Journal of Construction and Engineering Technology

EXPERIMENTAL STUDIES AND PROPERTIES OF GYPSUM CONCRETE BASED ON GYPSUM BINDERS

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Abstract

Analysis of literary and experimental data on the resource support of construction market has shown that the development of new and efficient materials with improved quality parameters is an urgent task and in the long term will serve as an impetus for the development of the market building materials. At the moment, the peat industry in the Russian Federation has low indicators for extraction of peat raw materials, the reserves of which are considered inexhaustible. For potential development peat industry in the territory of the Siberian region, the production of co- temporary heat-insulating and structural-heat-insulating materials based on local raw materials deposited in the deposits of the Tomsk region. The use of lowland peat and expanded vermiculite to create a new competitive material can help improve the economy economic and industrial prestige of the region, which will lead to the creation of new jobs.

Materials and methods. Studies have been carried out using the methods and tests outlined in national standards. The measurement of the density of the obtained material was carried out in accordance with in accordance with GOST 17177–94. Determination of the strength of samples in compression and in bending was carried out in in accordance with GOST 23789–2018. The determination of the percentage of moisture content of the samples was carried out in in accordance with GOST 23789–2018

Key words: Biosilica, hydraulic additives, plaster concrete, plaster knitting, plaster products, chemical structure, solutions, silica, carbide of silt, material, microsilica, mineral, durability, lime, waterproof, cement.

Introduction

In 2016-2021, in our country, in order to increase the durability of wall covering materials in terms of time, resistance to various climatic conditions and their strength, to improve their thermal and technical properties, in particular, to create a porous structure during the preparation process and to reduce the average density of burning additives use, optimization of material structure using mineral additives, creation of energy-efficient technologies of their production, conducting research and development aimed at improving the existing ones has developed.

In this regard, the Decree of the President of the Republic of Uzbekistan dated May 23, 2019 "On additional measures for the rapid development of the construction materials industry" regarding the production and expansion of new modern types of wall covering materials in the construction industry Decision No. 4335 covered these goals [1].

On the basis of this decision, in 2019-2025, on the basis of geological exploration, extraction and processing, the volume of the raw material base of the construction industry in terms of limestone will be - 13.1 mln. per ton and for gypsum stone - 1.8 mln. the scale of increase per ton was determined.

Today, the tasks of expanding the types of production of high-quality construction materials, filling the domestic market with import-substituting and competitive construction materials and domestically produced products are set.

Materials and Methods

The following three main directions of increasing the water resistance of gypsum products have been identified:

- reducing the solubility of hardened plaster;
- changing the capillary pore structure of gypsum stone with the aim of reducing water absorption and water absorption;

- the surface of materials that prevents water saturation of gypsum products is moisture-resistant, protected and impregnated.

In addition, it is possible to increase the water resistance of hardened plaster by using gypsum mass densification. But this method causes a high consumption of the binder and complicates the production technology of plaster products. Surface coating (zinc and sand silicate) has a temporary nature and is not always economically effective [2].

The first two directions are more promising, because in these cases, the water resistance of the entire volume of the material increases, regardless of accidental damage to the surface of the item or structure.

Various chemical additives were used to perform this task [3, 4]. The most effective, which allows to reduce the solubility of gypsum stone or concrete at the same time, is the one that allows to control the properties and structure of building materials.

The analysis of foreign experience on increasing the water resistance of gypsum binders shows that researchers mainly recommended the use of complex organic additives during hardening or impregnation.Scientists from the USA, Germany, Japan, Poland and France showed the greatest interest in this problem and recommended additives based on polysiloxane and silicon dioxide. Russian scientists (M.A. Matveev, K.M. Tkachenko) studied the method of impregnation with phenolformaldehyde and other water-soluble resins. The impregnation ensures the densification of the material and protects the crystals of two-water gypsum from the effects of moisture. However, the method of increasing the water resistance of this gypsum has serious drawbacks, which complicates the technological process of manufacturing the product and increases its price.

Currently, in the USA, Japan and Germany, methods of reinforcing gypsum products with mineral, organic and glass fibers and fibrous crystals of gypsum binder have been created. Their use increases the durability and water resistance of plaster products.

Polish researchers recommended the method of mixing semi-aqueous gypsum with high-baked gypsum binders and lime in a given ratio. The softening coefficient of such a binder is 0.7, but the use of additional chemical additives in its preparation increases the price of the product.

In the 1940s, the Russian scientist A.V. Volzhensky recommended the use of unslaked lime and dewatered gypsum, which felt hydrated due to heat [5]. Also, at the same time, the addition of a hydraulic additive to plaster together with lime increases the product's water resistance.For the first time in 1941, a specialist scientist I.E. Gaysins received a three-component gypsum binder. As a hydraulic additive, 30-40% of the binder mass was mainly domain granular rocks. Cracks appeared due to the uneven change in volume during solidification of the samples in water. This is due to the formation of calcium sulfoaluminate, which causes internal tension.

At the same time, A.V. Volzhensky conducted a series of researches and used the following as hydraulic additives: ash, trass, pumice, diatomite, opoka (a rock rich in sandy soil), cement, domain rocks, some The stones left over from burning myrrh were used. Similar experiments were conducted by Russian expert scientists V.P. Nekrasov, M.A. Matveev, K.M. Tkachenko, G.S. Palagin, M.S. Kuratsapov and others.

In 1942, Russian scientists P.I. Bozhenov and I.B. Konyushevsky conducted research on mixed binders based on high-strength gypsum, their composition is as follows: 50% gypsum, 15% lime, hydraulic additives (stone, trepel), etc.

The high water resistance of similar compositions is explained by the formation of a colloidal mass with calcium hydrosilicate, which allows solutions to be concentrated and reduces their leaching. For another type of mixed binders, the softening coefficient is in the range of 0.5-0.7, and the decrease in the amount of gypsum in the composition increases.

Researchers encountered a number of problems when using various hydraulic additives. In particular, the 28-day air hardening of gypsum-lime trepelly compositions provided 15 and 30 grades of the mixture, but reduced the strength of the composition by reducing the possibility of gypsum content in them. It was found that the subsequent hardening of the hydraulic additive and lime composition after 6 months in the air conditions had negative effects on the strength. In addition, the most water-resistant composition (80% gypsum, 5% lime, 15% trepel) showed the least stability when wetted and dried alternately.

Gypsum-lime-ash and cement compositions have a very low frost resistance (F2-F6 cycle), and in tests of stability in alternating wetting and drying, it withstood at most the F25 cycle.Gypsum-lime-stone mixtures are the leader in terms of absolute strength, with the advantage of strength on land, they have the property of hardening in water with a decrease in the amount of gypsum up to 60% (and in gypsum-lime-ash compositions, at least 80% of gypsum content, the strength decreases after 6 months). But all of them have a very different chemical composition, which is a significant drawback and indicates the need to prepare and select their composition through experimentation. Partial softening and thickening of the hydraulic additive in water compared to gypsum-lime binders (gypsum samples after 18 hours give up to 65% strength loss with gypsum-lime to 20% with gypsum-lime putsolan) in water In the first term, the strength of the ternary mixture is significantly lower. In addition, the amount of rN compared to gypsum-lime putsolan binders (8.2-8.8; rN in gypsum is equal to 6-7 without additives) significantly higher (10-11) in gypsum-lime binders slows down the rotting (rusting) of the reinforcement. . These factors drew the attention of scientists to the processing of gypsum-lime binder. The most effective of gypsum binders for gypsum concrete for barrier construction are gypsum-cement putsolan binders created by the Russian scientist A.V. Volzhensky. formed [5]. Such a binder has a softening coefficient of 0.6-0.8 and a frost resistance of F25.This barrier construction made it possible to start the production of low-grade binders for concrete and to improve its composition with the aim of reducing the amount of clinker used, which increases the price of the final product.

Gypsum-cement putsolan binders, which were created and recommended in the 1950s, were not widely used in construction due to the disadvantages of low activity and tendency to decrease strength during storage. Long-term durability of lightweight concretes based on gypsum-cement putsolan binders drops dramatically in small deviations from strict regulatory requirements for the selection of binders and concrete composition based on it.

Results

In order to increase the water resistance and frost resistance of the gypsum binder and to improve its strength characteristics, experimental studies were carried out by adding a muddy sand soil additive. Due to the interaction of calcium hydroxide and active SiO2, calcium hydrosilicates of low solubility are formed, which thicken the structure of the material and prevent moisture from entering the hardened gypsum (Fig. 1).

The presence of turbid carbide in turbid biosand soil gypsum binders reduces the solubility of hardened gypsum and, as a result, the material becomes more resistant to the atmosphere. In addition, its use solves the environmental problem, in particular, it disposes of many tons of man-made waste from acetylene production, and its use increases economic efficiency, reduces the cost of the final material [6, 7, 8, 9].

Replacing building lime with turbid carbide leads to an increase in adhesion and physico-mechanical properties of the multi-component gypsum binder and reduces their solubility.

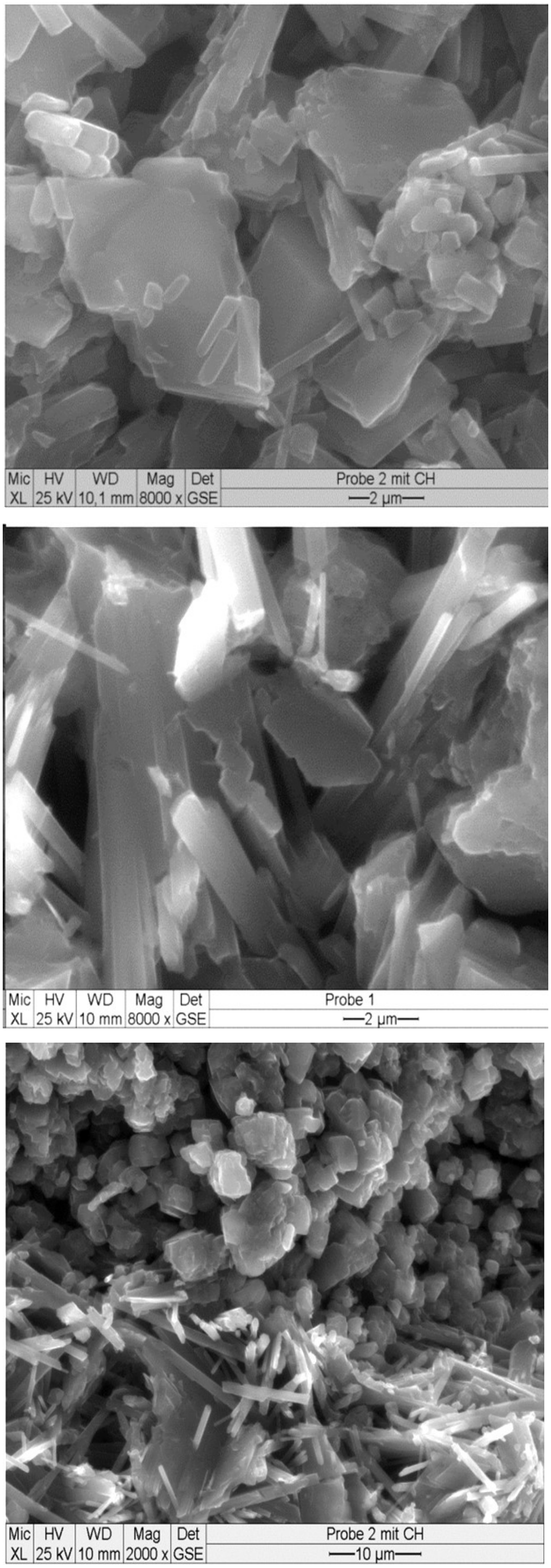

Figure 1. Microstructure of gypsum binder due to the interaction of calcium hydroxide and active SiO2.

For multi-composite gypsum binders, sandy soil was selected as a clayey sand soil additive, and microsand soil and biosand soil were studied.

The use of microsand soil as a mineral additive has become widespread in recent years [10]. The product of the production of silicon and ferro-silicon alloys is formed as a result of the reduction reaction of high-purity quartz with coal, and it has a highly dispersed dust that is captured by filters from the backgas of the sand soil. Dry compressive strength of samples is 5, 15, 25 MPa.

Comparison of the efficiency of using turbid carbide and building lime as additional ingredients of turbid sand soil.The use of construction lime as an additive to muddy sand soil in the state of water saturation increases the strength of the material based on multi-component gypsum binders by 2.1 times, and in the dry state by 1.3 times, and the use of cloudy carbide in the state of water saturation increases the strength of the material It allows 2.4 times and 1.5 times increase in dry strength. This is due to the fact that the activity of turbid carbide is 90-95% higher compared to the 80-85% activity of building lime. The stability of the chemical composition of the microsand soil in the territory of JSC "Ozmetkombinat" varies from 85% to 98% by mass with the amount of active sand soil in the amorphous state (Tables 1 and 2). This makes it possible to correctly produce the composition of gypsum binders with muddy biosand soil based on the passport indicators of gypsum and microsand soil.

Table 1

Chemical composition of microsand soil

Chemical composition, %			
SiO_2	Al_2O_3	CaO	P_2O_5
95,9	1,6	2,2	2,2

Microsand soil is advantageously distinguished from other active mineral additives by its high hydraulic activity (about 250 mg/g), in particular, 3 times higher than the average activated ash, and contains gypsum-cement putsolan binders (trepel, opoka, diatomite, etc. .) is 1.5 times higher than recommended mineral supplements. High dispersion is an advantage on the one hand. Because the hydraulic activity of the additive is provided by an inexpensive powder. Another disadvantage is that microsand soil has a specific surface area of 24 m2/g, which allows the use of fine aggregate instead of microsand soil to avoid the high water demand of the mixture.

Biosand soil is of biogenic origin and consists of finely dispersed silicon dioxide obtained as a result of specially mixed activity of natural diatomite heat-treated at a temperature of 700-800 ºC. Biosand is a soil structure-forming element, its initial flocculation structure ensures durability. The activity of biosand soil is 1.5 times higher than the activity of the most common mineral additive of man-made origin (microsand soil, highly active ash), hydraulic activity of which is around 395 mg/g.

Biosand soil is 100% putsolan, it is produced from sedimentary rocks. The composition of the sandy soil is active, it increases the amount of hydrated silicates of the CSH type and has the property of interaction with Sa(ON)2.As a result of impregnation of lime with biosand soil, after 30 days, exactly the same indicators of natural active mineral additives until March 4, and microsand increases the activity of the soil by 60%. For biosand soil, along with a high active indicator at 30 days, rapid absorption of lime is observed in the first 3 days.

Biosand soil has a high dispersity, is characterized by very small particles (0.1-0.5 μm) and a high specific surface area (22-26 m2/g), but with a uniform water/gypsum ratio, it is soft. the consumption of the additive is 25-30% less when using microsand soil.

The fact that the biosand soil has a constant chemical composition and activity allows for the correct production of gypsum binders with muddy biosand soil based on the parameters of the gypsum passport. In the course of research, semi-aqueous G5 gypsum, turbid carbide, sand forming agents (microsand soil and biosand soil), and fine additives are used to prepare multi-component gypsum binders. Prepared samples are stored in natural dry conditions for 28 days. Preliminary studies show that silty sand soil additives allow the use of microsand soil and biosand soil as sand soil builders, but their effectiveness varies.

Table 2

Chemical composition of active sandy soil in amorphous state

Chemical composition, % by mass						
SiO2	MgO	Fe2O3	Al2O3	MnO	SaO	W
95,8	0,7	0,8	0,4	0,4	0,4	0,3

Discussion

The use of microsand soil in the composition of muddy sand soil additives increases the strength of the material based on multi-component gypsum binders by 1.6 times in the water-saturated state and by 1.1 times in the dry state. In the same case, the use of biosand soil increases the strength of the material based on multi-component gypsum binders by 2.6 times in the water-saturated state and by 1.4 times in the dry state.

The most favorable ratio between microsand soil/biosand soil and turbid carbide is determined in a mixture of turbid carbide and sandy soil. In the same case, the most favorable ratio between sand soil composition and turbid carbide in different proportions is determined in the mixture of multi-component gypsum binders. The main scope of the research is carried out on samples measuring 4×4×16 cm, hardening conditions are carried out by keeping them in natural conditions for 28 days. The results of the research show that, from the point of view of increasing water resistance, the ratio between microsand soil and cloudy carbide is 1-1.2, and between biosand soil and cloudy carbide is 0. A ratio of 5-0.7 is calculated, which is in accordance with the stoichiometric calculation results for the reaction of Sa(ON)2 and SiO2. Thus, the consumption of biosand soil is 1.8 times less than that of microsand soil to ensure a complete reaction.

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