GREEN AND ENERGY EFFICIENT SOLUTIONS IN THE CONSTRUCTION INDUSTRY

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ABSTRACT

Ecology and environmental protection have been discussed more and more in the last few years. This trend was also affected by the construction and architecture department. Concepts such as green building, environmentally friendly materials, alternative energy sources and energy-efficient construction systems of buildings are depressed. All of this comes under the name "Green Buildings". Wood-based construction and material solutions are a response to these trends. Investors and users are gradually starting to think more environmentally friendly and therefore many times also make decisions for wood-based constructions. There are several systems that fall into the category of so-called crushed buildings. The aim of this work is to provide a look at the "greener" options offered in the construction industry with an emphasis on their energy and thermal characteristics. The subject of the research was selected structural parts of timber-based buildings applied to model constructions by means of which selected thermal-technical characteristics were evaluated. This work points out the differences between the compared design variants of wooden buildings in terms of their ability to effectively save energy sources for heating inserted during the operation of wood-based buildings.

Keywords: *efficiency, energy, green buildings, sustainability, wood constructions*

INTRODUCTION

Construction is a sector that consumes almost half of the energy produced; the other consequences of the construction process activities [1] relate to the consumption of materials, their extraction, processing and transport. This is followed by the energy demand during the operation of the building, the waste load and also the load associated with the demolition of the building [2]. All the above aspects accompanying the construction are put together in the resulting total load by which the constructed building affects the natural environment [3].

Act no. 17/1992 SR on the environment: "Sustainable development of society is such development that preserves the ability of current and future generations to meet their basic living needs, while not reducing the diversity of nature and preserving the natural functions of ecosystems". This definition is based on a report Brundtland (1991) issued in 1987 by the World Commission on Environment and Development (WCED) [4].

Sustainable construction is one where the required characteristics and functions of the construction are fulfilled with minimal adverse environmental impact [5], ideally with the simultaneous improvement of economic [6] and social conditions that have a positive impact on improving the quality and culture of the environment - local level to global level.

The “Green Buildings” philosophy aims to minimize the environmental impact of design, construction, full use, but also house demolition. One of the main approaches in the so-called eco-construction is the assessment of the so-called eco-construction. life cycle. It is a method that examines the life cycle of a product (a particular building material or building as a whole) in terms of its environmental performance [5], [6], [7].

As part of the "Agenda 21" and the evaluation of sustainable development indicators, it was adopted at the United Nations Summit in Rio de Janeiro in 1992 The Global Community Strategy and Action Plan sets out concrete steps towards sustainable development. Agenda 21 is followed by the "Agenda 21 for Sustainable Construction" document, which defines a sustainable building as follows:

- consumes minimal amounts of energy and water during his / her life,
- uses efficient raw materials (environmentally friendly, renewable materials),
- has a long lifetime (quality construction, adaptability),
- generates as little waste and contamination as possible during your life;
- uses land effectively;
- fits well into the natural environment,
- is economically efficient in terms of both implementation and operation;
- satisfies user needs now and in the future (flexibility, adaptability, quality of space),
- creates a healthy indoor environment [8].

In accordance with the strategic plans for sustainable construction, in particular in terms of the idea of efficient use of energy resources also in the construction industry, we have focused in this article on the phase of construction operations as such. The aim of this work is to provide a look at the "greener" options offered in the construction industry with an emphasis on their energy and thermal characteristics.

Timber-based constructions in terms of sustainability

Wood-based structural and material solutions are a response to sustainability trends. Wooden construction is an environmentally and economically beneficial way of building low-energy houses [9]. This is due to the use of wood as a building material as well as significant energy savings for heating. With a suitable combination of materials and building elements, it is possible to achieve passive house characteristics.

For hundreds of years, wood has not only been considered to be part of nature, but the use of this material as a building material is more environmentally friendly and environmentally friendly compared to masonry buildings [10], [11]. This material is one of permanently renewable resources that excels in several of its properties. Wooden buildings require less energy, leaving less carbon footprint compared to traditional buildings. This concept traditionally represents buildings that are made by materials that have been used for hundreds of years, proven and most trustworthy for the consumer [9].

The position of wood as a building material must also be assessed from the global point of view of the expected availability of raw materials in the 21st century. Wood as a permanently renewable raw material in well-maintained forests with favorable environmental properties will put high priority on the expected depletion of solid, liquid and gaseous fuels. Furthermore, the need to reduce the threat to the Earth's atmosphere by greenhouse gases, of which 61% is CO2 as a product of combustion. Therefore, wood as a building material is increasingly coming to the fore for sustainable construction. A timber building made of wood is considered to be an environmentally friendly building that prevents heat loss and heat radiation to the surroundings. Raw wood is an energy-saving raw material. Raw timber processing is environmentally friendly and could have a relatively zero balance of pollution. Timber itself as a building material in a timber building construction has a negative emission balance (after recalculation of energy consumption in the construction, operation and disposal of the greenhouse gas production building), as it absorbs or regulates more pollutants during tree growth than it produces . It is no wonder that a timber building is considered an ecological house. Our future lies in eco buildings, modern timber houses [12], [13], [14].

MATERIALS AND METHODS

In terms of sustainability, the environmental benefits of wood-based buildings are indisputable. From the point of view of energy efficiency, especially in the phase of building operation, it is necessary to distinguish different energy standards of building envelope structures as such. The assessment of the thermo-technical parameters of buildings is important for both the consumer and the contractor, where, thanks to the quality of its construction product or work, it determines its reputation on the market and facilitates consumer decision-making. In terms of thermo-technical characteristics of the peripheral structures, three structural variants of wood-based constructions were compared within this paper. The calculations of the individual thermo-technical characteristics were realized by means of the standard STN 73 0540. The following constructional variants were assessed: column perimeter wall variant, CLT perimeter wall variant and modern log wall perimeter variant and their material composition shown in Figures 1-3. The parameters of the thermal resistance of the structure R and the heat transfer coefficient U were chosen for the comparison of the structures.

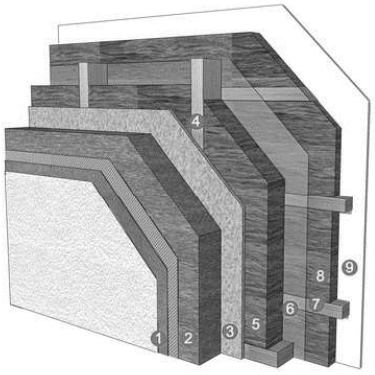

Fig. 1 Scheme peripheral wall – column variant [13].

(Note: material composition - 1- System plaster, 2- Facade graphite polystyrene, 3- Chipboard OSB, 4-Carrier system KVH, 5- Mineral insulation, 6- Vapor barrier foil; 7- Installation grid SM, 8- Mineral insulation, 9-Drywall).

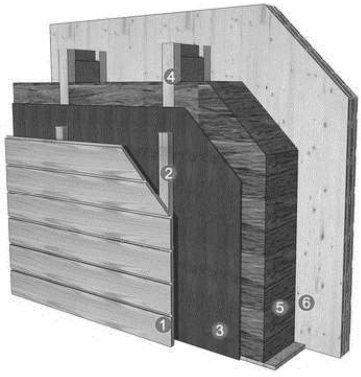

Fig. 2 Scheme peripheral wall – CLT variant [14].

(Note: material composition - 1- Facade slab larch, 2-Ventilation grate, 3- Facade foil Traspir UV, 4-Steico wall, 5-thermal insulation, 6-CLT panel).

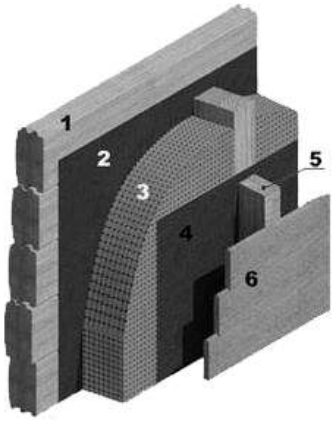

Fig. 3 Scheme peripheral wall – modern log variant [15].

(Note: material composition - 1 - log profile of massif thickness, 2 – vapor-permeable foil; 3 – insulating prisms, thermal insulation; 4 – vapor barrier; 5 – wooden grate, air gap; 6 – wooden lining).

RESULTS AND DISCUSSION

The individual analyzed and compared variants in terms of parameters considered are summarized in Tables 1-3.

Tab. 1 Structure of the perimeter wall construction – column variant.

Layer name	ρ	Λe	Λi	c	μ	Thickness [mm]
Drywall	750	0,22	0,15	1060	9	12,5
OSB board ECO	600	0,14	0,13	1700	150	12
Vapor barrier foil Jutafol D110	1740	0,35	0,35	1470	9090	0,22
Mineral insulation ISOVER Unirol	17	0,039	0,036	940	1	120
OSB board ECO	600	0,14	0,13	1700	150	12
Expanded polystyrene (EPS)	15	0,038	0,043	1270	55	120

Tab. 2 Structure of the perimeter wall construction – CLT variant.

Layer name	ρ	Λe	Λi	c	μ	Thickness [mm]
CLT panel	400	0,13	0,12	2510	50	100
Thermal insulation	65	0,036	0,031	1030	1	240
Facade foil TRASPIR UV	1000	0,21	0,21	1470	155	0,21
Ventilation grate	200	0,075	0,07	1630	5	40
Facade tile	800	0,11	0,1	1500	13	21

Tab. 3 Structure of the perimeter wall construction – modern log variant.

Layer name	ρ	Λe	Λi	c	μ	Thickness [mm]
Drywall	750	0,22	0,15	1060	9	12,5
Wooden grate	200	0,075	0,07	1630	5	28
Jutafol D 110 SP	1740	0,35	0,35	1470	9090	0,22
Thermal insulation	40	0,038	0,035	1020	1	140
Vapor-permeable foil	1000	0,21	0,21	1400	40	0,5
Log profile	400	0,13	0,12	2510	157	92

On the basis of analyzes of selected construction types of peripheral walls of wooden buildings the following characteristics were found: Post variant R = 6,033, U = 0,161; CLT variant R = 8.161, U = 0.120 and Modern log variant R = 4.825, U = 0.200. Based on the findings of the analyzes, the CLT construction achieved the best parameters in terms of the characteristics evaluated. The CLT construction was followed by a column variant and the last of the evaluated was placed a modern log variant.

CONCLUSION

Within this article, the basic sustainability context in the context of green buildings has been defined and the benefits of wood-based construction from the above mentioned areas have been discussed. Within the trend of decreasing the energy intensity of buildings as such, the principles and conditions related to this issue were listed. Within the increasing trend of increasing the number of timber-based buildings, the main environmental benefits of using timber-based buildings as well as other benefits were mentioned. In the practical part we focused on comparing three selected variants of wooden buildings in terms of thermal-technical characteristics and their mutual comparison. Concerning the outer peripheral wall, the CLT construction had the most favorable results and the least favorable log construction. From the findings it can also be stated that the evaluated design variants have reached such a thermo-technical standard through which it is possible to realize constructions that can offer efficient energy solutions in terms of saving financial costs during the construction use phase.

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