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INFLUENCE OF MINERAL FILLERS ON PHYSICAL AND MECHANICAL PROPERTIES OF GYPSUM CONCRETE COMPOSITIONS

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ABSTRACT
The article describes the physical and mechanical characteristics of gypsum concrete compositions modified with pulverized marble and travertine waste. It is shown that the increase in the physical and mechanical properties of composite materials is primarily due to the formation of new phases with the chemical participation of soluble marble and travertine minerals in the heterogeneous process of gypsum hardening, as well as the formation of gypsum stone. In a more perfect structure, both marble and travertine particles fill the pore space of the binder.

Keywords: marble, travertine, filler, gypsum concrete, waste, particle size distribution, particles, solubility, strength, electrical conductivity, water-gypsum ratio, average density.

The field of natural resources processing and their export is actively developing in Uzbekistan. However, since the traditional technological processes are outdated, disposal of man-made waste produced by many industrial enterprises and reduction of their negative impact on the environment is one of the urgent issues of the present time. About 90 percent of the waste in our country occurs during the enrichment of natural resources. At the same time, the waste recycling rate does not exceed 5%. Their amount is 2.5 billion tons every year. Therefore, in recent years, many developments by scientists are aimed at the efficient use of waste from various industrial enterprises. [1–6].

In our republic, there are many enterprises producing marble and travertine tiles. In the process of their work, waste is formed in the form of liquid slurry, which consists of clay, sand and dust, the composition of which is composed of marble and travertine particles. Their amount is 25 to 33% of the processed stone mass and poses a threat to the ecology of the environment. [7,8]. Therefore, from an ecological and economic point of view, it is appropriate to use these wastes as a filler in the production of gypsum concrete products.

MATERIALS AND RESEARCH METHODS

Crushed travertine waste from "Galaba" LLC in Chust district, Namangan region, crushed marble waste from "Zoirjon Fayz" LLC located in the economic zone of Uchkoprik district of Fergana region were used as mineral filler.

According to the chemical composition, marble waste is characterized by 55.51% calcium and 0.13% magnesium, 0.15% silicon dioxide, and travertine is characterized by 45.65% calcium and 6.77% magnesium, 2.26% silicon dioxide.
Granulometric composition determined by laser diffraction. according to the analysis, it can be seen that these wastes consist of nano- and micro-sized particles (tables 1, 2).

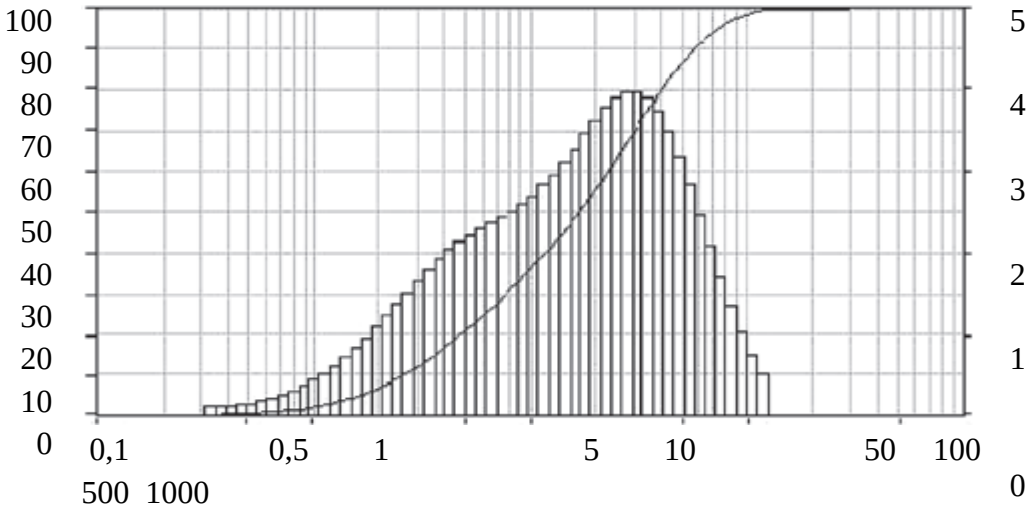
Table 1 Granulometric composition of marble waste of "Zoirjon Fayz" LLC

Particle size,	Quantity, %	Particle size, μm	Quantity, %	Particle size, μm	Quantity, %
5	1,628	40	11,766	75	34,908
10	2,622	45	14,176	80	40,368
15	3,644	50	16,815	85	47,416
20	4,794	55	19,720	90	57,019
25	6,139	60	22,881	95	73,226
30	7,736	65	26,356	98	92,309
35	9,612	70	30,326	100	138,74

Table 2 Granulometric composition of travertine waste of "Galaba" LLC

Particle size,	Quantity, %	Particle size, μm	Quantity, %	Particle size, μm	Quantity, %
5	0,061	40	6,186	75	26,487
10	1,309	45	7,804	80	29,661
15	1,792	50	9,836	85	34,647
20	2,365	55	12,296	90	40,872
25	3,090	60	16,141	95	50,469
30	3,874	65	18,315	98	67,542
35	4,903	70	21,741	100	79,742

The average size of particles in the studied range of marble waste is 16,815 microns; The amount of particles smaller than 2 microns is 7.84%, and the average size of particles in travertine waste is 19,431 microns; The amount of particles smaller than 2 microns is 10.26% (Fig. 1, Table 3)



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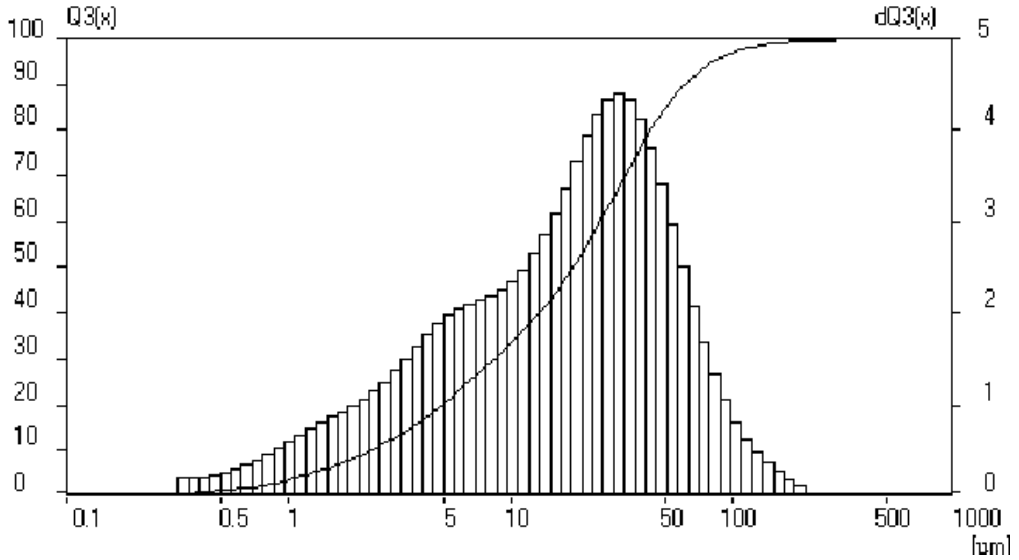

Figure 1. Integral and differential curves of particle size distribution of marble (a) and

The average size of particles in the studied range of marble waste is 16,815 microns; The amount of particles smaller than 2 microns is 7.84%, and the average size of particles in travertine waste is 19,431 microns; The amount of particles smaller than 2 microns is 10.26% (Fig. 1, Table 4). The ratio of the maximum and minimum size of the particles also indicates the high polydispersity of the waste.

Waste additives to the physical-mechanical properties of gypsum

G-10 grade binder (Rsiq.= 11.5MPa; Reg.= 4.8MPa) was used as a binder in the study of its effect.4-жадвал

Size distribution of waste particles

Name of waste	Maximum particle size (d98), µm	size (d50), µm Particle average	Soderjanie chastits menee 2 µm, %
Marble	92,309	16,815	7,84
Travertine	89,742	19,431	10,26

The solubility of mixtures based on gypsum binder and waste additives was evaluated by the electrical conductivity of the solutions using the "Multitest KSL-101" conductor.

RESULTS AND THEIR DISCUSSION

The results of the experiment (Fig. 2) showed that the electrical conductivity of solutions depends on the composition of both waste powders, their value increases when the amount of additives reaches 10%.

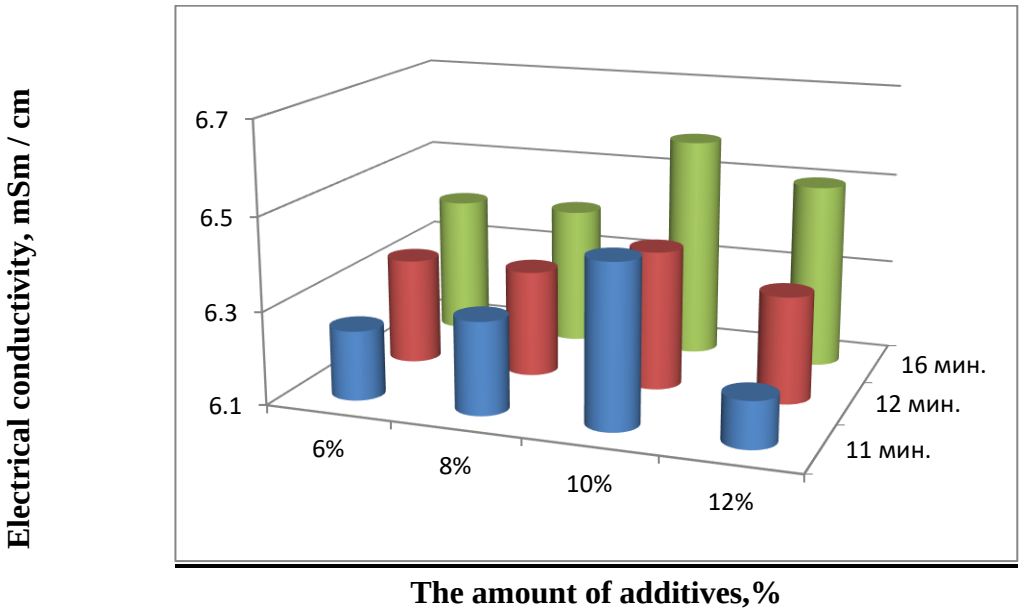

Figure 2. Electrical conductivity of gypsum mixtures depending on the amount of waste and time changes

The electrical conductivity of the compounds changed over time.

The maximum value of the electrical conductivity was 16 minutes for all studied compounds. The physical and mechanical properties of the obtained compositions were determined by testing sample sticks prepared according to the requirements of GOST 23789-79. The ratio of water-gypsum is from 0.36 to 0.375, the amount of waste powder is from 6 to 10% in relation to the mass of gypsum. The test results showed that the compressive strength limit of gypsum stone is 43.29 MPa when the amount of marble waste is 10%, and it is 38.15 MPa for travertine (Figure 3).

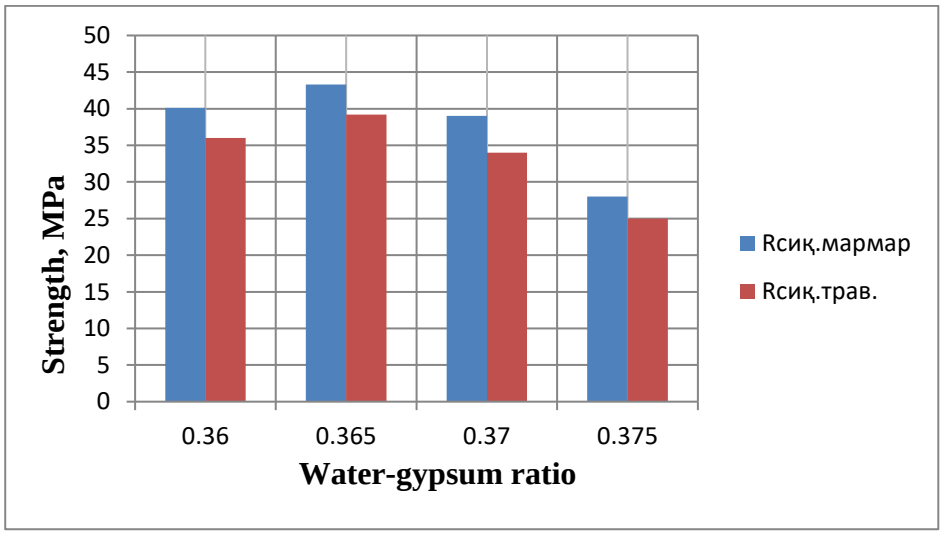

Figure 3. Dependence of the strength of gypsum stone based on binder and waste powder additives on the water-gypsum ratio

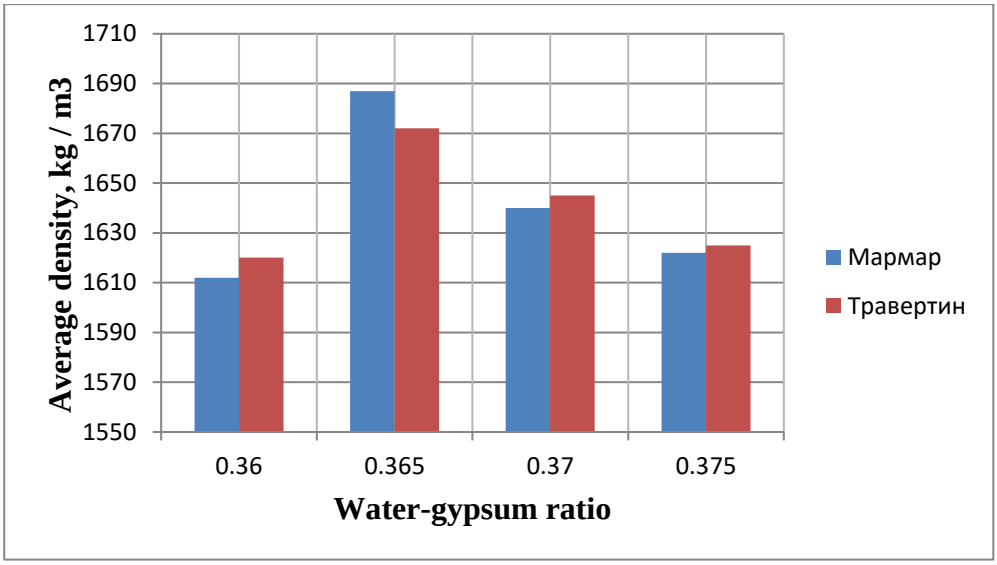

Figure 4. Dependence of the average density of gypsum stone based on binder and waste powder additives on the water-gypsum ratio

The highest density of 1685 kg/m3 of samples containing 10% marble waste was achieved when the value of water-gypsum ratio was 0.365 (Fig. 4).

Studies on the solubility and physical mechanical properties of gypsum binders and waste powders have shown that the intergrowth of calcite and calcium sulfate dihydrate crystals in marble and travertine wastes leads to a change in crystal morphology.

it can be concluded that it will come. This phenomenon is explained by the presence of soluble substances in the waste and their participation in the crystallization process [9]. The acceleration of phase formation processes leads to an increase in the number of new morphologically modified dihydrates in the gypsum system [10].

CONCLUSION

Thus, the conducted research shows that the increase in physical and mechanical properties of plaster compositions modified with marble and travertine powders, first of all, the formation of new phases with the chemical participation of soluble minerals of marble and travertine in the heterogeneous process of gypsum solidification and. it can be concluded that the particles of marble and travertine powder fill the pore space of the binder and ensure the formation of gypsum stone in a more perfect structure.

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