Poorly fitted wall insulation cuts thermal performance

It's well known that poorly fitted insulation has a thermal resistance significantly less than the R-value on the label, but how much less? A recent BRANZ study put some numbers on this.

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NZS 4246:2006 *Energy efficiency – Installing insulation in residential buildings* requires that insulation is fitted without gaps, tucks and folds. Research has shown that gaps as small as a few millimetres around the edges of wall insulation can sometimes halve the overall thermal resistance. This is the case where there are also gaps between the faces of the insulation and the inside faces of the cladding and lining materials (see Figure 1).

Heat can bypass around the insulation by the process of convective air movement. This is why it is recommended that the thickness of insulation product specified is identical to the frame cavity depth.

Even if there are no face gaps, only gaps around the edges of the insulation, the thermal resistance of a building component will be less than the calculated thermal resistance based on the nominal R-value of the insulation product.

Retrofitting wall insulation

A recent BRANZ research project investigated the performance of various retrofit wall insulation materials and systems. During this project, the impact of the edge gaps on their own was quantified, without the complicating aspect of air exchange associated with face gaps.

As the thermal performance requirements of a house increase, insulation products with higher R-values are needed. The higher the insulation R-value, however, the more significant the impact of thermal bridging from poor installation.

In retrofit wall insulation, it becomes even more critical, since installation costs are often a larger part of the cost than the insulation material. This often leads to a desire to install the highest R-value product available.

Different framing and gaps modelled

Thermal models were used to estimate the thermal resistance of a section of weatherboard clad wall insulated with a high-performance wall insulation product (R2.8). Edge gaps between the insulation and the framing varied from 0–20 mm. The modelling was done for two common framing layouts:

- Studs at 450 mm centres and no dwangs, often in houses needing retrofitted insulation.
- Studs and dwangs both at 600 mm centres, often the case with new housing.

Figure 2 shows the impact of the edge gaps on the R-value for the systems.

What starts out with an R-value of R2.6 and R2.4 respectively becomes R1.7 and R1.5 when edge gaps of 20 mm are included. In reality, high-performance wall insulation products are unlikely to have gaps as bad as 20 mm – they can usually be cut and fitted with a better tolerance than lower R-value products because of their higher density. If nothing else, the higher cost of the insulation product ought to be an incentive to take more time and care over its installation.

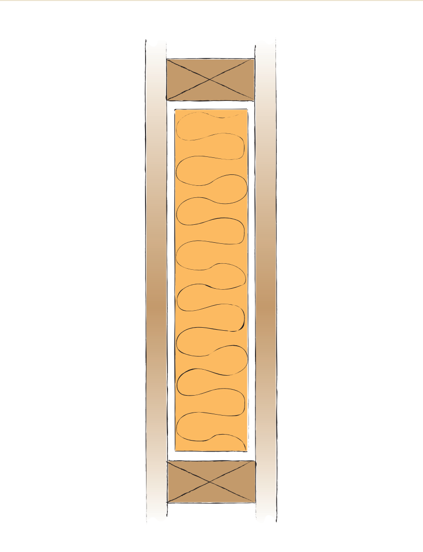

Figure 1: Gaps between the faces of the insulation and the inside faces of the cladding and lining materials will substantially reduce thermal resistance.

Wall in test with larger gaps around the edges of the insulation.

Properly fitted wall insulation in test with no gaps around the edges of the insulation.

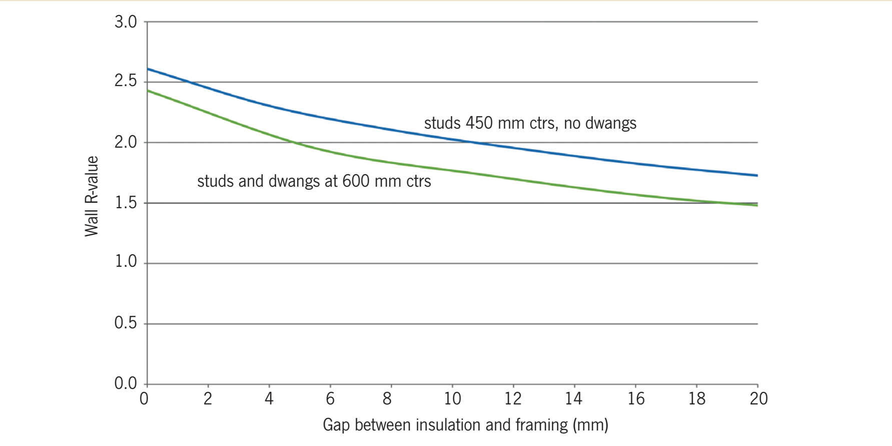

Figure 2: The impact of edge gaps on the system R-value.

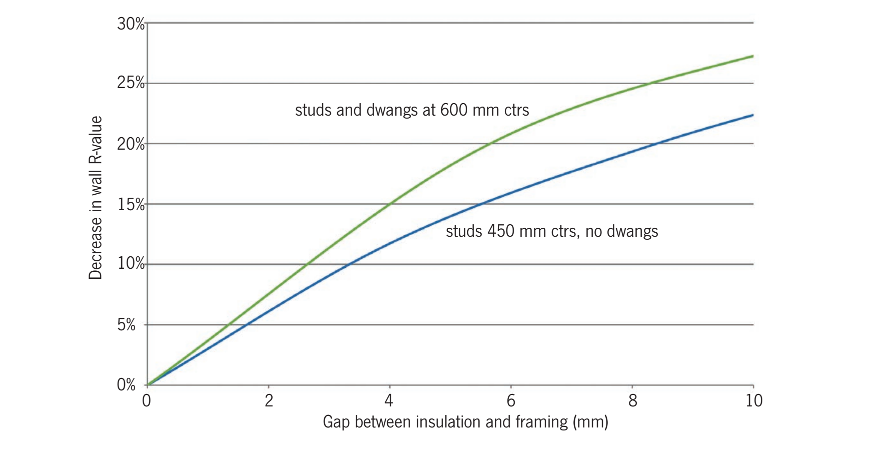

Figure 3: Modelling results for small gaps.

The data was extended to 20 mm so that measurements could be made of an actual wall panel in the BRANZ Guarded Hot Box apparatus. Using an artificially large edge gap allowed the accuracy of the thermal models to be checked more easily.

R2.8 with 16 mm gap = R1.4

The measured panel had framing with studs and dwangs at 600 mm centres. Measured system thermal resistance was R2.40 without gaps and R1.55 with 16 mm gaps (6% of the insulation segment width and height) compared with values of R2.42 and R1.60 calculated theoretically. This close agreement suggests that the thermal model should be accurate for interpolation with gaps between 0 and 16 mm.

The result with 16 mm gaps represents a 35% decrease in R-value for the system, and in fact, the overall effect is the same as if an R1.4 insulation product had been used instead but fitted without gaps. The R2.8 product with 16 mm gaps would therefore be performing equivalent to half its nominal value.

Smaller gaps still significant

Figure 3 shows an expanded view of the modelling results for small gaps but with the vertical axis changed from thermal resistance to the percentage decrease in R-value from the values with no gaps.

While the impact of small gaps is much less than it would be if there were also face gaps, the effect is still significant given that 4 mm gaps result in 12–15% lower system R-values.

However, well fitted high-performance insulation products will insulate effectively.