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SOME ASPECTS CONCERNING THE INCREASING THE ENERGY EFFICIENCY FOR BUILDINGS MADE OF BRICKWORK AND AUTOCLAVED AERATED CONCRETE MASONRY

BY

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Abstract. In the present context of the continuous increase of worldwide energy prices and of the concern to support the global efforts to improve climate change, each state has developed a strategy to increase the energy efficiency of buildings. The method of insulation the exterior walls of buildings by applying the thermal insulation layer on the outside is well known and has many advantages. There are also some cases where, due to several factors, the method of insulation on the inner surface of the exterior wall is used, which requires a careful analysis of the adopted solutions. This paper presents a study of the results of measures made in order to increase energy efficiency in the case of collective residential buildings, as well as a verification of the risk of condensation in the structure of an exterior wall, where the additional insulation is applied on the inside surface of it.

Key words: energy efficiency; thermal rehabilitation; condensation risk.

1. Introduction

The constructions of residential buildings with exterior walls of brickwork masonry and aerated concrete blocks dates from 1984-1990, this

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being the only solution that satisfies the requirements of the code NP15/1985. In this period the use of highly efficient insulating materials as expanded polystyrene or mineral wool were prohibited, these materials being considered as energy-intensive materials. The energy performance of this type of buildings is superior to those of monolithic panels or diaphragms made sliding shutterings, structures widely applied in that period.

In these circumstances, marked by the imminent increase in energy prices and encouraging the measures of energy thermal rehabilitation of residential buildings, the occupants of such buildings are concerned about reducing energy consumption by adopting additional thermal protection or other kind of measures.

Based on these elements, such a building was analysed in terms of thermal energy consumption, in order to determine the optimal solutions to increase performance energy.

2. Description of the Analysed Building

The collective housing building, which was the subject of study, is a building with groundfloor and 3 floors, located in town of Iaşi. The building was built in 1987 and has 7 apartments in the analysed section.

The building envelope consists of

a) exterior walls of brickwork of 25 cm thickness and insulation of BCA of 20 cm;

b) pitched roof type with unheated attic and insulation made of BCA plates of 20 cm thickness;

Fig. 1 – The analysed building.

c) windows of PVC frames and thermopane glass that replaced the old wooden joinery, achieved by occupants effort (Fig. 1).

The space heating is achieved with radiators.The general condition of the building is good, the finishings are not damaged and there are no condensation or mold points.

3. Thermal Analysis – Initial Situation

The thermotechnical and geometrical characteristics of the envelope are shown in Table 1.

Table 1
Thermotechnical and Geometrical Characteristics of the Envelope

Envelope element	Surface, [m^2]	Thermal resistance on a single direction m^2.K/W	Adjusted thermal resistance m^2.K/W
Façade N-E	138.9	1.424	1.180
Façade S-E	78.38	1.424	1.135
Façade S-V	122.14	1.424	1.078
Façade N-V	109.95	1.424	1.155
Slab under unheated attic	158.65	2.702	2.718
Wall toward unheated attic	13.24	1.465	1.273
Slab over unheated basement	158.65	1.511	1.509
Wall toward stairs case	130.47	1.074	1.073
Joinery	79.68	0.5	0.5

The main geometrical characteristics have the following values: S_{env} = = 990.06 m^2; V_{heat} = 1,573.6 m^3; S_{heat} = 526.41 m^2; A/V = 0.635

The results of energy performance analysis are presented in Table 2.

Table 2
Energetic Performance of the Building

Indicator	Symbol	Value
Mean thermal resistance of the whole building	R_{OM}, [m^2.K/W]	1.288
Global coefficient of thermal insulation	G, [W/m^3.K]	0.692
Number of degrees days of heating	N_{GZ}	1,624.75
Annual necessary energy for heating	Q, [kW.h/year]	56,315.21
Specific annual necessary energy for heating	Q, [kW.h/m^2.year]	106.98
Energetic class		*C*

The principal indicators related to energy performance show a level of thermal protection rather high compared to similar buildings built before 1990. Substantial contributions has the reduced value of the compactness index and the fact that the old wooden windows were replaced entirely with PVC windows and double glazing, the adjusted thermal resistance values estimated on elements being significantly lower than the standardized ones.

Verification of condensation risk inside the exterior wall structure for the minimum outdoor temperature, specific for climate zone III (*Te* = –18°C) shows that at lower temperatures, condensation can occur between BCA layer and the outer plaster layer (Fig. 2) (Văleanu, 2009).

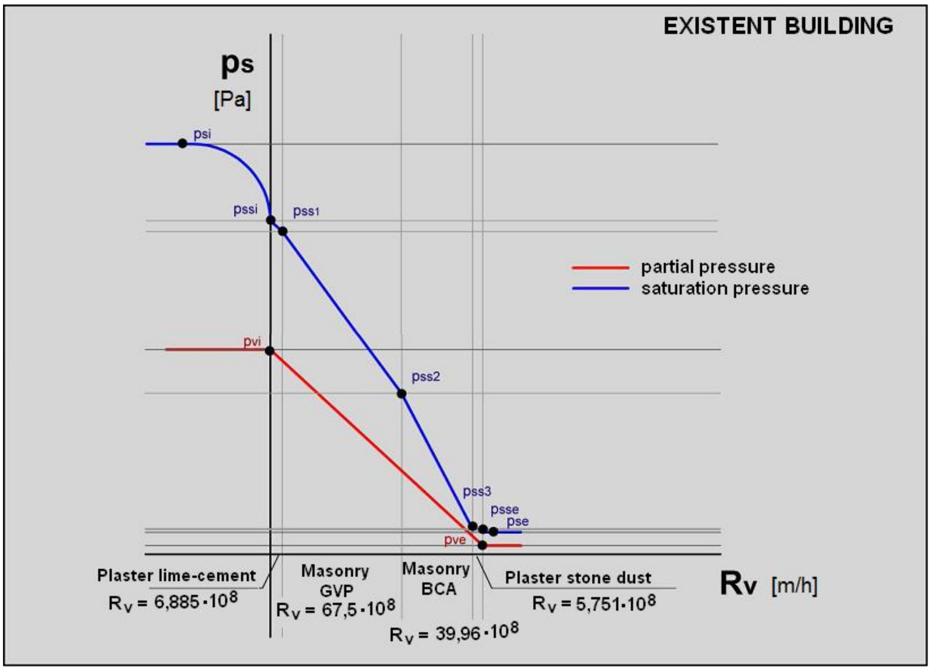

Fig. 2 – Verification of condensation risk in the wall structure for the initial situation.

4. Proposal for Thermal Rehabilitation

Having in view the relatively high level of energy efficiency for the analysed building, it was proposed a solution which is different from those currently practiced, mainly concerning the insulation of the exterior walls with a layer of insulating material with a thickness of 10...12 cm. In the given situation, it was analysed the way to increase the energy efficiency by placing an insulating layer of reduced thickness on the inside of exterior walls.

The thermal rehabilitation solutions are presented in Table 3.

To prevent the condensation risk on the surface, in areas of intersection between different elements, it was proposed an extension of insulation layer on the adjacent element on a lenght of 30 cm (Figs. 3,...,5) (Hauser & Stiegel, 2006).

Table 3
Thermal Rehabilitation Solutions

Envelope element	Thermal rehabilitation solution
Exterior wall	Expanded polystyrene 3 cm, protected by thin plaster reinforced with fiberglass mesh. On the inside surface of the insulation is provided a vapour barrier
Slab under unheated attic	Replacement of mineral wool insulation of 10 cm with extruded polystyrene of 15 cm protected by reinforced mortar screed reinforced with a mesh Ø4/100 mm.
Slab over unheated basement	Replacement of mineral wool insulation of 5 cm with expanded polystyrene of 10 cm on the inferior side of the slab, protected by a thin plaster layer, reinforced by a fiberglass mesh
Roof	Replacing the covering of burnt roofing tile with a covering of profiled sheet mounted on wooden board

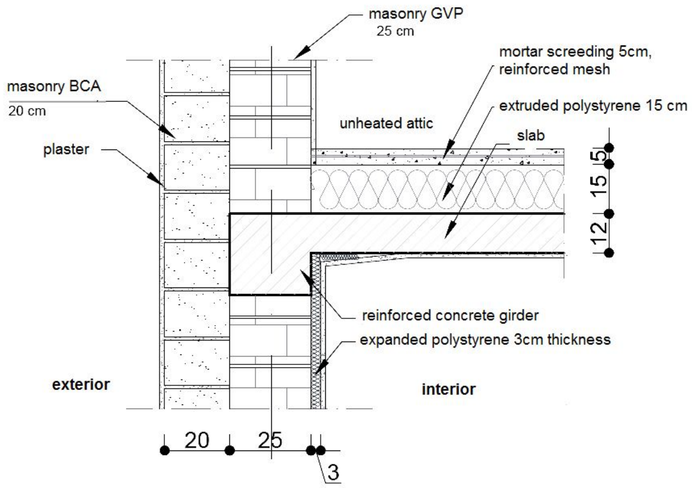

Fig. 3 – Detail of slab – exterior wall intersection.

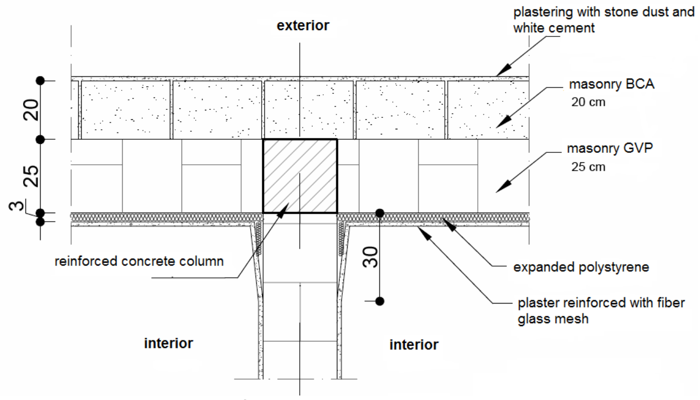

Fig. 4 – Detail of interior – exterior wall intersection.

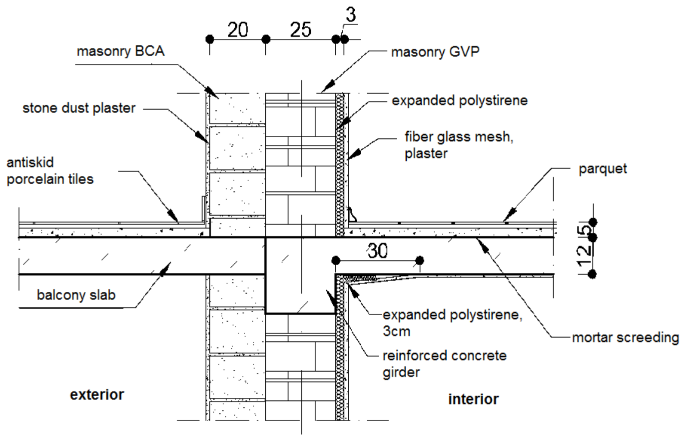

Fig. 5 – Detail of current slab – exterior balcony slab.

The main features of placing the insulation layer on the inside are:

a) it can be achieved more easily than the outside solution with no risk factors, particularly for collective housing, at any level;

b) it corrects thermal bridges in a smaller extent than in the case of external insulation;

c) is generally used for buildings with discontinuous occupancy;

d) it is used at buildings with special exterior architecture that would be affected by an external thermal insulation;

e) it could be an individual solution, for the time being, in big collective housing buildings that have achieved a partial thermal rehabilitation, thus avoiding an unpleasant urban image.

Fig. 6 – Façade partial insulated.

The motivation that led to this option in this situation results from the fact that the solution is preferred by the beneficiary due to simplicity of the implementation process and because it eliminates the need for a general agreement among all owners of apartments in the building. In the case of the external additional insulation solution, separate decisions of owners affect both the façade appearance and also the general aspect of the area (Fig. 6). The interior thermal insulation method can be made by each individual beneficiary in different periods of the year, with much lower capital expenditure. For studied building, appears also the exaggerated growth of the external wall thickness, associated with difficulties in attaching the insulating material to the structural layer.

The energy performance of the rehabilitated building, in the proposed solution, are presented in Table 4 (Mc 001/1 – 2006).

Table 4
Energetic Performance of the Rehabilitated Building

Indicator	Symbol	Value
Mean thermal resistance of the whole building	R_{OM}, [m^2.K/W]	1.933
Global coefficient of thermal insulation	G, [W/m^3.K]	0.529
Number of degrees days of heating	N_{GZ}	1,038.86
Annual necessary energy for heating	Q, [kW.h/year]	24,989.11
Specific annual necessary energy for heating	Q, [kW.h/m^2.year]	47.47
Energetic class		*A*

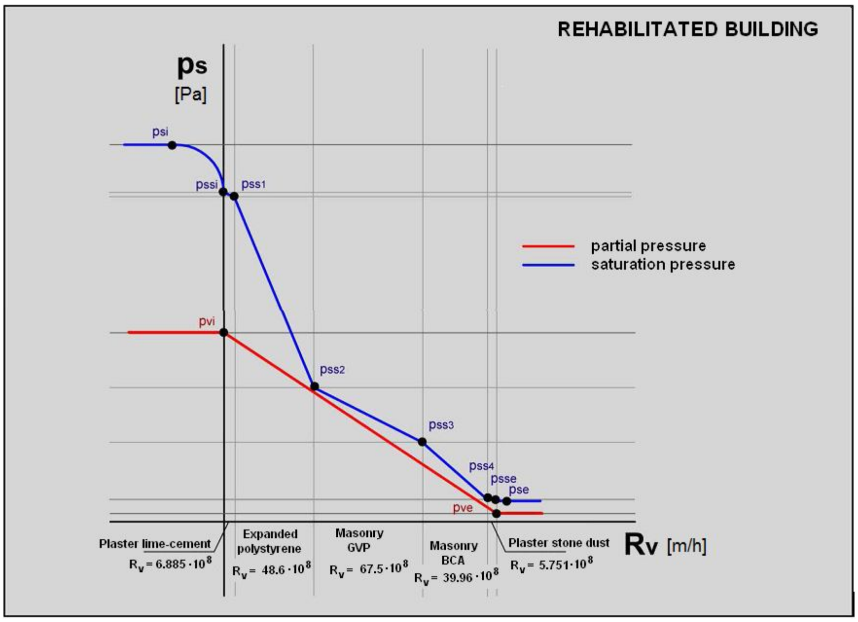

Fig. 7 – The verification of risk of condensation in the wall structure for the improved situation.

It can be noticed the increase of the general thermal protection degree by:

a) increasing of adjusted thermal resistance, for the envelope elements, over the standard values;

b) reducing the value of global coefficent of thermal insulation;

c) reducing the annual specific energy demand for heating and framing the building into class *A*.

The main matter relating to the disposal of the insulation layer on the interior side is the risk of condensation on the cold surface of the insulation (Fig. 7). For its elimination, a disposal of a vapour barrier is recommended on the inside of the wall, or making an interior finishing using gypsum boards.

5. Conclusions

The solution of adding a thermal insulation layer on the outside of the external wall has very well known benefits and these are validated by the practice.

But each case apart must be studied, in order to select the most adequate one, without excluding any possible alternative from the beginning.

In some cases, the additional insulation of the exterior walls on the inside surface, is not only acceptable but desirable.

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* * * *Metodologie de calcul al performanţei energetice a clădirilor*. Mc 001/1, 2006.

UNELE ASPECTE PRIVIND CREŞTEREA PERFORMANŢEI ENERGETICE LA CLĂDIRI CU PEREŢI DIN ZIDĂRIE DE CĂRĂMIDĂ ŞI BLOCURI DIN B.C.A.

(Rezumat)

În contextul actual al creşterii continue a preţului energiei pe plan mondial şi al preocupării privind susţinerea efortului global de ameliorare a schimbărilor climatice, fiecare stat a elaborat o strategie de creştere a eficienţei energetice a clădirilor. Metoda de izolare a pereţilor exteriori ai clădirilor prin aplicarea izolaţiei termice pe faţa exterioară este binecunoscută şi are avantajele ei. Sunt însă şi cazuri când, determinată de anumiţi factori, se aplică metoda izolării pe faţa interioară a peretelui exterior, ceea ce impune o analiză atentă a soluţiilor adoptate. Se prezintă rezultatel unui studiu privind consecinţele măsurilor de creştere a eficienţei energetice în cazul unei clădiri de locuit colective, precum şi o verificare a riscului de condens în structura peretelui exterior la care izolaţia suplimentară s-a aplicat pe suprafaţa interioară a acestuia.