Thermal bridging in commercial buildings

The NCC Performance Requirements can be met using either a Performance Solution, Deemed-to-Satisfy (DTS) Solution, or a combination of both. The following is a general representation of the DTS Provisions for thermal bridging.

The thermal bridging requirements are contained in the energy efficiency DTS Provisions in NCC Volumes One and Two. This is an introduction to thermal bridging and how the NCC deals with it for commercial buildings (clause J4D3(5)).

It explains how to account for thermal bridges when calculating the Total R-Value of certain construction types. It provides a national perspective of the NCC and does not contain any state or territory variations.

This information is useful for architects, building designers, façade engineers, builders and environmentally sustainable design (ESD) consultants.

What is thermal bridging?

Thermal bridging, in practical terms for the NCC, is an unintended path of heat flow between the outside and inside of the building envelope.

Thermal bridges may occur where there is an interruption in the insulation or where highly conductive materials (e.g. metal) are used.

As an example, if a steel truss roof directly supports an insulated corrugated iron roof, the heat flows through the truss more readily than the surrounding insulation, negating the effect of the insulation (i.e. the truss acts as a thermal bridge).

Figure 1 Metal roof truss

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What are the impacts of thermal bridging?

Thermal bridges can significantly reduce the effectiveness of the insulation (thermal resistance) of the façade by essentially bypassing the insulation in favour of a more conductive material (e.g. metal). This results in either losing heat from inside the building to the outside on a cold day, or adding warmth to the inside the building on a hot day. This may cause unwanted comfort issues in a building, and a likely increase in energy use by a building's heating and cooling systems.

Additionally, unaddressed thermal bridges may lead to condensation where warm, moist air contacts a colder surface and condenses into water droplets. Condensation can result in mould growth, causing indoor air quality issues, negative health impacts for occupants, and potentially affects the durability of the structure.

Thermal bridging and the NCC

The NCC prescribes methods for reducing thermal bridging in the following construction types:

- metal sheet roofing fixed to metal purlins, metal rafters or metal battens
- lightweight external wall cladding (such as weatherboards, fibre-cement or metal sheeting) fixed to a metal frame.

The NCC also requires thermal bridging to be considered when calculating the Total R-Value/Total System U-Value in the following construction types:

- steel and timber frames in the building envelope
- windows
- spandrel panels.

While the NCC does not prescribe methods for the following construction types, thermal bridging may also occur in:

- junctions between the floor, wall and roof
- penetrations in the building envelope for pipes and cables
- brackets or connection points for external shades or balconies
- slab projections
- steel wall ties used in masonry construction.

Case studies on thermal bridging of commercial construction

The ABCB has some detailed NCC Volume One case studies showing how to calculate Total R-Values with thermal bridges.

The case studies show the impact of thermal bridging using different materials in different climates zones.

Case study 1
Fibre cement cladding on timber framed stud wall for a Class 3 residential building in climate zone 5

Case study 2
Solid concrete, steel framed stud wall for a Class 6 shop in climate zone 3

Case study 3
Flat (horizontal) steel sheet roof with steel framing for a Class 7 storage facility in climate zone 6

Total R-Value and Total System U-Value: A recap

Total R-Value and Total System U-Value describe thermal resistance/transmittance (i.e. the ability of heat to transfer through a system or material). These values relate to one another, with the R-Value being the inverse of the U-Value.

Typically, R-Value is used to refer to a material's ability to prevent heat flow from a cold environment to a warm environment. Whereas, U-Value is used to describe a materials ability to transfer heat from a warm environment to a cold environment.

When using the NCC, R-Value (m^2.K/W) means the thermal resistance of a component, such as a layer of insulation. It is calculated by dividing its thickness by its thermal conductivity. The Total R-Value (m^2.K/W) means the sum of the R-Values of the individual component layers in a composite element, such as an external wall. It includes any building material, insulating material, airspace, thermal bridging and associated surface resistances.

When using the NCC, Total System U-Value (W/m^2.K) means the thermal transmittance of the composite element allowing for the effect of any airspaces, thermal bridging and associated surface resistances.

To understand what a 'good' or 'bad' value is, the higher the Total R-Value, the better insulator it is, whilst the opposite is true for the Total System U-Value.

What are the effects of thermal bridging on the Total R-value or the Total System U-Value?

The thermal resistance (or transmittance) of an element relates to the whole assembly (e.g. the frame and glazing elements of a window) or the entire façade. Therefore, thermal bridges can cause considerable thermal inefficiency and significantly decrease the R-Value (or increase the U-Value) of an envelope component. This means a small thermal bridge can have a substantial impact on the overall heat transfer through the building envelope.

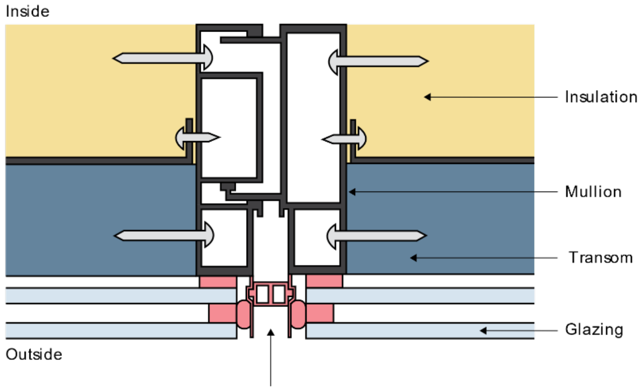
Fixing thermal bridges

While adding more insulation can help to account for thermal bridges, if they are to be truly fixed a thermal break is needed.

A thermal break is an element with low thermal transmittance placed strategically to interrupt the heat flow path through elements with high thermal transmittance.

Figure 1 provides an example of a thermal break in a spandrel panel. The thermal break is created by using a non-metal structural sealant, weather sealant, gasket and trim, as these have low thermal transmittance. The thermal break interrupts the connection between the inside and outside air through the metal mullion (with high thermal transmittance).

Figure 2 : Example of a spandrel panel with a thermal break (section view)



Calculating Total R-Values with thermal bridges

Total R-Values can be calculated with allowances for thermal bridging in accordance with AS/NZS 4859.2:2018 'Thermal insulation materials for buildings – Design'.

This Standard comprises of a calculation method (NZS 4214 'Methods of determining the total thermal resistance of parts of buildings') that accounts for the impact of thermal bridges on thermal performance.

Want to know more?

Examples showing how to calculate Total R-Values with thermal bridges are available separately from the ABCB website.