

Insulation



Thermal Bridging

How to Manage it Using Continuous Insulation



Introduction

In May 2019 a new National Construction Code introduced significant changes to the provisions outlined in Section J of Volume 1, which sets out the energy efficiency requirements of buildings. The Australian Building Codes Board recognises the important impact the construction industry has on the environment, and through more onerous requirements it will increase the energy efficiency of Australia's buildings by 40 per cent by 2030.

A big part of the improvements outlined in the energy efficiency provision of Section J comes from the inclusion of NZS 4214: 2006, a method to determine the total thermal resistance of parts of the building, as used in the New Zealand Building Code. The introduction of a direct reference to this method in Australia means that thermal bridging will now have to be accounted for in thermal calculations, directly impacting the Total R-value of building elements.

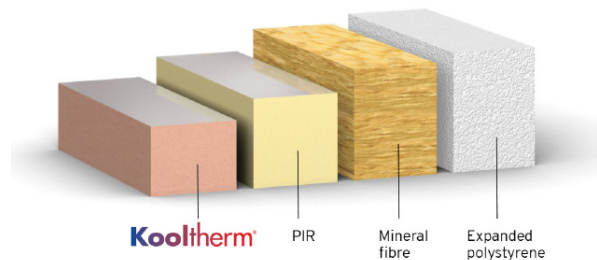
In order to highlight the impact of this new calculation method on different insulated wall lining systems, Kingspan Insulation commissioned Norman Disney & Young to conduct a thermal performance comparison between a traditional wall lining system (with bulk insulation) and Kingspan Kooltherm® K17 Insulated Plasterboard wall lining system.

The report, as outlined below, found that use of the Kingspan Kooltherm® K17 Insulated Plasterboard wall lining system can yield up to 60% thinner walls (complete wall thickness). It can yield walls that are up to 310 mm thinner for the equivalent thermal performance.

What is Kooltherm®?

The Kingspan Kooltherm® range is an extensive range of high performance rigid thermoset phenolic insulation for roofs, walls and floors. Kooltherm® is the most thermally efficient commonly used insulation material, which means you can minimise the thickness of your insulation compared with other conventional insulation materials, whilst achieving the same performance.

We aim to help the construction sector improve the thermal efficiency of building envelopes by providing exceptional insulation. In doing so, this will help significantly reduce building heating and cooling loads along with energy use.



Background and Purpose

To provide a comparative overview, Norman Disney & Young conducted a thermal performance comparison* between a traditional insulated wall lining system and the Kingspan Kooltherm® K17 Insulated Plasterboard wall lining system.

* The material and system examples in this report are based on typical values used at the time the report was created and offer a relative comparison between systems.

** Base Metal Thickness, thickness of the structural metal without additional coatings or colours.

The wall construction build-ups and components, for both the traditional insulated wall lining system and the Kingspan Kooltherm® K17 Insulated Plasterboard wall lining system are illustrated in Figures 1 and 2 (below).

The feature that differentiates the Kingspan Kooltherm® K17 Insulated Plasterboard wall lining system from a traditional wall lining system, is that the insulation layer in the former is not “bridged” by a higher thermal conductivity material (e.g. steel studs).

- 60 mm Kingspan Kooltherm® K17 comprising:
- 50 mm phenolic insulation; thermal conductivity = 0.02 W/mK
 - 10 mm plasterboard; thermal conductivity = 0.17 W/mK

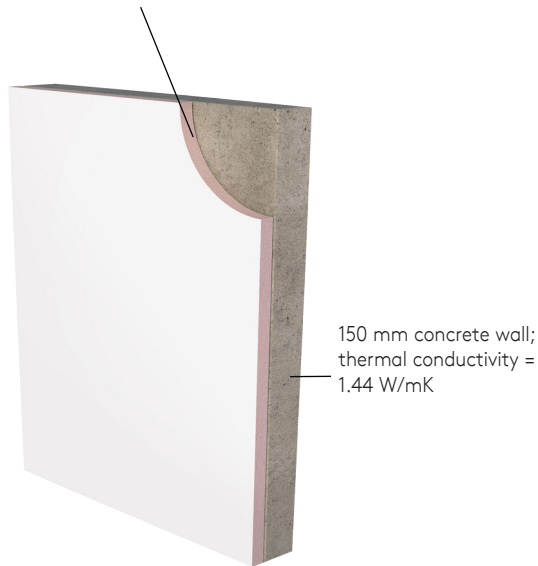


Figure 1 - Wall lined with Kingspan Kooltherm® K17 Insulated Plasterboard lining system

Studd and Nogging Details	
Studd Depth	92 mm
Studd Thickness (bmt**)	1 mm & 0.55 mm
Lap Width (average)	34.5 mm
Centres	600 centres
Nogging Height	1200 mm

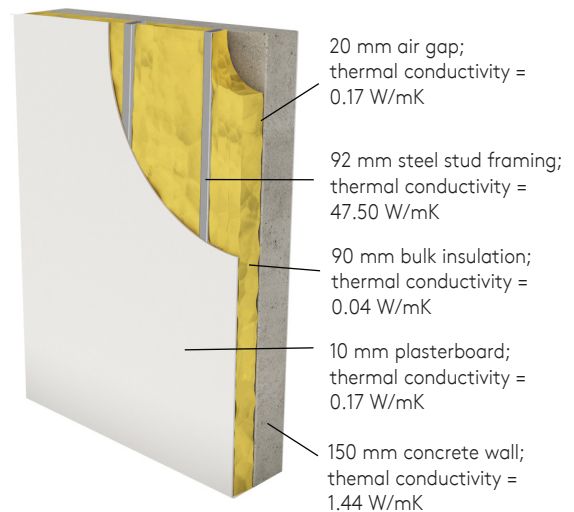


Figure 2 - Wall lined with traditional insulated wall lining system, comprising bulk insulation and steel stud framing

Results

Total Wall Thickness for Total R-value

When any thermal bridging within a wall construction is considered, it can impact (potentially quite considerably) the total system R-value. Norman Disney & Young calculated the required thicknesses of insulation and consequently, total wall thicknesses, to achieve target total R-values of 2.8 and 3.3 m²K/W, as per the requirements of the NCC 2016.

As can be seen in Figure 5 (below) the Kingspan Kooltherm® K17 Insulated Plasterboard wall lining system can yield up to 60% thinner walls. It can yield walls that are up to 310 mm thinner for the equivalent thermal performance. The required wall thickness for walls with thermally bridged bulk insulation is significantly greater than for non-bridged walls with high performance rigid thermoset phenolic insulation.

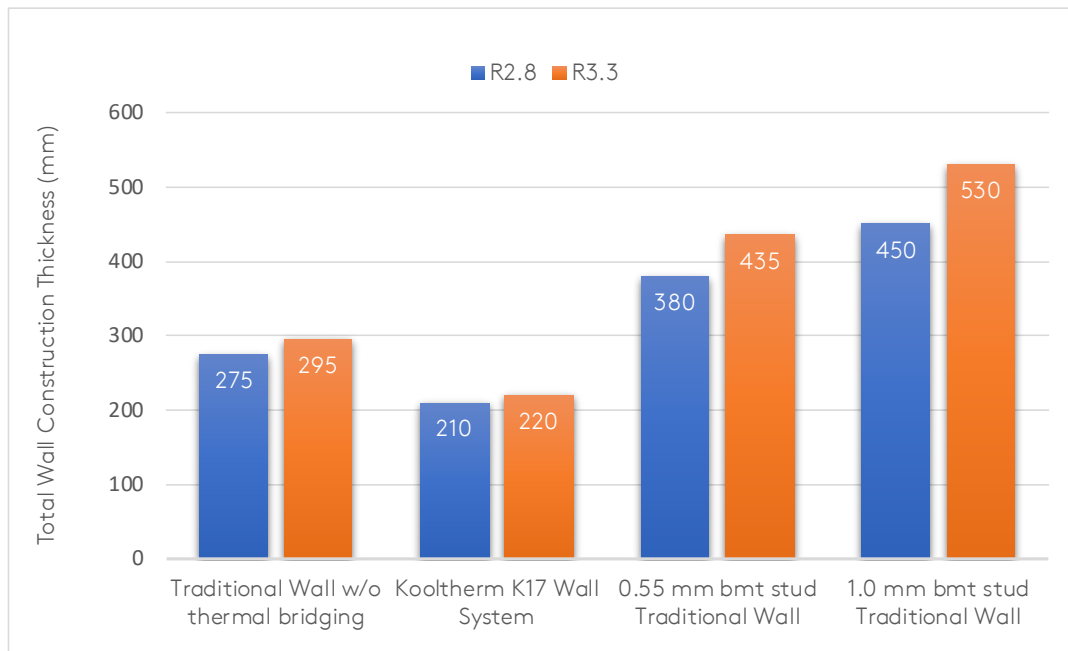


Figure 5 - Comparison of wall system thicknesses for two different target total R-Values

Conclusions

Kooltherm® K17 Insulated Plasterboard Increases Useable Floor Space

To achieve total R-values of 2.8 and 3.3 m²K/W, in accordance with NCC 2019, walls lined with the Kingspan Kooltherm® K17 Insulated Plasterboard wall lining system can be 170 - 310 mm thinner than walls lined with a traditional insulated wall lining system (with bulk insulation), when thermal bridging effects are calculated and offset. Accounting for the effects of thermal bridging will make achieving required R-values using just a traditional insulated wall lining system (with bulk insulation) impractical.

It is far better to employ a continuous layer of insulation such as that provided by Kingspan Kooltherm® K17 Insulated Plasterboard. A 170 - 310 mm wide band of additional floor area can be gained around the perimeter of a building by using the Kingspan Kooltherm® K17 Insulated Plasterboard wall lining system, when compared with a traditional insulated wall lining system (with bulk insulation).



Figure 6 - Class 3 building illustration

Conclusions

Kooltherm® K17 Insulated Plasterboard Increases Useable Floor Space - Example in Practice

For example, we can consider the impact this would have on a Class 3 building, which is a place of long term or transient living for a number of unrelated people (Figure 6). We are looking at a floor plan with 6 apartments, ranging between a 44m² studio, 50m² one bed or a 75m² two bed apartment (Figure 7). In this example we will consider the apartments as short stay serviced apartments, part of a hotel or Airbnb.

Across each floor plan the external wall length of insulated liner wall is 41m. Using a 170mm wall thickness difference, this creates a 6.5m² floor footprint saving on each floor level. Using a 15 level building complex, this would equate to 98m², meaning the footprint savings would yield an additional two studio apartments.

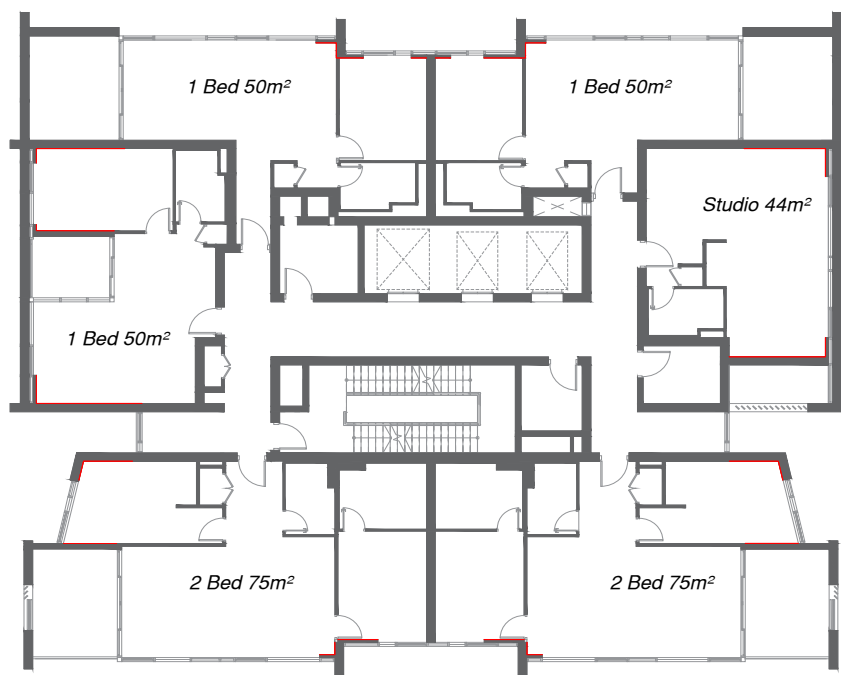


Figure 7 - Class 3 building example floor plan

Appendix

Methodology

The thermal analysis was conducted by way of 2-D heat transmittance estimates (conduction gains only). The methods investigated as part of this assessment are:

NZS 4214: 2006

Method to determine the total thermal resistance of parts of the building as used in the New Zealand Building Code and now also included in the NCC 2019

THERM

Finite Element Simulator computational package produced by Lawrence Berkeley National Laboratory (LBNL) and used for modelling 2-D heat transfer effects where thermal bridges are of concern (recognised by the Passive House [Passivhaus] Association)

CIBSE Guide A Environmental – Combined Method

Method to determine average thermal resistance of bridged structures – commonly used technical guide in the UK and produced by the Chartered Institute of Building Services Engineers

The results from NZS 4214 are midway between the upper and lower range of THERM and the CIBSE Guide A's.

As the results are similar and NZS 4214 is the method adopted by the NCC 2019 requirements for calculating system R-Values, it is reasonable to take the results from NZS 4214 as the system total R-Value for all wall types throughout the assessment. The results of this method are also very close to the calculated average of all three approaches.

NZS 4214

The analysis looks to split the construction into thermally bridged layers and homogenous layers where the material is consistent throughout the construction thickness. The thermally bridged elements such as metal frame (studs) are replaced with notional enclosing equivalent solid rectangle which has a thermal conductivity that would give the same heat flow. The bridged layers are bounded by solid surfaces and as such the air gaps of adjacent bridged layers are considered part of the bridged layer.

Determining the thermal resistance of the bridged portion of the structure is calculated through the formula:

$$\frac{1}{R_B} = \frac{f_1}{R_1} + \frac{f_2}{R_2} + \frac{f_3}{R_3} + \dots$$

f_x = fraction of the cross-section at right angles to the direction of heat flow occupied by each region

R_x = thermal resistance through the region corresponding to f_x

R_b = thermal resistance through the bridged portion of the structure

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