Influence of bed ash on the rheology and properties of gypsum building mixtures

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Abstract. In the article, the influence of the aluminosilicate part of fuel bottom ash and slag mixtures on the water demand of gypsum raw materials of dry building mixtures is considered. It is shown that the aluminosilicate filler has a plasticizing effect. This is due to the presence of microspheres in the composition of the filler. They reduce the amount of water needed to achieve normal gypsum paste consistency. This is reflected in other physical, mechanical and structural characteristics of gypsum. The ash filler in the optimal ratio with the gypsum binder compacts the structure of the stone. does not participate in chemical transformations. To increase the efficiency of the ash filler, it is necessary to introduce additional components that activate the processes of structure formation in ash-gypsum binders.

1 Introduction

The problems of preserving the natural environment and natural resources for future generations are becoming increasingly relevant. Modern building materials science solves these problems by developing recycling approaches and involving waste in the design and production of popular building compositions. The importance of solving problems is associated with the transition of production to new technological principles [1, 2].

An important aspect of the use of waste and by-products of industrial production in the production of building materials is the safety and efficiency of their use [3]. The interest of consumers is associated with providing a high level of comfort for construction projects.

The cement industry is one of the sources of industrial carbon dioxide emissions. At the same time, it is also the supplier of the main component of raw mixes and concretes [4]. To achieve the Sustainable Development Goals, it was proposed to consider the possibility of creating alternative binders or low-cement compositions [5, 6, 7, 8]. They should have similar performance with cement binder compositions or be in demand in certain areas of production [9]. In addition, much less energy can be spent on their production [8]. Microdispersed additives, nanomodifiers or their complexes allow achieving the required indicators [9, 10, 11]. As microdisperse modifiers without cement binders, industrial wastes are used - industrial dusts [12], sawing wastes, ash [13], ground granulated slags. Active

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mineral microadditives have an advantage, which can participate in physicochemical transformations and improve the properties of binders [9, 10, 13].

This work is aimed at studying the possibility of using aluminosilicate microspheres from ash and slag fuel bottom mixtures - waste from thermal power plants - as a gypsum stone modifier. The effect of microspheres on the water demand of gypsum dough and on the properties of modified gypsum stone was studied.

2 Materials and methods

Gypsum binder grade G-5 was used for research. This binder was produced at the Peshelan gypsum production. The main characteristics of the original gypsum binder are shown in table 1.

Table 1. Main characteristics of gypsum binder G-5.

Grinding degree, rest on a sieve with a clear mesh size of 0.2 mm,%, no more	14
Strength of beams at the age of 2 hours, MPa, not less: compressive strength: flexural strength:	 5 2.5

As an additive, aluminosilicate microparticles (microspheres) (Fig. 1, 2) obtained by flotation from ash and slag wastes of the Moscow region were used (Fig. 3, 4).

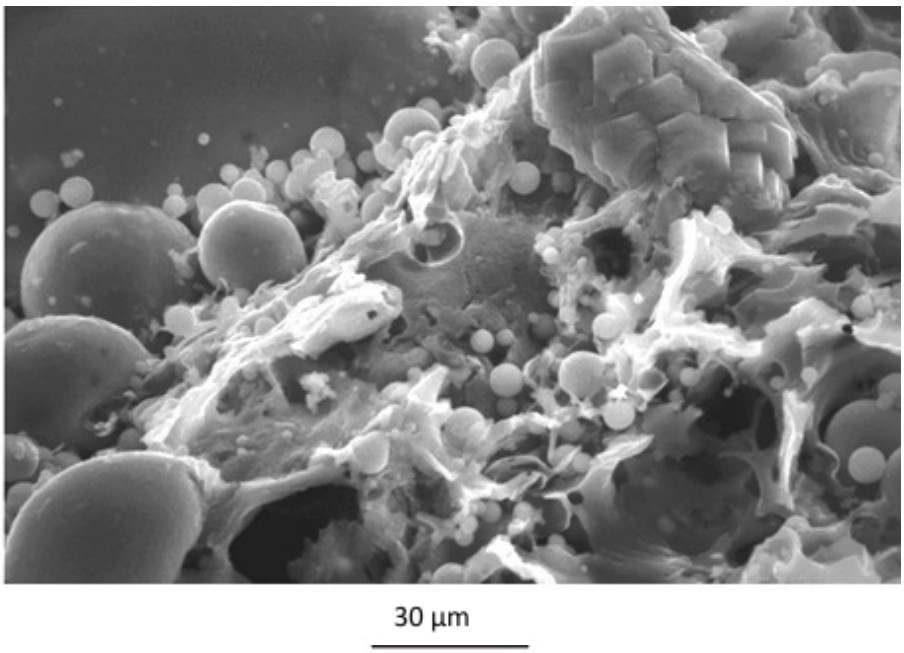

Fig. 1. Morphological features of the aluminosilicate additive.

The average size of microspheres is 13 µm. The structure of the microparticles is represented mainly by the glass phase, in some areas of which crystalline formations of quartz are visible. The carbon content was 2-4% by weight.

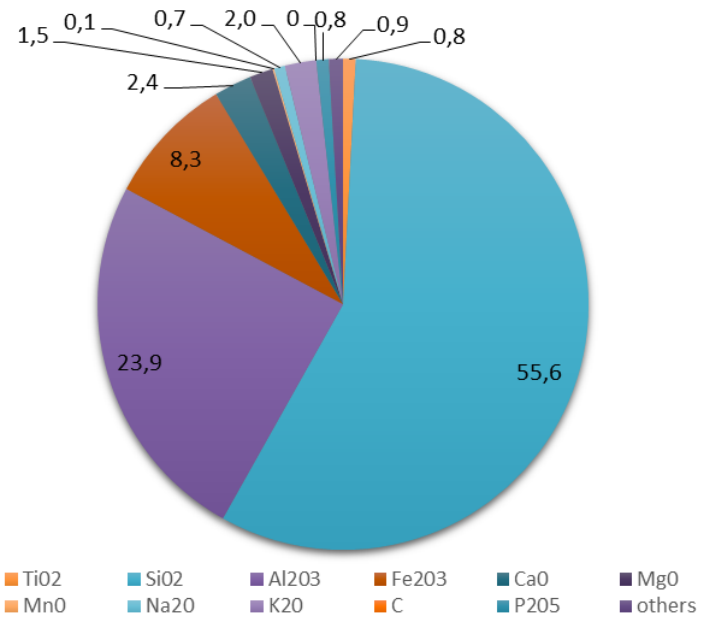

Fig. 2. The composition of the initial ash and slag mixture.

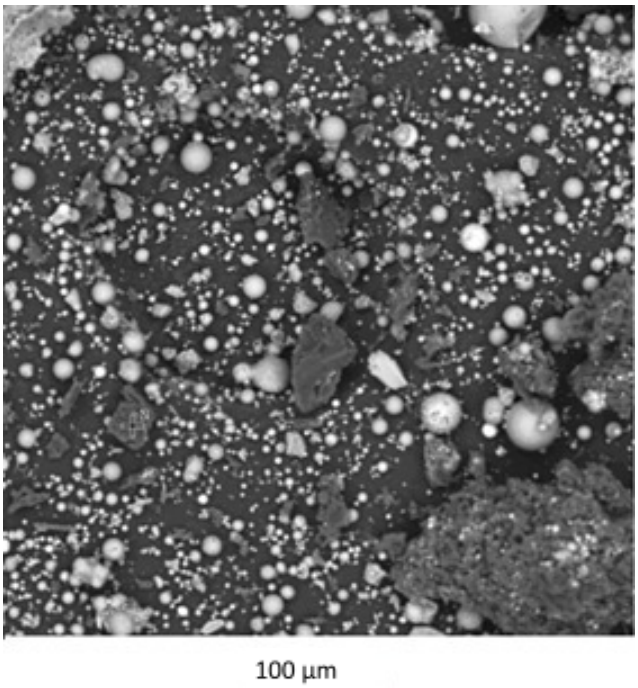

Fig. 3. Initial ash and slag mixture before flotation.

To obtain a gypsum composition with ash, dry powder of gypsum binder and aluminosilicate additive were mixed by hand until a homogeneous dry mixture was obtained (Fig. 5). After mixing, the mixture was stirred for 30 seconds with a mixer. The

normal density on the Suttard device, the strength and density of the gypsum stone was determined using standard methods.

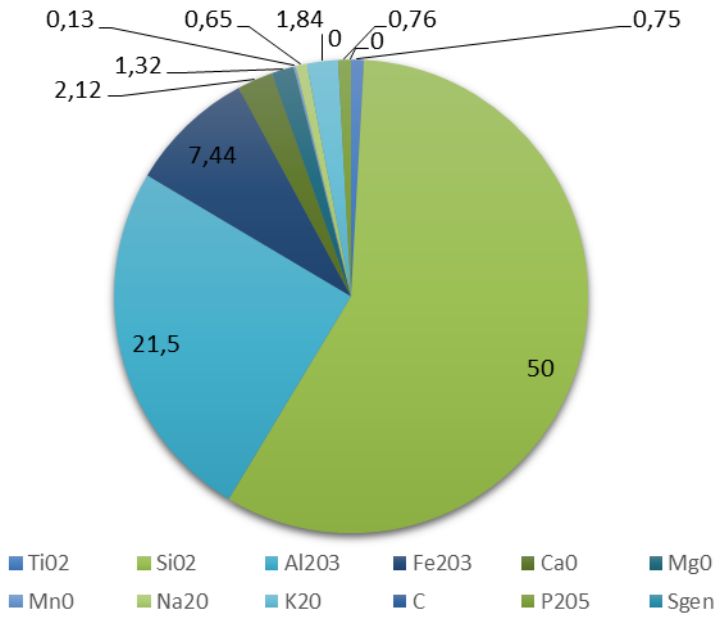

Fig. 4. The composition of the initial ash and slag mixture before flotation.

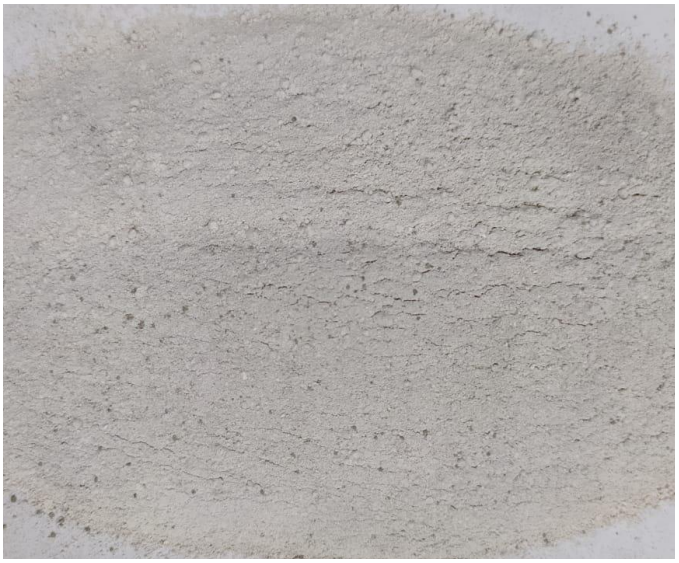

Fig. 5. Dry mix of gypsum binder and aluminosilicate additive (15% by weight of gypsum binder).

In order to study the effect of the addition of aluminosilicate microspheres on the water-solid ratio, average density and strength of gypsum, experimental studies were carried out to optimize the composition of the modified gypsum mixture. The results of the

study of the addition of microspheres to the spread of the gypsum mixture are shown in Fig. 6.

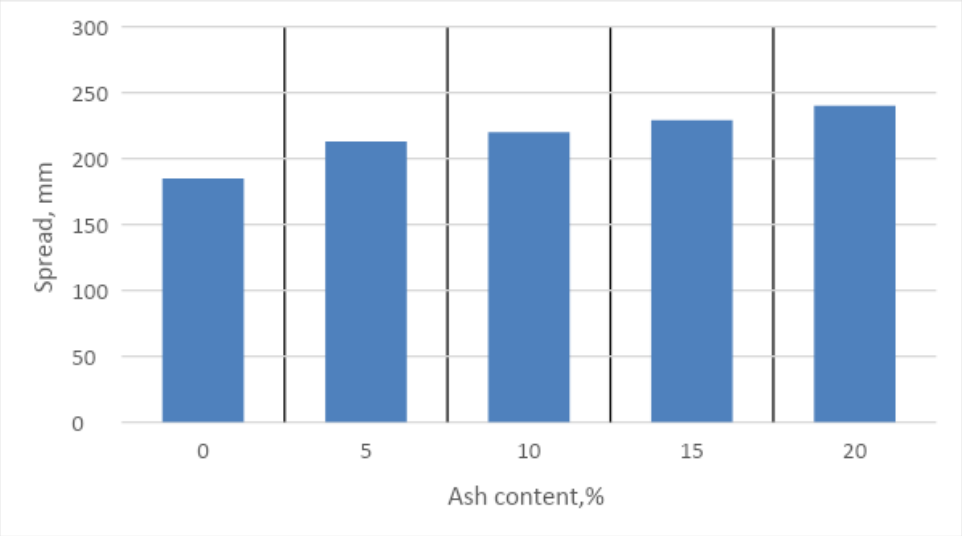

Fig. 6. Influence of the content of aluminosilicate filler on the amount of spread of gypsum paste.

The results of the study of the average density and compressive strength of gypsum are shown in Fig. 7, 8. It has been established that the ash has a plasticizing effect, the spread of the dough increases by an average of 30% with the introduction of microspheres up to 20% by weight. The average density of gypsum increases in the range of microsphere content from 0 to 10% - from 1200 to 1270 kg/m^3. Then, with an increase in the content of the additive above 10%, the density decreases. The strength of gypsum monotonically decreases by 14% with the introduction of ash aluminosilicate microspheres up to 20% by weight.

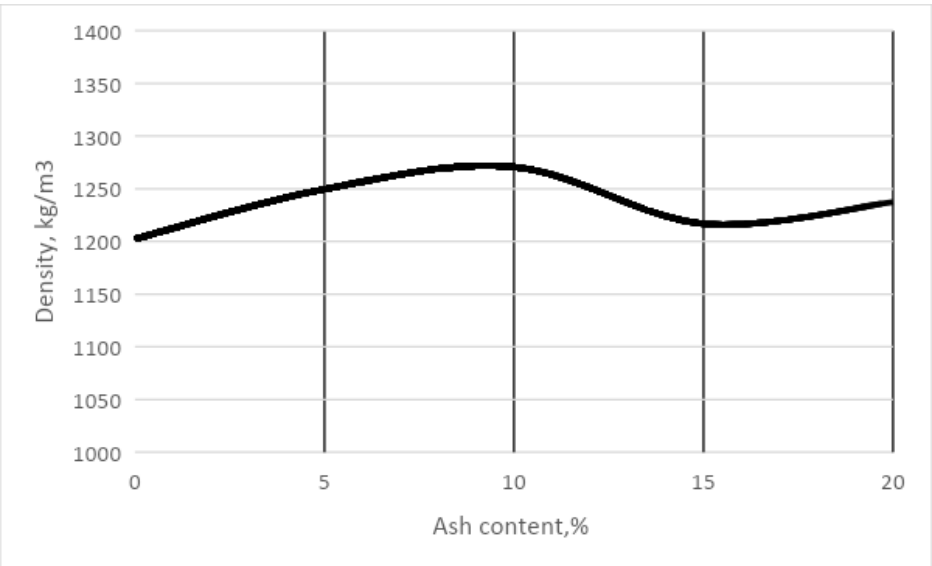

Fig.7. Influence of the content of aluminosilicate filler on the density of gypsum.

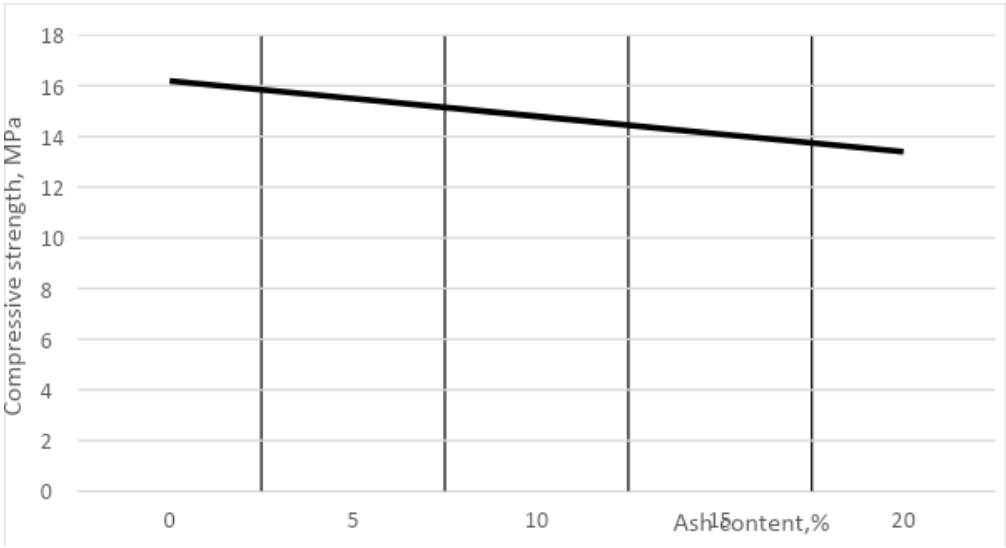

Fig. 8. Influence of the content of aluminosilicate filler on the gypsum compressive strength.

3 Conclusion

The results obtained confirm the positive role of microspheres in the plasticization of gypsum mixtures and the compaction of the gypsum structure. In order to improve the efficiency of using microspheres in gypsum mixtures, it is necessary to continue studying the basic properties of modified gypsum with the introduction of aluminosilicate microspheres in combination with additives that activate the structure formation of sologypsum mixtures.

Acknowledgements

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