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CONSTRUCTIONS BASED ON WOOD AS AN ECOLOGICAL AND ENERGY-SAVING TECHNOLOGY

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Not only the ecological aspects of the construction projects, but also the energy savings and efficient construction solutions are currently a very discussed topic. In spite of still persisting prejudices against timber-based structures within our region Slovak Republic, wood-based construction systems are gradually beginning to assert themselves in the construction market. Because modern-minded investors and users are beginning to re1alize especially the ecological dimension of wood-based buildings. Of course, wood-based structures also have many other advantages and disadvantages. Therefore, the aim of this manuscript is to present selected aspects of real wood-based constructions in terms of energy performance of projects in the use phase.

Key words: ecology, energy saving, sustainability, wood, wood constructions

Introduction

The use of wood and wood-based structural elements is gaining popularity in our conditions. It must be said that today it is no longer just the use of solid wood, but various products using wood as a basic raw material for construction material, but also for thermal insulation or interior and exterior cladding. Wood is a permanently renewable resource. Growing trees absorb carbon dioxide and produce oxygen. It can be said that a typical tree absorbs one tonne of CO_2 per meter cubic mass while producing an equivalent of 0.7 tonne oxygen. That is why in developed countries it enjoys great popularity and it is represented by 20 % to 90 % in newly built houses. At present, this share represents about 5–10 % for new family houses. Outdated fire protection legislation prevents greater use. However, changes are expected in the near future, and as in the Czech Republic, Austria, Germany and the Nordic countries, we are also expecting market acceleration in our country.

In terms of energy, ecological and economic efficiency of construction projects, the more the operational costs and energy resources needed for the use of residential buildings, houses and other buildings are discussed. Therefore, in this paper, we pay attention to the operating costs of wooden constructions in the context of economic and also ecological contexts.

Operational resources and costs associated with the use of buildings

In the past, energy efficiency was also important to people. However, the efficiency of energy use has only started to deal with the company now. We can start from the fact that society has begun to devote itself to this problem due to the present day, in which we resist the serious environmental problems of the decline in non-renewable resources, the high environmental cost of energy and materials, the expansion of settlements at the expense of nature, and especially climate change. The main goal of energy efficiency is to save fossil fuels, the environment that is very important for our existence, to reduce CO_2 emissions that contribute to climate change (Satterthwaite, 2008; Burgess, 1990). It is a good time to stop wasting natural resources and to use energy more efficiently. The importance of an ecological house, which is the energy efficiency of family houses, what is today's vision of energy-saving housing, cost-effectiveness, efficiency technique, and what is home energy certification. All these findings are related to the design of passive, low-energy houses or buildings (Stephan et al., 2013). Although passive and low-energy houses are very advantageous, their very construction will not save the already badly destroyed environment. However, these houses contribute to a more rational use of natural resources. Their main task is to provide a suitable living environment and reduce energy consumption for heating. The most important reasons for investing in a passive or low energy building is saving heating costs (Audenaert et al., 2008). Nowadays, much attention is paid to this issue because it is more concerned with the environment and energy saving. Many researches are presented by experts in this field on these buildings, which show much more advantages compared to standard houses. Uninformed and poor quality information about these buildings creates a concern for ordinary people about the return on higher investment in passive or low-energy homes compared to conventional ones. Passive and low energy houses not only save natural resources but also save money for users (Janson, 2010).

In the average household, heating, or heat supply, 60–80 %, the preparation or supply of hot water approximately 30 %, and electrical appliances with gas appliances only 10 % (Čejka and Šafařík, 2012). Of course, these values may vary from household to household, but the order is the same. On this basis, it is clear where the focus of austerity measures is. A precondition for purposeful saving is the measurement of consumption and its continuous monitoring by means of measuring devices.

The energy and operating costs of a house are mainly influenced by the following:

Choice of land and location of the house taking into account the local climate, terrain configuration, vegetation and prevailing winds,

Orientation of the house on the world side with regard to the impact of sunlight during the year, present and future projected shading of the house by the surrounding buildings,

Increased thermal protection of external building elements, ie. j. achievement of excellent thermal insulation parameters of external cladding elements – walls, floors, roof, windows, doors,

Prevent geometric and structural thermal bridges. Sufficient airtightness of the cladding – exclusion of leakage, windproofness,

Passive use of solar energy – properly dimensioned southern glazed areas, winter gardens, with the accumulation of passive energy gains, variable solar protection and summer protection against overheating of the house being an important measure,

Additional use of solar energy through active solar installations and hybrid convective systems,

Internal layout with respect to heating mode, thermal zone and space orientation on the world side,

Size of heated and indirectly heated spaces (volumes) and their adequacy for the purpose. Size of glazed surfaces on individual facades. Expected internal heat gains according to the nature of the operation,

Optimally selected heating system – with appropriate performance and good regulation, flexibly responsive to instantaneous temperature, possibly low-temperature,

Energy efficient hot water production – active solar installations,

Controlled ventilation,

Efficient use of electricity – energy-efficient lighting and home appliances,

User behavior – conscious operation, taking into account the time of day and year, and the correct operation of technical equipment (Pifko, 2017; Pifko and Špaček, 2008).

Operating cost analysis of wood buildings examined

In order to analyze the operating costs during use, the real wood houses used were constructed based on the column and panel construction systems, which are most widespread among the wooden construction systems. During the monitoring of the mentioned buildings, the structure of the costs of using the energy balance of these buildings was examined. Altogether, 29 wooden buildings in various energy standards were involved in the analysis. For better interpretation of the findings, the analyzed buildings were divided into groups according to energy standards. Table 1–2 shows a comparison of mono-monitored buildings divided by energy standards.

Table 1

Operating costs of monitored buildings depending on energy standards

		Monthly heating costs (EUR)	Other monthly operating costs (EUR)	Total monthly operating costs (EUR)
Low-energy house (n=17)	average	47.6	55.0	102.5
	stdev	14.6	40.2	48.3
	min	20.0	20.0	50.0
	max	70.0	190.0	250.0
Passive house (n=12)	average	34.1	28.2	62.3
	stdev	14.6	10.8	24.1
	min	15.0	13.5	30.0
	max	60.0	40.0	96.8

By comparing the total cost of building use, there is a significant difference between the low-energy house and the passive house. On average, Passive House had significantly lower total operating costs than Low-energy house. By a more detailed analysis, the split of the total costs of the low-energy house into two main parts was the heating costs, which accounted for almost 50 % of the total costs and other costs of use. This category can include household operating costs such as electricity, water and other media. Of course, these commodities are influenced by the way in which the house is used and occupied. For the Passive House, this cost ratio was slightly different than can be seen in Table 1. To unify the data, the values were converted to m^2 of utility area of each building. These calculations are shown in Table 2.

Table 2

Operating costs of monitored buildings depending on energy standards - conversion to m^2 of usable area of the building

		Monthly heating costs (EUR) conversion to m^2 of usable area of the building	Other monthly operating costs (EUR) conversion to m^2 of usable area of the building	Total monthly operating costs (EUR) conversion to m^2 of usable area of the building
Low-energy house (n=17)	average	0.34	0.36	0.69
	stdev	0.13	0.17	0.25
	min	0.09	0.09	0.17
	max	0.64	0.78	1.11
Passive house (n=12)	average	0.30	0.25	0.55
	stdev	0.13	0.10	0.22
	min	0.13	0.11	0.26
	max	0.56	0.38	0.90

Conclusions

In the broader context, the presented article dealt with the operation of buildings in the context of spent resources. Of course, other elements such as ecology and economy are also related to the resources spent during operation. Therefore, we have included in the article a summary of aspects affecting the operation and use of buildings as such. In the practical analysis, we dealt with specific wooden constructions which were monitored in the context of operation during real use. The findings show that the difference between the individual energy standards in terms of resources spent during operation. Of course, as already mentioned in the introduction of the article, the operating costs are influenced by several factors to be taken into account.

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КОНСТРУКЦІЇ НА ОСНОВІ ДЕРЕВИНИ ЯК ЕКОЛОГІЧНА ТА ЕНЕРГОЗБЕРЕЖНА ТЕХНОЛОГІЯ

Сьогодні однією з найактуальніших сфер дослідження є реалізація не тільки будівельних проєктів з екологічного аспекту, але й з погляду економії енергії та ефективних будівельних рішень. Незважаючи на упередження щодо використання дерев’яних конструкцій, у регіоні Словацької Республіки все більшого поширення набувають такі конструкції. Сучасні інвестори та користувачі починають усвідомлювати особливості екологічних аспектів будівель із використанням дерев’яних конструкцій. Звичайно ж, конструкції на основі деревини мають багато переваг і недоліків.

Дерева поглинають вуглекислий газ і виробляють кисень. Можна сказати, що типове дерево поглинає одну тонну CO_2 на метр кубічної маси, виробляючи еквівалент 0,7 тонни кисню. Ось чому в розвинених країнах цей матеріал дуже популярний і в новозбудованих будинках його від 20 % до 90 %. Нині його частка становить близько 5–10 % для нових сімейних будинків. Проте застаріле законодавство про пожежну охорону не дає можливості розширити використання деревини.

Що стосується енергетичної, екологічної та економічної ефективності будівель, то більше обговорюють експлуатаційні витрати та енергетичні ресурси, необхідні для експлуатації багатоквартирних житлових будинків, однородинних будинків та інших будівель.

Розглянуто практичне використання конкретних дерев’яних конструкцій, за якими спостерігали під час експлуатації в реальних умовах. Отримані результати показують, що є відмінність між окремими енергетичними стандартами щодо різних ресурсів, використаних під час експлуатації.

Тому в цій роботі звернено увагу на експлуатаційні витрати дерев’яних конструкцій в економічному, енергоефективному, а також екологічному контексті.

Ключові слова: екологія; енергозбережний; стійкість; деревина; дерев’яні конструкції.