BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
Publicat de
Universitatea Tehnică „Gheorghe Asachi” din Iaşi
Tomul LIX (LXIII), Fasc. 2, 2013
Secţia
CONSTRUCŢII. ARHITECTURĂ

SOLUTIONS FOR CREATING THE MAIN ELEMENTS WHICH CONDITION THE ENERGY CONSUMPTION
WALLS – BRIDGINGS

BY

ALIN RUBNICU*

“Gheorghe Asachi” Technical University of Iaşi
Faculty of Civil Engineering and Building Service

Received: October 8, 2012
Accepted for publication: October 18, 2012

Abstract. The main factor conditioning the energy consumption in an inhabited building is the envelope of the building and this must be analysed from the point of view of its structure, from the point of view of the volumetric shape, the 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 the main instruments of the architect and are determining factors in the plastic volumetric image of the resulting architectural object.

Key words: exterior walls; roof; bridging.

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

* *e-mail:* alin.rubnicu@yahoo.com

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. In this research, the exterior walls have been divided in three categories of envelope elements: exterior walls made of bricks, light exterior walls and exterior walls made of steel concrete (in basements and heated semi-basements). The envelope elements specific for the roof area can generally be of three types too: walk and non-walk roof terrace areas as well as roof trass areas. The inferior bridging can be divided as follows: different areas of bridging over the ground floor (with heated spaces, in console over the exterior and different areas of plate in direct contact with the ground).

2. Walls

2.1. Exterior Walls Made of Steel Concrete Diaphragms (corresponding to the basement or heated semi-basement)

In Fig. 1 there can be observed the disposal of the layers in creating the multilayer walls at the semi-ground and/or ground level, in three variants of exterior finishing.

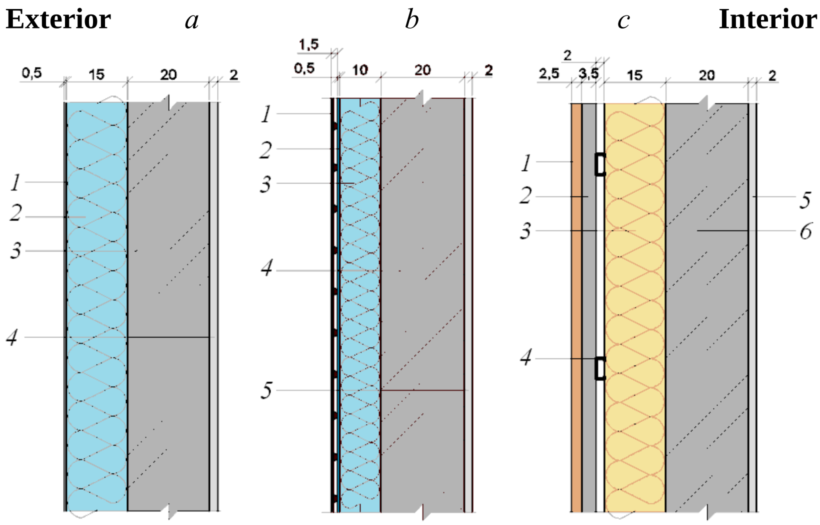

Fig. 1 – Exterior wall of steel concrete.

The exterior walls of the basement are made from steel concrete. In Fig. 1, a construction detail of this wall is represented, in which its component coatings can be observed, both in the surface buried in the wall and also in the wall in contact with the exterior air. Thus, the wall exposed to the bad weather

(Fig. 1 *a*) has an interior finish of interior plaster made with M5 binder (*4*). The thickness of the steel concrete wall (*3*) is of 20 cm. For a better thermal protection and for aligning the insulation of the basement wall with that of the ground floor wall, the thermal insulation will be of 15 cm and will be made from extruded polystyrene (*2*), and over this layer is disposed a reinforced mineral plaster (*1*). The buried wall (Fig. 1 *b*) also contains inside a hydro insulation protected with a clip bolt membrane.

The thickness of the steel concrete wall (*4*) is of 20 cm. The wall is insulated on the exterior with a layer of extruded polystyrene of 10 cm (*3*), and over this layer the hydro isolation against water without hydrostatic pressure will be layed out (*2*), protected against the perforation due to the ground pressure by its clip bolt membrane (*1*). This way, all the essential requirements for a good performance are accomplished.

The exterior wall of the basement with exposed surface, finished with wood panel, its detail of the wall being presented in Fig. 1 *c*, is built up as follows: on the interior the wall is mended with the same coating (*5*), the diaphragm thickness is of 20 cm (*6*). The thermal insulation is realized of rigid mineral wool with a thickness of 15 cm (*3*). On a structure made of open profiles with thin walls (*4*) there are bounded OSB panels, on which the wood panel will be fixed (*1*).

2.2. Exterior Walls Made of Brickwork GVP (corresponding to the ground floor)

The exterior walls made of GVP brickwork (at the ground floor level), are finished in three different constructive solutions: with reinforced mineral plaster and natural stone, presented in Fig. 2, the third solution being realized with wood panel as it can be observed in Fig. 2 *c*. The layout of the component layers is identical to the represented one in Fig. 2 *b*, only instead of the stone layer there is, in this case, a wood layer. In the thermal calculus only the layers disposed up to the ventilated air layer will be taken into account.

In Fig. 2 there are presented the technical details of the exterior walls made of GVP brickwork, with three variants of exterior finishing. In the case of the wall finished with reinforced mineral plaster the component layers are: interior plaster made with M5 binder (*1*), GVP brickwork (*2*), thermal insulation of rigid mineral wool (*3*) and reinforced mineral plaster (*4*). The wall finished with natural stone is composed of interior plaster (*1*), GVP brickwork (*2*), thermal insulation of rigid mineral wool (*3*), structure made from open profiles with thin walls (*4*) on which there are bound HERAKLITH panels (*5*), and in the end the natural stone layer (*6*), disposed on the previous layer by adhesion.

The layer of HERAKLITH panels are layed out to create a bed rigid enough to sustain the stone finishing. The HERAKLITH panels are made of wood fiber agglomerated with cement, hardly inflammable, with a weight of

250…450 kg/m^3 (Fig. 3). The panels are usually to be found in sizes of 200 × × 50 cm and a thickness of 2.5, 3.5, 5.0, 7.5, 10 cm (http://izotherm-serv.infoconstruct.ro).

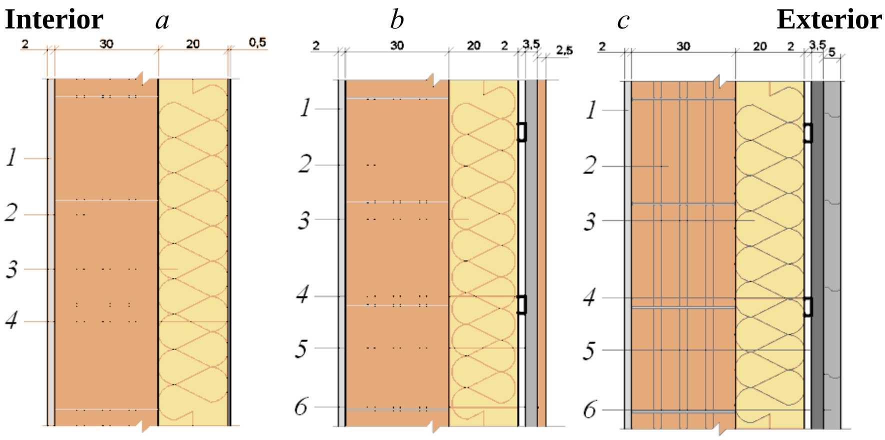

Fig. 2 – Exterior wall of brickwork: *a* – outer wall with outer finished with reinforced mineral plaster; *b* – outer wall of brickwork finished with wood panel; *c* – outer wall with exterior finish of natural stone

In the case of the wall finished with stone, a ventilated air layer is created between the HERAKLITH and the thermal insulation so as the layers, after the thermal insulation, will not be taken into account in the unidirectional thermal resistance calculus, the temperature of the air layer being approximately equal to the one of the exterior air.

Fig. 3 – HERAKLITH panels.

2.3. Exterior Walls on a Light Structure of Wood Frames (according to the floor)

For the exterior wall (corresponding to the floor), made of wood, there were similarly designed two different solutions of exterior finishing. Thus, in

Fig. 4, the constructive details of this type of wall are presented, with the two types of different exterior finishing.

On the interior there is boarded over a layer of dry plaster made of plaster-carton board plates (*1*). These are fixed on a continuous rigid support, made of OSB plates (*2*), onto which there was previously placed a foil vapour barrier. The wall's sustainment structure is made of a trellis girder with small girders of 4 × 4 cm (*3*) to avoid creating thermal bridges. Between these girders there is placed a thermal insulation layer of rigid basalt mineral wool 20 cm thick (*4*).

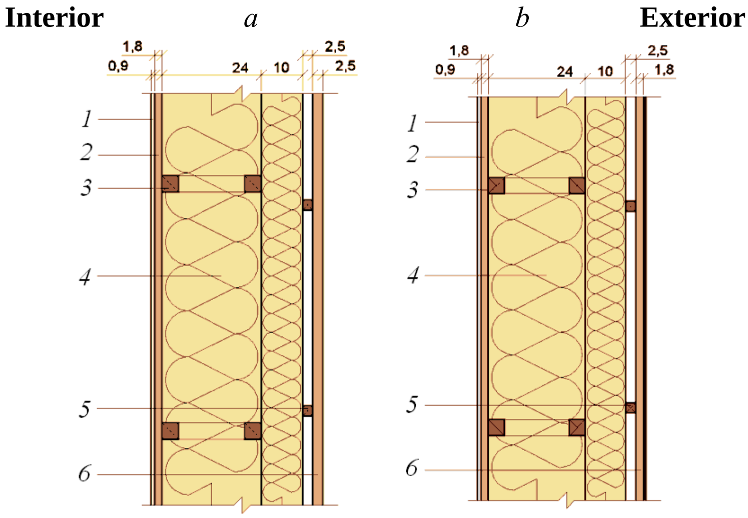

Fig. 4 – Exterior wall made of wood: *a* – wall closed on the exterior with wood panel of 2.5 cm thick; *b* – wall closed on the exterior with standing seem attached to a continuous support of OSB panels.

On the trellis girder there are attached, on the exterior side, perpendicularly, wooden planks with a section of 4 × 10 cm, between them being placed another layer of thermal insulation of rigid mineral wool, with the purpose of diminishing the effect of the thermal bridges represented by the trellis girder.

3. Bridgings

3.1. Inferior Bridging

The inferior bridging can be made of areas with bridging over exterior and panel on the ground.

The bridging over exterior (Fig. 5) is made of 6 layers which will enter in the calculus of the unidirectional thermal resistance. On the inside, the attrition layer of the bottom covering is made of tiles (*1*). To create a perfectly straight support for the tiles, there is made a leveling subfloor of M10 binder (*2*). Under this layer there is placed another of polystyrene (*3*) on which will be introduced the pertaining pipes for the under floor heating. The layer with structural purpose is the steel concrete bridging with a thickness of 15 cm (*4*). On its intrados a thermal insulation of rigid mineral wool (*5*) of 20 cm thick will be introduced. The thermal insulation will be protected on the outside with a layer of reinforced plaster (*6*). Special attention is required to protect, from the thermal point of view, this type of envelope, due to the fact that the thermal bridges pertaining to this one are very hard to correct. A continuity of thermal insulation all over the surface of this bridging is required.

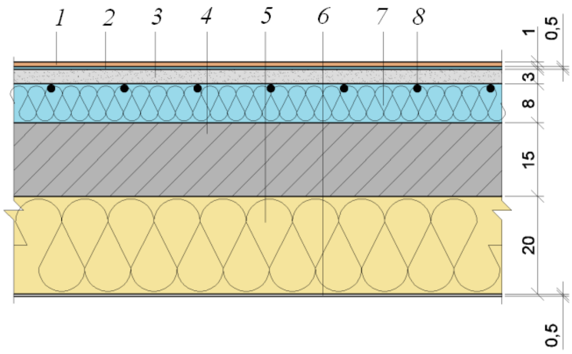

Fig. 5 – Deck over exterior.

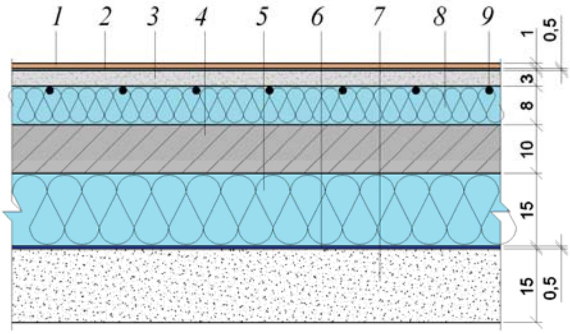

Fig. 6 – Panel on the ground.

The ground panel closes the building on the bottom side all over the surface of the basement and also under certain areas of the ground floor. In Fig. 6 it is represented a detail of this envelope element in which are indicated the inside layers. Thus, on the interior, the attrition rate of the floor is also made of tiles (*1*), set on a leveling sub-floor (*2*). Under this layer there is effectuated a layer of polystyrene (*3*), in which will be introduced the pertaining pipes for the under floor heating. The concrete steel panel (*4*) is a 10 cm thick one. In order to avoid the loss of heat toward the ground, there is set a layer of thermal insulation of extruded polystyrene, 15 cm thick (*5*). Under this layer there is placed a hydro-insulation against water without hydrostatic pressure (*6*). In order to avoid the ascension of water through capillarity , in the end of this construction element can be also found a capillarity breaking layer, made of ballast (*7*).

4. Conclusions

1. Paying sufficient attention to the architectural conception of inhabited buildings and integrating some simple but time efficiently proven concepts, as well as some innovative concepts, can significantly lead to a reduction of their energy consumption and to the proliferation on a large scale of such buildings.

2. By attentively analysing the building envelope and by smartly correlating its efficiency with intelligent systems of capturing and converting the solar energy, there can be obtained a housing building from the energy point of view, using a free architecture, without the constraints of the typical architecture of passive houses.

3. Using any type of multi layer wall analysed in this paper can greatly contribute to the creation of a house that is energetically passive, no matter of the architectural concept type used.

4. The use of insulating paving, together with the rest of the envelope, contributes to creating a very good global quotient of thermal protection.

REFERENCES

Andreica H.A., Dumitraş M., *Proiectarea construcţiilor*. Edit. Univ. Tehn., Cluj-Napoca, 1994.

Focşa V., Broşteanu M., *Higrotermica clădirilor*. Inst. Politehnic, Iaşi, 1983.

Focşa V., *Clădiri civile (Acoperişuri)*. Inst. Politehnic , Iaşi, 1973.

Gavrilaş I., *Fizica construcţiilor. Reabilitarea higrotermică a clădirilor*. Edit. CERMI, Iaşi, 1999.

Kreith F., Kreider F., *Principles of Solar Engineering*. Hemisphere Publ. Corp., NY, 1978.

Pruteanu M., *Soluţii neconvenţionale de protecţie termică*. Edit. Politehnium, Iaşi, 2011.

Rubnicu A., *Soluţii funcţionale şi de plastică arhitecturală în vederea îmbunătăţirii utilizării energiilor neconvenţionale la clădirile de locuit.* Teză de doctorat, Univ. Tehn. "Gh. Asachi", Iaşi, 2012.

* * * http://www.activehouse.info/

* * * http://www.german-renewable-energy.com/

* * * *Normativ privind calculul termotehnic al elementelor de construcţie ale clădirilor*. C 107, 2005.
* * * *Strategia energetică a României pentru perioada 2007-2020*. H.G. *1069*/2007.

SOLUŢII DE ALCĂTUIRE A PRINCIPALELOR ELEMENTE CARE CONDIŢIONEAZĂ CONSUMUL ENERGETIC
Pereţi – Planşee

(Rezumat)

Principalul factor ce condiționează consumul energetic la o clădire de locuit este anvelopa clădirii, iar aceasta trebuie analizată atît din punctul de vedere al alcătuirii ei structurale cît şi din punctul de vedere al formei volumetrice, a materialelor de finisaj interior şi exterior folosite. Totodată, din punct de vedere arhitectural, forma geometrica, materialele de finisaj exterior, culorile specifice şi modul de îmbinare a diferitelor elemente componente ale anvelopei, reprezintă instrumentele esenţiale cu care opereaza arhitecţii şi constituie factorii determinanţi ai imaginii plastic-volumetrice a obiectului de arhitectură rezultat.