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Use of the Additive Based on Amorphous Silica-Alumina in the Adhesive Dry Mixes

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Abstract

This article proves the possibility of using amorphous aluminosilicate as a modifying additive for the adhesive dry mixes. The data is given on the microstructure and chemical composition of the amorphous aluminosilicates. This article described the character changes in the rheological properties of cement-sand mortar, depending on the percentage of additives. The model of cement stone strength using synthetic additives in the formulation is illustrated. The results of physical and mechanical properties of tile adhesive made on the basis of the developed adhesive dry mix formulations are described.

Keywords: Dry mixes; Amorphous silica-alumina; Plastic strength; Tile adhesive; Cement

Introduction

One of the priorities of modern building materials science is the development of effective building materials. To regulate the technical and operating characteristics of dry mortar formulation is administered in their structure various modifying agents [1-8].

Most of the modifiers used in the formulation of domestic dry construction mixtures, are coming from abroad, which significantly increases the cost of dry mixes and makes production dependent on imported supplies. In this regard need to the development of domestic of production the modifiers. As the modifying agent of domestic production is proposed to use synthetic zeolites as structure-forming and water-retaining additive for dry construction mixtures.

Previous studies have confirmed the efficacy of synthetic zeolites as a modifying agent for cement and lime dry mixes [9-19].

Materials and Methods

We received amorphous silica-alumina their precipitation from the solution of aluminum sulfate of technical $Al_2(SO_4)_3$ with the addition of sodium silicate followed by washing the precipitate with water. Then, the resulting precipitate was dried.

Adhesive strength was determined by testing the samples fon stretching by tearing instrument ИР 50-57 with traverse moving speed 35 mk/c.

Plastic strength or yield stress of the mixture was determined by plastometer KP-3. Plastic strength determined by the formula:

$$\eta = \tau = \tau_0 = k * \frac{P}{h^2}, \quad (1)$$

Where η: Plastic strength;

τ: Shear stress;

τo: Yield stress;

k: coefficient depending on the value of the vertex angle of the cone; for the metal cone with an apex angle of 30° - k=1,116;

P: The weight of the movable part of the device (load);

h: Depth of immersion of the cone in the mortar mixture.

Research Results

Additive based on amorphous silica-alumina is a powder of white color with a high specific surface component S_{sp}=68.6 m^2/g. Microstructure and chemical composition of the amorphous aluminosilicate examined via analytical scanning electron microscopy (Figure 1 and Table 1).

It was found that the microstructure of the synthetic additives is characterized by particles of round shape, dimensions 5,208-5,704 µm, but the particles are present also oblong form, size 7.13-8.56 µm.

Analyzing the data in Table 1 revealed that predominate chemical elements O, Si, Na, S, and Al in chemical composition amorphous aluminosilicates-containing 60.69%, 31.26%, 24.23%, 18.69% and 8.29% respectively. The preponderance of this element has a positive

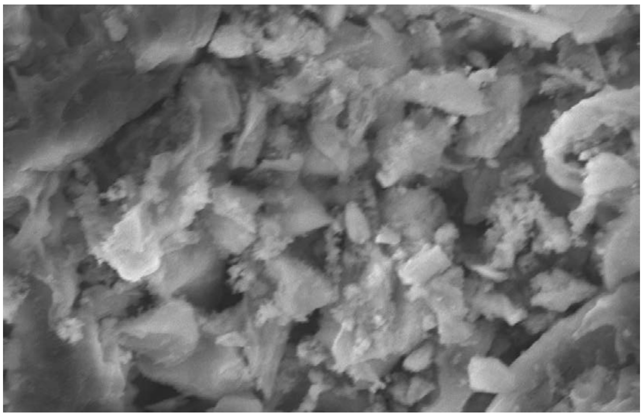

Figure 1: Microstructure of amorphous aluminosilicate.

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Content	Chemical elements additives weight, (%)				
	O	Na	Al	Si	S
Maximum	60.69	24.23	8.29	31.26	18.69
Minimum	36.73	8.61	1.10	7.92	0.68

Table 1: Chemical composition of the admixture.

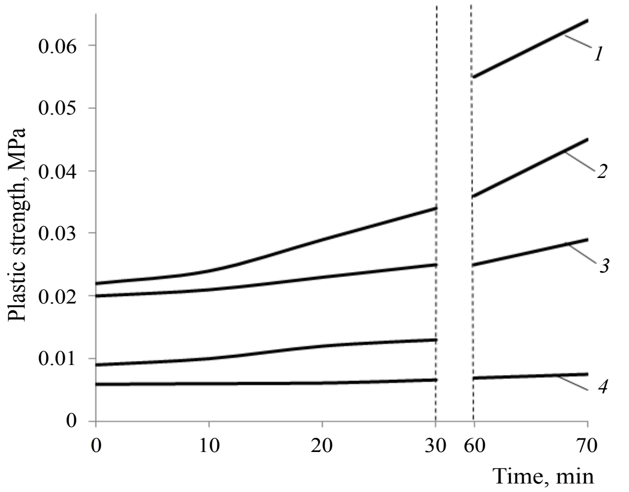

Figure 2: Kinetics set plastic strength cement-sand mortar: 1 - with a synthetic additive (30% by weight of cement) 2 - with a synthetic additive (20% by weight of cement), 3 - with the use of synthetic additives (10% by weight cement), 4 - a control sample (without the use of synthetic additives).

effect on the formation of cement stone structures with used synthetic additives.

The effect of amorphous aluminosilicate was investigated to modify the rheological properties of cement-sand mortar. For research we used Wolski portlandcement M400, and sand deposits of Ukhta in the ratio 1:2. In Figure 2 given results of these studies are presented.

Analysis Figure 2 showed that the introduction in the cement-sand mortar the additive based on amorphous aluminosilicate leads to higher values of plastic strength aged 20 min after curing compared to the control sample is 1.9-4.7 times (depending on the content the additives). Thus, the sample aged for 20 minutes from the beginning of solidification has strength was 0.0061 MPa, while the sample with using of amorphous aluminosilicate (20% by weight of cement) – 0.023 MPa.

It is obvious that, when introduced into the formulation of cement-sand mortar additives based on amorphous aluminosilicate period of hardening cement-sand mortar reduced, that is, the admixture has a water-holding capacity.

On the basis of mathematical research and experimental design [20] constitute the model of cement stone strength. The factors affecting the change in strength of cement paste were investigated size of the specific surface additives (x_1), the percentage of synthetic additives (x_2) and the percentage of plasticizer Kratasol PFM (x_3). After the analysis of the experimental data and the exclusion of insignificant coefficients of the regression equation, the model of cement stone strength expressed by the formula:

$$y = 24,477 + 2,6433 \cdot x_1 - 1,0383 \cdot x_2 - 1,3303 \cdot x_3 - 4,5958 \cdot (x_1)^2 - 3,3495 \cdot (x_2)^2 - 2,0564 \cdot (x_3)^2 + 0,69375 \cdot x_1 x_2 + 0,36875 \cdot x_1 x_3 + 0,31875 \cdot x_2 x_3 \quad (2)$$

Physical and mechanical properties of tile adhesive (includes the

Name of indicator	Value of the indicator	
	Designed composition	The prototype (no additives)
Density of the mix, (kg/m³)	1800	1670
The correction time, (min)	20	30
Water retention, (%)	97.8-99.3	95.0-97.0
Slipping tile no more than, (mm)	0.3	0.5
Frost resistance of tile adhesive	*F*50	*F*50
Frost resistance of contact zone	$F_{кз}50$	$F_{кз}50$
Adhesion strength, R_{adg}, (MPa)	более 1.4	1.1
Cohesive strength, R_{kog}, (MPa)	2.2	1.6
Adhesion strength in shear, (MPa)	0.92	0.6

Table 2: Physical and mechanical properties of tile adhesive.

M400 Portland cement, sand fractions (mm) 0.63-0.315: 0.315-0.16 in a ratio of (%) 80: 20, amorphous aluminosilicates, plasticizer Kratasol PFM and redispersible powder Neolith P 4400) are given in the Table 2.

Conclusion

Determined, that the use of a binder with additive amorphous aluminosilicate leads to higher values the plastic strength in early and late periods hardening. The given model of cement stone strength in the presence of synthetic additives and plasticizer Kratasol PFM proved the efficiency of the use of amorphous aluminosilicate as a modifying additive. This modifying additives a structure formation and improves the physical and mechanical properties of tile adhesive.

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