Handling Thermal Bridges in the Context of the EPBD: Description of the Approach Developed in Belgium

B. Vandermarcke[1], J. Schietecat[2], G. Houvenaghel[2], D. Van Orshoven[2], S. Roels[3], A. Janssens[4]

1. Hogeschool voor Wetenschap en Kunst, Department of Architecture Sint Lucas B-9000 Gent, Belgium
2. Belgian Building Research Institute (BBRI), Division of Building Physics and Indoor Climate, B-1342 Limelette, Belgium
3. Katholieke Universiteit Leuven, Laboratory of Building Physics, B-3000 Leuven, Belgium
4. Universiteit Gent, Vakgroep Architectuur en Stedebouw, Division of Building Physics, B-9000 Gent, Belgium

ABSTRACT

Within the context of an energy performance regulation, it is essential to take the transmission losses into account. If building details are not well designed or carried out, thermal bridges can substantially increase the transmission losses. Though, the physical principles for evaluating thermal bridges are well known and covered by European standards. However, the practical application of these calculation rules is not that evident and may be very time consuming.
Within the framework of the Flemish Energy Performance Regulation, a strict scheme for compliance is adopted, in which incorrect performances are linked to financial fines. Such framework for compliance check requires transparent and reasonable procedures for handling thermal bridges. In the beginning of 2006, such procedures were not available yet and, therefore, it will only be mandatory to take into account thermal bridges for building permits requested after January 2008.
In the framework of the TETRA IDEE project, a concept for handling thermal bridges is developed and should be finalised in December 2006.

THERMAL BRIDGES AND THE EPBD

Transmission losses mostly represent the largest part of the heat losses of a building. The calculation of transmission losses is covered by a range of European standards. Thermal bridges can substantially increase the transmission losses (in some cases up to 10 to 20% of one-dimensional heat losses).
The calculation of thermal bridges is covered by EN standards: prEN ISO 10211 (detailed calculations,2006) and prEN ISO 14683 (simplified methods, 2006).

EPBD IMPLEMENTATION IN BELGIUM

In General

In Belgium, the 3 regions (Flanders, Brussels Capital, Walloon Region) are responsible to implement the EPBD. The Flemish Region imposes EPBD requirements since January 2006. Information about the Flemish approach can be found in information paper N° 6 of the EPBD Buildings Platform. The other regions are preparing similar regulations.
An important feature of the Flemish approach is the strict control scheme, where non-compliance may result in fines. In order to implement such an approach, a declaration (the so-called ‘EPB declaration’) of the executed works has to be made after the finalisation of the building. Moreover, such an approach requires that all procedures must be very clear and there should be no discussion about input data.

At the same time, the efforts and time required for submitting an EPB declaration should stay reasonable.

Handling of Thermal Bridges

The assessment of thermal bridges is covered in annex 4 of the execution order. Five different approaches are foreseen:

1. The transmission losses can be calculated according prEN ISO 13789 and prEN ISO 10211 on the basis of a validated 3D computer calculation, including all thermal bridge effects.
2. The transmission losses can be calculated according prEN ISO 10211, where the linear Ψ-values and/or the point χ-values are determined on the basis of a validated 2D- or 3D computer calculation or estimated by using the tabulated values of prISO 14683.
3. In case:
   a. All building details of possible thermal bridges are executed in line with prescriptions given by the government;
   b. And their specific heat losses are not calculated in detail;

   Then it is allowed to apply a default value for the effect of the thermal bridges.
   This default value will be fixed by the government.
4. In case:
   a. The details of possible thermal bridges are only partly in line with the prescriptions given by government;
   b. Their specific heat losses are not calculated in detail;

   The following losses have to be added:
   a. The default value as specified in 3 which is covering the details in line with the prescriptions given by government;
   b. The influence of those building details not in line with the prescriptions given by government.
5. In case the effect of thermal bridges is not taken into account at all, a default value for the extra transmission losses due to thermal bridging has to be added.
   This default value (ΔU), to be multiplied by the building envelope area, is a function of the compactness of the building (C-value) whereby C=building volume/building envelope area.
   a. If $C \leq 1$: $\Delta U = 0.10$ W/m²K
   b. If $1 < C < 4$: $\Delta U = 0.10 * (C+2)/3$ W/m²K
   c. If $4 \leq C$: $\Delta U = 0.20$ W/m²K

PRACTICAL IMPLEMENTATION OF PRAGMATIC THERMAL BRIDGE APPROACH

Working Context

The preparation of an approach for the assessment of thermal bridges in the EPBD context has been worked out in the framework of the Flemish TETRA-IDEE project, coordinated by department of architecture Sint Lucas Gent, WenK with the support of BBRI, UGent, KULeuven and Physibel.
Moreover, there was an active involvement of several other associations and companies and the project was closely followed-up by the 3 regions. For the software

development (see §4.6.), financial support was provided by the Flemish, Walloon and Brussels regions and BBRI.

Global Approach

The global approach consists of the following elements:

1. Calculations of thermal bridge influence are in most cases not required if good building details are used. In such cases, the thermal bridges are handled by a default value in the EPB calculations;
2. A database of good building details is developed with an open structure allowing other details to be added in future;
3. A free thermal bridge simulation tool is developed.

Good Building Details: Maximum Ψ-Values

For each type of building detail (e.g. connection façade – inner wall or vertical wall – flat roof) a maximum Ψ-value is defined (e.g. 0.12 W/mK). This approach is very similar with the approach used in the German standard DIN 4108 Beiblatt 2: 2006-03. The following list of maximum Ψ-values is proposed:

proposed maximum _ -value (Flemish Region – Belgium)			
Windows 1		**Cross sectons**	
_ e ≤ 0.05 W/mK	horizonal wall section lintel window sill	_ e ≤ 0.07 W/mK	roof - wall roof – inner wall roof – common wall balconies
Windows 2			
_ e ≤ 0.10 W/mK	door sill roof window		
Outside external corners		**Other non geometric details**	
_ e ≤ - 0.02 W/mK	façade -foundation façade – flat roof flat roof – window (façade) façade – pitched roof	_ e ≤ 0.00 W/mK	border pitched roof roof – attic ridge (pitched roof) storey floor - wall common wall - façade

Figure 1: Proposed maximum ψ-value

Catalogue of Good Building Details

In order to make the approach as described applicable in practice, it is necessary that a set of good building details are available. Such building details have been developed.

In addition, the approach is such that others (companies, educational organisations…) can develop their sets of building details which meet the Ψ-criteria.

A pragmatic validation procedure for these alternative details will be implemented.

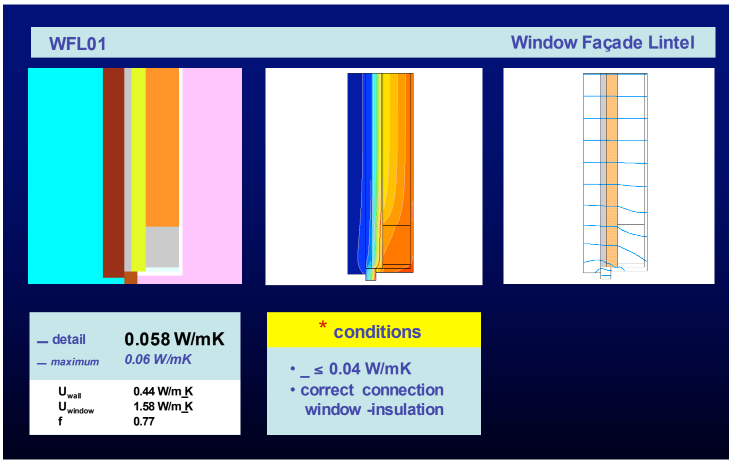

Figure 2: Example of a page in the catalogue

Website Database Application of Good Building Details

The buildings details in line with the Ψ-criteria will be made easily accessible by an on-line internet application. The concept of the database is such that the content of the database is easily extendable.

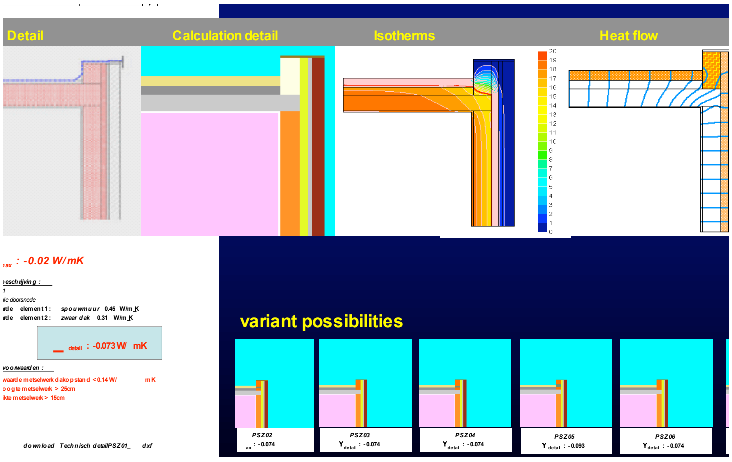

Figure 3: Example of a website page

Thermal Bridge Software Tool

It is clear that it is nearly impossible to include all possible building details in the database mentioned in above paragraph. In order to avoid that one has to use for other building details software tools which have to be purchased and for which the learning curve is important, a specific software tool has been developed by Physibel. This software tool will be freely available for use in Belgium (free use in other countries is possible if a national license fee is paid).
The Windows-based software tool KOBRA will be accompanied by an atlas of some 3000 building details. This atlas is based on the EUROKOBRA database.

A major advantage of this software tool is that the user can easily change various parameters in the construction details (dimensions, material properties, boundaries, …) in the atlas with a consecutive recalculation of the resulting heat losses, temperature distribution and condensation risk..

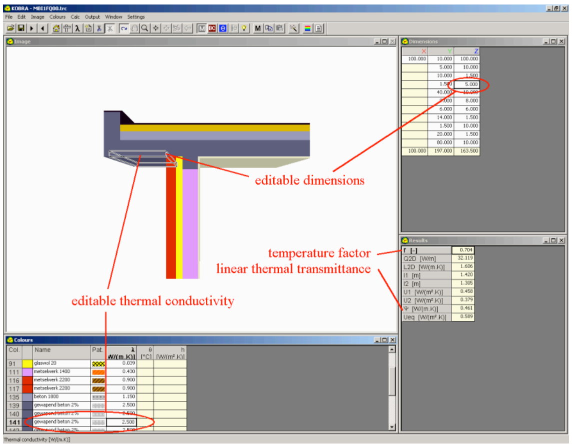

Figure 4: Example of a software tool page (overview)

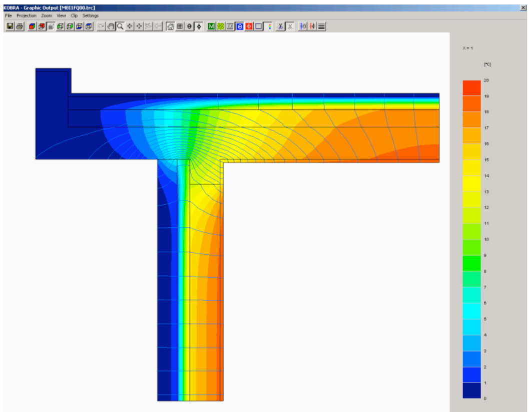

Figure 5: Example of a software tool page (detail heat flow and temperature distribution)

Awareness Raising: IAKOB

'IAKOB' is an independent software tool for a qualitative evaluation of thermal bridges. This has been developed in the framework of the Flemish HOBU programme. It is a software tool developed especially for architects and other building professionals which allows a purely graphical evaluation of details. Specific attention has been given to the user friendliness by using a lot of graphical symbols and pictures (Figures 6, 7 and 8).

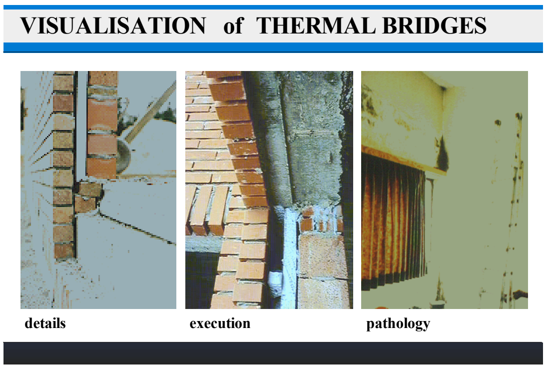

Figure 6: IAKOB CD: a lot of photos

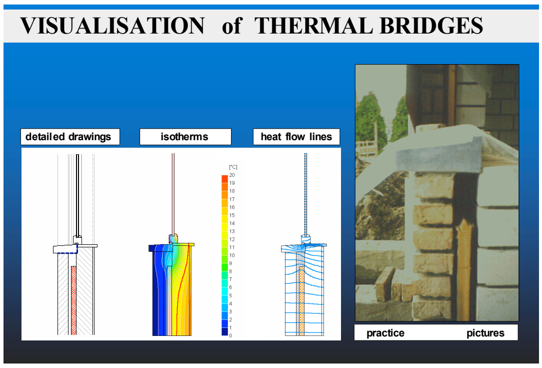

Figure 7: Various aspects and view possibilities

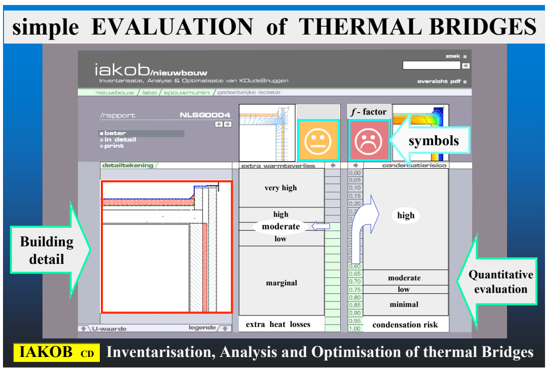

Figure 8: Purely graphical evaluation

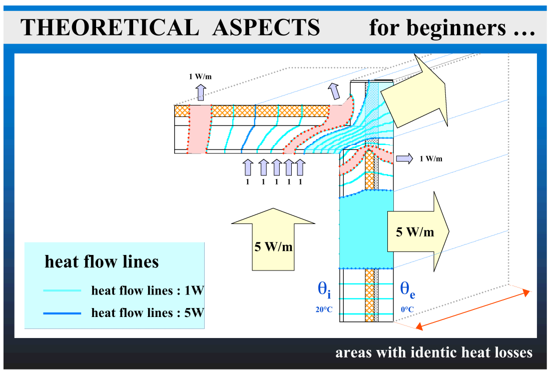

Figure 9: Example of theoretical aspects

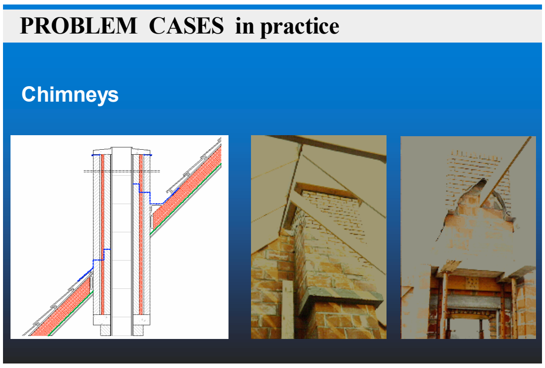

Figure 10: Examples of problem cases in practice

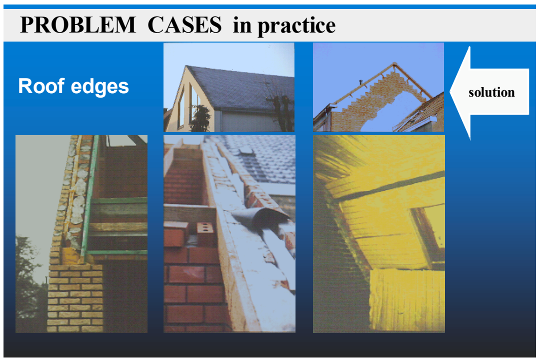

Figure 11: for a better understanding

It integrates also the evaluation of the extra heat losses (heat flow lines and isotherms) and the condensation risk (surface temperature) of a lot building details by giving pictures of the execution and relevant graphical details (Figure 9).

Moreover, background information for non-specialists is included, which makes it interesting for didactical purposes. Consequently the main goal is to achieve a better understanding of the thermal bridge problems and as a result better buildings (Figure 10). Therefore, there are often suggestions made in order to improve certain building details (Figure 11).

CONCLUSIONS

In the framework of the adopted Energy Performance Regulation in the Flemish Region of Belgium a specific concept for handling thermal bridges in daily practice is under development.
If good building details are used, a detailed calculation of thermal bridging effects is in most cases not required if good building details are used. In such cases building professionals can use default values in order to take thermal bridging into account.
For different types of building details a maximum Ψ-value is defined; a database of good building details (with Ψ-value) and a free thermal bridge simulation tool are under development. They should be finalised end 2006.
In addition, an independent software tool 'IAKOB' offers a user friendly qualitative evaluation of thermal bridges by using mainly graphical symbols and pictures

REFERENCES

Department of architecture Sint Lucas. *IAKOB software (Dutch/French version)*. +32.9.225.10.00
e-mail: bernard.vandermarcke@pandora.be, www.architectuur.sintlucas.wenk.be

EPBD Buildings Platform - *Information Paper n° 6: Status of the EPBD Implementation in the Flemish Region (Belgium)*

German Standard DIN 4108 Beiblatt 2: 2006

prEN ISO 10211 (2006) - *Thermal bridges in building construction. Heat flows and surface temperatures. Detailed calculations*

prEN ISO 14683 (2006) - *Thermal bridges in building constructions. Linear thermal transmittance. Simplified methods and default values*

www.eurokobra.org