On the properties of filled plaster of Paris with metallurgical slag and plasticizing additive

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Abstract. The article studies the properties of filled plaster of Paris with metallurgical slag and a plasticizing additive. In particular, the optimal compositions of the composite Bukhara and Samarkand gypsum binders modified with the addition of GLENIUM 27S and metallurgical slag, the area of optimal compositions of the gypsum binder have been determined, and the physical and technical properties of the modified gypsum composition have been studied.

1 Introduction

The task of creating gypsum binders for various purposes, modified by a rationally selected complex of local mineral fillers using highly effective chemical additives, affordable and competitive in quality, is very urgent [10, 11, 12, 13].

This article aims to study the properties of a filled gypsum binder with the addition of a polycarboxylate superplasticizer. As the subject of research were selected: gypsum binder from the Samarkand and Bukhara gypsum plant, mineral filler metallurgical slag of the Bekabad metallurgical plant with the addition of the polycarboxylate superplasticizer GLENIUM 27S [4, 2, 6, 18, 20, 21].

The studies were carried out using modern physical and mechanical research methods, the analysis of the physical and technical properties of stucco from the Bukhara and Samarkand plants with optimal properties, metallurgical slag with a plasticizing additive and without an additive was carried out [3, 16].

2 Materials and Methods

The optimal composition of the modified gypsum binder is given in Tables 1 and 2. In this case, for metallurgical slag - 20%, for superplasticizer GLENIUM 27S was - 1%.

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Table 1. Optimal formulations Bukharian composite gypsum binders modified with the additive GLENIUM 27S and metallurgical slag

№	The composition, %			Grinding fineness of metallurgical slag,% according to the residue on sieve № 008	The physico-technical properties of the composition	
	Construct ion gypsum	Metallu rgical slag	Additive GLENIUM 27S		Compressive strength, MPa after 28 days of theory / exp.	Softening factor theory/exp
1	85	15	0.5	14	16.1/16.2	0.45/0.46
2	80	20	1.0	0	18.0/18.2	0.48/0.47
3	75	25	1.2	5	16.1/16.2	0.46/0.45

The analysis of the physical and technical properties of the building gypsum of the Bukhara plant with optimal properties, modified with metallurgical slag with a plasticizing additive and without additive, has been carried out. Comparison of the properties of these compositions showed that at the minimum cost in a given factor space for grinding the slag (the fineness of grinding the slag is 14% according to the residue on sieve №008), it is possible to add it to the composition of stucco in an amount of -15% and superplasticizer GLENIUM 27S %. Simultaneously, the strength of the gypsum stone remains at the level of the control composition (without additive), and the softening coefficient increases from 0.3 (gypsum without additive) to 0.45. Slag in an amount of 20% and when ground to zero residue on a sieve № 008 with GLENIUM 27S superplasticizer - 1.0% increases the strength of the gypsum stone by 10%, the softening coefficient from 0.3 (gypsum without additives) to 0.48. It was found that the maximum possible amount of slag is 25% (provided that it is ground 5% based on the residue on sieve №008) with 1% superplasticizer, in the composition, in which there is no decrease in the strength of the gypsum stone less than the control values (for pure gypsum), with this increases the softening coefficient of gypsum stone from 0.3 (pure gypsum without additives) to 0.46.

Table 2. Optimal formulations Samarkand composite gypsum binders modified with the addition of additive GLENIUM 27S and metallurgical slag

№	The composition, %			Grinding fineness of metallurgical slag,% according to the residue on sieve № 008	The physico-technical properties of the composition	
	Construction gypsum	Metallurgical slag	Additive GLENIUM 27S		Compressive strength, MPa after 28 days of theory / exp.	Softening factor theory / exp.
1	85	15	0.5	14	13.2/13.2	0.36/0.37
2	80	20	1.0	0	14.3/14.5	0.39/0.42
3	75	25	1.2	5	13.1/13.3	0.37/0.37

A comparative analysis of the physical and technical properties of the gypsum compositions of the Samarkand plant with optimal properties, modified with metallurgical

slag with a plasticizing additive, and a gypsum binder without additives showed that at the minimum cost in a given factor space for grinding the slag (the fineness of grinding of the slag is 14% according to the residue on sieve №008), it is possible to introduce it into the composition of stucco in an amount of -15% and superplasticizer GLENIUM 27S - 0.5%. Simultaneously, the strength of the gypsum stone remains at the level of the control composition (without additive), and the softening coefficient increases from 0.3 (gypsum without additive) to 0.36. Slag in an amount of 20% and when ground to zero residue on a sieve №008 with GLENIUM 27S superplasticizer - 1.0% increases the strength of the gypsum stone by 8%, the softening coefficient from 0.3 (gypsum without additives) to 0.39. It was found that the maximum possible amount of slag is 25% (provided that it is ground 5% based on the residue on sieve № 008) with 1% superplasticizer, in the composition, in which there is no decrease in the strength of the gypsum stone less than the control values (for pure gypsum), with this, the softening coefficient of gypsum stone increases from 0.3 (pure gypsum without additive) to 0.37.

Having established the limits of the values of the ultimate strength in compression (not less than 6.4 MPa - the strength of the control composition without additive) and the softening coefficient not less than 0.45 - for binders of medium water resistance [1, 5, 7, 8, 9, 14, 17], the area of optimal compositions of gypsum binders, modified additives was obtained graphically and analytically GLENIUM 27S and metallurgical slag (Figure 1) [15, 19].

3 Results and Discussion

Photomicrographs were examined gypsum samples based on the modified gypsum binder optimal composition (20% of metallurgic slag fineness of 0% residue on sieve №008) and based on the binder, the composition of which is outside the established optimum range (15% slag fineness 14% by the remainder of the sieve № 008) (Figure 1).

Fig. 1. The area of optimal compositions of gypsum binder, modified with GLENIUM 27S additive and metallurgical slag

In figures 2 and 3 shown that two types of gypsum crystals are formed in the hardened stone: a mixture of stable and unstable. Unstable gypsum grains have a lamellar structure figure 2.

Fig. 2. Photomicrographs of gypsum-based binders are not included in optimal compositions. Corn plaster unstable with increasing X2000

Fig. 3. Photomicrographs of gypsum-based binders are not included in optimal compositions (unstable gypsum in the recrystallization step in stable) with increasing X2000

The quantitative ratio of the two types of gypsum crystals is determined by the ratio of water: gypsum in the gypsum slurry. There are dominated by unstable gypsum crystals.

The images under an electron microscope (Figure 3.) also show the stages of recrystallization of metastable gypsum into stable gypsum. It is seen that the grains of metastable gypsum have strengthened, their morphology has been preserved.

Micrographs of a gypsum stone based on a modified binder of optimal composition are shown in (Figure 4.) In this case, gypsum crystallizes in very thin elongated crystals and their aggregates, which intertwine with each other, creating a felt structure. The growth of elongated gypsum crystals on the slag begins and occurs in different orientations.

Fig. 4. Micrographs of a gypsum stone based on a binder of optimal composition (stable gypsum) at a magnification of x2000

4 Conclusions

1. The areas of optimal compositions of composite gypsum binders filled with metallurgical slag were obtained by graph-analytically;

2. Based on the need to obtain the required properties of the gypsum binder, the conditions for minimizing energy consumption for grinding the additive and the maximum degree of filling, the compositions of the compositions were optimized, and the strength and water resistance indicators of gypsum stone based on them were calculated; properties calculated graphically and analytically received experimental confirmation;

3. With the minimum costs for grinding in a given factor space and while maintaining the strength of the gypsum stone at the level of the control composition (without additives), it is possible to add metallurgical slag to the stucco composition (the fineness of grinding additive is 14% based on the residue on sieve №008) in the amount of 15%.

4. It has been established that the maximum strength and water resistance of gypsum stone in a given factorial space are achieved when the additive is ground to zero residue on sieve №008; the amount of slag is 20%, the superplasticizer GLENIUM 27S is 1.0%, and an increase in strength is observed by 10%, and the softening coefficient is up to 0.39 and 0.48.

5. By electron microscopy, it was found that with a different fineness of slag grinding, the degree of growth of new formations of gypsum crystals is different: the optimal fineness of grinding of the filler (to zero residue on sieve №008) promotes the formation of elongated crystals, which in turn provides an increase in the strength and water resistance of the gypsum stone.

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