#3508

Technical Note

Summary Thermal bridging by, for example, structural timber and mortar joints, is far too often neglected in *U*-value calculation. This is the case even with Building Regulations 'deemed to satisfy' constructions. Such bad practice is unnecessary because the *CIBSE Guide* Section A3 provides a method of calculation. This Note illustrates numerically the effects of thermal bridging in some typical building elements. The *U*-values are calculated by the CIBSE method allowing for thermal bridging, and compared with values calculated ignoring it.

Thermal bridging: Significance in *U*-value calculation

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1 Introduction

In the past, when insulation was not applied in buildings, the thermal conductivities of the various materials used were similar. Now, insulating materials are being applied in walls, floors and roof, but, often for structural reasons, the ideal of a continuous envelope of insulation is not achieved. Materials of relatively high thermal conductivity penetrate through the insulating materials and then become thermal bridges.

This Technical Note illustrates the calculated effects of some of these thermal bridges on *U*-values. The calculations have been carried out generally in accordance with the combined method given in the *CIBSE Guide* Section A3[1]. It is not the purpose of this note to assess the accuracy of this method but results are compared with a two-dimensional finite-element analysis[2] and agreement is within 0.01 W m^{-2} K^{-1}.

2 Thermal conductivities

The values of thermal conductivities used are listed in Table 1 and are generally published in Reference 1. These have normally been obtained for well prepared samples under laboratory test conditions. The authors have considerable reservations as to whether all of the values are applicable to the materials when in position in a building structure. A discussion on this topic is outside the scope of this Note, but further information is available[3,4].

3 Proportion of thermal bridging

The area of thermal bridging has been assessed taking the representative constructions shown in Figure 1 and described below. The internal finishes of plaster and plasterboard have been omitted from the wall illustrations for clarity.

3.1 Walls—brick/cavity/block/wet plaster

The thermal bridging is the mortar between the insulating blocks of the inner leaf. Taking block dimensions of 220 × 440 mm, and a mortar joint of 10 mm, the amount of bridging is 6.6% of the inner surface area of the wall. In Table 2 example (i) (*b*) and (*c*) shows the effect of insulating mortar. Such a mortar is available in which Perlite replaces sand, but its use is not established.

3.2 Walls—timber frame

The thermal bridging in this case is the timber itself, studs, sole plate, noggings and framing around windows. Typically it amounts to 15% of the inner wall surface.

3.3 Suspended timber floor

The thermal bridging by joists 50 mm thick at 400 mm centres, plus an extra end joist, amounts to 14% of the floor area.

Table 1 Thermal conductivities of some building materials

Material	Thermal conductivity (W m^{-1} K^{-1})
Autoclaved aerated concrete block (density 650 kg m^{-3})	0.19
Autoclaved aerated concrete block (density 480 kg m^{-3})	0.12
Facing brick	0.84
Ordinary mortar	0.80
Insulating mortar*	0.20
Softwood for joists and studs	0.13
Mineral fibre insulation	0.04

*A proprietary mortar is available but its use is not established.

Table 2 *U*-values ($W\ m^{-2}\ K^{-1}$) of typical elements of house construction

Construction (Figure 1)	Thermal bridging: Ignored	Thermal bridging: Included	% increase after allowing for bridging
Wall (i): Brick/cavity/block (6.6% mortar bridging)			
(*a*) meeting previous Building Regulations of 1.0 $W\ m^{-2}\ K^{-1}$	0.92	0.96	4
(*b*) meeting present Building Regulations of 0.6 $W\ m^{-2}\ K^{-1}$	0.59	0.69*	17
(*c*) As (*b*) but using insulating mortar	0.59	0.6	1
(*d*) meeting a value of 0.45 $W\ m^{-1}\ K^{-1}$	0.45	0.55	22
Wall (ii): Brick/cavity/timber frame (15% timber bridging)			
(*a*) 25 mm thick insulation	0.70	0.71	1
(*b*) 89 mm insulation (full stud depth)	0.35	0.42*	20
Floor: Timber joists (14% timber bridging) $U = 0.7\ W\ m^{-2}\ K^{-1}$ uninsulated			
(*a*) 25 mm insulation between joists	0.49	0.53	8
(*b*) 75 mm insulation between joists	0.3	0.35	17
Roof: Pitched (7% timber bridging)			
(*a*) 100 mm insulation between ceiling joists	0.33	0.38	15
(*b*) 100 mm between joists + 60 mm over them	0.23	0.24	4

*The effect of thermal bridging has also been calculated using a two-dimensional finite element analysis[2], giving 0.7 $W\ m^{-2}\ K^{-1}$ for wall i(*b*) and 0.4 $W\ m^{-2}\ K^{-1}$ for wall ii(*b*).

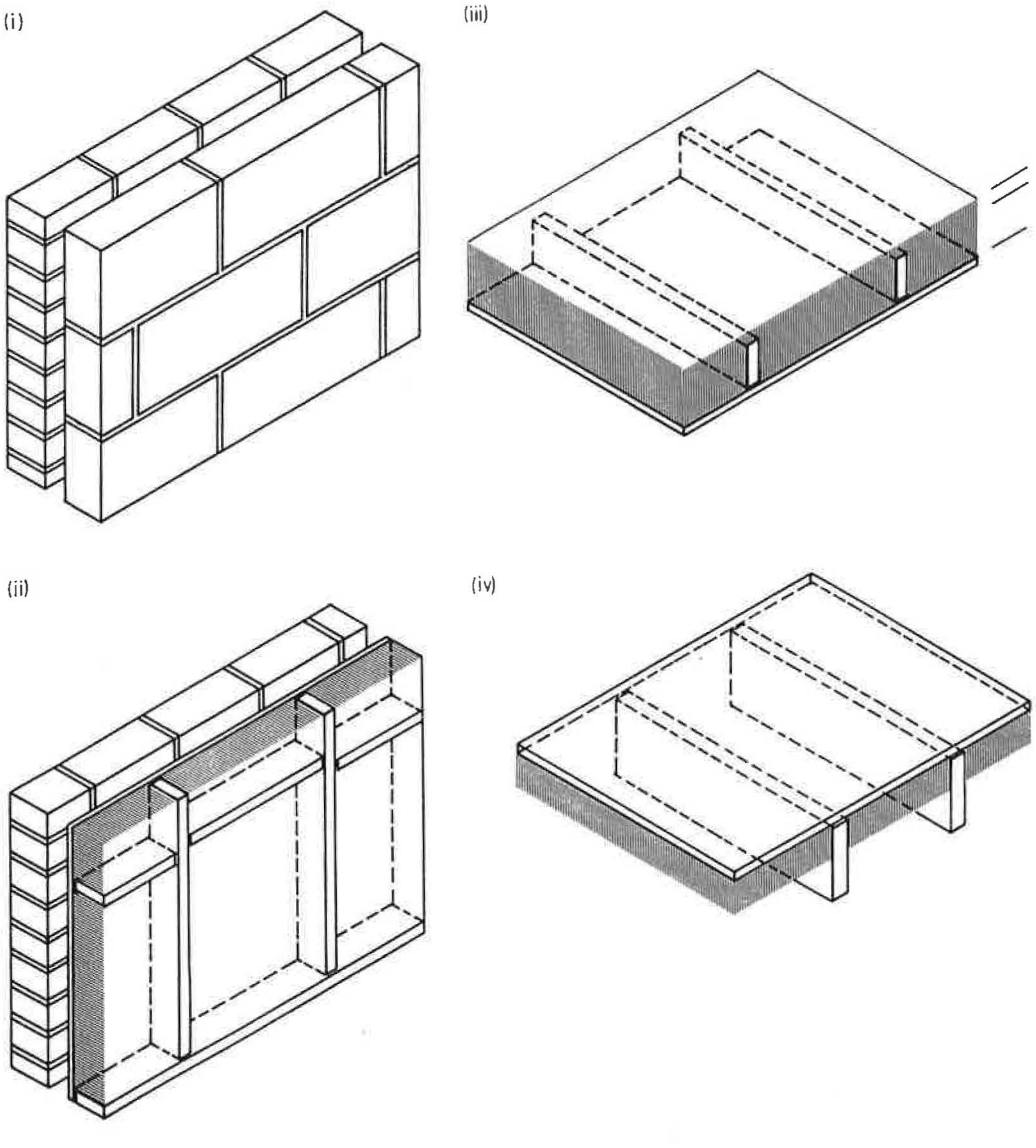

Figure 1 Examples of thermal bridging in house construction (i) Mortar bridging in a masonry cavity wall (plaster finish not shown but included in calculation) (ii) Bridging in a timber framed wall (plasterboard finish not shown but included in calculation) (iii) Partial bridging by ceiling joists (iv) Bridging by timber floor joists

3.4 Pitched roof

The thermal bridging by ceiling joists 38 mm thick at 600 mm centres, plus extra end joists and noggings, amounts to 7% of the ceiling area.

Thermal bridging may exist in other components of these elements, for example, the external leaf of the walls and the sloping part of the pitched roof. However, because thermal resistances of these components are similar and relatively small the effects on the *U*-value are negligible.

4 Calculated effects of thermal bridging

The calculated *U*-values are given in Table 2. It can be seen that the effects of bridging generally become more significant as insulation is improved. Differences are up to $0.1\,W\,m^{-2}\,K^{-1}$. However, when bridging no longer penetrates the insulating material completely, as in the loft, with 60 mm of insulation covering the joists, the bridging effect diminishes.

5 Conclusions

The effects of thermal bridging should be incorporated in the calculations for *U*-values. Improving levels of thermal insulation can result in greater discrepancies between calculation and practice if this is not done.

References

1 *CIBSE Guide* Section A3 (London: Chartered Institution of Building Services Engineers) (1986)

2 McIntyre D A *The increase in U-value of a wall caused by mortar joints* Memorandum **1843** (Capenhurst: Electricity Council Research Centre) (June 1984)

3 Siviour J B Thermal performance in practice of cavity walls insulated with urea-formaldehyde foam *Building Serv. Eng. Res. Technol.* **3**(2) 88–133 (1982)

4 Siviour J B Thermal performance of mineral fibre insulation *Building Serv. Eng. Res. Technol.* **6**(3) 91–133 (1985)