



Fig.1 Project of a public transport stop printed on a 3D printer - a shelter from debris
a – front view b – back view

In conclusion, it can be noted that the use of construction 3D printing technologies will speed up the restoration and construction of objects. The use of construction 3D printing technologies in the process of restoration and construction of the road network is expedient. With the help of 3D printing technology, you can restore and build roadside facilities, gas stations, public transport stops, etc. It should be noted that existing construction 3D printers require design improvements, development of new and improvement of existing construction mixes. As a result, improvements will increase the quality of construction objects and allow to expand the range of use of 3D technologies in the construction industry.

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V. Perepechko (PSACEA, Dnipro)

Scientific supervisor: V. Volchuk, Dr. Sc. (Tech), Prof.

Language consultant: S. Levytska, Senior lecturer

MODERN MATERIALS FOR REDUCING HEAT CONSUMPTION IN UKRAINE

Energy crisis in Ukraine, rising prices for energy sources, and their deficit necessitate the need to improve the quality of thermal insulation of structures and thermal units. One of the ways to address this issue is through the use of special high-efficiency thermal insulation materials capable of providing the desired thermal resistance values for constructions.

Modern material science trends are focused on technologies using organic substances in human life activities. Therefore, the development of thermal insulation materials based on minerals, characterized by low flammability and non-toxicity both during manufacturing and operation stages can be considered a priority. The properties of insulation materials are usually divided into three main groups: physical, ecological, and health-related.

This overview study is analyzing several types of thermal insulation materials that could be effectively used in Ukraine:

Rockwool. This is a type of insulator made from gabbro-basalt rocks, which allows for thermal and sound insulation of various structures or providing fire resistance. Rockwool insulation gained wide popularity at the beginning of the last century. Due to its physical and chemical properties, this type of

insulator serves as the primary energy-saving technology for processing facades, roofs, floors, and engineering networks of both industrial and semi-industrial, as well as residential, facilities. It is produced from rocks that melt at a temperature of 1500°C, after which the molten lava-like mass is drawn into rock fibers using centrifuges, special filters based on platinum or other refractory metals, and strong air currents. Then, various water-repellent additives and plasticizers are added to the obtained fibers, followed by polymerization at a temperature of about 200°C [1].

The thermal conductivity of the material is only 0.035-0.039 W/mK. Rockwool is a sufficiently strong and rigid material capable of withstanding loads of 70 kPa, which is equivalent to about 7 tons.

Cellulose insulation material. Cellulose insulation is made from recycled paper products and has a very high content of recycled material - from 82% to 85%. Initially, the paper is shredded into small pieces, giving it a fibrous texture. Manufacturers add mineral borate, sometimes mixed with cheaper ammonium sulfate, to provide resistance to fire, insects, and mold. Properly installed cellulose insulation cannot settle within the building cavity. It has an average thermal conductivity of approximately 0.040 W/mK (similar to glass wool and rockwool insulation) [2,4].

Hemp-based insulation products. The share of hemp insulation materials in the market can be considered very small in terms of physical volume and cost (both much less than 1% of the total market size). However, hemp insulation materials hold significant prospects for the future considering the increasing environmental awareness of people. The thermal conductivity coefficient of commercially available insulation products made from hemp ranges from 0.038 to 0.043 W/mK.

Hemp wool insulation is non-toxic, does not contain dangerous chemicals and has minimal susceptibility to allergens. It's a healthier option for indoors because it doesn't produce dangerous VOCs (volatile organic compounds). Thanks to the light weight of hemp wool insulation and the relatively simple installation procedure, installation time and effort can be reduced [3].

Unfortunately, the last two types of insulation are a bit uncommon in our region, accounting for approximately 5%.

Conclusion. The primary type of insulation used in Ukraine is expanded polystyrene, accounting for about 40%, while mineral wool and fiberglass products make 30% and 25%, respectively. A significant portion of this preference for energy-intensive insulation products such as polystyrene and mineral wool reflects their significant price advantage over biomaterial-based materials due to their dominance in the market. Since heating and cooling of a building constantly require the largest percentage of energy consumption within the building, it is crucial to focus on preserving as much heat as possible inside the building to reduce this demand. Ideally, this can be achieved by blocking heat flow using materials that will not harm our environment before, during, and after the service life as insulation material.

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