THERMAL BRIDGING

XCO2 KNOWLEDGE

With high levels of insulation now standard practice in new and refurbished construction, up to 30% of the building fabric heat losses of a dwelling can be accounted for by thermal bridging at poorly designed construction junctions[1]. Therefore, reducing heat losses via good detail design is imperative in achieving compliance with current construction standards.

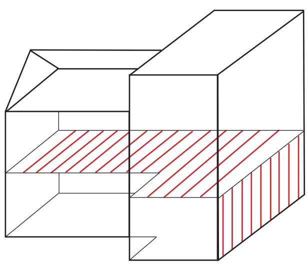
The designing of thermally efficient construction details allows for more carbon emissions reductions at the 'lean' stage of the energy hierarchy and is a more cost effective carbons savings effort, which are crucial to optimise before considering expensive low or zero carbon technologies. With the GLA now set to require offset payments to make up the shortfall of achieving 100% CO_2 savings for all major developments in London, increasing fabric efficiency and reducing heat losses becomes a higher priority.

So what exactly is a thermal bridge? A thermal bridge or 'cold bridge' is an area of building fabric which has a higher rate of heat transfer than its adjacent materials and usually occurs where the wall, floor or roof insulation is interrupted.

Construction junctions where there is a continuous, or non-continuous or geometrical interruption to an insulation layer are often locations where thermal bridges occur. These are known as 'linear heat losses' and are represented as 'psi' (Ψ) values. In addition, 'point heat losses' occur where there are non-linear interruptions to the building fabric (e.g. balcony supports).

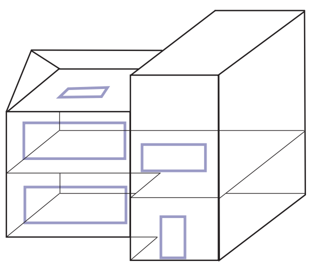
The U-values of the building fabric also contribute to the overall performance of each junction. Detailing these to minimise thermal bridge heat losses is important, as a wall packed full of insulation with a low U-value creates higher heat loss at a junction than if the wall was less well insulated.

Continuous Thermal Bridges



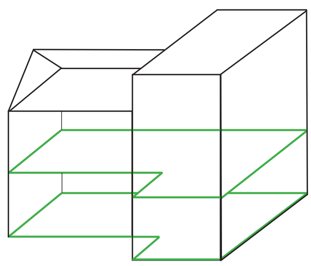
- Ceiling joists and ground floor joists interrupting insulation layers.
- Timber and steel studwork and I-beams in frame construction.
- Steel wall ties in masonry cavity external wall construction.

Non-Continuous Thermal Bridges



- Around windows, doors and rooflights.
- Around hatches to an unheated loft.
- Where internal walls/ floors or steel structural elements penetrate the thermal envelope.

Geometrical Thermal Bridges



- At the corner of an external wall.
- At wall/roof junctions.
- At wall/roof junctions.
- Junctions between adjacent walls that meet at parralell.

1 - BRE. 2012. The importance of thermal bridging. [ONLINE] Available at: https://www.bre.co.uk/certifiedthermalproducts/page.jsp?id=3073. [Accessed 12 October 2016].

What Criteria Influences Heat Losses at Junctions?

Low material conductivity + U values	High material conductivity + U values	Low material conductivity + U values
Bad design of construction junctions	Good design of construction junctions	Good design of construction junctions
High heat losses via junctions	Moderate heat losses via junctions BUT high heat losses via building fabric in general	Minimal heat losses via junctions

WHY IS IT IMPORTANT TO CONSIDER HEAT LOSSES VIA THERMAL BRIDGING?

- They account for a significant portion of heat losses through the building fabric.
- Current GLA requirement to reduce carbon emissions can be achieved more easily at the 'lean' stage.
- Lower limiting U-values for building fabric in Part L (2013) means that junction heat losses will be higher if not carefully designed.
- In addition, the inclusion of a thermal bridge also signifies the presence of potential condensation risks, as warm, moist air from the interior comes into contact with a cold surface.

SAP 2012 APPENDIX K PSI VALUES

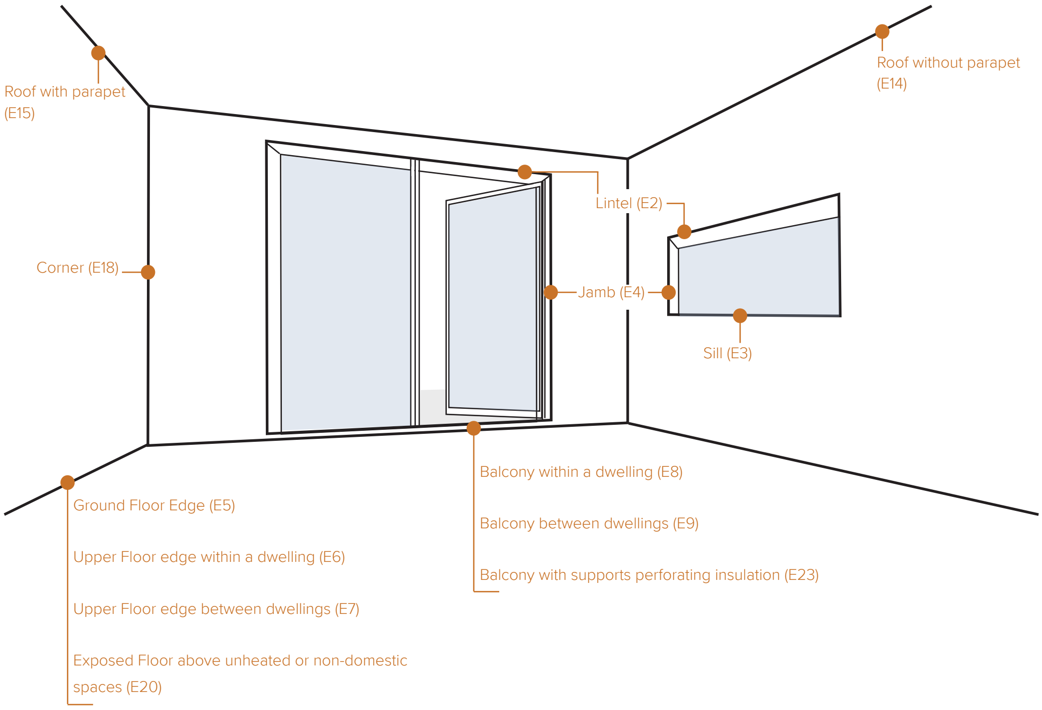
A thermal bridging standard has been introduced within SAP 2012 Appendix K, and now includes the majority of junction types. This standard introduces 'default' psi values which depict the heat losses acceptable from junctions that are built to 'typical' construction standards, and Accredited Construction Detailing (ACD) psi values which indicate lower heat losses from junctions that should be met in best practice construction.

Detailing criteria that indicates how junctions can be designed to meet ACD psi values were published on line in 2008. However, these have not been updated and are now out-of-date in comparison with current building fabric standards in the UK. Enhanced Construction Details (ECD) have been published by the Energy Savings Trust in 2011. However, ECDs are limited to a very few typical construction details.

In order to avoid the allocation of 'default' psi values in SAP, which tends to overestimate heat losses, some form of thermal bridging modelling is often necessary.

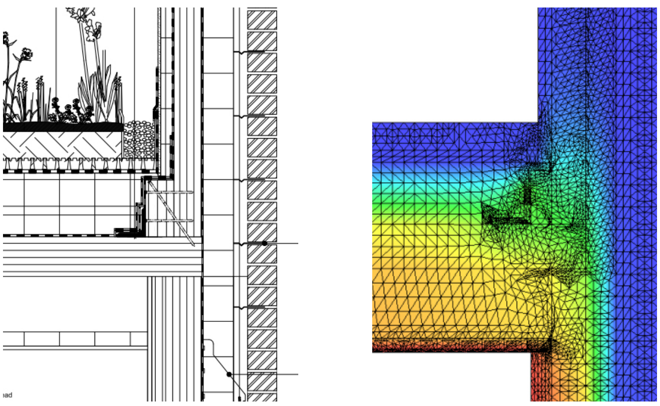
SAP 2012 APPENDIX K & THERMAL BRIDGING CONVENTIONS

Most types of junctions are now considered, including those adjacent to unheated spaces, such as garages, unheated corridors and stairwells. The procedure followed is to calculate psi values for junctions to these spaces, treating them as 'external' environments, and apply set 'factors' to the results as detailed within the SAP conventions update in May 2016.

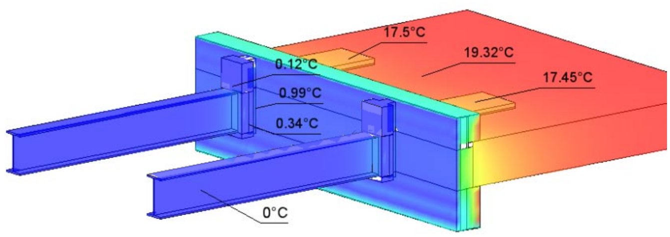


Typical Junctions assessed within a dwelling with SAP Appendix K (2012) ID numbers

TYPICAL THERMAL BRDIGE ISSUES IN CURRENT CONSTRUCTION	
Area of Concern	Strategy to mitigate heat losses
Lintels, sills and jambs	Use good insulated cavity closers
Secondary structures such as ‘metsec’	Include additional layer of insulation or insulation backed plasterboard
Steel structural supporting brackets and connections	Structural thermal breaks should always be used
Balcony Areas	Insulated balcony separators should be used
Edges of ground and upper floors	Use perimeter insulation
Ground floor/ Roof and wall junctions	Use aerated concrete blocks or structural timber to form ‘continuous’ low heat loss layer
Service and duct work perforations	Minimise with sealing grommets



Wall and roof junction with structural timber (architect’s detail and thermal image)



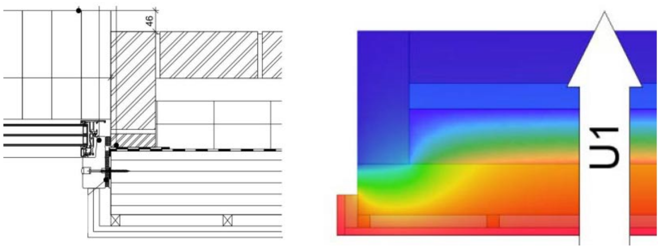
Steel balcony support structure penetrating wall insulation (thermal image)

ASSESSMENT PROCEDURE & ITERATIVE PROCESS

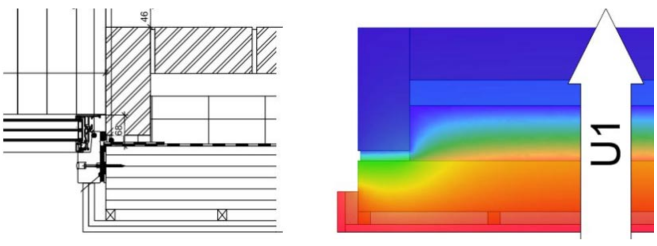
Initially, design drawings are reviewed and junctions with potential thermal bridging risks are identified. The relevant construction details are then assessed using Psi-Therm 2D or 3D software and psi values for each junction calculated.

Depending on the SAP assumptions made for the building, improvements (such as the inclusion of thicker perimeter insulation) may be required and additional iterations are performed. The overall results for original and improved details are provided within a report.

Generally, the improvements suggested are feasible in terms of construction and cost and yield a great influence on the overall improvement of the junction performance. For example, the psi value of the window jamb detail shown below improved from 0.111 W/mK to 0.055 W/mK by including an insulated cavity closer, resulting in an approximately 50% reduction in heat losses through all jamb details of the building.



Window Jamb detail excluding cavity closer: Architect's detail and thermal model



Improved Window Jamb detail including cavity closer: Architect's detail and thermal model

XCO2 Recommendation: Identify areas that may have high heat losses via thermal bridging early on and enable good detailing design from the onset.

INFLUENCE OVER DETAILING DESIGN

Architects, clients and the construction team must work together to reduce heat losses from thermal bridging and improve fabric performance in design and in operation.

We recommend that a junction designing workshop be carried out prior to the detailed design stage of a project. Planning stage drawings can be used to identify areas at risk and mitigation measures can be discussed to enable good detailing design from the outset. The workshop entails a discussion with the architect and includes input from structural and mechanical engineers, as well as any sub-consultant who will have an impact on designing the building fabric.

In addition, we recommend that workshops with the construction team be carried out prior to starting work on site, so that there is an awareness on site how the installation of specific elements influence thermal bridging heat losses.

HOW CAN WE HELP YOU?

We can carry out workshops or lunchtime presentations to discuss good construction detailing and perform thermal bridging assessments for any type of junction or detail.

To learn more, about our thermal bridging analysis services or for more details on arranging workshops get in touch with alexe@xco2.com