Investigation of the Effect of Plasticizers on the Properties of Binders Based on Gypsum-Containing Waste

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ABSTRACT

The article describes the results of experimental studies to identify the effect of polycarboxylate plasticizers on the properties and structure of a gypsum binder obtained from used moulds for casting sanitary faience. It has been established that the introduction of a new generation of polycarboxylate modifiers into the binder in an amount of 0.5 to 1.5% can increase its strength by 1.7 - 2.4 times.

Keywords: Gypsum-Containing Waste, Gypsum Moulds, Binder, Modifier, Strength, Polycarboxylate, Plasticizer, Water Absorption.

Introduction

At the enterprises of the building materials industry, a significant amount of gypsum-containing waste is generated that requires disposal. One of these wastes is used gypsum moulds - waste from the production of ceramic and porcelain-faience products. The need to dispose of this waste is caused by the importance of reducing the anthropogenic load on the environment and reducing the area of territories occupied by waste. One of the areas of waste disposal is the use in the production of building materials. At the same time, the proportion of used gypsum moulds in construction is very low. Meanwhile, the possibility of using gypsum binders obtained from man-made waste in gypsum boards and gypsum boards [1,2,3], in enclosing structures as wall blocks [2], in filling mixtures [3] and in dry building mixtures has been shown.

At the same time, in most cases, it is required to improve the technological and physical-mechanical characteristics. So, for example, when using binders from waste gypsum moulds in self-levelling floor screeds, it is necessary to ensure sufficient spreadability and viability of the mixture for a certain time, as well as strength characteristics. The properties of gypsum binder can be improved using various complex additives [4,5,6,7].

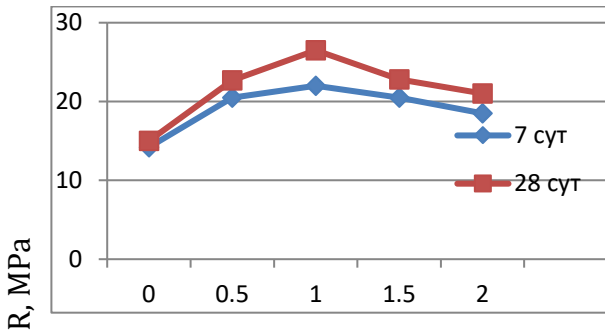
At the same time, the effect of polycarboxylate plasticizers on the properties and structure of binders based on technogenic raw materials can have a complex effect: reduce water consumption, increase strength, reduce water absorption due to a strong water-reducing effect and optimize the pore space, remains insufficiently studied. At the same time, they can also complicate the conditions for the hydration and structure formation of mineral

binders [5,6,7]. The work aims to study the effect of polycarboxylate plasticizers on the properties and structure of binders based on technogenic gypsum binders.

Experimental part

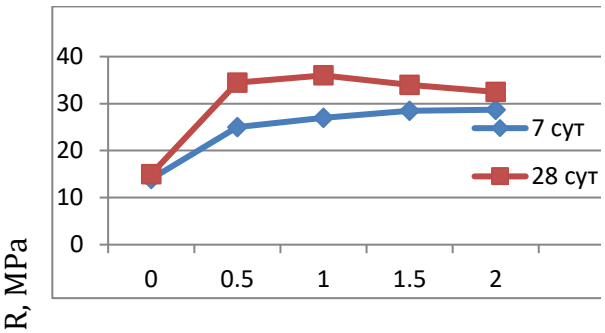
As the main material, a gypsum binder was used, obtained from used moulds for casting sanitary faience of EKOKERAMO LLC, Fergana. As modifying additives, polycarboxylate modifiers of a new generation were used: KJ-3 and KJ-3MB, developed by Uzbek scientists [8,9,10].

Modifiers were introduced into the binder in the form of aqueous dispersions in an amount of 0.5 to 1.5% by weight of the binder. To determine the physical and mechanical characteristics, beams with dimensions of 40 × 40 × 160 mm were made, which were kept for 7 days under normal conditions, followed by stripping and mechanical testing after 7 and 28 days.



a)

The content of the plasticizer from the weight of the binder,%



b)

The content of the plasticizer from the weight of the binder,%

Figure 1. Dependence of the compressive strength of samples on the content of plasticizers after 7 and 28 days: (a) with the addition of KJ-3MB; (b) - with the addition of KJ-3

Results and discussion

Thus, the compressive strength of the sample with the addition of KJ-3MB after 28 days increases by more than 1.7 times in comparison with the control composition, and when using KJ-3 - by 2.4 times with an optimal content of additives of 1% (Fig. 1) [11-17].

It is known that the mechanism of action of polycarboxylate plasticizers is based on the fact that the adsorption of the plasticizer on the surface of solid particles contributes to the rapid dispersion of the binder due to the manifestation of forces of the electrostatic and steric effect, which increases the contact surface of the particles with water and improves the conditions for hydration [18-21].

A significant increase in the strength of samples based on a binder obtained from spent moulds occurs due to a significant reduction in water consumption and a decrease in pore space.

When using KJ-3, higher characteristics are achieved in comparison with other plasticizers. When studying the setting time, water absorption and water resistance of samples based on used moulds, both plasticizers have a positive effect on the binder.

Conclusion

Thus, the following conclusions can be drawn:

1. Polycarboxylate plasticizers have a positive effect on the physical and mechanical properties of binders based on used gypsum moulds: binder water consumption is significantly reduced, compressive and bending strength increases, setting time is reduced, and water absorption is reduced. The obtained characteristics are sufficient for the development of compositions of dry floor mixtures based on gypsum binder obtained from used moulds.

2. The strength characteristics of the sample after 28 days of hardening with the addition of

KJ-3MB increase by more than 1.7 times, and when using KJ-3 - by 2.4 times with an optimal content of additives of 1%, in comparison with the control composition. At the same time, water absorption decreases from 18.2% to 7.8-8.6%, depending on the type of additive.

3. A significant increase in physical and mechanical characteristics is caused not only by a significant water-reducing effect but also by an improvement in the conditions for hydration and structure formation. The use of polycarboxylate plasticizers KJ-3MB and KJ-3 in the composition of the binder leads to a decrease in porosity, and an increase in the density of the gypsum stone, which provides higher mechanical characteristics.

4. When using KJ-3, not only does the content of crystal hydrates of gypsum dihydrate increase but also new formations of a different structure appear.

5. When using KJ-3MB, it should be noted that there are no changes in the structure of water molecules.

6. In this regard, the mechanism of action of KJ-3 remains unclear when using which an increase in compressive strength by 2.4 times is achieved. Thus, additional studies, including microstructural analysis of the samples, are required to explain these results.

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