Simplifying Thermal Bridging Calculation: Improving Energy Efficiency





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Introduction

This paper is about meeting the Australian Building Construction Board (ABCB)¹ *National Construction Code (NCC)*² *Section J* and equivalent New Zealand requirements, performance verification methods, energy efficiency design standards, and environmental certification criteria relating to thermal bridging calculation. It addresses architects, specifiers and energy consultants.

It is known that uncontrolled air leakage and lack of moisture management in buildings leads to building energy inefficiency and other problems worldwide. The need for real solutions to counter this is clear. Progress in this area to date in Australia and New Zealand includes the following:

In Australia the Council of Australian Governments (COAG) Energy Council supports stronger energy standards leading to higher performing buildings. Their 2015-2030 *National Energy Productivity Plan*³, sets out to reduce greenhouse gas emissions and improve energy productivity by 40% by 2030. The 2018 work programme *A Trajectory for Low Energy Buildings* by COAG proposed a route to 'zero energy and carbon ready buildings' through increases to the energy efficiency provisions in NCC 2019. The Australian federal government's *Commercial Building Disclosure Programme (CBD)*⁴ also now requires 'mandatory disclosure' of energy efficiency information when commercial office space of 1000sqm is sold or leased and this is being reviewed for other building sectors. The information to be disclosed includes that on energy efficient construction features, such as insulation, that form part of the federal government's *National Australian Built Environment Rating System (NABERS).*⁵

There has been a similar increased focus on energy efficiency in New Zealand. The most recent 2017-2022 *New Zealand Energy Efficiency and Conservation Strategy (NZEECS)*⁶ is a key part of the government's response to meeting its energy, climate change, sustainability and economic transformation goals and relates to the *New Zealand Energy Strategy (NZES)*⁷ 2011-2021.

Minimum Energy Performance standards and energy rating labels are developed jointly with Australia under the *Trans*-*Tasman Equipment Energy Efficiency*^{8,9} programme and there are government incentives for carrying out energy efficiency measures as well as related environmental certification routes in both countries.



National Regulatory And Environmental Certification Requirements Relating To Thermal Bridging

National Construction Codes

The ABCB's *NCC 2019* came into effect from 1 May 2019, and energy efficiency provisions have a 1 year transition period. It includes significant improvements to energy performance standards for non-residential buildings. In New Zealand, performance compliance is required with the *Building Code*¹⁰ contained in the *Building Regulations 1992*.

Performance verification

In NCC Section J, the JV3 Verification Method allows designers to assess annual energy consumption of a proposed building and compare it to annual energy consumption of a reference building, modelled using the minimum DtS Provisions of NCC Volume One. This verification method allows trade-offs, such as reducing energy efficiency of the building's services below the minimum required using the DtS Provisions, by increasing energy efficiency of a building envelope.

Design standards and thermal calculation

The shift from an energy-based metric to a greenhouse gas emissions-based metric is manifested through changes to thermal bridging calculation methodology, explained further in this paper.

NCC 2019 Section J now references AS/NZS 4859.2:2018¹¹ Thermal Insulation Materials for Buildings: Part 2: Design. It supersedes in part AS/NZS:4859.2.2002, replaces part of AS/NZS:4859.1 and forms an extension to take into consideration products in-service conditions.

This new design standard focuses on in-service performance of insulation. It considers the impact of thermal bridging on a building envelope's R-value performance. It's objective is to provide clear and concise requirements to determine and report total R-values and system R-values to promote greater consistency of these calculations within the Australian and New Zealand marketplaces.

NCC Section J compliance

There is a need for *NCC Section J* compliance in achieving energy efficiency in building work, development applications and environmental certification. Compliance itself is achieved through meeting *NCC Section J* Governing Requirements and relevant Performance Requirements.

Need for building work to meet minimum energy efficiency requirements

The NCC requires building work to meet minimum energy efficiency requirements under its *Section J Energy Efficiency Provisions*¹². *NCC Section J* compliance is assessed against 9 categories. Areas that do not comply under *NCC Section J* provisions need recommendations to meet the minimum requirements of its Deemed to Satisfy (DtS) provisions.

DtS provisions of Section J apply to building elements forming the envelope of a Class 2 to 9 building (other than J1.2(e), J1.3, J1.4,

J1.5 and J1.6(a) which do not apply to a Class 2 sole occupancy unit or a Class 4 part of a building).

Need for NCC Section J Reports in Development Applications

Beyond this, many Australian Councils now require an *NCC* Section J Report in order to proceed with a Development Application. A Section J Report outlines the solutions and provisions necessary for any development to meet Section J requirements. J1: Building Fabric¹³ refers to roof and ceiling construction, roof lights, walls and floors.

Need for Section J compliance for Environmental Certification

Section J compliance can also contribute to achieving environmental certification. Across the board in Australia and New Zealand, there are new requirements for major works to assure sustainable outcomes. The Green Building Council of Australia (GBCA) is working to develop guidance materials to not only support *NCC Section J* adoption, but on using *Green Star*¹⁴ environmental certification processes. The New Zealand Green Building Council (NZGBC) has likewise developed guidance to support it's *Homestar*^{®15} rating system, which includes credits relating to thermal bridging.



Why Use A Thermal Calculator?

Thermal Resistance (R-value)

R-values reflect the ability of a material to resist heat flow and are commonly considered in Australia. Units of measurement for thermal resistance (are kelvins per watt (°K/W) or the equivalent degrees celsius per watt (°C/W°). Higher R-value figures indicate better performance.

Thermal Bridging and Thermal Breaks

A thermal bridge, otherwise known as a cold bridge, heat bridge, or thermal bypass, is an area or component of an object which has higher thermal conductivity than the surrounding materials. It creates a path of least resistance for heat transfer. Simply put thermal bridging represents the multiple pathways in which heat can transfer from one side of the building envelope to the other.

Thermal bridging generally occurs where there is either a break in insulation, less insulation or insulation is penetrated by an element with a higher thermal conductivity. It is a localised weakness or discontinuity in the thermal envelope of a building. It effects inservice performance producing heat loss and cold spots which can lead to build up of condensation and promote mould growth. Thermal bridges can account for 20-30% of heat loss in new construction. So as insulation levels increase, the importance of thermal bridging becomes more significant. The more thermal bridging that is present as a higher percentage of a total wall area, the greater impact it will have on the R-value of a building envelope.

The opposite of a thermal bridge is a thermal break, also known as a thermal barrier, an element of low thermal conductivity within an assembly to reduce or prevent the flow of thermal energy between conductive materials. Thermal Breaks are required for roofs and walls under certain conditions, as stipulated by the *NCC 2019*.

Effective thermal conductivity testing and measurement are important but in regions such as Australia, there is an emphasis on the need to compare the opposite, the thermal performance of materials, using the thermal insulance or resistance (R) value.

Thermal Calculators

Thermal calculators can be used to obtain the R-value for building envelope systems. Thermal calculations incorporate elements such as building class, climate zone and construction elements. In Australia and New Zealand, thermal calculations form part of a compliance pathway¹⁶ to achieve compliance with *AS/NZS 4859.2.*

Thermal calculators are part of an efficient approach, saving time and cost involved in calculating thermal performance. Using a thermal calculator assists with specification of the correct insulation system to meet thermal and other requirements mandated or described by Building Codes and Standards and can also help those seeking environmental certification.

How Thermal Calculation Works

Single pathway layered approach to thermal calculation R-values were previously calculated by a *Single Pathway Layered Approach*.

The previous *NCC2016* stipulated that a layer plus layer R-value satisfied provisions to demonstrate thermal performance to *ASNZS 4859.1:2002 Material for thermal insulation of buildings*.

However single layered approaches to thermal calculation do not account for heat loss through framing or point connections, the overall decreased system R-value caused by thermal bridging nor its impact on total U-values.

Multiple pathway approach to thermal calculation : Isothermal Plane Method

The *Isothermal Plane Method*¹⁷ is a multiple pathway approach and involves calculating the R-Value for an entire thermally bridged zone by area weighting, and then adding on the R-values for the layers outside of that. The Isothermal Planes method can be used to forecast the effect of typical workmanship defects. A detailed approach to the use of products in-service is described using *NZS 4214:2006: Methods of determining the total thermal resistance of parts of buildings*¹⁸. *NZS 4214* methods are used to calculate the total thermal resistance of building elements assuming building design conditions such as thermal bridging and compression of insulation in roofs, floors, walls across building classes.

Thermal bridging calculation

The new 5-step approach to thermal bridging calculation for compliance involves the following steps:

- 1. Determine system
- 2. Identify pathways using the Isothermal Plane Method
- 3. Calculate individual pathway performance
- 4. Assess the fractioned contribution to determine impact on R-value contribution
- 5. Confirm system complies to minimum requirements.



Choosing The Right Thermal Calculator

In Australia and New Zealand, industry guidance is still needed to further translate global best practice in the field of thermal performance to the country's range of climates and construction techniques. However there are solutions available today that enable efficient assessment of it to meet a variety of current compliance needs, whether to meet DtS provisions, aid development applications or contribute to environmental certification processes.

Previously thermal calculators used a relatively simple layered approach for calculating R-values to *AS/NZS 4859.1*. New requirements of *AS/NZS 4859.2* are more complex as they involve linking calculations of thermal performance, to actual real-world performance, across multiple pathways, so it is important to use the right one that caters for this.

Knauf Insulation and Kompli™

Knauf Insulation, part of the global Knauf Group, are insulation manufacturing, research and development specialists, providing advanced energy efficiency solutions and tools for construction worldwide.

Knauf Insulation revolutionised thermal bridging calculation with the introduction of Kompli™¹⁹, a FREE dedicated compliance tool

that helps architects, specifiers and energy consultants meet new requirements for thermal bridging.

Benefits of Kompli™

Kompli[™] benefits are fourfold:

- 1. It facilitates the efficient production of written compliance reports that demonstrate how wall, roof and floor systems demonstrate compliance with thermal bridging requirements
- 2. It provides free pre-populated templates for common systems used in Australian construction to save time and cost
- It simplifies complex thermal bridging calculations relating to walls, roofs and floors of a building envelope including calculation of system R-value performance with thermal bridging
- It enables users to create customised solutions for their individual project requirements through its "Design Your Own System" feature.

To find out how Knauf Insulation can help with your project through its free Kompli[™] thermal calculation tool, visit and access Kompli^{™19}.

REFERENCES

- 1 https://www.abcb.gov.au/
- ² https://ncc.abcb.gov.au/ncc-online/NCC
- ³ http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/ National%20Energy%20Productivity%20Plan%20release%20version%20FINAL_0.pdf
- 4 http://cbd.gov.au/
- ⁵ https://www.nabers.gov.au/
- ⁶ https://www.mbie.govt.nz/assets/346278aab2/nzeecs-2017-2022.pdf
- ⁷ https://www.mbie.govt.nz/assets/55f3c6780c/nz-energy-strategy-lr.pdf
- ⁸ https://www.eeca.govt.nz/standards-ratings-and-labels/equipment-energy-efficiency-programme/
- ⁹ https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/low-emissions economy/energy-efficiency-in-new-zealand/
- ¹⁰ https://www.building.govt.nz/building-code-compliance/building-code-and-handbooks/
- ¹¹ https://shop.standards.govt.nz/catalog/4859.2:2018(AS%7CNZS)/scope?
- ¹² https://www.abcb.gov.au/Resources/Publications/Education-Training/NCC-Volume-One-Energy-Efficiency-Provisions
- ¹³ https://ncc.abcb.gov.au/ncc-online/NCC/2016-A1/NCC-2016-Volume-One/Section-J-Energy-Efficiency/Part-J1-Building-Fabric/ J10-DeemedToSatisfy-Provisions?inlineLink=%7BD27484CA-E3FC-4BEF-B247-7A72E354BA09%7D
- ¹⁴ https://new.gbca.org.au/green-star/
- ¹⁵ https://www.nzgbc.org.nz/Attachment?Action=Download&Attachment_id=1375
- ¹⁶ https://www.abcb.gov.au/Resources/Publications/Education-Training/energy-efficiency-ncc-volume-one
- ¹⁷ https://codehub.building.govt.nz/home/resources/a-manual-for-calculating-r-values-using-the-isothermal-plane-method/
- ¹⁸ https://www.standards.govt.nz/assets/Publication-files/BSP/NZS4214-2006.pdf
- ¹⁹ https://www.knaufinsulation.com.au/kompli-ncc-2019-tool



