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APPLICATION OF HEAT-INSULATING COMPOSITE GYPSUM FOR ENERGY-EFFICIENT CONSTRUCTION

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Annotation
The article deals with the use of finishing slabs from gypsum heat-insulating composite materials based on industrial waste in energy-efficient construction, the compositions and properties of these materials are considered.

Keywords. Construction, energy efficiency, finishing boards, thermal insulation materials, gypsum, travertine, properties.

On May 23, 2019, the Decree of the President of the Republic of Uzbekistan "On additional measures for the accelerated development of the building materials industry" was adopted [1]. The Decree set the task of creating favorable conditions for the accelerated development and diversification of the industry, attracting investment in the processing of local mineral raw materials and increasing the export of building materials.

Construction, as a priority sector of Uzbekistan, occupies one of the first places in terms of the use of material resources. The modern scale of construction sets the task of solving the issues of economical and rational use of resources, first of all, the implementation of existing reserves, i.e. creation of low-waste and energy-saving technologies using industrial waste. The implementation of these tasks leads, first of all, to the saving of expensive material resources, and secondly, to the refusal to import them from other regions.

Thus, according to the Uzpromstroymaterialy association, for 9 months of 2021, the volume of imports of various building materials amounted to 249 million US dollars [2].

In this regard, in modern conditions, it is relevant to find the possibility of using local resources to obtain imported materials that meet technical requirements and contribute to improving the environmental situation.

To accomplish these tasks, it is necessary to expand the range of building materials by using energy- and resource-saving building materials based on local raw materials and waste from various industries and advanced technologies for their production.

Modern buildings have great opportunities to improve their thermal efficiency based on the formation of thermal and air conditions, optimization of heat and mass flows both in the premises and in the enclosing structures [3].

Energy efficient construction is gaining more and more development every year.

The main weapon in the fight for energy saving and reduction of heat loss is the right heat-insulating material.

Therefore, the role of thermal insulation materials in ensuring the energy efficiency of buildings is great. The use of heat-insulating materials allows reducing the thickness and weight of walls and enclosing structures and reducing the main building materials (cement, metal, brick).

Reducing the weight of the structure is especially relevant in seismic areas, as it reduces seismic loads associated with the weight of buildings.

When choosing effective heat-insulating materials, it is necessary to take into account their heat-insulating properties, technological features, environmental safety, cost, the volume of their production in the country, and other factors [4]. Therefore, when choosing effective heat-insulating materials, an integrated approach is required, taking into account their social, economic and environmental significance.

In this regard, it is very important to study effective thermal insulation materials (especially with the use of local raw materials and waste) to ensure the energy efficiency of buildings.

As you know, gypsum tiles are widely used in construction as a heat-insulating material. They are used for plastering walls and ceilings of rooms. Thanks to the gypsum mortar, good sound and heat insulation is provided. Gypsum is mainly used for the production of gypsum and gypsum concrete building products used for the interior of buildings (thermal insulation boards, dry plaster, partition boards and panels, and a number of others), as well as for the manufacture of lime-gypsum plaster mortars for the interior walls of buildings [5].

In production conditions, to reduce the consumption of gypsum, artificial porous fillers are used as light fillers - perlite, vermiculite, agloporite, expanded polystyrene, etc. [6].

To replace artificial porous fillers (relatively expensive) in the composition of gypsum (grade G-5), waste from the production of travertine slabs was added to the solution.

Travertine is a fairly soft material, it is easily amenable to various types of processing. Thanks to these properties of the mineral, products of high geometric accuracy are made from it - for example, tiles that can be laid with virtually no seams. This stone has good resistance to low temperatures. Therefore, it can be safely used in various climatic conditions for finishing facades and interiors of buildings. In addition, travertine is an environmentally friendly material.

Travertine is one of the most popular decorative materials, which is widely used for both interior and exterior decoration.

Underground storerooms of the mineral are dispersed throughout the world. It is mined in Germany, Iran, Mexico, Greece, Portugal, the USA, and other countries. Turkey is a major importer. The oldest deposits in Italy are still rich [7].

Travertine deposits are known in the CIS countries: Azerbaijan, Armenia, Russia, Ukraine, Uzbekistan (Namangan region), Kyrgyzstan, Tajikistan, and others [8].

In the process of crushing rocks, grains with a size of 0-5 mm are formed. This material is called crush screening. As a rule, crushing screenings are not the main purpose, but waste from the main production for the extraction of building materials. Rock crushing screenings are accumulated in large volumes, which entails direct economic and environmental losses.

Crushing screenings are characterized by a rather high content (up to 25%) of dust-like particles, the size of which does not exceed 0.16 mm.

The most common are screenings of soft rocks - limestone, shell rock, dolomite, marble and travertine.

In Uzbekistan, travertine tiles are widely used for finishing buildings. In the manufacture of slabs and in the extraction of travertine, a large amount of waste is generated.

At the Department of Building Materials and Products of the Namangan Civil Engineering Institute, research was conducted to study the issue of using waste from the production of slabs and screenings from travertine mining to reduce the consumption of gypsum, improve its thermal insulation and strength properties and obtain a finishing slab on their basis. When travertine waste with a high content of dust particles is added to the gypsum mortar, their water demand increases. It is known that superplasticizers should reduce the water demand of gypsum systems and increase the strength of the mixture. Theoretical and practical studies have been carried out to study the effect of additives (especially plasticizers from local raw materials) on the water demand of gypsum. To reduce water demand and improve the plastic properties of composite gypsum, the most effective, according to research results, was the superplasticizer Dzhalilova-SJ-3 [9]. To determine the thermophysical characteristics of the finishing slab, gypsum tiles were made with various fillers (with the same content of the filler - travertine and marble crumbs) 160x160x40 in size, with the addition of a plasticizer. Three specimens were made for each test. The tests were carried out on dried samples to constant weight. Prior to this, the samples hardened in natural conditions. The results of determining the thermophysical characteristics of the finishing slab based on composite gypsum are shown in table-1.

Table1. Thermophysical characteristics of a finishing slab based on composite gypsum

№	Name of fillers	Type of filler	Density g/sm^3	Coefficient of thermal conductivity, vt/mk	Specific heat, kj/ktk
1	Travertine crumb		2.5	0.068	0.59
2	crumb of marble		2.6	0.078	0.71

As can be seen from Table-1, the low thermal conductivity of slabs using travertine chips. Based on the data obtained, it should be noted that the thermal conductivity of the material depends on the density of the fillers. In addition, the thermophysical properties of gypsum depend on the filler content in the material.

The most important physical and technical indicators of travertine are determined:

- material density - 2.5 g/cm3;
- degree of porosity about 8.1%;
- strength properties in compression within 41 MPa;
- water absorption - 1.8%
- the hardness of the material on the Mohs scale is 4 units;
- softening factor – 0.80.

Studies to determine the biostability of samples showed that the developed gypsum composite material belongs to the group of biostable materials and is not subject to biodegradation.

Tests for fire resistance of heat-insulating gypsum with travertine fillers were carried out on sample plates with a rib size of 150x60x10mm. The flammability was assessed by the mass loss of the sample after more than five minutes of exposure to fire. The results showed that the developed heat-insulating composite gypsum based on waste from the production of travertine boards belongs to the group of hardly combustible materials.

Conclusions. The results of the studies showed that the use of travertine slab production waste (instead of artificial porous fillers - relatively expensive) in gypsum to increase thermal insulation in energy-efficient construction made it possible to obtain a heat-insulating composite material with rather low thermal conductivity and heat capacity.

Must be noted:

- The thermal conductivity of the material depends on the density and content of the filler. It is determined that the most optimal is the content of the filler up to 50% of the total mass.
- Based on the test results, it can be concluded that the new gypsum composite building boards are bio-resistant and slow-burning.
- When adding SJ-3 additive to the composition of a new gypsum composite building material, the plasticity and wettability of the material increased, the amount of mixing water for gypsum hydration decreased, and the water resistance of gypsum increased.
- On the basis of gypsum composite building materials with the addition of pigments, it is possible to produce artificial finishing boards of different colors.
- The use of industrial waste is efficient both from an economic point of view (allowing to reduce the cost of heat-insulating gypsum) and from an environmental point of view.

Finishing slabs based on composite gypsum are recommended for use in energy-efficient construction in the form of slabs for finishing the internal walls of buildings, in order to provide thermal insulation inside the room, as well as when treating with waterproof compositions and for external facade decoration.

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