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Peculiarities of the Processes of Hydration of Binding Substances in the Arbolite Mixture

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Abstract. Cement and sand solution is traditionally used for production of wood concrete. But it is known that impact of water-soluble substances of wood on the hardening cement is shown in the stabilizing effect. The "Cement poisons" consisting generally of the HOCH carbohydrate groups, sedimented on a surface of particles of minerals of cement $3CaO{\cdot}SiO_2$ (three-calcic silicate) and $3CaO{\cdot}Al_2O_3$ (three-calcic aluminate) form the thinnest covers which complicate the course of processes of hydration of cement. Plaster in comparison with cement is less sensitive to extractive substances of wood therefore their combination to wood (including waste of logging and a woodworking) both coniferous and deciduous species is allowed. Composite plaster binding with hongurin as active mineral additive agent are applied at selection of composition of arbolite, at the same time dependences of their physicomechanical properties on characteristics of filler are received.

INTRODUCTION

Arbolite is one of kinds of local construction materials which can be produced on the basis of waste of various productions. Wood waste of logging, woodworking and forest chemical industry, and also waste of agriculture in the form of fires of flax, hemp, a kenaf, cotton stalks can be raw materials for such fillers. Cement, plaster, belite cement, the caustic dolomite and other are applied as binders [1].

Concrete and sand solution is traditionally used for production of arbolite. But in the middle of the last century it has been revealed that in wood, especially in bark there are some substances, such as, the hemicellulose, starch and extractive substances, etc. which are negatively influencing processes of curing of products on the basis of cement [2]. Earlier options of production of arbolite on the basis of high-strength plaster and gypsym- cement- puzzolan binder with positive effect were considered [3].

Wood filler, as well as many other organic cellulose fillers, along with valuable properties inherent in them has also negative qualities which complicate receiving material of high durability from high-strength components (a cement stone and wood). Treat the specific features of organic cellulose filler which are negatively influencing structurization processes, durability and resistance of arbolite to moisture variable influences: the increased chemical aggression; considerable volume moist deformations and development of pressure of swelling; sharply expressed anisotropy; high permeability; low adhesion in relation to a cement stone; considerable elasticity at firming consolidation.

There has been made assumption that the low durability of this composition is connected with the chemical composition of wood which are presented in the Table 1.

Early studies have shown that wood contains the easily hydrolyzed and extractive substances — the "cement poisons" harmful to cement which slow down a set of durability of products. Therefore all efforts of researchers and practicians have been directed to neutralization of their adverse effect. Later the works which are have been carried out by domestic and foreign researchers it has been established that the most harmful impact is made by readily soluble protozoa of sugar: sucrose, glucose, fructose and a part of a hemicellulose capable in certain conditions to

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turn in these sugar, are also to a lesser extent dangerous starch, tonnida and pitches. The alkaline environment of the cement test promotes release of "cement poisons" which amount fluctuates in considerable limits depending on kinds of wood, conditions and terms of her storage [4].

TABLE 1. Wood's chemical composition.

Components, %	Spruce	Pine	Aspen	Beech
Cellulose	58.3	55.6	54.1	47.9
Lignin	28.3	26.5	20.1	22.5
Hemicellulose	10.3	9.6	22.4	26.0
Extractive substances	1.9	2.3	2.3	2.4

Plaster in comparison with cement is less sensitive to extractive substances of wood therefore use of wood (including waste of logging and a woodworking) both coniferous and deciduous breeds are allowed [5].

As a result of the aforesaid, it has been decided to use already developed earlier composite plaster binders: gypsym cement-zeolitic and gypsym- lime zeolitic that will allow excluding an adverse effect of the easily hydrolyzed and water-soluble extractive substances of wood on processes of curing of the binding substance [6].

In this work local raw materials and also wood waste were used. First of all in receiving wood concrete spill from waste of the mixed kinds of a woodworking which doesn't conform to requirements of GOST P 54854-2011 "Concrete easy on organic fillers of a phytogenesis" is applied.

As a binder it is used gypsym cement-zeolitic binder (GCZB) and gypsym- lime zeolitic binder (GLZB) developed at department of production of construction materials of North -Eastern Federal University.

MATERIALS AND METHODS OF RESEARCH

As a binder it was used composite plaster, consisting of construction plaster (75 %), cement (12.5 %) and zeolite of the Suntar "Honguruu" deposit (12.5 %).

The following materials were used to receive GCZB: the plaster binding substance of the G-5IIA brand (75 %), a portlandtcement of the TsEM I 42.5 brand (12.5 %), zeolite (12.5 %) and additive SP-1 superplasticizer. For receiving GLZB: the plaster binding substance of the G-5IIA brand (75 %), air lime (10 %), zeolite (15 %) and additive SP-1 superplasticizer.

TABLE 2. Main peculiarities of GCZB.

Indicators		Unit of Measurement	GCZB
Normal distribution	–	%	60
	plasticizer	%	54.5
Setting time:	start of setting	minute	5.5
	end of setting	minute	7.5
Softening-Coefficient		%	1.11
Grade		M100	

TABLE 3. Main peculiarities of GLZB.

Indicators		Unit of Measurement	GLZB
Normal distribution	–	%	69
	plasticizer	%	48
Setting time:	start of setting	minute	21
	end of setting	minute	28
Softening-Coefficient		%	0.7
Grade		M100	

Natural zeolite of the Suntar Honguruu deposit of fraction of 5 mm is used and its chemical composition is given in Table 4.

TABLE 4. Natural zeolite of the Suntar Honguruu chemical composition.

Chemical Composition, %								
SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O+Na_2O	TiO_2	H_2O^+	H_2O^-
65.11	12.16	1.08	2.62	1.88	3.30	0.13	8.89	4.26

As organic fillers waste of the wood processing enterprises which are in Yakutsk were used. Annually the enterprise processes near from 40–50 $\cdot 10^3$ m^3 of timber from which about 40 % is for waste.

Tests of wood spill were carried out in accordance with GOST P 54854-2011 "Concrete lighter on organic fillers of a phytogenesis".

On the carried-out tests it has been received the following values of properties of wood spill:

– bulk density in naturally dry condition of 149 kg/m^3;

– humidity of W = 11 %.

RESULTS

By results of the X-ray diffraction and radiometric analysis the maintenance of radioactive elements in zeolitic breeds is much lower the clarkscomponents in acid breeds. Therefore hongurin can be used as raw materials, for production of various construction materials. The X-ray phase analysis carried out on the DRON-2 diffractometer by a powder diffraction method (Fig. 1).

The obtained experimental data on Tables 5 and 6, give an assessment of quality, show a possibility of use of zeolite as sorption material.

TABLE 5. Physical properties of hongurin.

Characteristics	Unit of Measurement	Results
True density	g/cm^3	2.64
Average density	kg/m^3	1660
Water absorption	%	17.3
Hygroscopicity	%	11.0
Porosity	%	35.6
Mohs Hardness Scale	-	3…4

TABLE 6. Hydrophysical properties.

Size Fraction, mm	Average Density, kg/m^3	Water Capacity, %
1–3	1480	24.7
3–5	1480	20.0
5–10	1490	16.5
Mixed sample	1480	18.9

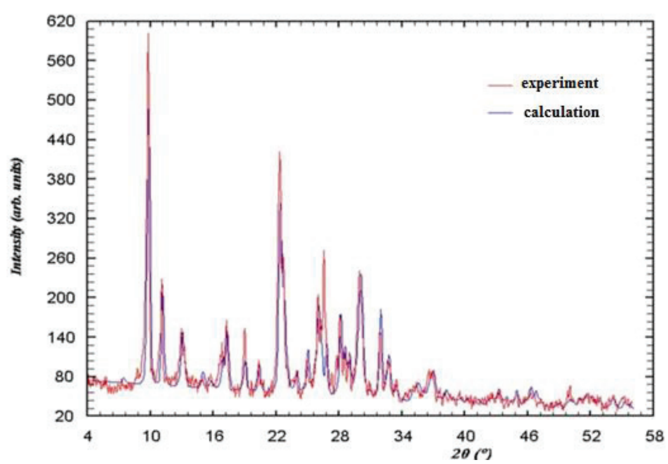

FIGURE 1. Powder XRD patterns of zeolite-hongurin

The volume weight of small fractional zeolite in the range from 1 to 10 mm practically doesn't change while value of a full moisture capacity not considerably decreases (by 6 %) with increase in dimension of a stone.

On the basis of researches by method of an ion-exchange chromatography it is established that the adsorptive activity depends on fractional structure. The small fraction (<0.5 mm) adsorbs ions of ammonium and acetic acid quicker, and large (>3 mm) more slowly.

Ion-exchange properties of a hongurin were investigated on the example of ions of copper and lead as most widespread toxic ions. And they have established that ion-exchange ability in relation to different ions is various, for example the ion-exchange capacity of zeolites in relation to ions of lead is higher, than to copper ions, but also is high.

Samples were prepared on the basis of the obtained samples. The samples were also made on the basis of Portland cement and gypsum binder. As can be seen in Fig. 2, samples based on GCZV and GLZB at a density of 800 kg/m^3 have high strength.

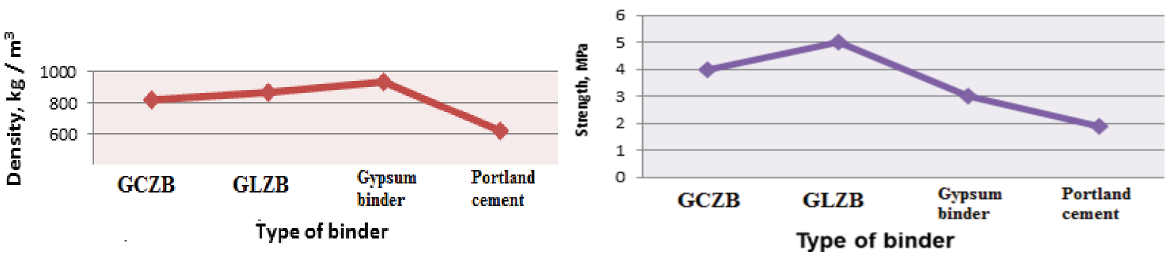

FIGURE 2. Comparison of the dependence of density (left) and strength on the ratio of the type of binder to wood chips (right)

CONCLUSIONS

Based on the experiments, calculations and finite element analysis, the following conclusions can be drawn.

Arbolite on the basis of composite gypsum binders with the addition of zeolite honguruu does not react with readily hydrolyzable substances found in organic aggregates. At a density of 800 kg/m^3 have strength of 4.5 MPa. The production of arbolite on a composite gypsum binder instead of portland cement allows us to abandon the heat treatment, which reduces electricity costs and increases productivity.

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