Multicomponent Raw Mixes for Autoclave Products with Improved Properties

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Abstract. This article discusses a method for solving the problem of increasing the adhesion strength of silicate brick to peel with masonry mortars based on a study of the work of scientists in this direction, the physicomechanical properties of currently manufactured silicate brick from sand dunes and its production technology. Implementation of the goal of enrichment of a mixture of ultrafine active mineral additives, which allows you to effectively control the process of coagulation structure of formation and formation of the optimal structure with improved physical and mechanical properties. The properties of ultrafine active mineral additives based on local plant waste from agriculture are experimentally determined and investigated. Possible joint utilization of rice husk wastes in the resource turnover will lead to a reduction in environmental impact.

1 Introduction

The large scale of construction in our country requires further development of the production of building materials, expansion of their range and quality improvement.

Along with the development of the production of cement-based parts and products, much attention is paid to the production of cement-free materials, in particular, autoclave-hardened silicate materials. Despite the achieved high level of cement production in our country, which exceeded the annual output of up to 25 million tons per year, the role of the construction industry sectors operating according to cement-free schemes, and primarily the silicate autoclave industry, after some stagnation began to grow continuously. The successes in the development of the production of silicate materials are directly related to the achievements of science in this field [1-3].

The developed fundamentals of the theory of hydrothermal hardening serve as a basis for further scientific research and development of the production of silicate autoclave materials.

In recent years, the technological scheme involving the use of a ground mixture of lime and sand – the so-called lime-sand binder - has found the greatest use in the production of these materials. Due to the fact that fine quartz sand is introduced into the silicate charge, the hardening processes are significantly accelerated, a large number of strong, low-base calcium

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hydro-silicates are formed and the density of concrete increases, which, in general, makes it possible to obtain a silicate material of high strength.

The use of lime-sand binder opens up new opportunities in the production of silicate materials, as it allows you to use not only quartz sands, but also other rocks or waste, which is one of their main advantages. But local, in addition to quartz sand, in many parts of the country are the waste of various industries, mining and engineering industries. In particular, during the development of limestone quarries, dolomites, etc., producing dimensional and fractionated stone for the production of lime, fluxes for the metallurgical industry, crushed stone for the ballast layer, aggregates for concrete, etc., waste in the form of sand and fine (up to 20 mm) crushed stone is formed in large quantities, which are still used insignificantly, accumulate in huge quantities and require special costs for their removal. Waste is especially high (more than 50%) during the extraction of stone from various low-strength limes tones, such as shell rocks, tuff limes stones, etc., widespread in many parts of the country.

Since the main component in the production of silicate materials is lime obtained by firing limestones, small fractions of which - sand and crushed stone can serve as finely ground fillers in the composition of silicate masses, it is possible to organize the complex use of this raw material, for which it is necessary to study the properties of silicate autoclave materials with carbonate fillers.

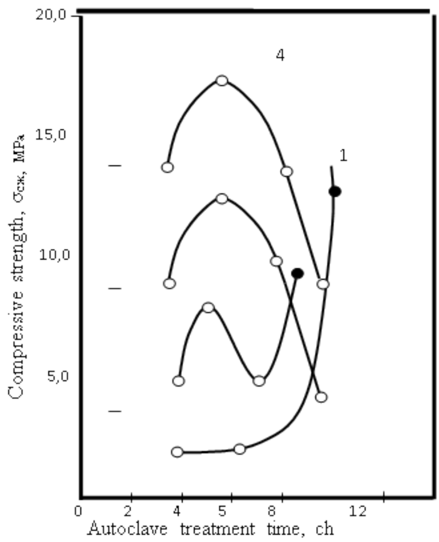
This work is devoted to the study of silicate autoclave materials, a distinctive feature of which is the use of various carbonate rocks and spent molding sands (foundry waste) as an additional raw material component in the form of fine additives. In order to obtain a silicate autoclave material (concrete) of increased strength, in the production of silicate bricks on quartz sand, a certain amount of finely ground sand is usually introduced into the raw material mixture. In this case, part of the sand is pre-ground in ball mills, most often together with lime. The introduction of about 10% of ground sand into the composition of the raw material mixture makes it possible to significantly increase the strength of silicate materials. Due to the absence of conditioned quartz sands everywhere, we partially (up to 30%) used foundry waste - spent molding sands (OFP) or finely ground carbonate rocks instead of carbonate sand, which, accordingly, are accumulated in large quantities at foundries in Uzbekistan and in quarries producing carbonate rocks, in lime-silica binders [4-6].

2 Methods

The work used modern standard and proven methods for studying the physico-chemical and physico-mechanical properties of autoclave-hardened silicate building products. The features of physico-chemical transformations and structure formation during autoclave treatment of silicate masses were studied using a complex of physico-chemical analysis methods (X-ray phase, DTA, electron microscopic, IR spectroscopic, etc.).

Based on the studies carried out, compositions of silicate masses for hydrothermal hardening construction products using finely ground fillers made of natural limestones, spent molding sands, cement dust and wollastonite, characterized by improved construction and technical properties, have been developed. Results of studies of the phase composition of the hydrothermal hardening products of the system CaO - SiO2 – CaCO3 – H2O the DTA and RFA methods expand the field of knowledge of the features of the processes of phase interaction and structure formation, the formation of strength in a hardened silicate stone based on sand dunes due to the introduction of a new composition of lime-silica binders into the silicate mass [7-8].

X-ray analysis revealed that in samples made from raw materials of separate grinding, a greater amount of CSH(I) and tobermorite was observed than when lime was ground together with wet OFP. Strength properties are determined to a greater extent by the quality of OFP, the number of neoplasms and the structure of the hardened stone. The use of cement production dust for the manufacture of silicate materials increases the manufacturability of their production and significantly improves the quality indicators of these materials, increases the removable strength of silicate samples without increasing the activity of the charge.



1 - sand dunes; 2-, 3-, 4 - the same with the addition of 10, 20, 30 wt. % OFP of the sand mass, respectively

Fig. 1. Compressive strength of lime-silica samples with the ratio CaO:SiO2 = 0.5 depending on the autoclave hardening time and the amount of OFP

Partial replacement of lime by 10-15% of dust leads to a significant increase in the strength of samples with constant water absorption, has a positive effect on the strength parameters of silicate samples autoclaved at 8 ati for 8 hours. The introduction of 15% dust into the charge instead of the same amount of quartz sand in a lime-silica binder with the same amount of lime as in the factory charge – 10%, increased the strength of the samples almost twice – from 11.2 to 21.7 MPa.

The introduction of a lime-silica binder on quartz sand into the composition of silicate masses with the replacement of the latter within 1-10% of wollastonite increases the bending strength by 2 or more times, during compression - by 3 or more, depending on the size of wollastonite crystals. Moreover, the greatest increase in strength is achieved with the introduction of β-wollastonite crystals with a length of 1.8 mm.The addition of β-wollastonite crystals to the lime-silica binder reduces the open porosity of the stone from 40 to 35%.The introduction of crushed wollastonite rock before passing through the sieve No. 05 into a silicate brick based on the sand of the Urgench silicate brick factory in an amount of 1.0-10% by weight of the dry silicate mixture leads to an increase in the strength of the brick and its grade.

3 Results and Discussion

The results of the study of the properties and phase composition of the products of hydrothermal hardening of the CaO-SiO2-CaCO3-H2O system. For this purpose, using modern methods of analysis (X-ray phase, DTA), studies were conducted on the effect of finely dispersed calcium carbonate on the strength of silicate masses of various activities, on the binding of lime silicate masses during their hydrothermal treatment. The processes of interaction of calcium oxide hydrate and calcium carbonate during their hydrothermal treatment without additives and in the presence of additives of spent molding sand were studied.

Our research was aimed at identifying the role of calcium carbonate, present as the fourth component in limestone-sand compositions, and its effect on the properties and phase composition of hydrothermal hardening products. Lime-sand masses consisting of finely dispersed components CaO-SiO2-CaCO3 with an activity of 10, 15, 20 and 30% were used for the research. Moreover, the SiO2-CaCO3 ratio in them varied from 5:0 to 0:5. This made it possible to consistently follow the changes occurring in the CaO-SiO2-H2O system with a gradual increase in the content of CaCO3 up to compositions in which quartz sand is completely replaced by calcium carbonate. In addition, both pure CaCO3 reagent and various carbonate rocks were used as a carbonate component. The strength parameters during compression and bending of samples subjected to hydrothermal treatment at 17500C for 6 hours, the degree of lime assimilation and the phase composition of the reaction products were studied.

When conducting studies of the effect of additives of finely dispersed calcium carbonate of various rocks instead of quartz sand in a lime-silica binder on the strength and phase composition of neoplasms during hydrothermal treatment of the CaO - SiO2 - CaCO3 - H2O system, it was found that the compressive strength of samples from silicate masses depends on the content of finely dispersed calcium carbonate and quartz sand in a lime-silica binder. The best results were obtained when replacing from 20 to 40% quartz with a carbonate additive in a lime-silica binder. The increase in strength at the same time reaches 30-56%. The greatest efficiency of increasing strength is observed with the introduction of reactive CaCO3 and Dzhumertau limestone, characterized by a fine-crystalline structure, into the composition of a lime-silica binder. Highly recrystallized Gazgan marble, having large crystals, gives an increase in strength by 11-29%. A certain role is played not only by the degree of recrystallization and the size of the crystals, but also by their strength.

An increase in the bending strength of silicate masses containing up to 40% carbonate micro-filler and 60% finely ground quartz micro-filler indicates a high degree of its adhesion to those hydrate neoplasms that are formed during hydrothermal treatment. The decrease in the content of unbound CaO in silicate masses consisting of lime and calcium carbonate during hydrothermal treatment can be explained by partial adsorption of lime on calcite, as well as an increase in the degree of carbonation of Ca(OH)2 with air carbon dioxide. It is noted that in the presence of fine-crystalline limestones, a high degree of lime binding is observed due to dissociation of the latter and carbonization of calcium oxide hydrate with simultaneous formation of magnesium hydrosilicates present in dolomitized limestones.

The phase composition of hydrate neoplasms of the CaO - SiO2 - CaCO3 - H2O system of hydrothermal hardening, studied by DTA and XFA methods, is represented by calcium hydrosilicates of the SSN(B) group and a small amount of free quartz. The endoeffect at 672-6800 0C, which appears when calcium carbonate is introduced into the silicate mass and increases with the addition of CaCO3, can be explained by the formation of a complex compound between hydrosilicate and calcium carbonate during hydrothermal treatment. Systematic studies of the CaO - SiO2 – CaCO3 – H2O system on masses of different activity and with the use of carbonate materials of different mineralogical nature and crystal structure allowed us to record the presence of an endothermic effect at 680-6900 0C, which is stably present in all samples of a four-component composition and, apparently, is associated with the destruction of a complex compound of calcium carbosilicate.

X-ray phase studies of the effect of finely dispersed calcium carbonate and quartz sand in a lime-silica binder on silicate masses of various activities have established (fig.) that an increase in the amount of CaCO3 introduced into a lime-silica binder changes the conditions of interaction in the reaction medium, preventing the formation of dibasic hydrosilicates.

Diffraction reflections of a complex compound of calcium carbosilicate were noted on diffractograms of systems containing CaCO3, the formation of which was also confirmed by differential thermal analysis.

The bending strength varies accordingly to the compressive strength and in many cases, even when replacing 40% of quartz sand in calcite-silica binder, it turns out to be higher than the strength of the original samples. These data indicate a high degree of adhesion of the carbonate micro-filler with those hydrate neoplasms that occur during hydrothermal treatment of silicate masses.

4 Conclusion

For the first time, the possibility of increasing the construction and technological properties of silicate materials on sand dune containing fine carbonate filler, spent molding sand, cement dust and wollastonite, suitable for obtaining autoclave-hardened silicate bricks, has been scientifically substantiated.

It is established that the introduction of finely ground carbonate additives into the composition of silicate masses improves the cohesion of the masses in the manufacture of autoclave-hardened silicate bricks, increases their strength, weather and water resistance. The positive effect of additives of fine carbonate rocks on the properties of silicate material is a consequence not only of physical compaction, but also due to the manifestation of a certain chemical activity in the medium under study. It is proved that the addition of carbonate aggregate in the initial period of autoclave treatment of silicate mass shows its activity during recrystallization, when all or most of the lime is bound. During this period, due to the destruction of old and the manifestation of new bonds, favorable conditions are created for the involvement of calcium carbonate in the reaction and the formation of a complex complex compound of calcium carbosilicate and low-base calcium hydrosilicates, providing high strength of the silicate material at a later time of hardening.

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