Transilvania University of Brasov
FACULTY OF MECHANICAL ENGINEERING

ICMSAV2018 & COMAT2018 & eMECH2018
Brasov, ROMANIA, 25-26 October 2018

DETERMINATION OF HEAT LOSS THROUGH THE WALLS AT A HOTEL UNIT IN THE BRASOV AREA

Sebastian Blaj Brezeanu[1]
[1] Transilvania University of Brasov, Brasov, ROMANIA, blaj.sebastian@yahoo.com

Abstract : *This article presents the calculation of energy losses through the walls of a hotel unit function building. At the building under consideration there are heat losses due to building insulation, so there can be noticed the very large differences between the non-insulated and the insulated structural members. Thermal resistance to non-insulated walls is low and heat insulated walls are high. It is recommended that thermal insulation be applied to all building elements that make up the building under consideration.*
Keywords : *Hotel unit, thermal resistance, thermal insulation*

1. INTRODUCTION

The existing building stock in Romania, executed in different stages, with different structural and architectural solutions and with different degrees of thermal protection, will need to be coordinated and extremely necessary in the near future for thermotechnical rehabilitation and eventually for architectural modernization and functional, in order to improve the quality of interior comfort, reduce energy consumption and environmentally harmful emissions. At the present stage, it is of great importance to organize a wide range of analyzes and conclusions on the technical and economic options, including the financing ones, on the need of improving the thermal qualities of the existing constructions in the short and medium term (rehabilitation of thermal insulation in a way correspondingly), respectively the efficiency of the thermal installations of these buildings. Also, the use of high-performance building materials has been encouraged, technologies have improved as heat resistance has increased. Brick masonry has always been the building material most appreciated by the Romanian and European population due to the hygrothermal characteristics of the brick, and in particular the better behavior of moisture, fire, and the ability to absorb and restore heat periodically. The experience with large reinforced concrete panels and monolithic reinforced concrete walls did not enjoy the same success because of the lower hygrothermal characteristics of these materials, so that the thermal bridges formed at the level of the reinforced concrete elements were very high, the thermal resistances of they were very small, which led to a very large heat loss through these types of elements.

2. TECHNICAL REQUIREMENTS

This paper presents the determination of heat losses through the walls of a hotel unit in the Brasov area. The heat losses recorded through the walls of the building are due to the way these elements are built. The walls of the building under consideration have low thermal resistances, which leads to a loss of heat through them, so some of the energy needed to heat the hotel unit is lost through the building elements that make up the construction. According to the calculations to reduce the heat loss through the building elements (walls of brick masonry, floor above the ground, floor above the last level) that make up the building, layers of thermal insulation were applied to their faces so that the thermal resistances of the constructive elements increased and heat losses have dropped considerably. This specific measure of thermal insulation of the construction elements that make up the construction, together with other measures, allows for the realization of buildings that are truly extremely thermally efficient. The exceptional quality of the thermal insulation of a building can also be noticed by the comparative analysis of the infrared images for the façades of the two different buildings presented in Figures 1 and 2. Figure 1 shows the facade of a building without thermal insulation and in Figure 2 the facade a building that was thermo-insulated.

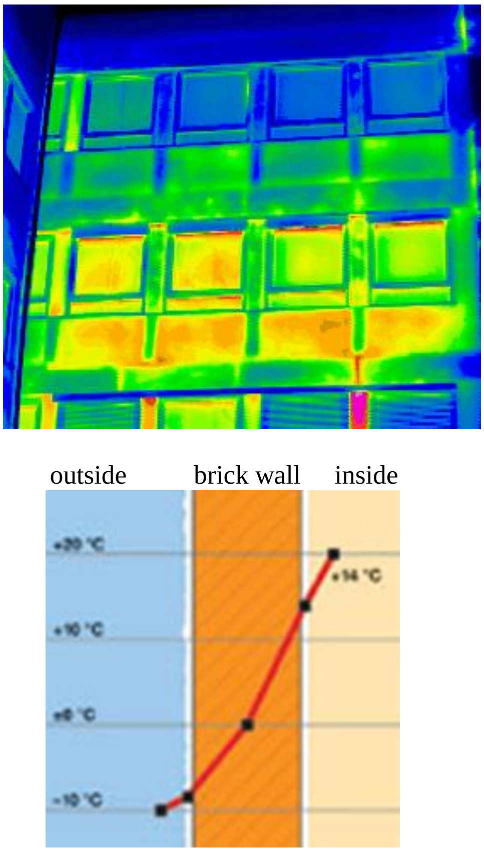

Figure 1 Building without thermal insulation **[6]**

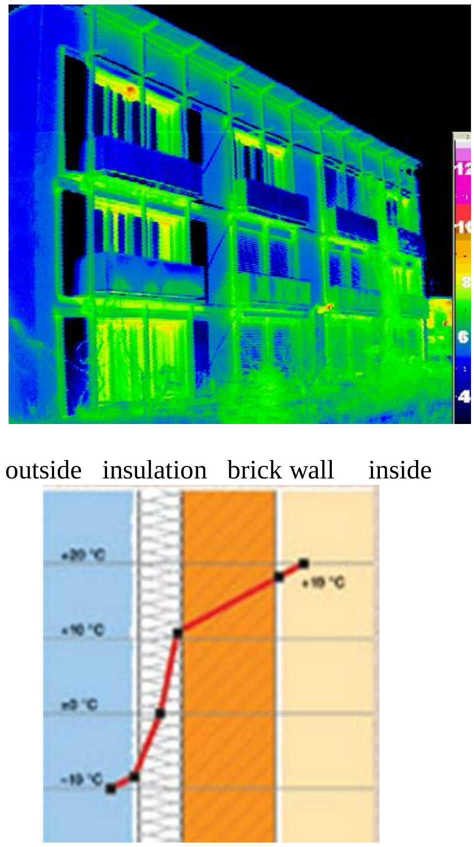

Figure 2 Building with thermal insulation [6]

Calculation of unidirectional thermal resistances

$$R = R_i + \sum \frac{d_j}{a_j \lambda_j} + R_e = \frac{1}{\alpha_i} + \sum \frac{\delta_j}{a_j \lambda_j} + \frac{1}{\alpha_e} \qquad \left[\frac{m^2 K}{W}\right] \text{..................(1)...}$$

α_i- coefficient of superficial heat transfer inside [W/m²K]
α_e- outer surface heat transfer coefficient [W/m²K]
a- coefficient of increase of the thermal conductivity depending on the state and the age of the materials, conformable , Mc001 -PI; ***λ:*** *conductivitatea termica de calcul;* ***λ'****: conductivitatea termica corectata de calcul; R - the unidirectional thermal resistance of the existing layer; d_j - thickness of the layer added; λ_j - thermal conductivity.*

Table 1 Constructive masonry wall without thermal insulation

Brick masonry wall						
Nr.Crt	Material	d	λ	a	λ'	R
[-]	[-]	[m]	[W/mK]	[-]	[w/mK]	[m²K/W]
1	Plaster of lime mortar	0,020	0,700	1,050	0,735	0,027
2	GVP blocks	0,350	0,580	1,150	0,667	0,525
3	Plaster of lime-cement mortar	0,050	0,870	1,150	1,001	0,050
				TOTAL		**0,60**
					αi	0,125
					αe	0,042
				$R_0 = 1/\alpha_i + R + 1/\alpha_e$		**0,77**

Table 1.1 Constructive masonry wall with thermal insulation

Brick masonry wall						
Nr.Crt	Material	d	λ	a	λ'	R
[-]	[-]	[m]	[W/mK]	[-]	[w/mK]	[m^2K/W]
1	Plaster of lime mortar	0,020	0,700	1,050	0,735	0,027
2	GVP blocks	0,350	0,580	1,150	0,667	0,525
3	Plaster of lime-cement mortar	0,050	0,870	1,150	1,001	0,050
4	Polystyrene	0,10	0,044	1,150	0,051	1,581
5	Plaster mortar	0,010	0,930	1,150	1,070	0,009
				TOTAL		**2,19**
					αi	0,125
					αe	0,042
				$R_0 = 1/\alpha_i + R + 1/\alpha_e$		**2,36**

Table 2 Floor construction element over basement without thermal insulation

Floor over the basement - cold floor						
Nr.Crt	Material	d	λ	a	λ'	R
[-]	[-]	[m]	[W/mK]	[-]	[w/mK]	[m^2K/W]
1	Reinforced concrete	0,150	2,030	1,150	2,335	0,064
2	Thermal insulation	0,020	0,042	1,150	0,048	0,414
3	Self-leveling screed	0,025	0,460	1,050	0,483	0,052
4	Floor tiles	0,015	2,030	1,050	2,132	0,007
				TOTAL		**0,54**
					αi	0,167
					αe	0,083
				$R_0 = 1/\alpha_i + R + 1/\alpha_e$		**0,79**

Table 2.1 Floating floor element over basement with thermal insulation

Floor over the basement - cold floor						
Nr.Crt	Material	d	λ	a	λ'	R
[-]	[-]	[m]	[W/mK]	[-]	[w/mK]	[m^2K/W]
1	Plaster mortar	0,010	0,930	1,150	1,070	0,009
2	Polystyrene	0,10	0,044	1,150	0,051	1,581
3	Reinforced concrete	0,150	2,030	1,150	2,335	0,064
4	Thermal insulation	0,020	0,042	1,150	0,048	0,414
5	Self-leveling screed	0,025	0,460	1,050	0,483	0,052
6	Floor tiles	0,015	2,030	1,050	2,132	0,007
				TOTAL		**2,13**
					αi	0,167
					αe	0,083
				$R_0 = 1/\alpha_i + R + 1/\alpha_e$		**2,38**

Table 3. Constructive floor element over the last level without thermal insulation

Floor over the last level (circular terrace)						
Nr.Crt	Material	d	λ	a	λ'	R
[-]	[-]	[m]	[W/mK]	[-]	[w/mK]	[m^2K/W]
1	Plaster of lime mortar	0,020	0,700	1,050	0,735	0,027
2	Reinforced concrete	0,150	2,030	1,050	2,132	0,070
3	Concrete slope	0,150	0,930	1,050	0,977	0,154
4	BCA blocks	0,200	0,220	1,050	0,231	0,866
5	Cement mortar	0,013	0,870	1,150	1,001	0,012
6	Waterproofing bitumen	0,015	0,170	1,150	0,196	0,077
7	Sand	0,020	0,700	1,050	0,735	0,027
8	Concrete tiles	0,020	1,620	1,050	1,701	0,012
				TOTAL		**1,25**
				αi		0,125
				αe		0,042
				$R_0 = 1/\alpha_i + R + 1/\alpha_e$		**1,41**

Table 3.1 Construction element floor over the last level with thermal insulation

Floor over the last level (circular terrace)						
Nr.Crt	Material	d	λ	a	λ'	R
[-]	[-]	[m]	[W/mK]	[-]	[w/mK]	[m^2K/W]
1	Plaster of lime mortar	0,020	0,700	1,050	0,735	0,027
2	Reinforced concrete	0,150	2,030	1,050	2,132	0,070
3	Concrete slope	0,150	0,930	1,050	0,977	0,154
4	BCA blocks	0,200	0,220	1,050	0,231	0,866
5	Cement mortar	0,013	0,870	1,150	1,001	0,012
6	Polystyrene	0,10	0,044	1,150	0,051	1,581
7	Plaster mortar	0,010	0,930	1,150	1,070	0,009
8	Waterproofing bitumen	0,015	0,170	1,150	0,196	0,077
9	Sand	0,020	0,700	1,050	0,735	0,027
10	Concrete tiles	0,020	1,620	1,050	1,701	0,012
				TOTAL		**2,84**
				αi		0,125
				αe		0,042
				$R_0 = 1/\alpha_i + R + 1/\alpha_e$		**3,00**

Calculation of corrected thermal resistances

$$R' = r * R = R * \frac{1}{1 + \frac{R\left[\sum(\psi \times l) + \sum \chi\right]}{A}} \quad (2)$$

Table 4. Specific linear coefficients of heat transfer per element

Linear thermal transfer coefficients					
The building element	Detail	**Table C107/3**	**Ψ [W/mK]**	**l [m]**	**Ψ×l [W/K]**
Exterior wall	1. Intersection of walls with a column	1	0,1	351,1	35,11
	2. Intersection of walls without a column	1	-0,04	146,3	-5,851
	3. Corner column with column	3	0,16	165,8	26,53
	4. Corner column without a column	3	0,09	58,51	5,266
	5. concrete beam	24	0,14	257,3	36,02
	6. concrete beam	24	0,04	257,3	10,29
	7. Basement base	42	0,05	64,33	3,216
	8. coupled windows	61	0,12	145,4	17,44
	9. Linkage jointed joinery	62	0,12	91,36	10,96
	10. Solbanc jointed joinery	53	0,12	91,36	10,96
	Total				149,95
Plan over the basement	11. Wall inside the slab over the basement	46	0,09	88,78	7,99
	12. Basement base	42	0,3	64,33	19,3
	Total				27,29
Plate over the top floor	13. Atic Terrace 1	31	0,32	64,33	20,58
	13. Atic Terrace 2	31	0,22	64,33	14,15
	Total				34,74

Ψ *- linear thermal transmittance of the linear thermal bridge;*
l *- the length of linear thermal bridges of the same type;*

Table 5. Thermal resistances corrected on building elements without thermal insulation

Corrected thermal resistances							
Building construction	A	R	Σ(Ψ×l)	[Σ(Ψ×l)]/A	1/R'	R'	r
	[m^2]	[m^2K/W]	[W/K]	[W/ m^2K]	[W/ m^2K]	[m^2K /W]	[-]
Outside walls	715,00	0,77	149,95	0,21	1,51	0,66	0,86
Plan over the basement	168,50	0,83	27,29	0,16	1,37	0,73	0,88
Floor over the top floor	168,50	1,41	34,74	0,21	0,91	1,09	0,77

A - the area of the tire elements; R - unidirectional specific heat resistance for area A (According to C107 / 1); R'- corrected thermal resistance; r - correction coefficient for thermal bridges

Table 5.1 Thermal resistances corrected on building elements with thermal insulation

Corrected thermal resistances							
Building construction	A	R	Σ(Ψ×l)	[Σ(Ψ×l)]/A	1/R'	R'	r
	[m^2]	[m^2K/W]	[W/K]	[W/ m^2K]	[W/ m^2K]	[m^2K /W]	[-]
Outside walls	715,00	2,36	149,95	0,21	0,42	**2,36**	0,67
Plan over the basement	168,50	0,83	27,29	0,16	0,42	**2,38**	0,88
Floor over the top floor	168,50	3,00	34,74	0,21	0,33	**3,00**	0,62

3. CONCLUSION

For the correct evaluation of the building, the specific corrected thermal resistances of the building elements are compared with the minimum thermal resistances R'min. These standardized minimum resistances are given in accordance with the normative for the thermotechnical calculation of the building elements of the indicative buildings C107 / 2005

The values for the minimum thermal resistance R'min represent reference values for the corrected thermal resistance, the calculations taking into account the influence of the thermal bridges related to the surfaces through which the heat transfer through the transmission takes place. In the field, the value of the unidirectional thermal resistance R is much higher.

The corrected thermal resistance of each building element that makes up the building envelope will be compared with the minimum thermal resistance R'min, admissible, set for new buildings on energy-saving criteria in building operation.

REFERENCES

[1] Course notes Hygrothermal rehabilitation of Comsa Emil, Transilvania University of Brasov, Faculty of Civil Engineering.

[2] Mc001/2 - Methodology for calculating the energy performance of buildings ;

[3] Normative regarding the thermotechnical calculation of building elements of buildings, indicative C107-2005;

[4] NP048-2000- Normative on thermal and energy expertise of existing buildings and heating and hot water heating systems;

[5] NP048-2000- Normative for the elaboration and granting of energy certificate for existing buildings.

[6] http://www.dalmatina.ro/eficienta.html