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CONTINUOUS MONITORING OF THE OPERATING TEMPERATURE OF WOOD CONCRETE USING A SMART-SYSTEM

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Wood concrete is one of the bio-stable and hardly combustible materials. The material provides the necessary air exchange and regulates the humidity in the premises. The experiment showed comparable heat retention results for mineral wool, expanded polystyrene and wood concrete. Foil was found to be significantly less effective.

Introduction. Currently rural houses are built with bricks or reinforced concrete panels. In order to reduce the cost, walls in modern houses are made of gas silicate blocks or of panels with insulation and sheathing made of wood or siding. However, each of these types of wall materials has its own disadvantages. So, in houses built with reinforced concrete panels, because of insufficient humidity in the premises, asthmatic diseases are exacerbated among residents. In houses with walls made of cellular gas silicate blocks, mold and fungus on the walls can be observed, what may cause allergic diseases. In addition, the materials must be environmentally friendly and have a low cost price. In a market economy, the developer must have a choice - wall materials must meet new modern requirements for creating a favourable microclimate in residential premises.

In view of the above, it should be recognized that at present an excellent wood-based material - wood concrete - is undeservedly forgotten. Wood concrete is one of the bio-stable and hardly combustible materials, it has high heat-insulating and sound-insulating properties, it is well finished with cement mortar, sawn and nailed. The material holds fasteners firmly, has high sound absorption and improved crack resistance. This allows to reduce the risks of building sinking when the maximum safe loads are exceeded. The material provides the necessary air exchange and regulates the humidity in the premises [1-6].

Task formulation. Improvement of the energy efficiency of residential buildings, resulted from the energy crisis, required a significant change of regulatory requirements for the heat transfer resistance of the building envelopes and the development of a set of energy-saving measures.

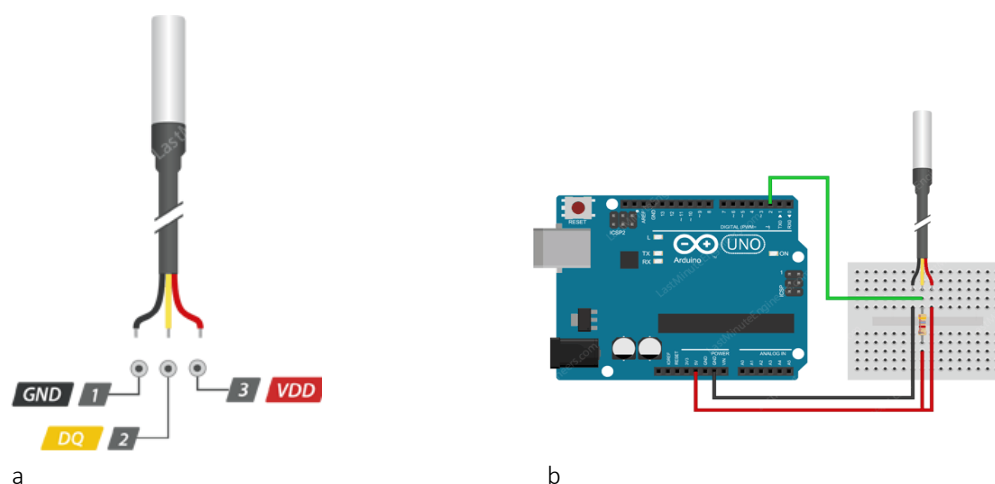
At the moment, issues related to the use of screen insulation in modern building envelopes are not well understood. At the same time, the lack of methodology for calculating such heat-shielding systems and technical solutions for the insulation of building envelopes hinders the use of the above materials in construction.

The goal of the study was to compare popular thermal insulation materials with wood concrete using continuous temperature control sensors.

Methods of research. Digital temperature sensors were used to monitor the temperature readings.

Main characteristics of digital temperature sensor ds18b20: - range of measured temperature from -55 to + 125 ° C; - measurement error in the range from -10 to + 85 ° C is 0.5 ° C.

The connection diagram of the ds18b20 sensor to the microcontroller (for example, Arduino) is shown in Fig. 1.



a - diagram of the terminals of the ds18b20 sensor; b - wiring diagram of the ds18b20 sensor through a 4.7 kΩ pull-up resistor to the Arduino Uno microcontroller. GND, VDD - power pins (3.3 to 5 V). DQ - digital output for connection to a microcontroller.

Fig. 1. – Connecting the ds18b20 sensor to the Arduino Uno microcontroller

Based on the analysis of existing heat-insulating materials, we carried out laboratory studies in which the following were used as heat-insulating materials: mineral wool, penoplex, expanded polystyrene, aluminium foil, wood concrete.

A sample (with sensors inside) was placed on the setup, a lamp inside the sample was turned on and heated the space (Fig. 2.). The temperature readings were recorded by sensors and provided information to the specialized program Arduino Uno. The automated processing of the obtained experimental data was carried out using the Microsoft Office Excel software package.

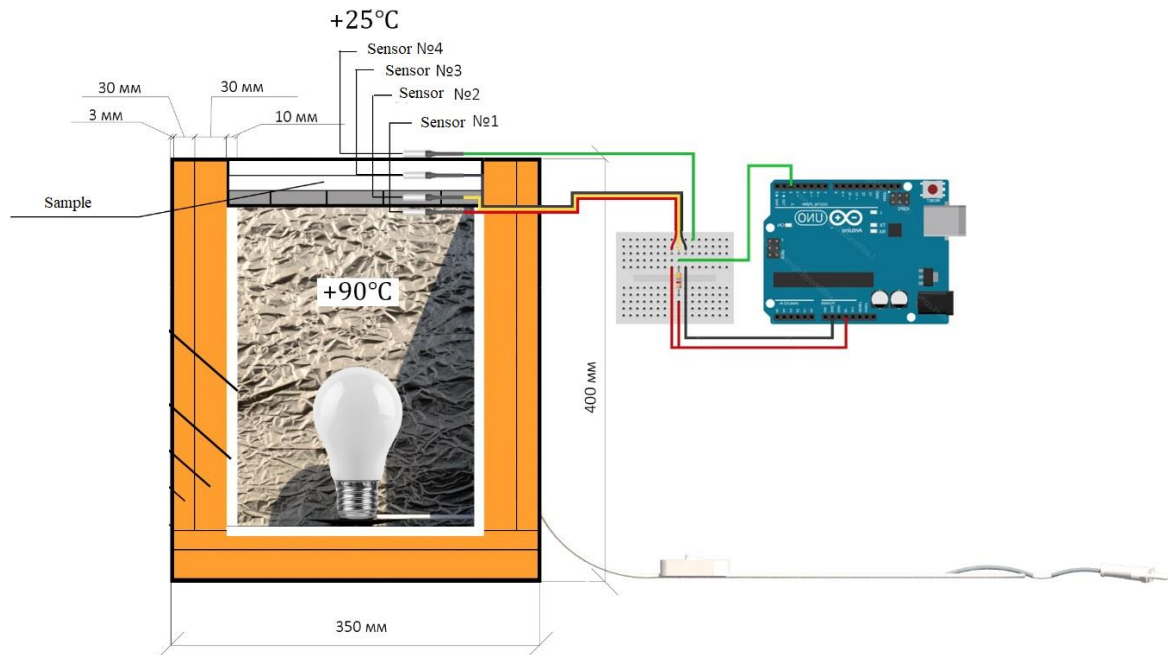


Fig. 2. – Sectional view of the pilot plant

Results, discussions and outlooks. A prototype was placed on the top of the pilot plant. The pilot plant was heated to create a temperature difference of +90 °C and +25 °C, after heating the incandescent lamp was turned off and the temperature readings as well as the rate at which the heat from the pilot plant went outside were monitored (Fig. 3).

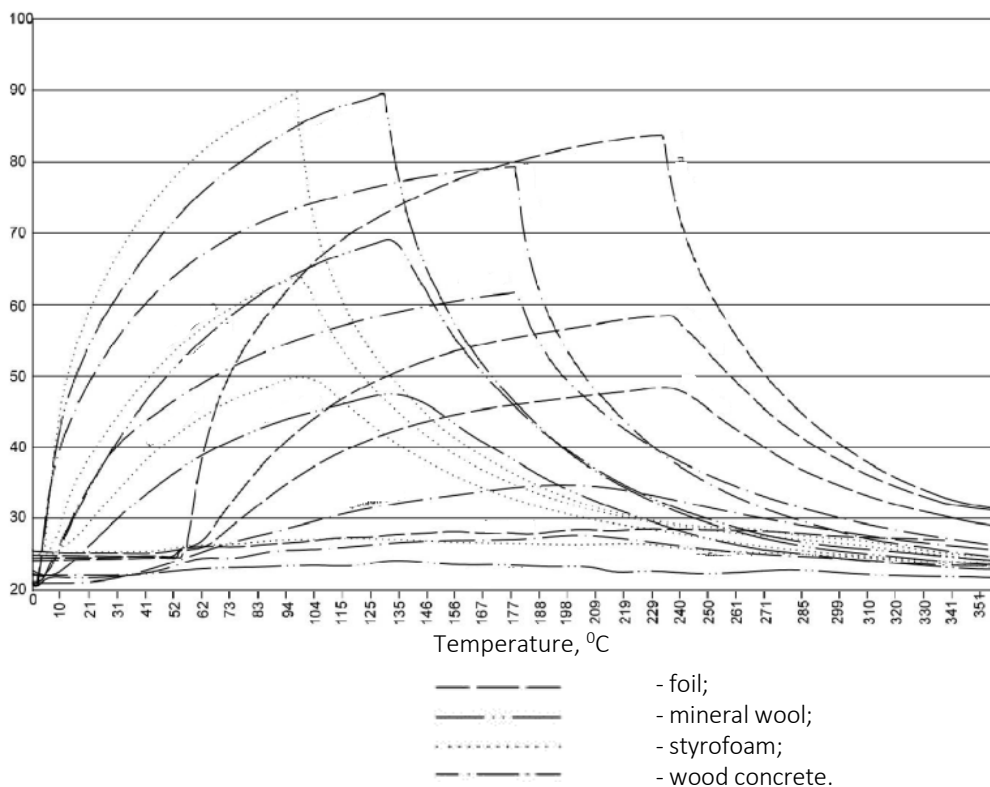


Fig. 3. – Graph with sensor readings (Temperature, °C – Time, min)

The experiment showed comparable heat retention results for mineral wool, expanded polystyrene and wood concrete. Foil was found to be significantly less effective.

Conclusion. Having finished laboratory tests the authors are going to carry out full-scale tests in existing buildings, what will allow to continuously monitor the temperature and maintain an optimal thermal regime as well as save energy for heating.

REFERENCES

1. Wilson, J. D. Modeling the effects of biological tissue on RF propagation from a wrist-worn device / J. D. Wilson, J. A. Blanco, S. Mazar, M. Bly // 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society. doi:10.1109/embc.2014.6944290. – 2014. – p. 3146-3149.
2. Li, M. Mechanical characterization of concrete containing wood shavings as aggregates / M. Li, M. Khelifa, M. El Ganaoui // International Journal of Sustainable Built Environment. – 2017. – №6. – p. 587-596.
3. Coatanlem, P. Lightweight wood chipping concrete durability / P. Coatanlem, R. Jauberthie, F. Rendell // Construction and Building Materials. – 2006. – №20. – p. 776-781.
4. Chowdhury, S. The incorporation of wood waste ash as a partial cement replacement material for making structural grade concrete: An overview / S. Chowdhury, M. Mishra, O. Suganya // Ain Shams Engineering Journal. – 2015. – №6. – p. 429-437.
5. Bouguerra, A. Effect of microstructure on the mechanical and thermal properties of lightweight concrete prepared from clay, cement, and wood aggregates / A. Bouguerra, A. Ledhem, F. de Barquin, R.M. Dheilly, M. Que'neudec // Cement and Concrete Research. – 1998. – Vol. 28. - №8. – p. 1179-1190.
6. Koohestani, B. Experimental investigation of mechanical and microstructural properties of cemented paste backfill containing maple-wood filler / B. Koohestani, A. Koubaa, T. Belem, B. Bussière, H. Bouzahzah // Construction and Building Materials. – 2016. – №121. – p. 222-228.