method

Non-autoclaved gas-ash concrete was obtained on the basis of complex gas-forming agent[5,6]. The following materials were used for the production of cellular concrete mixture:

- portland cement M400 from Kuvasay cement plant, satisfying GOST 10178-76;

-activated ash from dry extraction of Fergana TPP with specific surface of 3000-5000 cm2/g

-source ash from dry selection of Fergana CHPP with specific surface of 1800-2500 cm2/g;

-gas-forming agent -aluminum powder PAP-I;

-activator of gas release and hardening - water-soluble polymer K-9, introduced into cellular concrete mixture (in the amount of 0,002% of binder weight) together with ash by their joint grinding to the specified specific surface area and used for preparation of water-aluminum suspension.

Consumption of materials per 1m3 of produced cellular concrete mixture for heat-insulating non-autoclave slabs was: Portland cement 110kg; activated (finely ground) ash -160-165kg; initial ground ash -270-275kg; aluminum powder-580-600g.

The technological sequence of cellular concrete mixture preparation was developed: in the mixer of CM type binders (Portland cement with ground ash) were activated with one third of water heated to +400C.

Simultaneously, the remaining heated water was mixed with initial unground ash and water-aluminum suspension in a mixer of CM type. Then the activated binder was combined with the mortar part.

Slabs were formed in metal molds. The size of one cell of the mold corresponds to the size of the slab 40x50x10cm.

Heat treatment of aerated concrete products was carried out in heliocameras of "Hot Box" type construction with a radiation-receiving surface of the installation made of glass profile filled with high-density liquid (food industry waste), playing the role of heat receiver and heat accumulator [8].

Simultaneously with the slabs, control cubes were formed from each working composition of cellular concrete mixture of 10cm rib size 9 pieces each, which were manufactured under the same conditions as the slabs.

The results of compression tests of control cubes made simultaneously with slabs from cellular concrete mix of working composition cured in the same conditions are given in Table 1.

Table 1 Results of compression tests of control cubes using the developed technology

Product type	Date of manufacturing	Concrete component ratio by weight	Water solid ratio	Average dry density of concrete kg/m3	concrete compressive strength, MPa		
					Sut Pro steam	7	28
Thermal insulation boards	15.06.23	1:1,5:2,5:0,006	0,58	495	7,8		10,8
	23.06.23	1:1,5:2,5:0,006	0,56	510	8,2		11,6
	12.07.23	1:1,5:2,5:0,006	0,58	480	7,6		10,5

Note: The ratio of components in concrete is given in the following order: Portland cement, fine ground ash, unground ash, aluminum powder.

In addition, cubes of the same composition were made according to the technology of cellular concrete mixture preparation known from construction norms - water + dry sand (initial ash) + binders (Portland cement and ground ash) + aqueous suspension of aluminum powder.

According to the results of the researches of the developed non-autoclaved aerated ash concrete the following is established: for all compositions the decrease of average density by 100-150 kg/m3 is characteristic. Replacement of sand in cellular concrete with ash (50 % of the volume and full 100 % replacement), which has amorphous structure and bulk density less than the bulk density of sand leads to a decrease in thermal conductivity. Joint use of ash and polyfunctional polymer additive K-9 reduces the thermal conductivity of concrete by 7.5 %. The value of shrinkage deformations of non-autoclaved aerated ash and concrete on developed комплексном газообразователе находится в пределах (50-75)$\cdot 10^{-5}$м.

Comparative strength characteristics of the developed non-autoclaved aerated ash concrete and aerated concrete according to GOST are given in Table 2. Compositions of aerated concrete mixtures for the manufacture of aerated concrete products with a density of 300-900 kg/m3 are given.

Table 2. Test results of samples of non-autoclaved aerated concrete according to GOST and experimental samples of the developed composition of non-autoclaved aerated concrete

Composition of non-autoclaved aerated concrete with microfillers and additives	Average density, kg/m3	Compressive strength according to GOST, MPa	Compressive strength of experimental samples, MPa
No additives	300 600 900	- 1,0-2,0 2,5-5,0	0,32 1,80 4,98
TPP ash	300 600 900	- 1,0-2,0 2,5-5,0	0,404 2,23 5,76
Polymer additive K-9	300 600 900	- 1,0-2,0 2,5-5,0	0,56 2,90 14,1
Complex additive: TPP ash, polymer additive K-9	300 600 900	- 1,0-2,0 2,5-5,0	0,60 3,0 15,0

Table 2 shows the improvement of strength characteristics of the developed composition of non-autoclaved aerated ash concrete of optimal structure.

Conclusion

The analysis of the conducted researches shows that at manufacture of gas-ash concrete it is possible to observe the basic regularities which are expressed by the law of the stem of the general theory of artificial building conglomerates: the complex of extreme properties - the most favorable properties of the conglomerate - corresponds to the optimal structure [9]. The use of TPP ash, polyfunctional polymer additive (K-9) in non-autoclaved aerated ash and concrete improves their moisture, thermal and other operational modes, increases durability, saves fuel and energy resources and allows to obtain non-autoclaved cellular concrete, the strength of which is comparable to the strength of autoclaved concrete.

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