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Proposal for a Romanian thermal bridges catalogue

Rodica Rotberg[1], Laura Dumitrescu[1]

[1]Department of Civil and Industrial Engineering, "Gh. Asachi" Technical University of Iasi, Iasi, 700050, Romania

Summary

Traditionally the evolution will demand better and better thermal insulation in buildings due to higher energy costs, the Kyoto protocol, thermal comfort and so on.

There are several methods to reach the goal of lower energy use in new buildings, some are:

- *Increase insulation thickness. This method has been used historical;*
- *Insulate more effective through minimizing thermal bridge;*
- *Find new insulation materials with lower thermal conductivity;*
- *Change habitant's behaviour.*

Of course, many other factors contribute to the over all energy use in a building.

Thermal bridges are parts of the building envelope, which are not correctly insulated and are often responsible for severe condensation and mould problems as well as increased energy losses. The use of improved thermal bridge assessment is important both in the early design stage and for remedial action on retrofits. In order to bring complex thermal bridge calculations closer to practice, a software tools was developed in the framework of the SAVE EUROKOBRA project. Other aim of the project was, to build up a database of representative thermal bridge details in the participating countries. Romania hasn't been partner to SAVE EUROKOBRA.

EUROKOBRA is a user-friendly two-dimensional heat transfer model for analyzing the impacts of thermal bridges in building components.

This paper describes EUROKOBRA thermal bridge program and proposes to develop a Romanian atlas with the aim of giving designers an easy to use, flexible assessment tool.

Keywords: thermal bridge, thermal insulation, computer program, regulation, energy lost, database.

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R. Rotberg, L. Dumitrescu

1. INTRODUCTION

During recent year a great deal of effort has been made to obtain a better insulation quality of the building envelope and to realize a healthier indoor air quality in buildings.

The main reasons for the improvement of thermal insulation are:

- a reduction of the energy consumption in buildings;
- a reduction of the risk of condensation and mould growth;
- an improvement of thermal comfort in winter and summer conditions.

Thermal bridge is part of the building envelope where the otherwise uniform thermal resistance is changed by:

- full or partial penetration of the building envelope by materials with a different thermal conductivity and/or;
- a change in thickness of the fabric and/or;
- a difference between internal and external areas, such as occurs at wall-floor-ceiling junctions [1].

The most common thermal bridge are the two dimensional so-called "linear", occurs at the junction of two or more building elements, or at the places where the structural composition of a building element is changing. Typical locations of common types of two-dimensional thermal bridges are shown in figure 1.

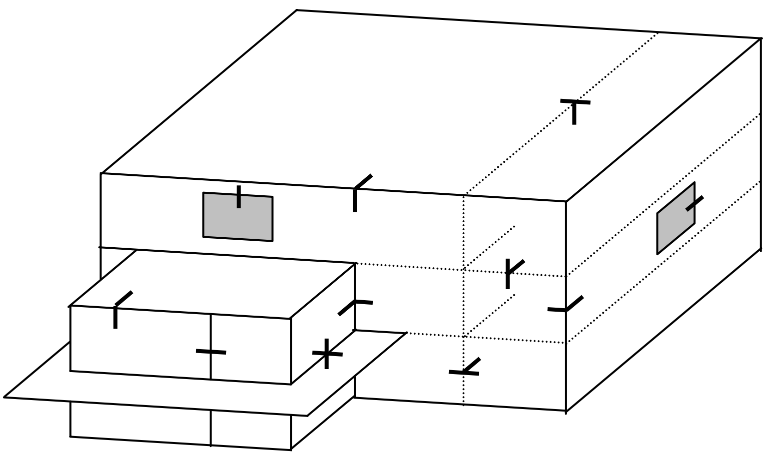

Figure 1. Typical thermal bridges in a building

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Three-dimensional thermal bridges occur when an insulated wall is perforated by an element with high thermal conductivity (point thermal bridges) or in three-dimensional corners.

The study of heat transfer in buildings can be achieved by subdividing the structure into wall types (walls, windows, doors, floors and roofs), for which heat losses can be calculated separately.

The heat transfer can be described by the thermal transmittance of the wall (U-value) and heat loss (ϕ value). The size of extra heat loss due to the cold bridges is introduced by:

- the linear thermal transmittance (ψ factor); this is the heat loss per meter length through a structural element containing a thermal bridge minus the heat loss that would occur if the thermal bridge was not present [2];

- the point thermal transmittance (χ value).

The values of ψ and of χ depend on the configuration and thermal conductivities of the material layers and which U values were chosen for the different building elements and to which surface they correspond.

The temperature factor of the surface gives an estimate of the *quality* of the thermal bridge independently of the imposed boundary conditions and can be used as an index of the likelihood of mould growth.

Traditionally, facilities available to designers for assessing thermal bridges have involved either the use of guidebooks or steady state analysis using computers programs. The development of the EUROKOBRA database of 2-D thermal bridges, in conjunction with a software package for their selection, manipulation and analysis is enabled through an EC supported project.

2. EUROKOBRA THERMAL BRIDGE DATABASE AND PROGRAM

KOBRA is a computer program to query an atlas of building details on their thermal behaviour (two-dimensional & steady state). An atlas contains several pages of building details, each page containing up to 16 details. When a detail is selected, a report with a thermal bridge analysis, i.e. relevant information on condensation risk and heat loss effect (temperatures, temperature factor, heat losses, U-values, linear U-values), is displayed. The flexibility of KOBRA lies in the facts that the detail can be edited: measures, materials and boundary conditions can be altered easily and that subsequently the temperature field is re-calculated using the accurate energy balance technique; therefore, isotherms and heat flow lines can be represented in a clear way. The flexibility fills up the important gap of thermal bridge atlases in book form. By its simplicity in use, by its fast access to relevant and accurate information, and by its flexibility, KOBRA is an interesting tool for building professionals interested in building physics without being experts in the field. KOBRA can help to improve the building detail thermal quality by avoiding condensation and by minimising the heat losses both for new building projects and for renovation projects. The EUROKOBRA atlas is a database containing today up to about 4000 building details. The atlas was prepared by the EUROKOBRA grouping, consisting of building physics experts of research institutes in 7 European countries (Austria, Belgium, France, Greece, The Netherlands, United Kingdom, Switzerland). The program and the atlas are available in different languages and are adapted to national dependent regulations and criteria concerning thermal bridge evaluation.

3. CRITERIA FOR THE EVALUATION OF THERMAL BRIDGES

3.1. Thermal performance of building elements containing thermal bridges

At present no (pr)EN–standards exist which give performance requirement for thermal bridges in building elements. However it is recommended that some rules, which can be imposed on national level, are followed:

- all avoidable thermal bridges should be avoided at the design stage or during the renovation of the building;
- all unavoidable or existing thermal bridges must be built or treated in such a way that [1]:
    - the impact on energy is low, i.e. so that the global U-value of the building element (thermal bridge effect included) stays below a certain U_{max}-value (absolute requirement in national insulation regulation), and/or that the influence of the thermal bridge is not higher than the 5% of the total heat loss through the building element;
    - the condensation risk is minimal, the temperature factor must stay above a certain critical value.

3.2 Classifying thermal bridge effects

In table 1 is given an example of a possible classification of thermal bridge effects, which is only based on the relative importance of ψ value.

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Table 1. Classification of thermal bridge effect on heat losses [1]

Classes of thermal bridge effect, based on the evaluation of the ψ value			
C1	C2	C3	C4
$\psi_{i,e}<0,1$	$0,1<\psi_{i,e}<0,25$	$0,25<\psi_{i,e}<0,5$	$\psi_{i,e}>0,5$
Negligible effect	Poor effect	Important effect	Very important effect

4. ROMANIAN STANDARDIZATION AND REGULATION CONCERNING THERMAL INSULATION

4.1 Calculation of U-values

The calculation of the U values must be done according to the guide C107/3-97 [3].

This guide defines the method to be followed for the calculation of:

- the U–value of opaque walls in buildings;
- the U-value of glazing and linear thermal transmittance of the spacer;
- the linear thermal transmittance of 2D thermal bridges including default values for classical thermal bridges;
- the point thermal transmittance for 3D thermal bridges;
- tabulated calculation values for the thermal conductivity of building materials;
- thermal resistance of ventilated and unventilated air spaces.

4.2 Insulation level of buildings

Concerning the thermal insulation of buildings, minimum admissible values of the thermal specific resistance are given in the table below (table 2) [4]:

Table 2. Minimum admissible R-value per components

Building element	Minimum R-Value (m^2.K/W)
Opaque walls in contact with the outside	1.40
Windows or glass door without protection	0.50
Terrace slab	3.00
Slab over basement	1.65
Lower floor in contact with the outside or a parking lot	4.50
Walls facing joint	1.10

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The possibility given by EUROKOBRA database to modify some parameters (thickness of material, boundary condition, or thermal conductivity of material) in a large quantity of European details is a good tool to supplement the tabulated values of C107 and to give information about condensation risk.

4.3 Heat losses calculations

The transmission heat loss, Q_T, of a single zone building at uniform internal temperature, during a given period of time, is:

$$Q_T = H_T(\theta_i - \theta_e)t \tag{1}$$

where:

H_T is the transmission heat loss coefficient;

θ_i is the set-point temperature;

θ_e is the average external temperature during the calculation period;

t is the duration of the calculation period.

The transmission heat loss coefficient, H_T (W/K) is calculated from the equation:

$$H_T = L_D + L_S + H_U \tag{2}$$

where:

L_D (W/K) is the thermal coupling coefficient through the building envelope defined by equation (3);

L_S (W/K) is the ground thermal coupling coefficient;

H_U (W/K) is the heat loss coefficient through unheated spaces.

The thermal coupling coefficient is:

$$L_D = \sum_i A_i U_i + \sum_j l_j \psi_j + \sum_k \chi_k \tag{3}$$

where:

A_i (m^2) is the area of the building element i;

U_i (W/m^2K) is the thermal transmittance of the building element i;

l_j (m) is the length of the two-dimensional thermal bridge j;

ψ_j (W/mK) is the linear thermal transmittance of the two-dimensional thermal bridge j;

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χ_k (W/K) is the point thermal transmittance of the three-dimensional thermal bridge k.

The most cases, however, calculations will be limited to those for linear thermal bridges, because these are most common, while 3D-calculations will be employed only in exceptional cases.

5. CONCLUSIONS

The development of the interactive software package for the evaluation of thermal bridges (KOBRA) in combination with the thermal bridge database (EUROKOBRA) will offer for the first time the opportunity to building professionals to analyse easily most of their construction details with respect to condensation risks and/or energy losses.

All calculation results are in line with the existing European standardisation, taking into account the criteria for the evaluation of condensation risk and heat losses which are given in the existing national or local regulations. Moreover the programme can be used as a calculation tool in the calculation procedures of the energy performances of buildings, complying with the EC-Directive 2002/91/EC.

Software and database are extremely user friendly which means that almost no time has to be spent for understanding the use of the programme.

The package (software + database) is now available in all European countries, which have a representing partner in the KOPRACTICE project.

The work for the Romanian atlas will include:

- Translation of all text files within the program;
- Choosing details to add to the database;
- Adding the details and make the results;

It will permit to evaluate readily available insulation materials for use in the building industry.

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References

1. Wouters, P., Schietecat, J., Standaert, P. *Practical guide for the hygrothermal evaluation of thermal bridges, a SAVE–KOPRACTICE-project document*, 2003.
2. Strachan, P., Nakhi, A., Sanders, C., Thermal bridge assessments, *IPBSA 1995 Proceedings*, pp. 563-569
3. *C107/3-97 Normativ privind calculul termotehnic al elementelor de construcție ale clădirilor*, Buletinul Construcțiilor vol. 13, 1998, pp. 1-167 (in Romanian)
4. *C107/1-97 Normativ pentru calculul coeficienților globali de izolare termică la clădirile de locuit*, Buletinul Construcțiilor vol. 14, 1998, pp. 2-34 (in Romanian)
5. Thorsell, T. *Advances in thermal insulation*, Kungl Tekniska Hogskolon, Stockholm, 2002.

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