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SOLUTIONS FOR CREATING THE MAIN ELEMENTS WHICH CONDITION THE ENERGY CONSUMPTION
EXTERIOR WINDOWS - ROOF

BY

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Abstract. The envelope of the building often has a complex geometry in which a multitude of different sub-assemblies can be identified. The envelope elements specific to roof areas can generally be of three types: walk and non-walk terrace roof as well as roof truss. The exterior joinery analysed is PVC type with four glass sheets.

Key words: exterior windows; platforms; roof terrace; roof truss.

1. Introduction

The main factor conditioning the electrical consumption in an inhabited building is the building envelope and this needs to be analysed according to its structure as well as from the volumetric point of view, its exterior and interior finishing materials. Also, from the architectural point of view, the geometrical shape, the exterior finishing materials, the specific colours and the blend of different components of the envelope represent essential elements for the architect and are determining factors in the plastic volumetric image of the resulting architectural object.

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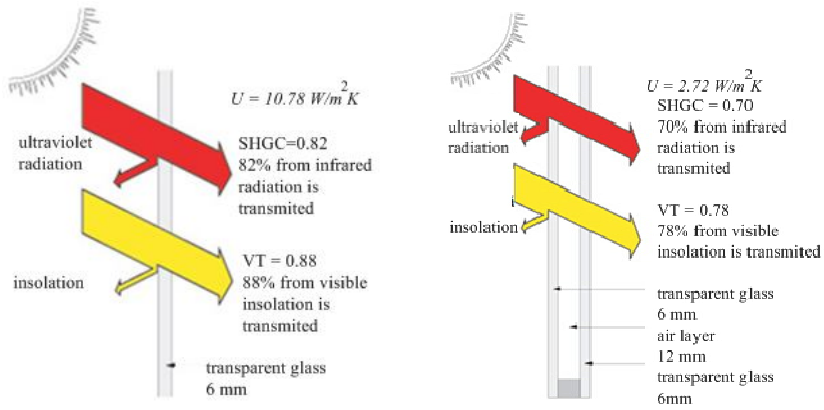
The envelope of the building often has a complex geometry, in which there can be identified numerous different sub-assemblies.

The envelope elements specific for the roof areas can generally be of three types: walk and non-walk roof terrace as well as roof truss. The exterior joinery is made of PVC with four sheets of glass.

1.1. Exterior Windows

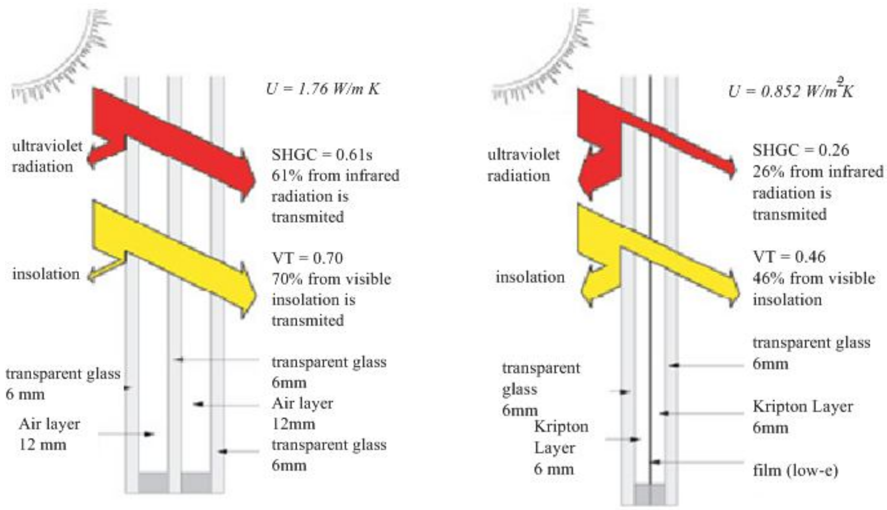
Windows are a component part of buildings which usually goes unnoticed even if the progress in this field for the past 30 years have been extraordinary (http://www.comercialwindows.umn.edu). More and more producers try to obtain high thermal performances and with this purpose they use combinations of several sheets of glass, among which ordinary sheets of glass and sheets of low emissivity glass (low-e) and gases with low thermal conductivity, such as Argon or Kripton. If in the beginning years of the race towards obtaining a high performance window, with a loss of energy smaller than the energy obtained from the luminous radiance of the sun, the use of a greater number of window sheets was tried, being doubled with low emissivity films to obtain a greater thermal resistance, nowadays there are efforts to obtain an equilibrium between the thermal resistance of the window and its other properties such as the degree of light transmission or infrared radiation.



a *b*

Fig. 1 – Thermal transmittance, transmission of infrared radiation and of the solar luminous radiation for simple windows (*a*) and double glazing windows with two window sheets (*b*), (http://www.comercialwindows.umn.edu).

To highlight the fact that a superior thermal protection diminishes the transmission of light and the energy gains coming from the ultraviolet and infrared solar radiations there are schematically presented the thermal transmittance, the transmission of the gained infrared and ultraviolet radiation for five types of windows, such as: simple window of 6 mm (Fig. 1 *a*); double glazing windows with two window sheets of 6 mm and an air layer of 12 mm between them (Fig. 1 *b*); double glazing window with three window sheets of 6 mm and two air layers with 12 mm between them (Fig. 2 *a*); double glazing window with two window sheets of 6 mm and a Kripton layer of 12 mm between them, in the middle of the layer being placed a low-e film (Fig. 1 *b*) and finally a double glazing window with three window sheets of and two layers of Kripton of 6 mm between them, on the interior glass sheet being placed on the both sides two low-e films (Fig. 1), (http://www.comercial-windows.umn.edu).



a *b*

Fig. 2 – Thermal transmittance, transmission of infrared radiation and of the solar luminous radiation for double glazing windows with three window sheets (*a*) and double glazing windows with two window sheets, Kripton and low-e film (*b*) (http://www.comercialwindows.umn.edu).

It can be observed that, in order to reach approximately equal values of unidirectional thermal resistance for the glazed space with those of the opaque space (R = 2.2 m^2.K/W) the solar inputs diminish considerably reaching only 24% of the entire gained ultraviolet+ultrared solar radiation reaching the exterior surface of the window.

However, the biggest problem in using the windows with high energetic performance is not the thermal resistance of the products that the market offers, but their high price which, in most of the cases, are unaffordable for the ordinary person. A window produced in Germany, imported, with an unidirectional thermal resistance of 1.25 m^2.K/W, can reach a final price three times higher than an ordinary window.

To ensure a high level of thermal protection, the double glazing window with four window sheets and PVC joinery was chosen (Fig. 3).

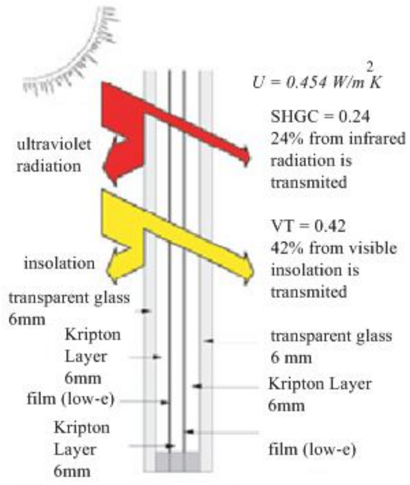


Fig. 3 – Thermal transmittance, transmission of infrared radiation and of the solar luminous radiation for double glazing windows with three window sheets, Kripton and two low-e films (http://www.comercialwindows.umn.edu).

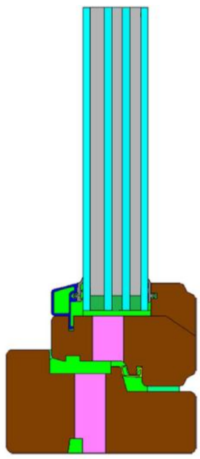


Fig. 4 – Section of joinery; the pink areas are the polyurethane foam insertions with the role of breaking the thermal bridge and the brown coloured areas represent the PVC part of the joinery.

The double glazing window with four window sheets is obtained by the same technique as the simple double glazing window. Just as in the case of double glazing window, in the three spaces between the glass sheets can be introduced a rare gas such as Argon. The unidirectional thermal resistance of the glass area, established following a study of the literature in the field, is R = 1.4 m^2.K/W. This value will be corrected due to the influence of the smaller thermal resistance of the joinery and to the contact between the glass and the joinery. It is proposed the use of a PVC joinery (Fig. 4) with an insertion of polyurethane foam to break the thermal bridge. It is observed that by using this type of joinery, the unidirectional thermal resistance diminishes under 20% which leads to adopting the value R' = 1.2 m^2.K/W for the corrected thermal resistance of the windows.

2. The Roof

2.1. Terrace Roofs

The superior bridging-terrace roof is designed in two different constructional solutions these being walk terrace roof and non walk terrace roof. In Fig. 5 it is represented the detail of a non walk terrace roof with 10 layers in composition. On the interior, the bridging is finished with a coating of binder M5 (*10*).

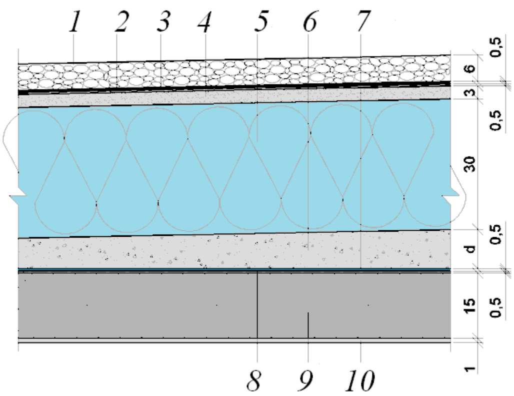


Fig. 5 – Superior bridging- non walk terrace roof.

The resistance layer of the roof is the platform of steel concrete (*9*), 15 cm thick. Next, there are two layers with the role of stopping the water vapours from inside of the building to get to the thermal insulation layer and being diffused outside the building. These two layers are the diffusion layer (*8*) and the vapour barrier (*7*). In order to create the necessary chute destined to collecting and draining the meteoric water, a chute layer of approximately 7 cm thick, made of M100 mortar, will be placed there (*6*). Over this layer will be put the thermal insulation of Styrofoam, of 30 cm thick (*5*). In order to create a support rigid enough to suitably install the hydro insulation, there is placed a lightly reinforced, 3 cm thick sub-floor, made of concrete with small granularity aggregate sheathed with scolded net with reduced dimensions of the bars (*4*). The layers placed between the vapour barrier and hydro insulation contain a certain amount of water in the moment of being made. Due to the high values of temperature that can be reached in the hydro insulation during the summer, a part of the water from the above mentioned layers will evaporate, creating a pressure that can dislocate the hydro insulation from it support layer. To balance this pressure and implicitly to diffuse the water vapours appearing toward the exterior of the building, there is placed another layer of diffusion (*3*) between the hydro insulation and the support layer. The hydro insulation made of polymeric membranes (*2*) has the role of preventing the meteoric waters to get into the layers of the roof. The last layer of the roof is a layer of gravel with small granularity and light shaded grains with the role of protecting the hydro insulation against the ultraviolet sun radiation (*1*).

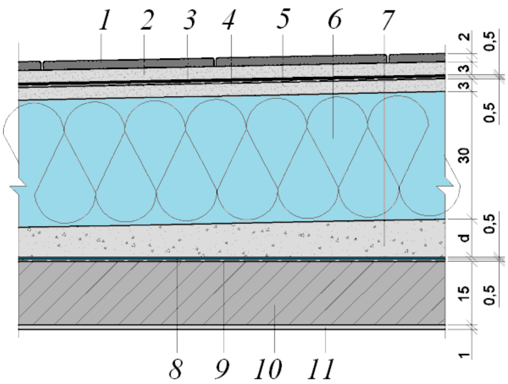


Fig. 6 – Superior bridging- walk terrace roof.

Composing the walk terrace roof (Fig. 6) there are the same layers previously presented: interior coating (*11*); platform of steel concrete (*10*); diffusion layer (*9*); vapour barrier (*8*); chute layer (*7*); thermal insulation (*6*); lightly reinforced sub-floor (*5*); diffusion layer (*4*); hydro insulation (*3*). With the purpose of distributing the charge on a greater surface in order to eliminate the risk of piercing the hydro-insulation, there is placed a layer of ceramic flagging with a surface of 40 ×40 cm. These slabs are placed on a sand layer with a granularity bigger than 3 mm. The slabs will not be glued, in order to allow the water to drain through the formed joints and through the layer of sand towards the outflow.

In the calculus of the unidirectional thermal resistance there are taken into account just the layers placed under the hydroinsulation.

2.2. Roof Truss

The structure of resistance of the roof with large chute is made of wood, represented in Fig. 7. There are indicated the layers which contribute to the thermal resistance of this roof. Thus, on the inside there is used a dry coating of gypsum-carton board panels (*1*). Between the truss frame of the roof and above them there will be placed a thermal insulation of rigid mineral wool, made of two layers of 10 cm thick, placed perpendicularly (*2*), on two directions. With that end in view, on the truss frame will be placed a net of little girders, squared on them.

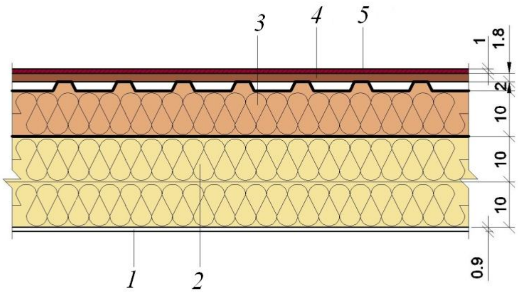


Fig. 7 – Roof truss.

On this net of little girders there will be placed a layer of thermal insulation panels, sandwich type, with a thickness of 10 cm (*3*), with a core of polyurethane foam. Over these it will be placed a panel of OSB (*4*) as support layer for the standing seam. Finally, on this support layer of OSB it is placed the cover, made of standing seam (*5*).

4. Conclusions

Using the „smart windows”, window type has a very important role both in the insulation of the building and in its ventilation, as well as in obtaining a thermal and even energetic major input in the energy economy of an inhabited building.

By carefully analysing the envelope of the building and by intelligently correlating its efficiency with intelligent systems of capturing and converting the solar energy, there can be obtained a habitable building, efficient from the energetic point of view and using a free architecture, unconstrained by the typical architecture of passive houses.

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SOLUȚII DE ALCĂTUIRE A PRINCIPALELOR ELEMENTE CARE CONDIȚIONEAZĂ CONSUMUL ENERGETIC
Ferestre exterioare – Acoperiş

(Rezumat)

Anvelopa clădirii are de multe ori o geometrie complexă, la care pot fi identificate o multitudine de subansambluri diferite. Elementele de anvelopă specifice zonelor de acoperiş pot fi în general, de trei feluri şi anume: zone de acoperiş terasă circulabilă şi necirculabilă, precum şi zone de acoperiş şarpantă. Tâmplăria exterioară analizată este din PVC cu patru foi de geam.