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Justifiability Installation of New Types of Window

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Abstract: The market appears an increasing number of different types of windows, depending on the type of material from which made the window frame, method of preparation and dimensions. Each kind of windows characterize certain characteristics in terms of energy efficiency, on the one hand, but also the durability and the stability and the cost of purchasing and maintaining the other side. The paper will be presented to the types of windows, thermal characteristics test results and comparative analysis of certain types of windows to be installed in the building in Bosnia and Herzegovina, and the display of the current development research in improving the properties of windows that are carried out in Europe with a view to facilitate the selection of types of windows when installing new windows in the house or the replacement of existing windows.

Key words: Types of windows, energy efficiency, performance windows, materials, thermal performance.

1. Introduction

The window is an integral part of the building. The window, with its size, shape and characteristics, affects the aesthetic, static, constructive, and the energy characteristics of the building. The window is influenced by the various impacts.

Through the windows loses a large amount of heat (around 36%, and old poorly-insulated buildings up to 47%), bearing in mind the increasing cost of energy is used for heating or cooling selection of appropriate type of windows is of increasing importance.

On the Bosnia and Herzegovina market appears a growing number of window types, which differ by the materials they are made from, the construction and dimensions. It usually offers aluminum, PVC and wooden window frames. The aluminum frames are better in the operation of different weather conditions (sun, wind, rain or salt), retain their shape, don't get old, easy to maintain. Aluminum has a high thermal conductivity. Thermal insulation is an important thermal break between the inner and outer surfaces of the aluminum profile, which is achieved by inserts of material to poor thermal conduction. PVC frames are missing less heat than aluminum frames, but they have a shorter life span, and have less strength than the aluminum frame. PVC frames are easier to maintain than wooden frames, and the price is lowest. Wooden window frames take up an important share of the market (around 40%), environmentally acceptable, and with quality care and maintenance can last up to one hundred years. To wooden windows, they were resistant to weathering, often produced with additional external aluminum covers or in combination with other materials. In such composite structures, all materials together define the properties window. . A good compromise is the production of window frames with the combination of the wood inside and the aluminum outside. Massive wooden frame has a supporting and insulating function, and the outer aluminum frame provides perfect protection from harmful weather conditions and leaves a nice aesthetic impression. In this way, it increases the durability of the window frame, the elasticity and stability of the construction window.

Window frame, regardless of the material, must provide good sealing, thermal barrier in the frame profile (PVC and aluminum), easy opening and closing, low thermal transmittance and good protection against noise.

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The window sash is mounted fixed glazing with one, two or three glass. Glass can be transparent, colored or low-emission (low-e) glass. In the case of using the insulating glazing, unit of the interface between the glass panes is filled with air, argon or krypton.

Each window type has its advantages and disadvantages. When selecting the type of windows for installation, customers are sometimes in doubt to choose.

2. Characteristics of the Existing Built-in Window in Bosnia and Herzegovina

The window is the most dynamic part of the building envelope. He also acts as a receiver of solar energy in the interior space of the building, as well as protection against external influences and heat losses.

Depending on the materials they are made, wood, aluminum or PVC, in the choice of windows customers should pay attention to certain traits. For windows frames that made of PVC are essential following characteristics such as water tightness, air permeability, wind resistance, mechanical strength, thermal insulation, sound insulation, burglar resistance, solar protection, climatic resistance and operating force. When choosing windows with wooden frames customers should pay attention to the wind load, sound insulation, water tightness, thermal insulation, fire characteristics, bullet resistance, burglar resistance, mechanical durability, radiation properties, smoke characteristics, air permeability and behavior between different climates.

Customers in Bosnia and Herzegovina when selecting windows, except price, the most important factor is the thermal characteristics of the window.

The thermal performance of windows affect types and thermal characteristics of the material from which made the window frame, window frame construction, types and characteristics of glass for glazing, glazing design characteristics and quality of the installation of windows in the wall of the building.

Losses through the windows of the transmission (they through a closed window) and ventilation (they through an open window). When they are added together, through the windows is lost the more than 50% of total heat loss of the building. For the analysis of heat flows one window, it is necessary to know the values of heat loss that is realized through the glass window and no glass parts (wings and window frames), heat loss due to ventilation, heat loss through thermal bridges, and any gains heat from external sources.

In determining the total heat transfer through the window takes into account, the average heat transfer frame and glass, share their surfaces and heat losses at the joints. Thermal transmittance of single windows U_W is calculated by the Eq. (1):

$$U_w = \frac{\sum A_g * U_g + \sum A_f * U_f + \sum l_g * \psi_g}{\sum A_g + \sum A_f} \quad (1)$$

where, U_g is the thermal transmittance of the glazing, U_f is the thermal transmittance of the frame, Ψ_g is the linear thermal transmittance due to the combined thermal effects of glazing, spacer and frame, A_g, A_f are the surface of the glazing and frame respectively.

Technical regulation on energy efficiency and energy performance of buildings provides the passage of heat through the window shall not greater than 1.6 W/m^2 at the window with wooden profile, , the profile of synthetic weight and the profile of the combination of materials, the wooden base profile or one of the types of plastics, and 1.8 W/m^2·K at the window with a

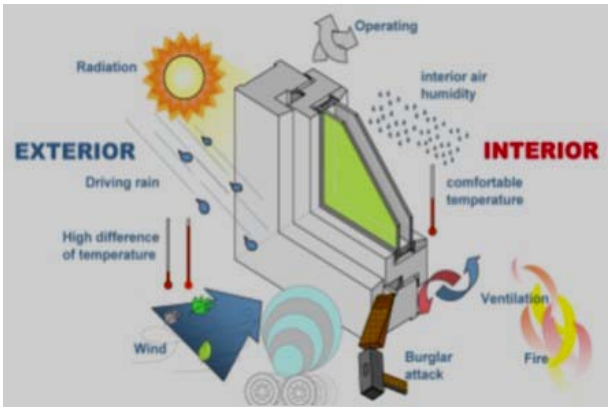


Fig. 1 Influences of window.

metal or concrete frames. In heated rooms of the building is sufficient to use glazing with thermal transmittance Uw = 1.4 W/m^2·K with a factor of solar radiation over the passage of at least 0.55. If you are in compliance with the requirements of regulations on sound protect buildings incorporate glass with increased acoustic hood, its heat transfer must be Uw = 1.8 W/m^2·K.

Windows with triple glazing installed in passive houses. . The window frames of passive houses have in chambers the thermal insulation. Heat transmission of such window (frame and glass together) is at most 0.8 W/m^2·K, and glazing only 0.5 - 0.8 W/m^2·K.

Heat flow by radiation represents two-thirds of the total heat loss, thus the technological development of the window is still in the direction of reducing the heat loss of radiation using low-e coating. Heat, except radiation passes through the glazing, is conduction and convection. Low-e coating on the glass allows unimpeded passage of narrow-solar radiation in space but misses long wave thermal radiation. Coating is a thin invisible metal oxide which reduces the emissivity (transmission) area to the value of 0.04.

The use of a noble gas (usually argon is used) as a filler sense only in cases of low-e layers for the use of noble gas convection and conduction reduce heat losses.

If in the glazing with Uw = 1.1 W/m2•K used the air instead of argon, the value would increase to 1.4 W/m^{2}K. Such heat transfer glazing can be expected after the loss of noble gas from the space between panes. Experience has shown that the noble gas remains in the glazing about 10 years.

Technology is possible to create a window with U values below 0.5 W/m^2·K (for example vacuum glazing), but its price is very high.

Depending on the type of glazing (insulating capabilities), inner side of the glass (inside the room) has a specific temperature. Examination of the temperature on the inside of the glass depending on the type of glazing in the window temperature of the external environment of – 10 °C and an internal room temperature of 20 °C were obtained by the temperatures in Table 2

Aluminum spacer between the panes, which are most often encountered in the windows on the territory of Bosnia and Herzegovina, is the great cause of the thermal bridge that occurs due to the higher thermal conductivity of aluminum compared to air or gas filling (Argon) in the rest of the glazing. As the window frame at the connection between the glazing and frame narrowed can lead to thermal bridges and surface condensation on the inner surface of the window glass, thus, a large number of chambers in

Table 1 Thermal transmittance of the window (W/m^2·K) [1].

Frame			Glazing				
Material	Type sash		Single	Double	Three	Double-glazing + low-e + Argon	Double-glazing + low-e + gas mixture
		U	5.5 -5.9	2.9 -3.4	2.0 -2.5	1.1 -1.3	0.9
Wood	Connecting			2.3	1.7		
	Standard single		4.6	2.4 -2.9	1.9	1.4 -1.7	1.0 -1.4
PVC (Polyvinyl chloride)	Connecting a single-chamber			2.5	1.9		
	Connecting multi-chamber			2.6	2.0		
	Standard single-chamber	2.4 - 2.6		2.8 -3.1			
	Standard multi-chamber	1.2 - 1.8		1.7 -2.5	2.0	1.3 -1.8	1.1-1.3
Metal	Connecting			3.7			
	Connecting – interrupted thermal bridge			2.9	2.3		
	Standard	6.0 -10.0		3.7 - 4.0			

Table 2 The temperature on the inside of the glass depending on the type of glazing (Source: EIHP (Energetski Institut Hrvoje Požar), Zagreb, Croatia).

Type of glazing	The temperature of the inside of the glass
Single glass thickness of 4 mm - U = 5.9 [W/m^2·K]	– 2 °C
Double pane insulated glass 4 + 8 + 4 filled with air – U = 3.0 [W/m^2·K]	8.3 °C
Double pane insulated glass 4 + 12 + 4 filled with air – U = 3.0 [W/m^2·K]	9.0 °C
Double pane insulated glass 4 + 16 + 4 low-e with argon – U = 1.1 [W/m^2·K]	15.7 °C
Triple pane insulated glass 4 + 12 + 4 + 12 + 4 low-e with argon – U = 0.5 [W/m^2·K]	18.1 °C

PVC profiles on that site is not emphasized. Because of these difficulties, the most modern windows have instead of aluminum spacer installed thermal insulation materials (for example hard or silicone hollow polycarbonate). The spacers, in which the thermal bridge is broken with the synthetic materials, are also built. The thermal conductivity of such spacers is less than 0.6 W/m^2·K.

The thickness of the elements and frame construction affects the thermal performance of windows. During the development of the awareness for energy savings, the profiles of window frames are also developed.

The study of the thermal performance of single wooden windows measuring W × H = 1.230 × 1.480 mm made of fir / spruce three-layer or four-layer laminated (for frames section 92/82) according to EN ISO 10077-1, which are installed in houses in Bosnia and Herzegovina, obtained the data shown in Table 3 [2].

Depending on the climate region, it is very important to think about the solar protection. In Bosnia and Herzegovina there are buildings with large windows and unprotected windows (no shutters), buildings whose windows have adaptive protection and houses with relatively small windows with blind out shutter.

3. Overview of Current Developmental Research to Improve the Properties Window

The trend of sustainability, energy efficiency and environmental protection in civil engineering - or "green building" - quickly became an international mega trend and a significant driver of the global economy. The envelope of the building, together with their windows, facades and windows, has a significant impact on energy consumption and comfort of living in the building.

As current and future specifications of the Energy Savings Ordinance (EnEV), increasing energy costs prompted the Government of developed countries in Europe to take significant measures to give additional incentives for the development of construction techniques that are energy efficient. Since this results in ever more stringent requirements of certain construction products, in terms of new structures in the segment of renewable energy building, elements of windows and external doors as well, must keep pace with these developments, and there must be an improvement in the value of coefficient thermal transmittance (U-value) these constructions.

The increasing stringency in the future will require a significant improvement in the coefficient of heat transfer window frame (U_f value), in addition to improvements in the field of glass, are carried out many tests and improve the structure of the window in order to improve the thermal performance of windows on one side, and cost-effectiveness of their production and installation.

German Institute IFT Rosenheim GmbH done much research in the area of improving the characteristics of wooden windows. Research in improvement thermal characteristics of wooden windows are conducted through the implementation of two concepts: the concept of integration of insulation materials in the window frame and the concept use of thermally modified wood for window frames. The current tests IFT Rosenheim GmbH Institute show that it is possible

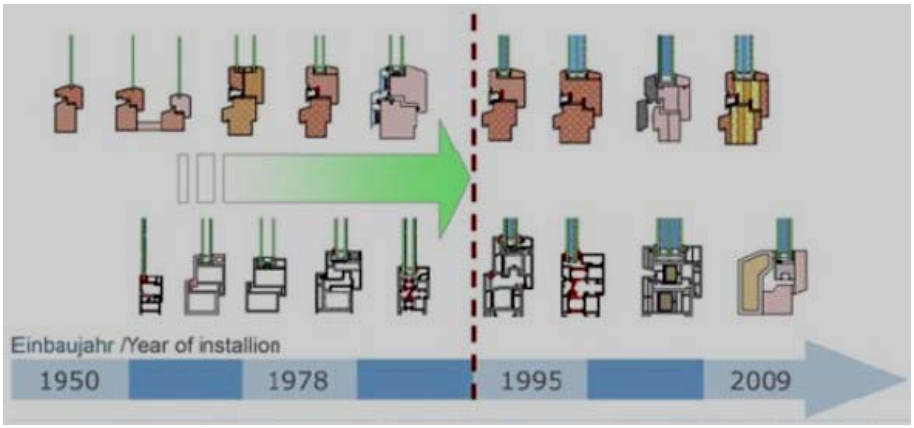


Fig. 2 Optimization profile of window.

Table 3 Thermal properties of single wooden windows (Source: Bor doo Bihac).

Type of window / Characteristic	Wood 68/82 mm Eurofalz	Wood 68/82 mm Soft Line	Wood - Aluminum 78/82 mm	Wood 78/82 mm	Wood 92/82 mm	Wood - Aluminum 92/82 mm
Frame area A_f [m^2]	0.539	0.537	0.592	0.540	0.592	0.540
Thermal transmittance of the frame U_f [$W/m^2 \cdot K$]	1.7	1.7	1.3	1.3	1.1	1.1
Glazing area A_g [m^2]	1.281	1.283	1.228	1.280	1.228	1.280
Linear thermal transmittance of Al spacer Ψ	0.6	0.6	0.6	0.6	0.6	0.6
Thermal transmittance of the glazing Ug [$W/m^2 \cdot K$]	1.1	1.1	0.7	0.6	0.5	0.5
Configuration glazing	4/16/4	4/20/4	4/12/4/12/4	4/15/4/15/4	4/20/4/18/4	4/20/4/18/4
Frame area A_f [m^2]	1.43	1.43	1.00	0.98	0.84	0.83

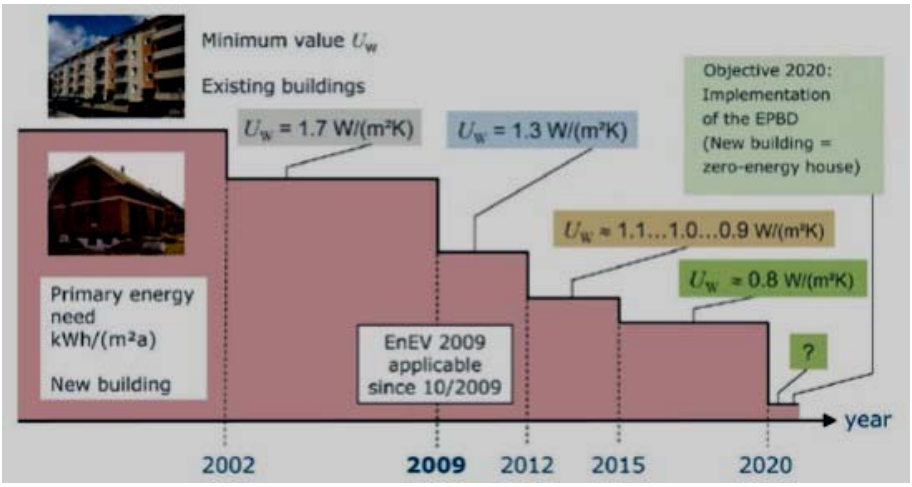


Fig. 3 Development of the level of requirements of the EnEV.

to achieve excellent thermal insulation with casement window and coupled window constructions along realization of the concept of integration of insulation materials in the window frame. Moreover, it is easier to integrate technical components, such as ventilation and solar shading system, in these windows. Window manufacturer is no longer cumbersome and expensive. Integration of insulation materials in the window frame allows easy, but effective solution, which requires relatively little effort during production, with

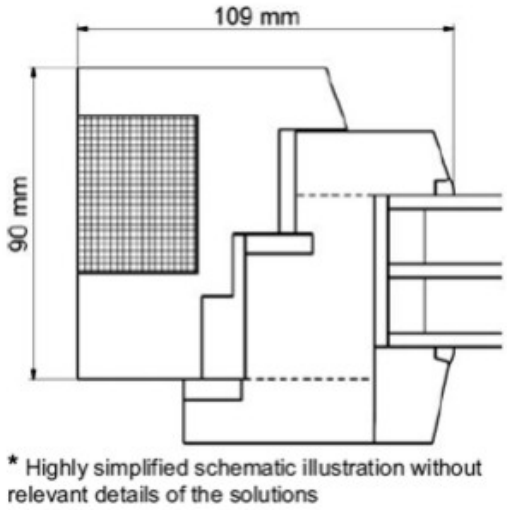


Fig. 4 Example of timber window construction with a combination of a profile construction and the use of insulation material (U_w = 0.84 [W/m^2·K].

a significant improvement in the thermal performance of the massive cross section. If necessary, insulating material can be introduced into the groove from the outside, regardless of the shape of the window (e.g. pieces, round, etc.).

This concept of installing insulation material (foam) with the frame already accepted some manufacturers of PVC windows and successfully marketed.

Research the use of modified wood or those that have a low density and thermal conductivity for the production of wooden windows, also provide promising prospects for achieving improvement of thermal characteristics of wooden windows (e.g. Use of thermally modified poplar wood). They can be used, for example, in the central part of the edges of the window, to improve the thermal properties.

Great potential for development in innovative glazing systems or structures integral window. The complete solution to facilitate the reduction of the width of view, and thus, provide advantages in respect of both design and thermal properties.

The prototype that produced and analyzed at the Institute IFT Rosenheim has shown very good performance, adequate structural characteristics and excellent thermal characteristics. Easy and fast glazing of the finished structure is facilitated by using multi-layer insulating glass, including a binding framework as the product supplied. The limitations of such production variants can occur in the very structures. Solutions for window profiles often fall on account of compatible adhesives, but they offer great potential for development.

The frame thickness of at least 90 mm in combination with a triple-layer insulating glass can be seen today as the "new standard" or "state-of-the-art technology". Wooden window frame thickness from the current 90 mm can be reduced (reduction in cross-section) and the use of triple-layer MIG (Multi-layer insulation glass) in the case of production of dimensionally large elements.

The significant tests for the application of a vacuum in the IGU (insulating glazing unit) are currently held. In the case of solar, protection is proposed use of solar control glazing with screen print. The optimization of the glazing construction was made by the selection of

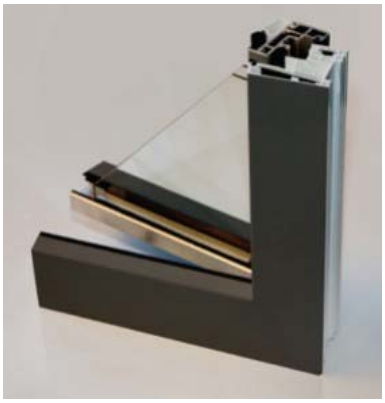
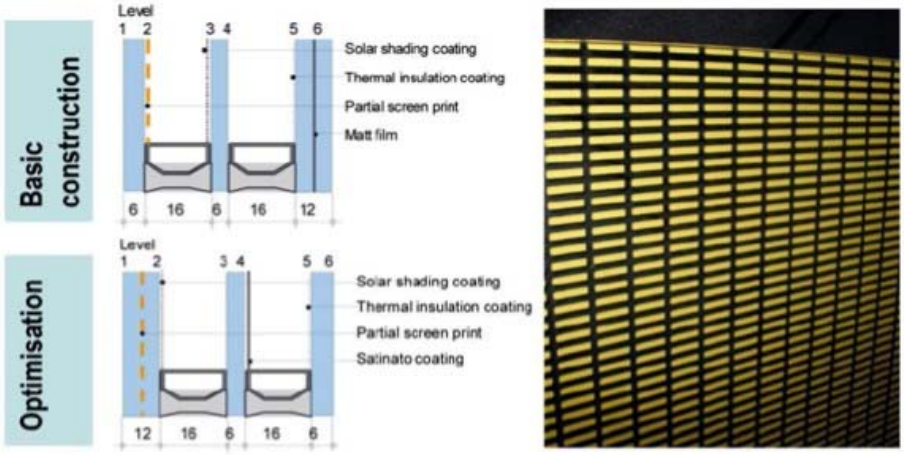


Fig. 5 PVC window "Aluplast GmbH", Karlsruhe Germany.

Fig. 6 Components window made of modified wood.



Coating IGU (Insulating glass unit)	Set value at 32 % screen print	g-value IGU without screen print **before optimisation**	g-value with screen print **before optimisation**	g-value IGU without screen print **after optimisation**	g-value with screen print **after optimisation**
70/40	26 %	41 %	32 %	33 %	25 %
51/26	20 %	34 %	27 %	22 %	17 %
41/21	13 %	32 %	25 %	19 %	14 %
			Requirement not fulfilled		Requirement fulfilled

Fig. 7 Optimization and characteristic value of solar control glazing with screen print (Source: Sottas SA).

the coating levels of screen print. Thus the solar shading / thermal insulation as well as g-value had been reduced significantly. But it still need to work on this improvement because the first implementation of the requirements radiant physical properties could not be fulfilled.

In implementing and developing these new systems, it is necessary to have a constant coordination with the manufacturer of hardware fittings, sealing profiles and tools and with all other relevant suppliers as early as possible during the development phase itself.

4. Conclusions

When decide on the choice of the type of windows you need to take into account the identification of all necessary information essential for defining the requirements of the specific conditions of use. Today the market of Europe can get various types of windows that meet the current requirements on energy efficiency and energy saving. However, the achieved level of the quality of the final window is not performed because the relevant research in improving the thermal performance of windows with a view to

the new construction of buildings achieve zero-energy level.

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