HOW TO REDUCE THERMAL BRIDGING

Last month, we looked at how the Standard Assessment Procedure assesses heat losses at thermal bridges. The worst losses are generally at the lintels, at the perimeter of the ground floor, and at gable walls (with a cold loft).

The simplest assessment of the overall heat losses due to thermal bridging is obtained by using the 'global heat loss factor', $y$, set by SAP to be 0.15 W/m²°C. This is likely to give a gross over-estimate of the actual heat losses. To obtain a better assessment, each bridge needs to be considered individually.

The heat loss at a bridge can be calculated using the bridge's 'linear thermal transmittance', $\Psi$ (psi).

\[
\text{Rate of heat loss} = \Psi \times \text{length of bridge} \times \Delta T \text{ watts},
\]

where $\Delta T$ is the temperature difference between inside and outside.

To obtain a value for $\Psi$ at any particular bridge, there's a choice of four methods:

- Use the SAP default value for $\Psi$ that applies to a bridge at the given location.
- Build the bridge with an Accredited Construction Detail. For every ACD, there is an approved value for $\Psi$.
- Build the bridge with some other officially approved detail that has an approved value for $\Psi$.
- Enter the details of the bridge into software that calculates a value for $\Psi$.

Accredited Construction Details

The government publishes Accredited Construction Details showing standard methods of construction at thermal bridges. These involve no special measures to reduce thermal bridging, but if such a detail is used, then the approved value for $\Psi$ may be used in SAP. This approved value is generally half of the default value. (See the table below, and Further Info, for the government's website.)

<table>
<thead>
<tr>
<th>Location</th>
<th>Default $\Psi$ (W/m°C)</th>
<th>ACD $\Psi$ (W/m°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lintel (of different types)</td>
<td>1.0</td>
<td>0.5 or 0.3</td>
</tr>
<tr>
<td>Sill</td>
<td>0.08</td>
<td>0.04</td>
</tr>
<tr>
<td>Jamb</td>
<td>0.10</td>
<td>0.05</td>
</tr>
<tr>
<td>Ground floor</td>
<td>0.32</td>
<td>0.16</td>
</tr>
<tr>
<td>Upper floor</td>
<td>0.14</td>
<td>0.07</td>
</tr>
<tr>
<td>Eaves (with the loft floor insulated)</td>
<td>0.12</td>
<td>0.06</td>
</tr>
<tr>
<td><strong>Gable</strong> (with the loft floor insulated)</td>
<td><strong>0.48</strong></td>
<td><strong>0.24</strong></td>
</tr>
<tr>
<td>Corner of wall</td>
<td>0.18</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Values for $\Psi$ at major thermal bridges

(Taken from Table K1 of SAP 2012.)
As a marker of what to aim for in an ultra insulated home, bear in mind that the Passivhaus Primer says that thermal bridges should have a Ψ-value no greater than 0.01. That is way below the values given in the above table. In the Passive House, thermal bridging is virtually eliminated.

Other collections of construction details

As mentioned previously, ACD’s do not include any special measures to reduce thermal bridging. There are, however, two collections of details which do take measures to reduce thermal bridging:

- Enhanced Construction Details, produced by the Energy Saving Trust.
- Constructive Details, produced by Constructive Details Ltd.

Each of their details comes with a value for Ψ. You might imagine, as I originally did, that these two schemes have government approval. But BRE have told me that currently no such scheme has government approval.

You can, of course, use any of these freely available details in your design. But in theory, your SAP assessor should not use the values for Ψ given with the details. He or she should either calculate the Ψ-values or use default values – in the later case, thereby reducing the SAP ratings.

Let’s look at the two schemes in more detail.

Enhanced Construction Details

As can be seen from the table above, the three worst thermal bridges are at lintels, the ground floor, and the gables. The Energy Saving Trust have published details designed to greatly reduce thermal bridging at these locations. The details are applicable to three variations of cavity wall, two variations of 140mm timber-frame walls, and three types of ground floor: solid slab, beam-and-block, and suspended timber.

The details are neither difficult nor very costly to build, but they do result in big reductions in Ψ. The value of Ψ given by EST varies from case to case, as in the table:

<table>
<thead>
<tr>
<th>Type of cavity wall:</th>
<th>Type of timber-frame wall:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MV01</td>
<td>MV02</td>
</tr>
<tr>
<td>Lintel</td>
<td>0.010</td>
</tr>
<tr>
<td>Gable</td>
<td>0.057</td>
</tr>
<tr>
<td>Ground floor:</td>
<td></td>
</tr>
<tr>
<td>Slab</td>
<td>0.075</td>
</tr>
<tr>
<td>Beam and block</td>
<td>0.074</td>
</tr>
<tr>
<td>Suspended timber</td>
<td>0.048</td>
</tr>
</tbody>
</table>

Ψ for Enhanced Construction Details (W/m°C)

Note: The values in the table may vary a little according to the actual U-values of the elements involved (wall or floor).

The values of Ψ for these Enhanced Construction Details are a huge improvement on the corresponding Accredited Construction Details.
Enhanced Construction Detail at a gable

Here is an example of an Enhanced Construction Detail – for the bridge at the gable of a cavity wall (with a cold loft).

The key feature is that the blockwork for the distance marked in red must have a thermal resistance of at least 1.74 m²°C / W. Do we need special blocks for this? If the distance of the red line represents 33 cm, then the thermal conductivity of the blocks must be no more than 0.19 W / m°C. (0.19 = 0.33 / 1.74.) Standard aerated concrete blocks have a thermal conductivity of about 0.15, so these would be suitable – but not solid concrete blocks, which typically have a conductivity of about 1.3.

Other features of note:

- The extra layer of insulation on the underside of the trusses.
- The plasterboard ceiling is fixed to battens (not shown) which are fixed across the underside of the trusses. This forms a service void for wiring. (Enhanced Construction Details are designed to give good airtightness, as well as reduced thermal bridging.)

Constructive Details

Here's a quote from the website of Constructive Details Ltd:

The British Board of Agrément and Robust Details Limited have joined forces to form a joint venture called Constructive Details Limited. This new
The company will provide an accredited thermal bridging scheme to meet the requirements of Approved Document L1A.

The website has been in existence since 2010, but note the word 'will' in the above sentence, ie, their details are still not approved by the government.

Nonetheless, the details are publicly available, presented in five 'handbooks' (pdf's). The first three handbooks have been prepared for the Aircrete Products Association – which gives a clue to their scope.

They cover:

- Cavity walls with internal insulation.
- Solid walls with external insulation.

The fourth handbook has been prepared for Icopal Ltd, with party wall details – not for selfbuilders. The fifth handbook is for Pittsburgh Corning Europe, and covers the use of their Foamglas blocks for a ground floor or a flat roof. Which brings us to the next topic.

**Foamed glass blocks**

Foamed glass blocks have been available for decades. Like aircrete blocks they are load bearing, but their thermal conductivity ($\lambda = 0.058 \text{ W/m°C}$) is about half that of the best insulating aircrete blocks. They are made from glass, 60% of which has been recycled. For the brick-sized, 100 x 65 blocks (as in the diagram) the price is about £10 per linear metre – more costly than ordinary blocks/bricks. Nonetheless, with the increasing need to reduce thermal bridging, it may be that their time has come.

![Constructive Detail with a course of foamed glass](image)

The above is a Constructive Detail representing the junction of a concrete slab floor with a full-fill cavity wall – including a course of foamed glass at the base of the inner leaf. $\Psi$ varies with the dimensions, etc, but in a typical case is 0.09 – well below the 0.16 of the ACD, but still well short of the Passivhaus target of 0.01.
Thermoblocks

Thermoblocks can be used to reduce thermal bridging in a similar way to glass blocks.

A Thermoblock is a composite unit:

Many narrow, vertical cylinders of polymer concrete are embedded in extruded polystyrene. (The concrete supplies the compressive strength, and the polystyrene the insulation.) The top and bottom of the block are finished in a fibreglass mesh embedded in a cementitious mix.

According to their Agrément Certificate, the blocks have an effective thermal conductivity of 0.078 W/m°C (with the heat flowing vertically when the blocks have been laid).

Thermal bridging at corners

In the table at the beginning of the article, a Ψ-value is given for a corner. In a cavity wall, the insulation at a corner is continuous, uninterrupted by any bridge. Nonetheless, a corner is regarded as a thermal bridge because extra heat is lost there due to a 'geometrical effect'. A point at the warm internal corner losses heat to many more points on the cold corner outside.

The diagram shows a normal corner. A building may also have one or more 'inverted corners'. For example, a house with an 'L' shaped plan has one inverted corner. At such a corner, the 'geometrical effect' leads to a reduction in heat loss, and Ψ has a negative value.

REPEATING THERMAL BRIDGES

A thermal bridge is found where a poor insulator interrupts two layers of insulation. If there are two or more similar bridges, they are called repeating thermal bridges.

Loft insulation provides a simple example. The insulation is laid between the roof trusses. The wood of a truss has a higher conductivity than the mineral wool, and so it acts as a thermal bridge. Another example is the framework of timber frame panels. Though there is insulation between the framework, the wood again acts as a thermal bridge. (Nowadays, it is common to have an extra layer of insulation across the wooden members. This reduces the thermal bridging, though it is not completely extinguished.)

For the purposes of SAP, heat losses for repeating bridges are not assessed by using a y-value or Ψ. Rather, an average U-value for the whole element, eg, the wall or roof, is
found according to the method laid out in the BRE report, Conventions for U-value calculations (BR443).

FURTHER INFO:

*Enhanced Construction Details: introduction and use (CE297)*
Enhanced Construction Details: thermal bridging and airtightness (CE 302)
Published by the Energy Saving Trust. Free downloads:
www.energysavingtrust.org.uk.

*Assessing the effects of thermal bridging at junctions and around openings*
A BRE Information Paper published in 2006: IP1/06. 6 pages, £9.

*Passivhaus Primer: Designer's guide*
Published by BRE Trust. 12 pages.
www.passivhaus.org.uk.

*Details for Passive Houses*
Austrian hardback in both English and German. 340 pages. £85.

*Conventions for U-value calculations*
Published 2006 by BRE. 44 pages, free download (BR443):
www.bre.co.uk.

*Accredited Construction Details*
www.planningportal.gov.uk.

*Constructive Details*
Free registration for details.
www.constructivedetails.co.uk.

*Foamglas Perinsul*
Foamed glass blocks by Pittsburgh Corning Corporation. (The material is also suitable for flat roofs.)
www.foamglas.co.uk.

*Marmox*
Suppliers and manufacturers of Thermoblocks.
www.marmox.co.uk.

*Low Carbon Housing – Learning Zone*
A website published by Leeds Metropolitan University and the AECB. Has info about thermal bridging, as well as airtightness and thermal design.
www.leedsmet.ac.uk.

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