DRY PLASTER MIXES BASED ON GYPSUM AND WOODWORKING ELEMENTS

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Abstract
Development and application of dry plaster mixes is a relatively new direction in the technology of finishing works. This article presents the main results on the use of finely ground elements of wood and other vegetation included in the composition of gypsum plaster mixes. The main physical and mechanical properties and characteristic technological features of the proposed composition have been studied.
Key words:bio filler, breathable conglomerate, thermo physical modeling, bioresearches, fractions, shavings, fibers, gypsum, dry building mixtures, adhesion, cohesion, durability

1. Introduction

Development and application of dry plaster mixes is a relatively new direction in the technology of finishing works. Research and development of highly efficient finishing materials is one of the main tasks of modern science. At the same time, several main tasks of innovative development in the field of building materials can be identified. Among them are the development and implementation of innovative bio - and nanotechnology of dry plaster mixes that are safe both for human health and for the environment.

Gypsum as a binder is widely used in the building materials industry and in the technology of finishing works, and its role is increasing with the development of the construction industry. The range of building materials is expanding, especially due to energy-efficient, new modern innovative bio-waste-derived materials. One of such modern innovative building materials is dry plaster mixtures with fibers of biological origin [1, 2]. One of the

ways to reduce costs in the production of dry mixes (i.e. plaster mixes) is to introduce low-cost components with high physical and mechanical properties using local raw materials.

2. Proposed methodology

Currently, in the process of active creative work in our country, the demand for high-quality decorative materials, including plaster, is growing day by day. At the same time, great demands are placed on all the physical and mechanical properties of plaster mixtures, their resistance to chemical and aggressive influences, quality and efficiency.

Production of dry construction mixtures from local raw materials and industrial wastes, reducing the cost of production is one of the pressing issues facing researchers. In order to regulate the thermo physical properties of traditional, gypsum-based dry plaster mixtures and ensure that the plaster layer becomes a porous and "breathable" conglomerate, natural perlite, vermiculite, agloporite, expanded polystyrene and expanded clay grains are added to its composition. However, it is necessary to process the raw material many times before adding the recommended materials to the plaster mixture, i.e.: - washing, drying, grinding, sorting, which leads to an increase in the cost of the material. Nevertheless, the plaster layer to which the above natural stone aggregates are added is considered to be a relatively cold and relatively brittle conglomerate.

The purpose of our research is to improve the technological and operational properties of the above-mentioned gypsum-based plaster mixtures, modeling its naturalness, aesthetics, and thermal physics. In implementing our ideas in this regard, we recommend the use of bio resources as inert fillers in dry plaster mixtures, namely: - wood, plant stems, as well as in nature, wood twigs and plant stems often rot or burn without use and cause great damage to the environment transmits [3, 4, 5].

3. Analysis of literature and scientific sources

In many countries around the world, materials scientists have been conducting research for many years on the problems of plant and wood stems, their processing, and obtaining industrial raw materials from them. In particular, there are many detailed solutions in the United States, Russia, China, India, Australia, as well as in our country. For example, as a result of processing wood and plant stems from it are known technologies for molding gypsum fiber coatings, wood chips, wood fiber, pressed sheet coatings, wood, plant, sometimes rubber and leather waste by crushing in a gypsum-based mixture. For example, in an article published at the Bio-resources Conference in 2015, research was conducted on the production of various types of brick grains by pressing plant and wood, as well as rubber into gypsum and pressing it under pressure [6]. Also, in the development of Brazilian scientists, it is proposed to mold pressed stone blocks with the addition of gypsum-based binders from a fraction of wood chips with minimum dust content of 0.42 ... 1.2 mm to 5, 10, 15%.

According to the analysis of the scientific literature and sources on the subject, the addition of bio-fillers to the composition of plaster mixtures and scientific work in this regard has not been observed.

4. Analysis of experiments and results

According to the idea put forward in the article, in order to create new innovative compositions of gypsum-based plaster mixtures, ieto effectively use bio-resources made from wood and plant stems as an inert filler in the plaster mix, the following objectives and problems are solved:

- the use of wood and plant stems as inert fillers in gypsum-based plaster mixtures, determination of their type, optimal fractional composition and amount;
- analysis of structural-phase processes, periodic integral, aggressive effects that may occur in the contact zone of gypsum binder and bio-fillers;
- the results of testing and control of the proposed plaster mixture for compliance with the requirements of the traditional normative standard, the analysis of physical, mechanical and technological parameters of the material;
- evaluation of the thermal physics and acoustic properties of a conglomerate alloy formed from a mixture of plaster.

For our experiments and research we used ready-made gypsum binders G5, manufactured by BMAX BUILDING MATERIALS LLC. Preliminary analysis revealed the compliance of construction gypsum with the requirements of GOST 125-79. The granular analysis of G5 construction gypsum is given in table 1.

Table 1 Granular composition of G-5 gypsum

Standard sieve mesh dimensions, mm	The amount of residue remaining in the sieve as a result of the analysis:	
	massesgram	masses, %
0,63	10,9	1,09
0,315	23,8	2,38
0,212	37,9	3,79
0,16	29,2	2,92
The soft part from 0.16 mm	898,2	89,82
Total	1000	100

Attempts were made to use the simplest and most perfect technology for crushing wood and plant stems and preparing them as bio-fillers by sorting them into fractions. In other words, the DKU-2,0 UKRAINKA machine was used to grind wood and plant stalks. With the help of this machine, the branches of poplar trees, cotton and straw stalks from annual plants were accepted as raw materials for our experiments. They are ground and fractionated on a machine to a size $t \leq 1.25$ mm (Fig. 1). The granular fraction composition of bio-fillers is given in Table 2.

Figure 1. General view of lant and wood chips

Table 2 Granular composition of milled plant and wood stalks on DKU-2.0 machine

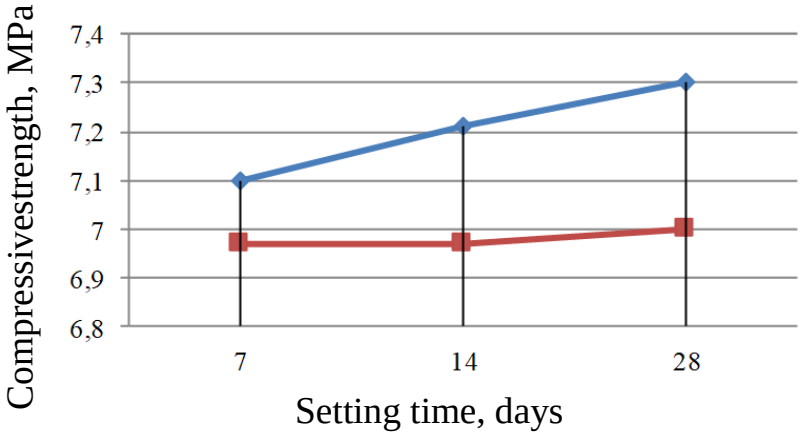
Standard sieve mesh dimensions, mm	The amount of residue remaining in the sieve as a result of the analysis:	
	masses gram	masses, %
5	0,0	0,0
2,5	0,0	0,0
1,25	0,9	0,09
0,63	9,1	0,91
0,315	98,0	9,80
0,212	252,1	25,21
0,16	186,0	18,60
The soft part from 0.16 mm	453,9	45,39
Total	1000	100

Before placing the wood and plant stems in the grinding machine, it is necessary to dry them to an average moisture content of 6.2… 7.7%. For this purpose, the grinding machine includes a raw material drying equipment, which has sufficient drying capacity of the product. The average fractional size of the bio-filler prepared on the crushing machine is up to $0.7 \leq t \leq 1.25$ mm, and the bulk density is 220… 240 kg / m3.

In order to model the optimal amount of bio-filler in the gypsum-based dry plaster mixture, experimental experiments were carried out with the addition of 2, 5, 10%.

A dry plaster mixture of perlite grains was taken as an analog, prototype, or comparison option for the ingredients presented in the article. The results of the study and test comparison are shown in Figures 2 and 3.

Various compositions were prepared from the above selected raw materials and wastes and compared with perlite filler, the results of which were obtained by studying their basic physical and mechanical properties are shown in Figures 2 and 3.

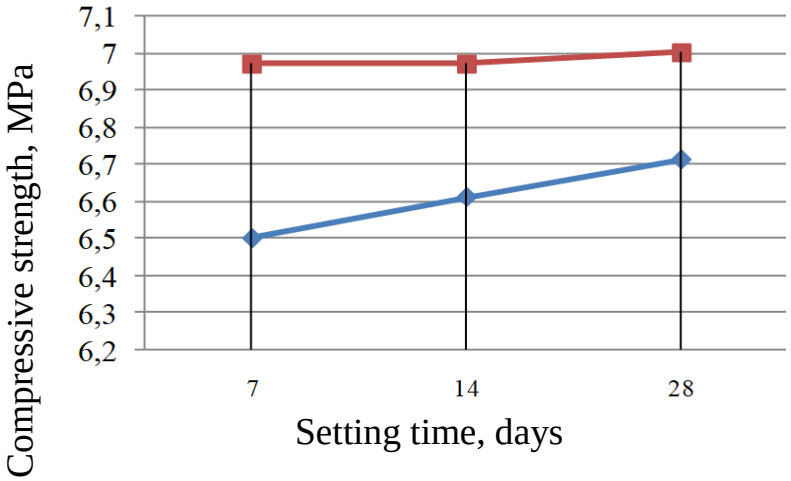


bio filler, chopped wood-plant stems up 2 %

composition prototype, with perlite, up 2%

Figure 2. Time dependence of compressive strength

Note: The reason that the compressive strength of the samples was obtained from 7 days is explained by the fact that plant and wood chips affected the construction process in the composition



bio-filler, chopped wood-plant stems up 5 %

composition prototype, with perlite, up 2%

Figure 3. Time dependence of compressive strength

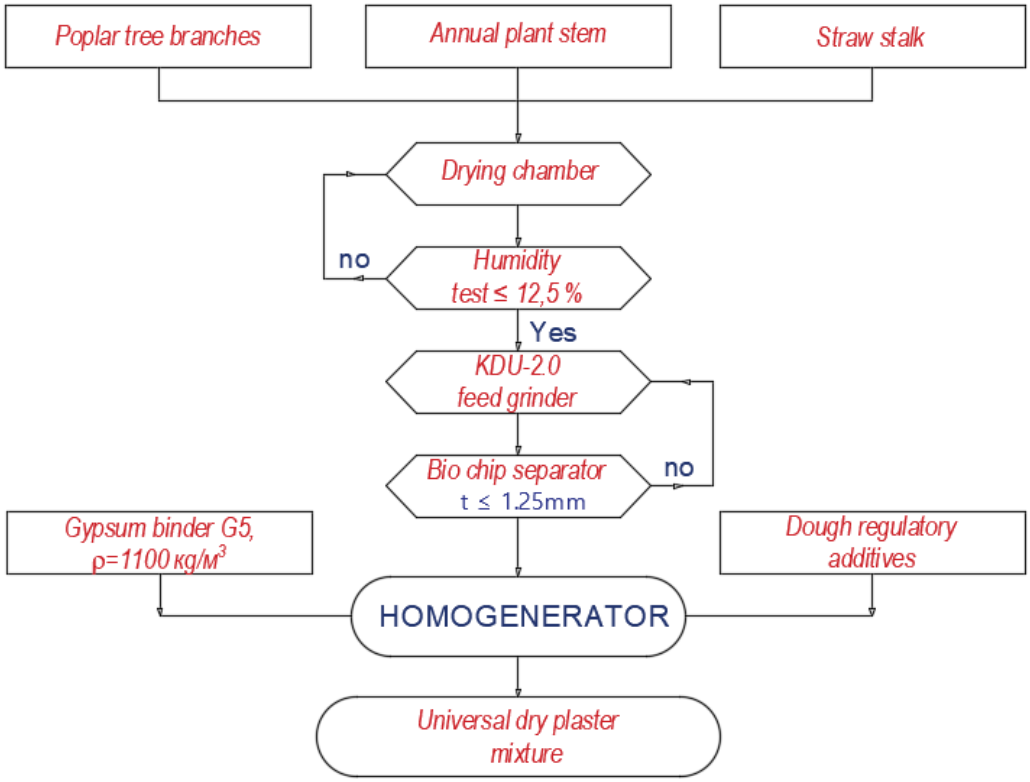


Figure 4. Technological scheme of production of dry plaster mixture

5. Discussions

The volumetric weight of the gypsum-based dry plaster mixture made from plant and wood stem bio-fillers was 943 ± 20 kg / m3, and the volumetric weight of gypsum used for plastering was 1011 ± 20 kg / m3. It should be noted that the average adhesion of the finished dry plaster mixture to the wall surface is 0.47 MPa for concrete walls, 0.50 MPa for brick walls, while the water requirement of the mixture is 0.55% of the dry mass. The proposed technological scheme for the production of gypsum-based dry plaster mix is given below (Figure 4).

It is known from studies that 5% bio-filler has a negative effect on the strength of samples, the increase in strength when the size of the sawdust is large, it is known from previous studies [6, 7, 8, 9, 10]., which shows that the size of the sawdust is reduced that is, the physical and mechanical properties do not meet the requirements of GOST 31377-2008, as well as the abundance and softness of the sawdust changes the color of the mixture. Therefore, the results on the properties of 10% sawdust mixture are not given in the article.

In accordance with the requirements of GOST 31377-2008, the strength of the conglomerate alloy can be reduced to a value not less than 2.0 MPa [1]. When this is done at the expense of reducing the amount of binder and the amount of bio-fillers, two goals are considered. First - replacing the binder, i.e. a certain part of the gypsum with sawdust, while maintaining the desired strength, reduces the bulk density of the dry construction mix intended for plastering,

which naturally improves the thermal and sound conductivity coefficients. Second, it is possible to save up to 10% in some cases a certain amount of gypsum, which gives more strength than necessary.

Other construction and technical properties of optimal compositions that give the required strength were studied. When examining the structures of samples of different compositions, it can be seen that an increase in the amount of bio-filler results in the formation of flat-scattered porous structures (Fig. 5). Such structures allow the creation of a better sanitary-hygienic breathable layer of plaster layers in the building compared to plasters with a dense structure.

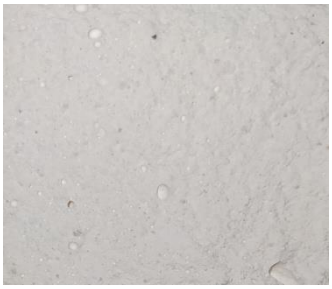
 a)  b)  c)

Figure 4. Visual samples of plaster layers formed by solid conglomerate alloy: a - 5%, b - 2% bio-filler and c - samples made of ordinary perlite

From this point of view, the thermal insulation properties of the 2% components selected for optimal construction and technical properties at different thicknesses were examined. For this purpose, in accordance with the requirements of GOST 7076-99 in the stationary heating mode, the parameters of thermal conductivity and thermal resistance were determined on the equipment "ITS-1, 150" in the finished samples. The results obtained are presented in Table 4 below.

Table 4

Temperature storage properties of plaster conglomerate alloy of different thickness

Naming	Amount of biofiller,%	Plaster layer thickness, mm	Thermal conductivity of the sample, W / (m · K)
Gypsum-based biofiller plaster mixture	5	10	0,2590
		20	0,3131
		30	0,3672
	2	10	0,3012
		20	0,3553
		30	0,4094
Gypsum-based perlite lightweight filler plaster mix	2	10	0,2580
		20	0,3342
		30	0,3915

6. Conclusion

Local raw materials and biological wastes - agricultural plant stalks were crushed, inert fillers were prepared and effective dry plaster mixtures were developed in terms of quality level and construction technical indicators. Recommended as cheap local filler from various wood and plant stems, it is possible to use a plaster composition that replaces traditional mineral fillers - perlite, agloporite, vermiculite, foam-polystyrene and others. The results of laboratory studies have confirmed that the introduction of these proposed light additives into practice is a cost-effective development. It is advisable to use them in the interior plastering of buildings and structures, and this is one of the energy-saving technologies.

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