UDC 69.001.5

THERMAL INSULATION FROM JUTE AND COCONUT FIBERS

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Data are presented on the use of jute and coconut fibers to obtain effective thermal insulation materials. The compositions of thermal insulation boards based on coconut fiber and jute were selected. The results of studies of the thermal characteristics of the developed thermal insulation boards are presented.

In recent years, eco-construction has become especially popular. People want to live in houses that are safe for life and health, using materials that do not emit harmful substances and help maintain a normal microclimate. Therefore, many owners of private houses are considering the possibility of insulating the building with materials based on natural raw materials. An example of thermal insulation boards of plant origin are insulation materials made from flax tow, cotton waste, sphagnum moss and oil palm bark fibers [1-5]. The high efficiency of thermal insulation boards with a fibrous structure and a practically unlimited raw material base give the right to consider the development of the production of such insulation materials as one of the most important directions in the development of new progressive building materials. Currently, at the Polotsk State University named after Euphrosyne of Polotsk, research is being conducted on the production of insulation materials based on jute and coconut fibers. Sodium liquid glass is used as a binder.

To determine the physical and mechanical properties of insulation materials, the average density was varied from 60 to 100 kg/m^3 with changes in the structure-forming material and binder consumption. The quantitative composition of heat-insulating boards made of jute fibers is given in Table 1. The average density and thermal conductivity of samples made of jute fibers was determined on samples measuring 250×250×30mm.

Table 1. – Quantitative composition based on jute fibers

№ composition	Component consumption, kg/m^3		№ composition	Component consumption, kg/m^3	
	jute fibers	liquid glass		jute fibers	liquid glass
1	52	8	9	78	12
2	62	8	10	88	12
3	72	8	11	44	16
4	82	8	12	54	16
5	92	8	13	64	16
6	48	12	14	74	16
7	58	12	15	84	16
8	68	12			

Indicators of average density and thermal conductivity are presented in Figure 1. Analysis of the obtained dependencies (Figure 1) allows us to conclude that an increase in the amount of jute fiber to a density of 80 kg per 1 m^3, regardless of the binder consumption, leads to a decrease in the thermal conductivity coefficient , and a further increase or decrease in the consumption of the structure-forming material causes an increase in the parameter under study. For example, with a consumption of jute fibers of 92 kg per 1 m^3 for composition 5, the thermal conductivity is 0,041 W/(m·°C). A 20% reduction in jute consumption causes a decrease in the thermal conductivity coefficient to 0,037 W/(m·°C). A further decrease in the amount of bark fiber causes an increase in thermal conductivity by 14% to 0,042 W/(m·°C). With a consumption of structure-forming material of 52 kg per 1 m^3 for composition 6, the thermal conductivity is 0,042 W/(m·°C). The thermal conductivity coefficient decreases to 0,04 W/(m·°C) when the consumption of jute fibers increases by 1.6 times. A further increase in the number of jute fibers leads to an increase in the thermal conductivity coefficient to 0,045 W/(m·°C). For compositions 11–15, the minimum value of the thermal conductivity coefficient of 0,044 W/(m·°C) corresponds to a consumption of structure-forming material of 72 kg per 1 m^3. With a reduction in jute consumption (composition 11), an increase in the thermal conductivity coefficient was found to increase by 11% to 0,049 W/(m·°C), and with an increase in the amount of jute fiber (composition 15), the studied parameter increased to 0,049 W/(m ·°C). It has also been established that with a constant density, but an increase in sodium liquid glass, an increase in binder consumption causes an increase in the thermal conductivity coefficient. For example, with an average density of 60 kg per 1 m^3 (compositions 3, 8, 13), the increase in thermal conductivity is 17%. In the considered ranges of component consumption, the thermal conductivity coefficient of the insulation varies from 0,037 to 0,049 W/(m·°C).

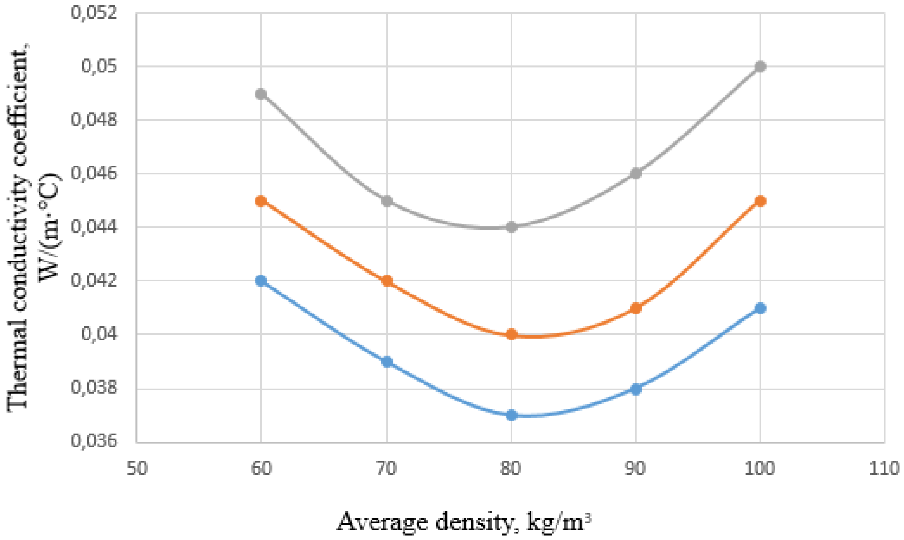

Figure 1. – Dependence of the thermal conductivity coefficient of jute insulation on average density

The average density and thermal conductivity of samples made from coconut fibers were determined on samples measuring 250×250×30 mm, varying the average density of the samples in the range of 70−145 kg/m^3. Table 2 shows the quantitative composition of the components of thermal insulation boards.

Table 2. – Quantitative composition of insulation based on coconut fibers

№ composition	Component consumption, kg/m^3		№ composition	Component consumption, kg/m^3	
	coir	liquid glass		coir	liquid glass
1	62	8	10	101	14
2	77	8	11	116	14
3	92	8	12	131	14
4	107	8	13	50	20
5	122	8	14	65	20
6	137	8	15	80	20
7	56	14	16	95	20
8	71	14	17	110	20
9	86	14	18	125	20

Indicators of the average density and thermal conductivity of samples made from coconut fibers are presented in Figure 2.

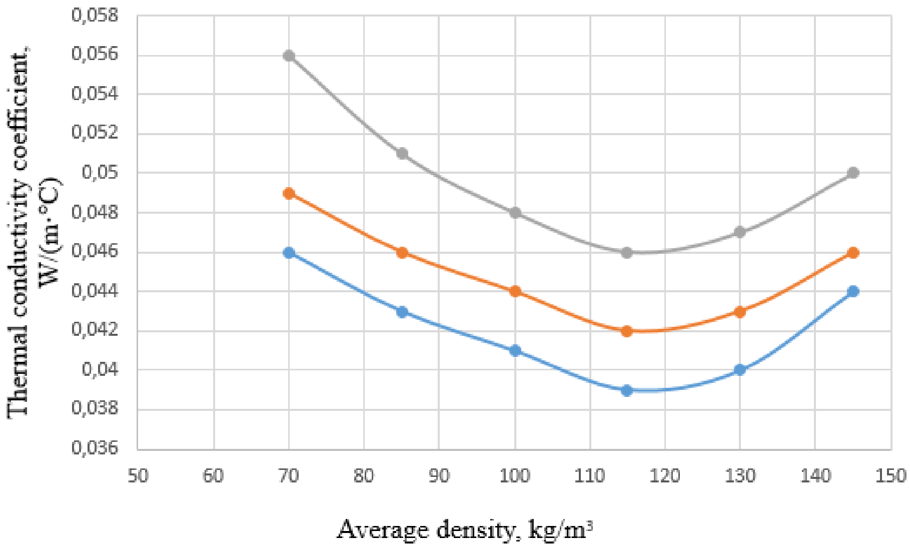

Figure 2. – Dependence of the thermal conductivity coefficient of coconut insulation on average density

Based on the data obtained (Figure 2), it was established that an increase in the number of coconut fibers to 115 kg per 1 m^3, regardless of the binder consumption, leads to a decrease in thermal conductivity, and further An increase or decrease in fiber consumption causes an increase in the thermal conductivity coefficient. Thus, with a quantity of coconut fibers of 62 kg per 1 m^3 for composition 1, the thermal conductivity of the sample is 0,046 W/(m·°C). An increase in the amount of structure-forming material by 1,7 times causes a decrease in the thermal conductivity coefficient to 0,039 W/(m·°C). An increase in the amount of coconut fibers to 145 kg per 1 m^3 causes an increase in thermal conductivity by 13% to 0,044 W/(m·°C). With a fiber quantity of 131 kg per 1 m^3 for composition 12, the thermal conductivity coefficient is 0,045 W/(m·°C). A decrease in thermal conductivity to 0,042 W/(m·°C) occurs when the amount of structure-forming material is reduced by 30%. Further reduction of fibers leads to an increase in the thermal conductivity coefficient to 0,049 W/(m·°C). For compositions 13–18, the minimum thermal conductivity value of 0,046 W/(m·°C) corresponds to a quantity of coconut fibers of 95 kg per 1 m^3. With a decrease in the structure-forming agent (composition 13), an increase in the thermal conductivity coefficient was established by 22% to 0,056 W/(m·°C), and with an increase in the amount of coconut fibers (composition 18), the thermal conductivity increased to 0,05 W/(m·°C). It has also been established that with an increase in the consumption of liquid glass, but a constant density of thermal insulation materials, an increase in thermal conductivity occurs. For example, with an average density of 70 kg per 1 m^3 (compositions 1, 6, 11), the increase in thermal conductivity is 22%. In the considered ranges of binder consumption, the thermal conductivity of insulation varies within the range of 0,039–0,056 W/(m·°C).

The conducted studies confirmed the possibility of using jute and coconut fibers for the manufacture of thermal insulation boards. The use of coconut and jute fibers makes it possible to solve the problem of recycling plant waste for the Philippines, India, as well as other regions of Asia and Africa, and to produce effective natural insulation from local natural raw materials.

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