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USING RICE HUSK TO OBTAIN A THERMAL INSULATION MATERIAL

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Abstract: *The development of compositions and study of the construction-technical and thermophysical properties of thermal insulation material on the basis of rice husk and portland cement was the purpose of this investigation.*
The obtained research data on adhesion between rice husk and Portland cement, strength and thermal properties of the developed material are given.

Key Words: *light concrete, agricultural waste, rice husk, optimal compositions, physical and mechanical properties, three-layer construction.*

1. INTRODUCTION:

In the world in the sphere of building the portion of the use of new forms of ecologically clean materials, application of effective energy-saving technologies increases. In this respect, special attention is paid to the development of the compositions of new building materials and constructions, in particular wall materials on the basis of local raw material and to creation of energy-saving technologies for their production. Furthermore, for purposes of the savings of fuel-energy resources and reduction in the operating costs, the vital problem of contemporary building is an increase in heat shielding civil and industrial buildings. Its solution can be achieved due to the application of thermal insulation materials with the high resistance to heat transfer, first of all utilized in the walls, and also garret overlaps and coatings. Alternative to the traditionally utilized thermal insulation materials - slag cotton, the foam polystyrene and polyvinyl chloride, foam glass, porosified lightweight concrete and other can be composite materials on the basis of the vegetable raw material - withdrawals of wood processing, timber cuttings and mineral binding.

In Uzbekistan, where are limited the reserves of forest the withdrawals of annual agricultural plants - shive of hemp and flax, the stems of cotton plant, straw and husk of rice and, etc., can serve as the most valuable raw material for preparing the thermal insulation materials. In this region the use of a rice husk is most advantageous, since it with the use, in contrast to other plants, does not require the additional expenditures of those connected with the crushing, isolation of crust and, etc.

2. LITERATURE REVIEW:

Wood-mineral compositions are a relatively new building material in Uzbekistan, and abroad they are known as heat-insulating and structural material that has been used for many decades. Abroad such materials have various names [1]: "durizol" in Switzerland, "windstone" in the USA, "pilin concrete" in the Czech Republic, "chenteri-boad" in Japan, "duripanel" in the Federal Republic of Germany, "velox" in Austria and etc. They show sufficient performance.

The main scope of such materials is low-rise construction, where they are used as insulation and wall material in the form of small-sized blocks and panels. They also apply to multi - storey construction, where it is used as a material for partitions, wall panels, and even for floor slabs under light loads [2-4]. A wide range of their application is due to a number of its positive qualities, in which the average density can be 400 kg / m^3 or less, while possessing a low thermal conductivity of 0.07-0.19 W / m · K and good sound insulating ability [5]. Due to the ability to maintain a normal indoor climate, eliminating the formation of condensation on the surface of enclosing structures, they are one of the best wall materials.

Analysis of the available literature data [5–13] on the problems of obtaining material from cellulose-containing fillers based on plant origin showed that the use of calcium binders, in particular, Portland cement, does not allow obtaining products from them with stable strength characteristics. This is primarily due to the presence in the organic filler of water-soluble polysaccharides [6-13], which adversely affect the hydration of Portland cement, and in sufficient quantities even stop the hydration of the latter.

3. MATERIALS:

To achieve the goal in research, Portland Cem II/A-Sh Akhangarancement JSC was used as a binder, the characteristics of which are given in Tables 1-3.

Table 1 -Mineralogical composition of Portland cement

Cement type	Content of basic minerals				Additive content	
	C_3S	C_2S	C_3A	C_4AF	additive	SO_3
Cem II/A-SH	56,5	17,0	6,3	13,2	9,6	2,55

Table 2 - The chemical composition of Portland cement

Cement type	Oxide content, %							
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	$CaO_{св}$	the alkali
Cem II/A-SH	21,69	4,96	3,92	65,24	2,77	0,32	0,85	0,80

Table 3 - Physic-mechanical properties of Portland cement

Physical and mechanical properties	Indicators
True density, gr/sм^3	3.1
Bulk density, gr/sм^3	1.3
1. Normal density, %	27.0
2. Setting time, min	
- Start	135
-End	285
3. Grinding fineness, %	8.7
4. Strength at 28 days, MPa:	
- under compression	41.3
- bending	7.4
Uniform volume changes	Sustained

As a organic filler in studies used the rice chink. Rice crack is a waste of rice-processing industry - is an elliptical flake from light yellow to yellow color with a length of 6-8 mm, a width of 3-4 mm and a thickness of 0.3-0.5 mm (Fig. 1). The main components of rice husk as a plant material are cellulose, polysaccharides, hexosans. For research used rice husk Karakalpak rice-processing plant.

Chemical and fractional compositions, as well as the comparative characteristics of rice husk are given in table 4 -5.

Figure 1 - Rice husks

Table 4 - Chemical composition of rice husk [14]

Component	Content, % (масс.)
Water	3,75 - 24,08
Ash	11,86 - 31,78
Pentosan	4,52 - 37,0
Cellulose	34,32 - 43,12
Lignin	19,20 - 46,97

Protein	1,21 - 8,751,2
Fat	0,38 - 6,62

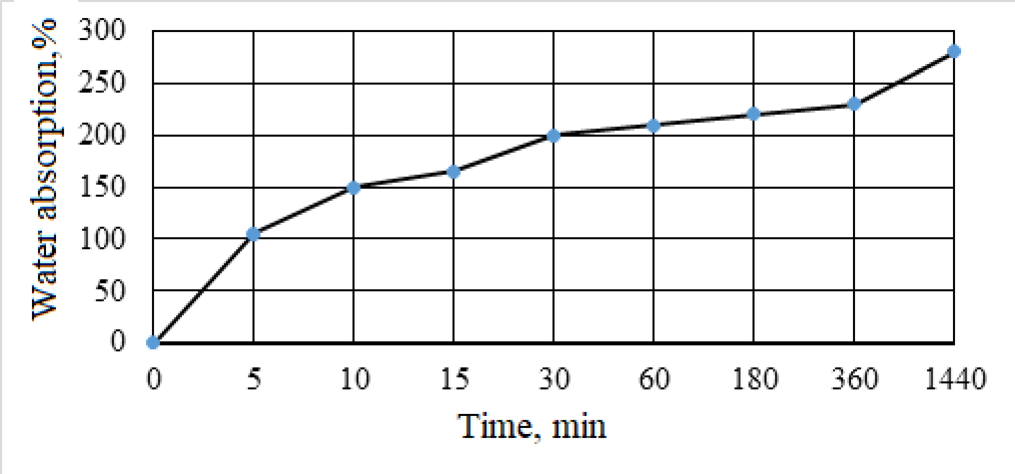

Figure 2 - Water absorption of rice husk in time

Table 5 - Fractional composition of rice husk

Name organic placeholder	Type o reminder	Sieve residue with hole, mm, %				Bottom
		20	10	5	2,5	
Rice husk	Private	0	10	9	67	22
	Full	0	10	19	86	

Used as an additive:

- Soluble liquid glass with a silicate module Ms = 3.04 and a density of 1.4 g / cm^3;
- For refining rice husk used a 3% aqueous solution $Ca(OH)_2$.

4. METHOD:

Compliance of materials with the required characteristics was determined by standard methods, as well as by special methods using non-standard instruments and equipment.

Determination of adhesion of Portland cement with rice husks.

Rice husk has maximum particles (<7mm), which do not allow to determine adhesion by existing standard methods. To determine the adhesion of Portland cement to rice husk was carried out as follows: rice husks were glued together with epoxy glue on a substrate of thick plywood and remained until the epoxy glue was completely cured (Fig. 3).

After achieving a strong adhesion of the rice husk with epoxy glue (after 1 day), their surface using a formwork with a diameter of 4.5 cm was poured with dough of normal density Portland cement. After the binder had reached the brand strength after 28 days of hardening, the nozzle of the device for determining adhesion was glued to the surface of the binder with polyurethane adhesive.

The adhesion strength was determined using a Haftprüfer Pull-off Tester Form + Test Prüfsisteme DYNA proseq Haftprüfer machine (Fig. 3).

Figure 3 - Fragments of the test of rice hull adhesion with portland cement

Preparation of the composition

The preparation of the organic-mineral composition was carried out as follows: with the aim of refining rice husk, a 3% aqueous solution of Ca $(OH)_2$ was used. To do this, rice husks were soaked for 24 hours. Then the rice husk was pulled out and allowed free flow of water. Rice husk was dried to 30-35% moisture. Then from the metered amounts of the components were mixed and of which samples were prepared by molding - cubes. The strength of the image under compression was determined at the age of 7 and 28 days after molding. Samples hardened in natural conditions with a relative humidity of 45-60%.

Determination of thermal characteristics

To determine the thermophysical characteristics, samples were prepared with dimensions of 15x15x2 cm. Determination of thermophysical characteristics was carried out using an ITS-1 instrument. The device "ITS-1" is designed to measure thermal conductivity and thermal resistance of building and thermal insulation materials by the method of stationary heat flow in accordance with GOST 7076-99. The range of measurement of thermal conductivity, 0.02 ... 1.5 W / (m · K). The measurement range of thermal resistance is 0.01 ... 1.5 (m^2 · K / W).

First, the thermal conductivity of samples with natural humidity, stored in laboratory conditions with a relative humidity of 45-50% and a temperature of 24 ° C, was determined, then the samples were dried at a temperature of 105 ° C to constant weight. Then determined the thermal conductivity of the samples in the dry state.

5. DISCUSSION:

In studies of the adhesion between rice husk and Portland cement, the effects of rice husk processing on the bond strength between the latter and Portland cement were examined. In the first method, rice husk was used without treatment, in the second method, rice husk was soaked in water for 24 hours, and in the third case, rice husk was soaked in 3% aqueous solution $Ca(OH)_2$.

The results obtained found that the adhesion strength between raw rice husk and Portland cement is 1.15 MPa (Fig. 4). Soaking the rice husks in water led to a slight increase in the adhesion strength, which amounted to 1.17 MPa. And in the third variant, soaking the rice husk in a 3% aqueous solution of $Ca(OH)_2$. made it possible to obtain an adhesive strength of 1.43 MPa. In our opinion, this can be explained by the fact that soaking the rice husk in a 3% aqueous solution of $Ca(OH)_2$. leads primarily to leaching of the polysaccharides contained in the rice husk [6,7], and the remaining part of the polysaccharides are neutralized. In addition, the use of an aqueous solution of liquid glass 1% by weight of Portland cement on the one hand accelerates the setting of the latter, on the other hand also neutralizes water-soluble polysaccharides. It can also be assumed that liquid glass penetrating into the pores of the rice husk interacting with $Ca(OH)_2$. forms calcium hydrosilicates, which lead to the strengthening of the organic aggregate itself, as well as an increase in the adhesion force.

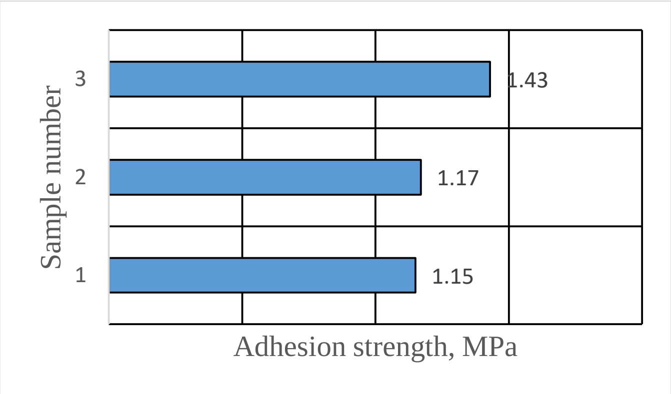

Figure 4 - Adhesion strength between rice husk and portland cement

In the development of compositions of organic-mineral composition based on Portland cement and rice husk, the consumption of the number of components was appointed based on preliminary results obtained. Portland cement consumption was selected from 300 to 400 kg / m3, and rice husk from 140 to 180 kg/m^3 (Table 6). Soluble water glass was added 1% by weight of cement.

The data obtained (Table 6) found that the strength of the composition based on Portland cement and rice husk is mainly influenced by the consumption of Portland cement. From the data obtained it follows that with the same consumption of Portland cement, the change in the consumption of rice husk has almost no effect on the strength of the composition. The increase in the strength of the compositions over time increases slightly.

Table 6 - The strength of the composition based on Portland cement and rice husk, depending on the consumption of materials

№	Component consumption, kg/m^3		Average density, кг/м^3	Compressive strength (MPa) at age	
	Portland cement	Rice huck		7 day	28 day
1	300	180	545	0,27	0,28
2		160	525	0,27	0,33
3		140	510	0,27	0,28
4	350	180	610	0,23	0,36
5		160	590	0,2	0,31
6		140	585	0,25	0,27
7	400	180	660	0,35	0,41
8		160	645	0,29	0,31
9		140	620	0,26	0,32

It is well known that the properties or indicators of the quality of building materials, including thermal insulation, are divided into functional (specific) and building and operational (general).

Functional properties are determined by the main purpose of the material. For insulating materials, such properties will be the heat insulating capacity (thermal conductivity) and the limiting temperature of use.

The most important thermo physical properties include three characteristics of heat transfer: thermal conductivity, thermal diffusivity and specific heat capacity [15]. Without knowledge of these characteristics, it is impossible to rationally design fencing structures and thermal protection of equipment.

The thermal conductivity of materials "depends on the following factors [16]:

- physical condition and structure, which are determined by the phase state of the substance; degree of crystallization and size of crystals; anisotropy of thermal conductivity of crystals and the direction of heat flow; the volume of porosity of the material and the characteristics of the porous structure;
- chemical composition and presence of impurities, the latter especially affect the thermal conductivity of crystalline bodies;
- operating conditions depending on the temperature, pressure, humidity of the material.

The influence of each of these factors is not equivalent.

Different materials have a different ability to protect against cooling and heating, or, as they say, have different thermal conductivity. Thermal conductivity is the ability of a material to conduct or transfer heat from its heated side to the cold side [15].

It is known that gases in a quiet, i.e. stationary, state have the lowest thermal conductivity. The air in the pores of the composite can be considered calm. Materials that contain a large number of pores filled with air are characterized by low thermal conductivity and have high insulating properties [15]. In heat-insulating materials, the share of heat transferred by the thermal conductivity of air accounts for 65-90% of the total heat transfer [17.18].

The thermal conductivity of porous materials with a constant composition of the solid phase depends on the volume of porosity, the type and characteristics of the porous structure. Thermal conductivity varies inversely with the total volume of porosity, decreasing with its increase [15]. Therefore, increasing the porosity is the optimal solution for improving the thermophysical properties of building materials.

The coefficient of thermal conductivity of samples with natural humidity is from 10 to 18% higher compared with the performance of samples in a dry state (Table 6).

The study of thermal conductivity of the developed compositions of organic-mineral composites based on Portland cement and rice husk shows that it meets the requirements of regulatory documents in terms of thermal conductivity.

Table 7 - Thermophysical properties

No. of composition table. 6	condition	Average density (kg/m^3)	λ (W/m·K)	R (m^{2}K/W)	q (W/m^2)	ΔT
2	Natural moisture	525	0.0776	0.2835	60.91	14.5
	Dry		0.0705	0.3019	89.95	23.4
5	Natural moisture	590	0.735	0.2993	58.48	14.5

	Dry		0.0649	0.3391	53.96	14.6
8	Natural moisture	650	0.0990	0.2324	73.37	15.10
	Dry		0.0835	0.2634	62.01	14.6

6. SUMMARY:

Conducted research obtained composites based on Portland cement and rice husk with strength of 0.27 to 0.41 MPa, respectively, at a density of 0.53 to 0.62 g / cm3.

Studies have found that composites based on Portland cement and rice husk increase their strength over time. The samples obtained in the dry state had a coefficient of thermal conductivity from 0.0705 to 0.0835 W/m·K, depending on the density.

REFERENCES:

1. Наназашвили И. Х. Арболит — эффективный строительный материал. М,, 1984. 122 с.
2. Справочник по производству и применение арболита /Крутов П.И. Наназашвили А.Х., Склизков Н.И., Савин В.И. /Под ред. Наназашвили И.Х. М., Стройиздат, 1987. - 208 с.
3. Арсенцев В.А. Арболит. Производство и применение, М., 1977, 348 с.
4. ГОСТ 19222-84 Арболит и изделия из него. Общие технические условия.
5. Наназашвили И. Х. Строительные материалы из древесноцементной композиции. — 2-е изд., перераб. и доп. — Л.: Стройиздат, 1990, —415 с.:
6. Щербаков А.С., Хорошун Л.Г., Подчуфаров Р.С. Арболит. Повышение качества и долговечности. М., Стройиздат, 1979.-160 с.
7. Miller D.P., Moslemi A.A.: Wood-cement composites: species and heartwood-sapwood effects on hydration and tensile strength // Forest Products Journal, Vol. 41, (1991) (3). pp. 9-14.
8. Bin Na, Zhiqiang Wang, Haiqin Wang, Xiaoning Lu. Wood-cement compatibility review // WOOD RESEARCH. 59 (5): 2014. pp. 813-826.
9. Garas G., Bakhoum E., Allam M. RICE Straw-cementitious bricks: analytical study on mechanical properties and sustainability measures // ARPN Journal of Engineering and Applied Sciences. Vol. 10, №18, October 2015. pp. 7959-7968.
10. Amel B.A. et al. Effects of kenaf bast fibres on hydration behaviour of cement effects of kenaf bast fibres on hydration behaviour of cement. Journal of Tropical Forest Science 26(3): 340–346 (2014)
11. D.P. Miller, A.A. Moslemi. Wood-cement composites: Effect of model compounds on hydration characteristics and tensile strength. Wood and Fiber Science, 23(4), 1991, pp. 472-482 by the Society of Wood Science and Technology,
12. Arnaud Peschard, Alexandre Govin, Philippe Grosseau, Bernard Guilhot, René Guyonnet. Effect of polysaccharides on the hydration of cement paste at early ages. Cement and Concrete Research, Elsevier, 2004, 34(11), pp.2153. ffhal-00124310.
13. Giedrius Vaickelionis, Rita Vaickelioniene. Cement hydration in the presence of wood extractives and pozzolan mineral additives. Ceramics − Silikaty 50 (2) 115-122 (2006)
14. Рис. Мировое производство и генофонд [Текст] : монография / А.Г. Ляховкин. - 2-е изд., перераб. и доп. - СПб.: "ПРОФИ - ИНФОРМ", 2005. - 288 с. - Библиогр.: с.223 .
15. Коротких А.Г. Теплопроводность материалов: учебное пособие / А.Г. Коротких; Томский политехнический университет. – Томск: Изд-во Томского политехнического университета, 2011. – 97 с.
16. Фокин В.М., Бойков Г.П., Видин Ю.В. Ф75 Основы технической теплофизики: Монография М.: "Издательство Машиностроение-1", 2004. 172 с.
17. http://penzavod.ru/funkcionalnye-svojstva-teploizolyacionnyx-materialov/
18. http://lib.kstu.kz:8300/tb/books/Terloizolyatsionnye%20materialy/teory/4.htm