

NATURAL FIBROUS THERMAL INSULATION MATERIALS IN BUILDING

**Zijad Pašić, Mirsad Topalović, Albert Kobaš
Faculty of Mining, Geology and Civil Engineering, Univerzitetska 2, Tuzla,
Bosnia and Herzegovina**

ABSTRACT

Energy Efficiency in buildings necessarily implies heating building with thermo insulation materials. This paper presents the technical characteristics of local natural fibrous thermal insulation materials: wood wool, straw and cane, which are environmentally preferable in comparison with artificial thermo thermal insulation materials (mineral wool, polystyrene, etc.).

Keywords: thermal insulation in buildings, natural thermal insulation materials.

1. INTRODUCTION

Buildings are the largest single consumer of energy, and thus a great environmental pollutant. Because of their long life, buildings have a long and continuous impact on the environment in which we live, and that cannot be ignored. A feature of almost all types of existing residential, commercial and public buildings in Bosnia and Herzegovina is the irrational consumption of energy for heating, cooling, venting, lighting etc. Insufficient heating insulation leads to increased heat loss in winter, cold construction frames, damage caused by condensation (moisture) and room overheating in summer. Consequences include damage to structures and uncomfortable and unhealthy housing. Heating such space requires greater amount of energy which leads to an increase in the maintenance cost of running premises, but also to increased pollution.

The most important resolutions of the European Parliament, European Commission Directive, legislation at the European and national levels, related to the energy efficiency of buildings and saving energy are:

Directive 2002/91/EC of the European Parliament and the Council of 16.12.2002. (Official Journal L 001,04 / 01/2003)

Directive of the European Parliament and of the Council on the energy performance of buildings; Directive on the energy performance of buildings, whose main goal is to establish a permanent, unique mechanisms for improving energy performance of residential and public purpose buildings at EU level, taking into account climatic and local differences between individual countries.

Essential requirements of Directive 2002/91/EC relating to energy efficiency:

- Establishing a general framework for the methodology of calculation of energy performance of buildings
- Application of minimum energy efficiency requirements for new buildings
- Application of minimum energy efficiency requirements for existing buildings in major reconstruction (usable area over 1000 m²)
- Energy certification of buildings.

2. USE OF LOCAL NATURAL FIBROUS MATERIALS FOR THERMAL INSULATION OF BUILDINGS

2.1. Wooden Wool

Wood is used as construction and roof material. Raw wood is also used for numerous products (panels, plywood, chipboard) and as insulation material (wood wool, cellulose flakes). Wood does not have an unpleasant impact on humans and environment, acting positively on the residential environment and after the removal does not cause harmful emissions.

Wooden wool (Heraclitus) as building material is made of long wood fibres. Wood fibre is impregnated and then mixed with cement to form a panel (board, sheet). After the impregnation the wood fibre becomes resistant to swelling, insects, decay, water absorption and significantly improves its resistance to fire (B1 according to DIN 4102). Some tests show that these properties even improve in years after the production. The interior panel of wood wool is filled with the numerous pores of air (about 70% of the volume of plates), which affects the thermal insulation properties. Panes made of wood wool do not contain any harmful substances and are very acceptable as a biological construction material. Due to the porous surface they represent a good base for "accepting" mineral mort.

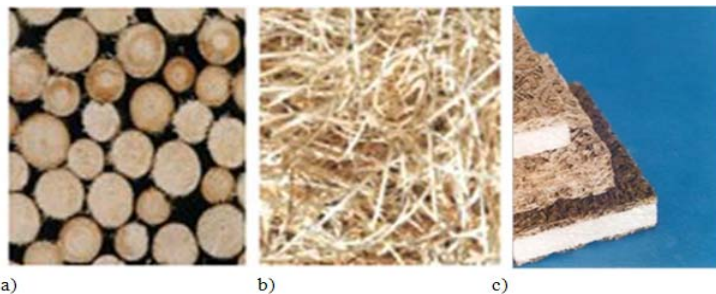


Figure 1. a) wood, b) wood wool, c) slabs of wood wool [4]

Selection of wood fibre for insulation depends on its purpose. It can be chosen in form of panes of different density and thickness. In addition to the "pure" product, there are products impregnated with natural resins for use in borderline conditions (humidity). Environmental approach to the production process and favourable technical characteristics allow to make structures with low energy consumption.

Panes with magnesium bond are identified by the beige colour, while the panes with cement are grey. Over decades, lightweight wood wool building boards proved to be good insulation panels which can be used both outside and inside.

Technical characteristics of wood wool: Volumetric mass-360 to 480 kg/m³; Coefficient of thermal conductivity $\lambda = 0.090$ W / mK; Needed depth for $U = 0.40$ W/m²K is 21 cm; Resistance factor to water vapor diffusion $\mu = 1$ to 2.

2.2. Straw

Straw is a good thermal insulator. The coefficient of thermal conductivity in straw bale is 0.09 W / mK, which, combined with the value of the wall thickness of typically above 450 mm, gives the coefficient of heat 0.13W/m²K, which is much lower than required by current regulations.

As part of the project "Systems of walls made from renewable sources" experiments were carried out with wheat straw bales of different density. Testing of thermal insulation was conducted by a department from Municipality 39 in Vienna according to ISO 8301 and ÖNORM B6015 Part I. Measurements according to ISO 8301 were as follows $\lambda_{10} = 0.0369$ and 0.0337 W / mK (dry material at 10 ° C), while the value $\lambda_{10} = 0.0380$ W / mK was obtained according to ÖNORM B6015. Under EU rules, the reference value should be the calculated λ value, which includes 20% added moisture. Therefore, the reference value of thermal conductivity of wheat straw bale density 100 kg/m³ is $\lambda = 0.0456$ W / mK. Thus, the straw-heating conductivity in the range with other natural insulation materials (flax, hemp, wool, cork, cellulose). Such a low coefficient of thermal conductivity of straw allows for easy fulfilment of passive standards and construction of passive houses.

Technical characteristics of straw: Density approx. 110 kg/m^3 ; Coefficient of heat conductivity $\lambda = 0.045$ to 0.13 W / mK ; Thickness required for $U = 0.40 \text{ W/m}^2\text{K}$ is 23 to 33 cm.

Development of construction elements made from straw is oriented towards the elements that are suitable for application in construction. Having that in mind, construction elements of pressed straw (Figure 2-a) were made, usually as boards of various sizes, the so-called CP blocks. These very new construction materials are an area for further development of thermal insulating material.

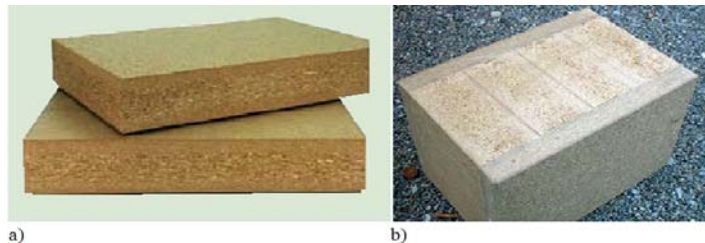


Figure 2. Products of straw: a) slabs of pressed straw; b) CP blocks of straw [4]

2.3. Cane

In the past, reed (cane) was mostly used as house (roof) cover, for making and reinforcing the walls which were veneered and coated with mud. It turned out that such houses had very good thermal insulation properties which lasted for over 100 years. Nowadays, reed is used in form of panes (panels) as thermal insulation and for construction of walls, ceilings, floors. It is also used for making light constructions and as a preparation base for mortar, and for the reconstruction of cultural heritage.

Cane panels are the building material produced by pressing cane stems and binding them with galvanized wire to form a panel. Such panels are used for thermal and sound insulation of buildings. Standard dimensions of cane panels are: width 100cm and 150cm, and 200cm lengths. The thickness can be 3 or 5 cm. The greatest advantage, compared to other insulating materials, is that the cane (reed) panels are completely natural materials, environmentally acceptable and when installed pose no risk to human health.

Such thermal insulation is natural and healthy, very durable, resistant to rodents, easy to process and does not deform under pressure.

Cane panels can be used as supporting panels, or as heating insulation and insulation against noise. Due to the large presence of acid, cane is hardly inflammable as building material. Good thermal insulation is based on the fact that the air in each cane stem is stationary. The material is extremely environmentally friendly for the implementation and production as it can annually re-grow in large quantities. Cane has long-term usage, is recyclable and resistant to pests.



Figure 3. Isolation of the outer wall of reed [4]

Technical characteristics of cane: Mass 9 kg/m^2 (panel thickness 5 cm); Coefficient of thermal conductivity $\lambda = 0.040$ to 0.060 W / mK ; Factor of water vapour diffusion resistance $\mu = 1$ to 2 ; Thickness required for $U = 0.40 \text{ W/m}^2\text{K}$ is 10 - 15cm.

3. CONCLUSION

Today's energy consumption for heating in building is unacceptably high and should be significantly reduced, and that can be achieved by using local natural materials for energy and environmentally efficient buildings.

By using natural energy and environmentally efficient materials the following can be achieved: save energy for space heating and cooling, reduce greenhouse gases and increase the comfort factor in the buildings.

4. REFERENCES

- [1] Directive 2002/91/EC on energy performance of buildings / Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings (Official Journal L 001,04 / 01/2003)
- [2] Glasnović, Z., Horvat, J., Omahić, D., "Straw as a superior Building Materials", Tehnoeko 3 / 2008, Zagreb, 2008., 14-17.
- [3] Vrančić, T., " Thermal insulation materials of natural resources," Građevinar 59 (9), Zagreb, 2007., 835-837.
- [4] Kobaš, A., " Materials for energy and environmentally efficient building ", Graduate work, RGGF, Tuzla 2008.