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Features Of The Structure Formation Of A Filling Mixture Based On Industrial Waste

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ABSTRACT

The article presents the structure formation and obtained research results in aggregates based on ash, loose rock-based sand and marble processing waste.

KEYWORDS

Backfill mixture, fly ash, marble processing waste, additive, waste sand, analysis, X-ray diffraction pattern, structure formation.

INTRODUCTION

Analysis of the state of production of filling mixtures showed that the use of traditional calcium binders, in particular Portland cement, does not allow obtaining filling mixtures that fully meet the necessary requirements. The recommended ways to improve their physical and mechanical characteristics, as a rule, are associated with the need for a significant overconsumption of the binder, the use of natural resources and technological methods that require additional labor and energy consumption [1, 2].

PURPOSE OF WORK

In this regard, scientists and material scientists are conducting research to improve the quality of the product and reduce the cost of using local raw materials and various industrial wastes in the production of filling mixtures to fill the mined-out area.

THE MAIN FINDINGS AND RESULTS

The binders that open up the possibility of eliminating the disadvantages of cement backfill mixtures include ash-cement and slag-cement. The hydration products of these binders are fundamentally different from the hydration products of Portland cement.

Using the above research methods, the peculiarity of the processes of structure formation of filling mixtures based on Portland cement, fly ash (active mineral additive), copper smelting slag, sand based on waste rock and marble processing waste, as well as a chemical additive has been studied.

SCIENTIFIC RESULTS AND THEIR ANALYSIS

To identify the processes of structure formation in cement and ash-cement compositions, we studied samples that hardened for 28 days in a normal hardening chamber at a temperature of 20 ° C and an air humidity of 95%. The hardening of the filling mixture with fly ash is due to the hydration of calcium oxide, anhydride and the interaction of these products with ash glass hydrolyzing in an alkaline medium, as well as with amorphous clay substance [3, 4].

The X-ray diffraction pattern of a cement filling mixture sample (Fig. 1a) contains intense lines of mullite (d=3.78; 2.72; 2.58; 2.54; 2.20 Å), calcium hydrosulfoaluminate (d= 5.71; 4.76; 3.92; 2.79 Å). Relatively weak lines confirm the presence of calcium hydroxide (d= 2.62 Å) and gypsum (d= 4.29; 3.07 Å).

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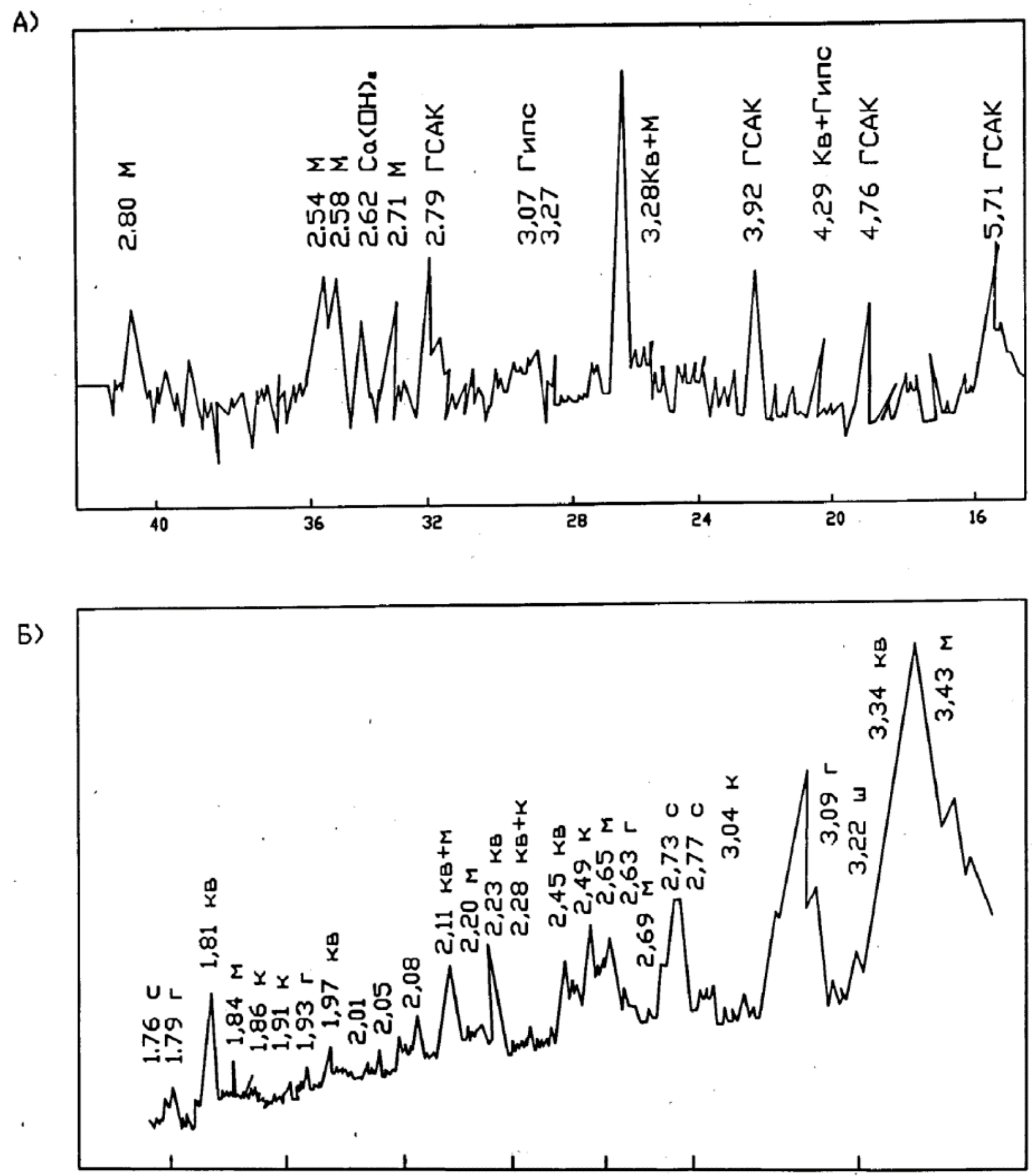

Figure 1 - a, b. X-ray diffraction patterns of filling mixtures of cement (a) and cement-ash (b) compositions. Legend of lines: Кв - quartz; M - mullite; G - calcium hydroxide; C - calcium silicates; K-calcite; CHDL - calcium hydrosulfoaluminate

There is no unhydrated calcium oxide in the sample. There is also no anhydrite. The dihydrate gypsum is preserved in very small quantities. Thus, further hardening of the filling mixture in time, in the absence of the main components of binder hydration, is significantly limited.

It is possible to increase the number of new formations of hydration products, and therefore to increase the strength of the filling massif, if ordinary Portland cement is added to the mixture on fly ash. In our studies, for this purpose, we used 400 Portland cement of the Bekabad Cement Plant.

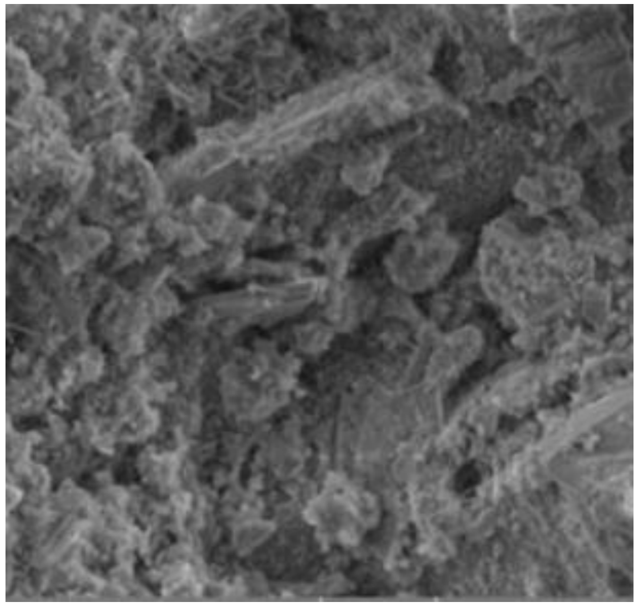

Figure 2. Microstructure of a backfill sample x200 µm

Under the microscope, among the unchanged products, grains of detrital impurities of quartz and feldspars, as well as acute-angled particles and glass phase balls are clearly visible. The surface of these grains is usually clean, although sometimes there are secretions of hydrated neoplasms in it. Signs of hydration and hydrolysis of slag glass are almost imperceptible. Unhydrated clinker - no more than 5%. Mainly bright polarizing aggregates of belite grains are observed, between which brown-brown films of calcium alumoferrites are visible (Fig. 2).

Particles of clay material amorphized by firing, fly ash are strongly altered due to hydration and interaction with a liquid phase - a saturated solution of $Ca(OH)_2$.

Since the particles are highly porous, this interaction is not limited to the surface, but also occurs in the pores. The change in the outer zone of the particles is expressed in the loss of clarity, blurring of the contour, the particle, as it were, swells. As a result of the transformation of the anhydrous aluminosilicate mass into a hydrated calcium-aluminosilicate mass, the light refraction of the surface cement layer decreases to 1.51 - 1.52. The intergranular space is filled with a gel-like (submicrocrystalline) cementitious substance, including calcium hydrosilicate $C_2S_2H_2$, free calcium hydroxide $Ca(OH)_2$, and cryptocrystalline calcite, a carbonization product during the storage time of the samples.

The X-ray diffraction pattern of a sample of normal hardening (Fig. 1, b.) Contains intense lines of quartz (d=3.34; 2.45; 2.28; 2.23; 2.11; 1.97; 1.81 Å) and mullite (d=3.43; 2.69; 2.55; 2.20; 2.11; 1.84 Å). The presence of feldspars is confirmed by a line with d= 3.22 Å. The complex of weak lines with (d=2.77; 2.73; and 1.76 Å) refers to the unhydrated dicalcium silicate (belite) of Portland cement clinker. Calcium hydroxide was identified by lines with (d=3.09; 2.63; 1.93; 1.79 Å), and calcium by lines with (d=3.04; 2.49; 2.08; 1.91 и 1.86 Å).

Thus, during the hardening of the filling mixture under normal conditions, the hydration of the calcium oxide (CaO) of the ash, the hydration of the minerals of Portland cement, the interaction of calcium hydroxide with the amorphous clay matter of the ash, and the carbonization of the cementitious composition take place.

Due to the significant content of calcium oxide (CaO) in the original ash of dry selection, the complete assimilation of Ca(OH)2during hardening is not achieved, which is a reserve for the growth of the strength of the filling mixture over time. This is confirmed by the change in the strength of the filling mixture as a result of testing cores and cube samples after 180 and 360 days [4, 5].

CONCLUSION

Thus, the optimization of the processes of structure formation of composite binders occurs due to the provision of sequential growth of new formations during hardening of the system "clinker minerals-quartz of various genesis-ash-water-superplasticizer", due to different intensity and time of interaction of polygenetic quartz and ash particles with hydration products of clinker minerals. Chalcedony, reactive metamorphic, and also partially dynamo-metamorphic generation of quartz from marble processing waste intensively bind calcium hydroxide into fine-crystalline insoluble calcium hydrosilicates, and the contact-metamorphic variety and larger sand particles act as substrates and crystallization centers, which generally contributes to a decrease in the number of defects, reduction of crystallization pressure and optimization of the material structure.

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