THERMAL BRIDGE REFERENCE DOCUMENT

New Zealand Green Building Council

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1 Thermal Bridges

The term *thermal bridge* refers to an area that has higher thermal conductivity than the surrounding materials. Thermal bridges are problematic if not managed as they can be a source of energy loss in homes and buildings. Furthermore, they can lead to lower localised surface temperatures, which can in turn cause moisture to accumulate.

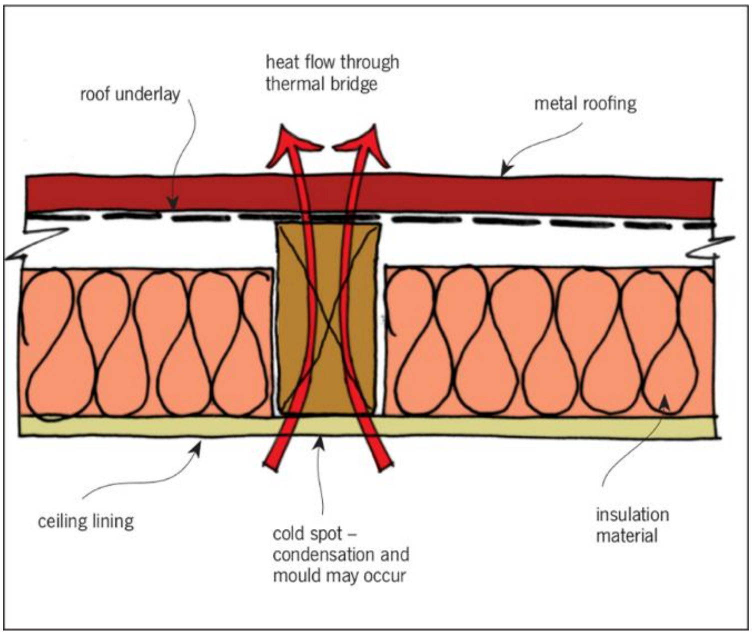


Image source: Build magazine Aggravated thermal bridging Malcolm Cunningham, 1 December 2011, Build 127

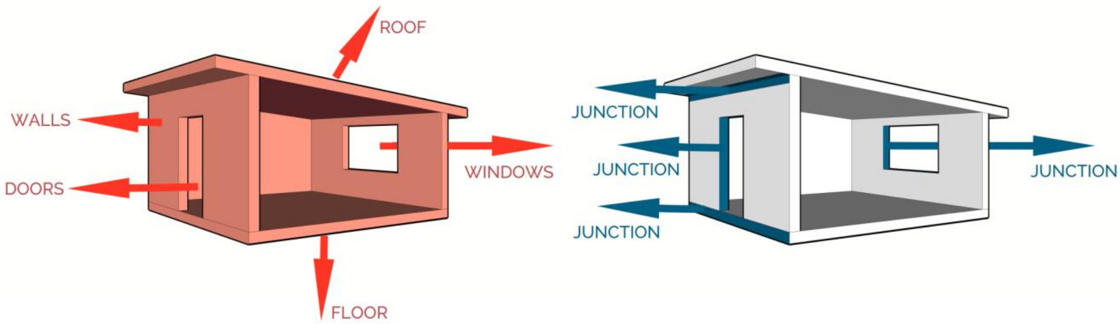


Image source: High Performance Construction Details Handbook

2 fRsi Value

fRsi value is a dimensionless number between 0 and 1 which can help determine the risk of condensation and mould growth at a thermal bridge. It describes the relative magnitude of temperature variation and is calculated as the difference between the interior surface temperature and the exterior air temperature, divided by the average temperature difference between interior and exterior. The acceptable fRsi results depend on the climate zone, but in general, the closer the fRsi is to 1 the better because this reflects a more consistent surface temperature.

$$\text{Minimum Temperature Factor} = \frac{\text{Minimum interior surface temperature} - \text{External temperature}}{\text{Interior air temperature} - \text{External temperature}}$$

3 PSI Value

Psi value (Ψ) represents the rate at which heat passes through a junction. The rate is measured per metre Kelvin temperature difference [W/m·K]. For example, along the Junction between two walls forming an external corner, the length of the junction (i.e., height of the corner) is multiplied by the PSI value to calculate the heat loss coefficient for that corner[1].

4 Homestar Requirements on Thermal Bridges

4.1 fRsi values

For Homestar v5, all junctions between external walls and floors, roofs, windows and internal walls must be demonstrated to meet the following minimum fRsi factors respective climate zone:

Climate Zone	1	2,3,4, and 5	6
Minimum fRsi temperature factor	0.55	0.65	0.7

Windows must be thermally broken. Thermally broken window frames are defined as having a minimum R-value of 0.25. Thermally broken aluminium, timber and uPVC frames are deemed to comply.

Mandatory Minimum for all Homestar ratings	
The junctions between external walls and floors (including mid-floors), and external walls and roofs meet the fRsi factor appropriate for the climate zone. AND All windows must be thermally broken.	2 points
Mandatory Minimum for 9 and 10 Homestar	
The installation detail for all windows must meet the fRsi factor appropriate for the climate zone.	1 point

6 Homestar Only: Exemptions and Deemed to Satisfy Details

The horizontal junction between the conditioned parts of the dwelling and a balcony or an unheated garage (or other internal unheated spaces) may be exempted from the fRsi requirements.

The junction between a concrete slab and a wall is deemed to satisfy the fRsi requirements where the slab edge is insulated to the following minimum (product) R-values:

[1] https://passivehouse.nz/hpcd-handbook/

Climate Zone	1	2,3,4, and 5	6
Minimum foundation perimeter edge R-value (product R-value)	R0.7	R1.0	R1.25

Note that these exemptions and deemed to satisfy details will be reviewed, and likely revoked, when Homestar v5.0 is updated to v5.1.

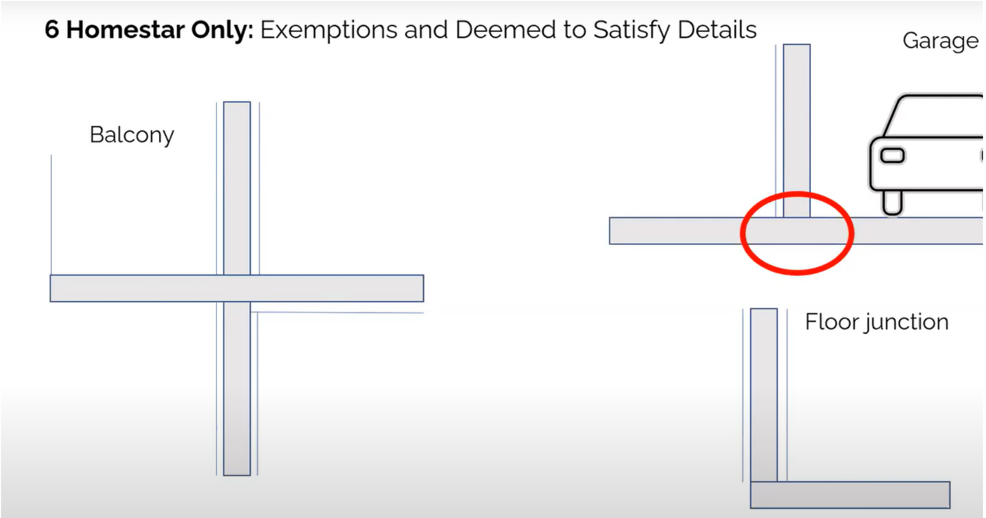


Image source: NZGBC webinar How to Homestar v5: Thermal bridges

4.2 Psi values

As a minimum, for a Homestar submission, the psi values for the slab (or suspended floor) edge must be included. If the psi value for the slab or suspended floor is not known, the default value of 1.0 W/(m·K) must be used. The length to be considered is the length of the slab or suspended floor that loses heat to the outside. Junctions with intertenancy walls are excluded but junctions with an unheated space such as a garage should be included.

In addition, where junctions are exempt from the fRsi requirements of HC4 (deemed to satisfy junctions such as balcony edges in apartments) these must also be included with a default psi value of 1.0 W/(m·K).

Additional thermal bridges may be added, and this may be beneficial where details are known to be high performing. Psi values for high performing junctions can be negative meaning that they reduce the estimated annual energy demand.

5 Calculating Thermal Bridges

There are three main options open to Homestar Assessors for deriving the required fRsi and psi values.

1. Finding previously calculated values for common details in the High Performance Construction Details Handbook. The is the preferred method for the most common details. Some minor variation from the details shown may be allowed. Contact NZGBC for assistance.
2. Where figures cannot be determined from predefined junctions, a value will need to be calculated using available software packages. Details of recommended software follows in the next section.
3. If the Homestar Assessor does not have access to, and is not confident with calculation thermal bridge values, a third-party consultant should be engaged to carry out the necessary calculations. A list of consultants is provided on the Homestar Technical Resources page of the NZGBC website.

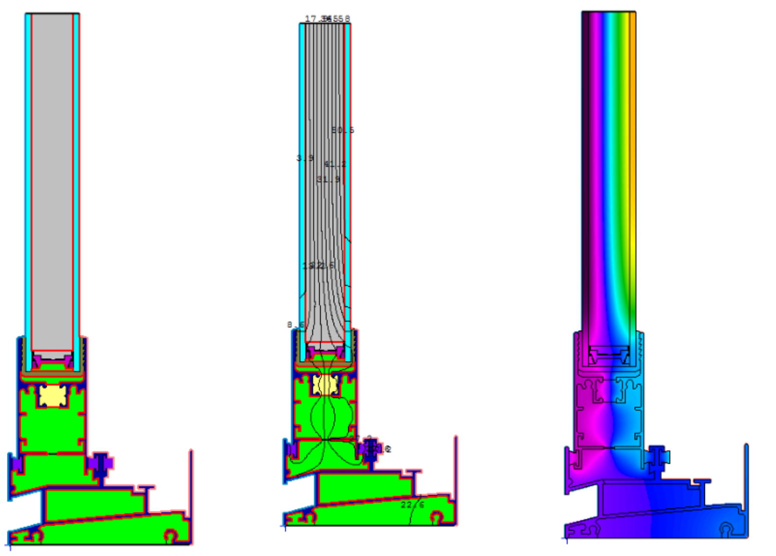
6 Thermal Bridge Software

6.1 THERM

THERM can be used to model two-dimensional heat-transfer effects in building components such as windows, walls, foundations, roofs, and doors; appliances; and other products where thermal bridges are of concern. THERM's heat-transfer analysis evaluates a product's energy efficiency and local temperature patterns, which may relate directly to problems with condensation, moisture damage, and structural integrity.

Find out more about THERM: https://windows.lbl.gov/software/therm/

Sample Screen Shots

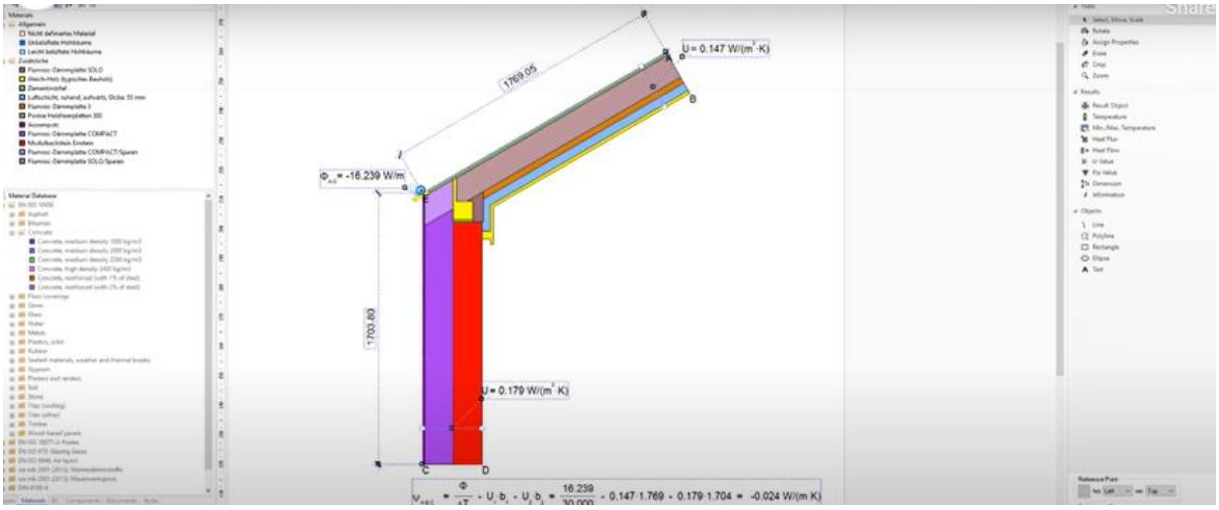


Sample Cross Section (Aluminum Slider Window Frame) | Sample Isotherm Results (Aluminum Slider Window Frame) | Sample Color Infrared Results (Aluminum Slider Window Frame)

6.2 flixo

flixo is a validated thermal bridge program according to standards EN ISO 10211 and EN ISO 10077-2. It's a tool to analyse the thermal properties of a design or construction, and to document those results. Two main tools comprise flixo: a CAD workspace and entry tool, and a document generation tool. flixo calculates and gives an overview of temperatures and heat flux. It shows temperatures in specific places along with other global thermal properties.

Find out more about filo: https://www.flixo.com/

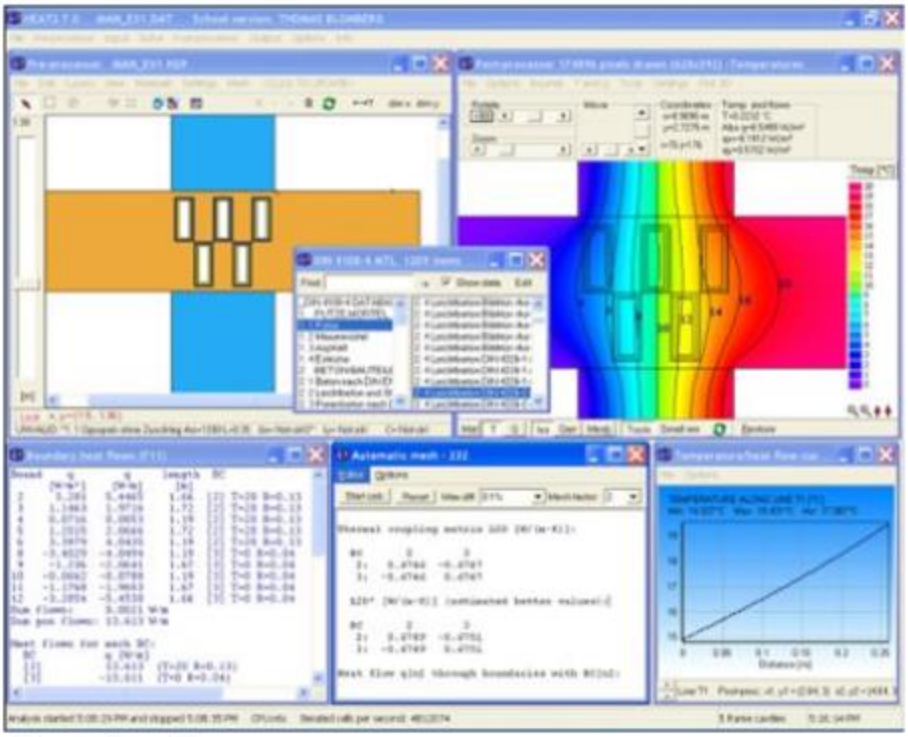


6.3 HEAT2—Heat transfer in two dimensions

HEAT2 is a PC-program for two-dimensional transient and steady-state heat transfer. The program is along with the three-dimensional version HEAT3 used by more than 1000 consultants and 100 universities and research institutes worldwide. The program is validated against the standard EN ISO 10211 and EN ISO 10077-2.

Automatic calculation of thermal coupling coefficient(L2D) and thermal transmittance (ψ) according to EN ISO 10211 for a wide variety of problems involving thermal bridges.

Find out more about HEAT2: https://buildingphysics.com/heat2-3/



HEAT2 user interface.

7 Useful Resources

- Webinar: How to Homestar v5: Thermal bridges Training: https://www.nzgbc.org.nz/Event?Action=View&Event_id=1077
- High-Performance Construction Details handbook, authored by Jason Quinn on behalf of PHINZ: https://passivehouse.nz/hpcd-handbook/
- Hygiene Criterion applied to a thermal bridge, Jason Quinn 2018: https://sustainableengineering.co.nz/hygiene-criterion-applied-to-a-thermal-bridge/
- Thermal Bridges: The psi value: https://emupassive.com/2015/11/09/thermal-bridges-the-psi-value/