

1 Introduction

JPA Designer version 5.03a2 build 002 introduces modifications to the U-value module to improve the treatment of more complex thermal bridging. This technical paper describes those modifications and gives examples of their use.

2 Background

JPA Designer treats thermal bridges in adjacent layers which have the same bridging fraction as being on the same heat path. For example, in a timber frame wall where the insulation does not fill the whole stud depth, the layers for the insulation and cavity have the same bridging fraction and are treated as one heat path.

Whilst that method works satisfactorily in most cases, it does not give the correct results for:

- linked bridges, such as those which occur with i-beams, where thermal bridges in non-adjacent layers regularly coincide, and some of the bridging fractions are different;
- bridges in adjacent layers which run at right angles to each other.

We have revised the program to allow both those conditions to be assessed accurately. The revisions are available in all versions of JPA Designer from 5.03a2 build 002 onward.

3 Linked bridging

The U-value calculation in JPA Designer did not allow for constructions in which bridging in non-adjacent layers was linked. For i-beams that meant thermal bridges formed by the two flanges and the web were assessed independently of each other, resulting in a slightly lower U-value.

To resolve that problem the **Layer list** in the main **U-value** window now has an additional column, **Link brg** (see Figure 1). The **Link brg** column is used to mark those layers in a construction in which the bridging is dimensionally related. Clicking once in the **Link brg** box for a layer turns the box red and indicates the bridging of that layer is associated with that of the other layers with linked bridging. Clicking again clears the box.

	Layer	Thickness (mm)	Thermal Conductivity (W/mK)	Thermal Resistance (m ² K/W)	Vapour Resistivity (MN/gm)	Vapour Resistance (MN/g)	Pitch (°)	Bridge Details	Link brg.
1	Outside surface resistance	-	-	0.040	-	-			
2	Airspace behind tiles on tile hur	-	-	0.120	-	0.00			
3	Fibreboard (BS5250)	20.0	0.070	0.286	275.00	5.50			
4	Mineral wool (BS5250)	40.0	0.040	1.000	5.00	0.20	15.0% S _i		
5	Mineral wool (BS5250)	120.0	0.040	3.000	5.00	0.60	4.0% S _i		
6	Mineral wool (BS5250)	40.0	0.040	1.000	5.00	0.20	15.0% S _i		
7	Fibreboard (BS5250)	20.0	0.070	0.286	275.00	5.50			
8	Inside surface resistance	-	-	0.130	-	-			

Figure 1: The red **Link brg** boxes indicate the layers with linked bridging

To set linked bridging for a construction:

1. Create a U-value calculation and insert layers for all components.
2. Set bridging data for each of the bridged layers.
3. Click the **Link brg** box for each layer where bridging is to linked.

The result of a U-value calculation where linked bridging is marked will be slightly different to that of the same calculation which does not have linked bridging marked.

When setting the bridging details for the layers it is best to use bridged and non-bridged widths which will give the correct fraction, rather than using the actual bridge dimensions. So, for 15% bridging enter a bridge width of 15 mm and non-bridge width of 85 mm. For 4% enter 4 mm and 96 mm respectively.

3.1 The underlying issue

The issue mainly affected constructions containing i-beams, which have different bridging fractions for the flanges and web of the beam (typically 15% for flanges and 4% for the web). Without linking, the program treats the bridging in the three layers¹ as wholly independent and defines eight heat paths through the construction, with bridging fractions ranging from 69.3% (mineral wool/mineral wool/mineral wool) to 0.09% (flange/web/flange).

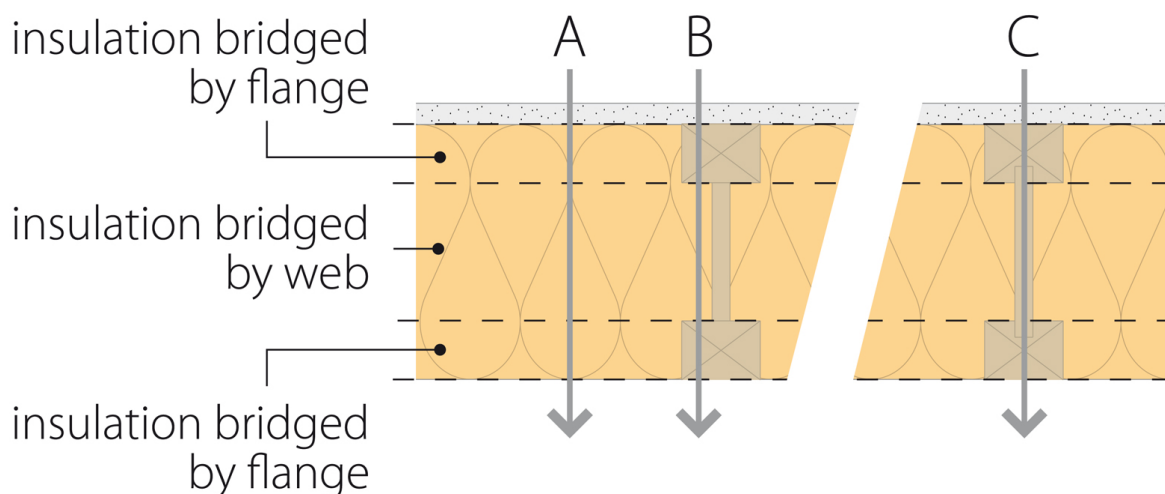


Figure 2: I-beam construction showing the alignment of flanges and web

However, as the two flanges coincide completely and the web always coincides with the same part of the flanges (see Figure 2) there are only three heat paths:

- Path A: Insulation/insulation/insulation;
- Path B: Flange/insulation/flange;
- Path C: Flange/web/flange.

Setting the three layers with linked bridging instructs the program to align the bridging in the three layers and produces the correct number of heat paths.

3.2 Worked example

Figure 1 shows the **U-value** window for a wall which includes composite studs with their whole depth filled with insulation. The bridging fraction for the flanges is 15%, but 4% for the web, so the insulation is divided into three separate layers. When the three layers are not linked the reported U-value is $0.189 \text{ W/m}^2\text{K}$, which is too low. When the layers are linked the U-value is $0.191 \text{ W/m}^2\text{K}$. The difference in calculation results is small, $0.002 \text{ W/m}^2\text{K}$, but may in some circumstances be significant.

¹BR 443 allows i-beams to be treated as three layers, provided the thermal conductivities of the flanges and web are within 20% of each other. Where that is not the case the i-beams must be treated as five layers.

4 Bridging at different orientations



Figure 3: Thermal bridging running in two different directions

JPA Designer presumes that if two adjacent layers have identical bridging fractions that bridging will always coincide. However, there are constructions which do not follow that rule, for example, in a warm roof construction, a layer of insulation may be fitted between the rafters, with a second layer of insulation set between battens fixed to the underside of the rafters, but running at right angles to them (Figure 3).

Treating the battens in such a construction as if they ran in the same direction as the rafters results in a U-value result which is higher than it ought to be. For example, one such roof construction gave a U-value of $0.265 \text{ W/m}^2\text{K}$ instead of the correct figure of $0.248 \text{ W/m}^2\text{K}$.

With JPA Designer 5.03a2 build 002 it is now possible to set the direction in which bridging members run for each bridged layer. The **Thermal bridging** section in the **Edit material** dialogue has a new **Angle** list which can be used to set the relative angles of

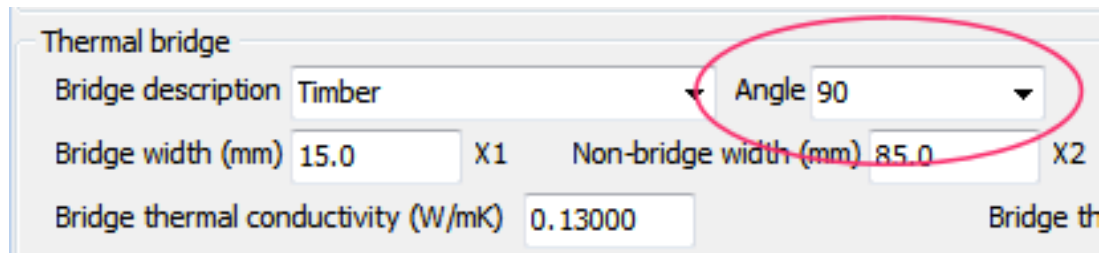


Figure 4: The new **Angle** list in the **Thermal bridging** settings

bridging in different layers (see Figure 4). The angle at which bridging runs can be set to 0°, 45° or 90°.

4.1 Setting the bridging orientation

Where there are two layers with thermal bridging running in different directions the first step is to determine which bridging direction will be treated as standard and which will be treated as being at an angle. The clearest way to do this is to treat the orientation of the main structural members as standard: bridging in any other orientation is then regarded as being at an angle.

So, for the example in Figure 3 the rafters would be treated as the standard direction, as would any other timber running from eaves to ridge, while the battens would be at 90° to the standard direction. To set the bridging orientation in JPA Designer:

1. Create a U-value calculation and insert layers for all components.
2. Set bridging data for each of the bridged layers.
3. For each layer where the bridging runs in the standard direction set **Angle** to 0°.
4. For each layer where the bridging runs at right angles to the standard direction set **Angle** to 90°.

4.2 Limitations

JPA Designer differentiates between two types of bridging:

- *one-dimensional bridging*, where the bridging material runs in one direction. This is used for timber and steel framed structures.
- *two-dimensional bridging*, where the bridging material runs in two directions. This is used almost exclusively for masonry, where mortar or thin-joint adhesive runs horizontally and vertically.

The **Angle** setting is only intended for use with one-dimensional bridging: it should not be used with two-dimensional bridging conditions.

5 Further information

Information about JPA Designer may be found at <http://www.techlit.co.uk>².

Technical support enquiries by email only³ to support@techlit.co.uk.

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³<mailto:support@techlit.co.uk>