Retrofitting insulation in weatherboard walls with linings on: Effective water management

Around half of all New Zealand houses have no insulation in their walls. Retrofitting insulation in walls typically involves replacing the interior linings, so retrofits are often done only as part of wider renovations. Linings-on retrofits are possible by blowing insulation into the wall space, but in some cases, there will be no existing wall underlay. This poses a potential risk of water tracking through the insulation towards the inside of the wall, a problem that has been experienced overseas when rolling out widespread retrofits. BRANZ has developed a proposed evaluation method to provide a level of confidence that this will not happen when retrofitting insulation into timber-framed walls.

When it comes to installing thermal insulation in older uninsulated houses, the roof space and underfloor are generally the first areas to be addressed. Insulating these areas can give very good results in making a house warmer, access is often reasonably easy and there are few risks involved.

It is a different matter with retrofitting wall insulation. Unless extensive renovations are being undertaken, with cladding or lining removed, installation can be difficult. A loose-fill insulation system that demonstrates compliance with the New Zealand Building Code via CodeMark, blown in through holes, is the only current practical solution. Yet where cladding is direct-fixed and there is no wall underlay - a reasonably common situation with many older homes - there is a risk that the insulation can act as a bridge, carrying moisture from the back of the cladding to the wall framing. Given New Zealand's history with leaky buildings, this risk for potential growth of mould or rot is taken seriously. This explains why retrofitting insulation into walls requires a building consent, while retrofits to roof spaces or under floors do not. When no underlay is present in a linings-off situation, steps are usually taken to ensure effective water management, in particular, following NZS 4246:2016 *Energy efficiency - Installing bulk thermal insulation in residential buildings*.

Widespread improvement to the thermal performance of the housing stock is something that should be encouraged. The 2015 BRANZ House Condition Survey suggested that just over half of all our existing housing stock is lacking wall insulation. For houses that only have roof-space insulation or roof-space and floor insulation, the (uninsulated) walls contribute significantly to heat loss.

Effectively retrofitting insulation in walls can therefore have noticeable benefits in improving energy efficiency and making houses easier to keep warm. However, it is important to understand any risks and ideally mitigate against them.

Loose-fill insulation

While there are some loose-fill insulation providers in New Zealand, the practice is not as common as using bulk insulation. NZS 4246:2016 contains detailed guidance on installing insulation, including retrofits, and is a key document for the industry. While it contains an overview of the installation of loose-fill insulation, it does not provide the same step-by-step installation process as it does for other materials. Installation of loose-fill insulation into walls without a wall underlay is outside the scope of the standard.

There is little help to be found in other countries, chiefly because their construction systems are different to ours in key respects. BRANZ has not found any documentation anywhere in the world, whether from government or industry, that provides installation guidance for safely retrofitting blown-in insulation into timber-framed walls where the cladding is direct-fixed and there is no underlay.

There are cases from overseas where cavity wall insulation has led to water ingress. These instances have typically led to guarantee and quality control schemes being put in place by the industry and/or government in those countries.

BRANZ carried out some research to assess potential solutions for linings-on retrofits in New Zealand. The research confirmed that, without an underlay present, water transfer can occur, irrespective of whether the insulation material itself is treated to be water-resistant.

The research also found that it was possible to install insulation in a way that resists moisture transfer to the inside of the wall. It has highlighted pathways for a linings-on retrofit for weatherboard walls with or without underlay and developed a laboratory-based evaluation method for assessing the performance of walls retrofitted with insulation. It is intended to be used as part of an overall assessment of an insulation system's suitability to be used in a wall without underlay without negatively affecting the water management behaviour for the wall.

Developing a water management test for New Zealand loose-fill insulation

This project examined whether insulation could manage water penetration in walls without an underlay between cladding and framing. The work focused on weatherboard as it the most common cladding on older properties, but the principles can be applied to brick veneer cladding as well. It also focused on loose-fill insulation, but the principles can be applied to bulk insulation too.

A full-scale test method was investigated. Verification Method E2/VM1 was selected as the basis for this because it is intended for use with timber-framed walls and is recognised in the New Zealand Building Code. In part of E2/VM1, the wetwall test, the cladding is required to stop water transferring across the drainage cavity when there are defects in the cladding and there is a 50 Pa pressure difference across the cladding. For loose-fill insulation used without an underlay, the proposed test requires the insulation to prevent water transfer to the framing under the same conditions.

Thermal imagery is a key part of the proposed method. Any water that is transferred to the inside of the wall can be identified because of the resultant temperature change on the surface of the specimen – typically the water corresponds to a cold spot or a dark colour in the images. The method allows an assessment of water transfer because it shows wetting both when the internal linings are in place and during disassembly. It also allows for a time-lapse video to be created of the whole test and an easy comparison with the baseline uninsulated case after insulation has been removed.

The baseline comparison case (Figure 1) shows the leakage pattern of an uninsulated wall after the linings have been removed. The short dark vertical lines are water draining back out of the weatherboards between the lap joints.

A test was then conducted on a specimen that had underlay installed against the back of the weatherboards. As expected, no water was able to transfer through the underlay to the framing. When different types of insulation were added and the test repeated, again there was no evidence of water transfer. This was to be expected as the arrangement is the same as a direct-fixed weatherboard wall built to today's Building Code requirements.

With no underlay and with loose-fill insulation installed, depending on the specific details of the installation, the testing found cases where no water transfer occurred and

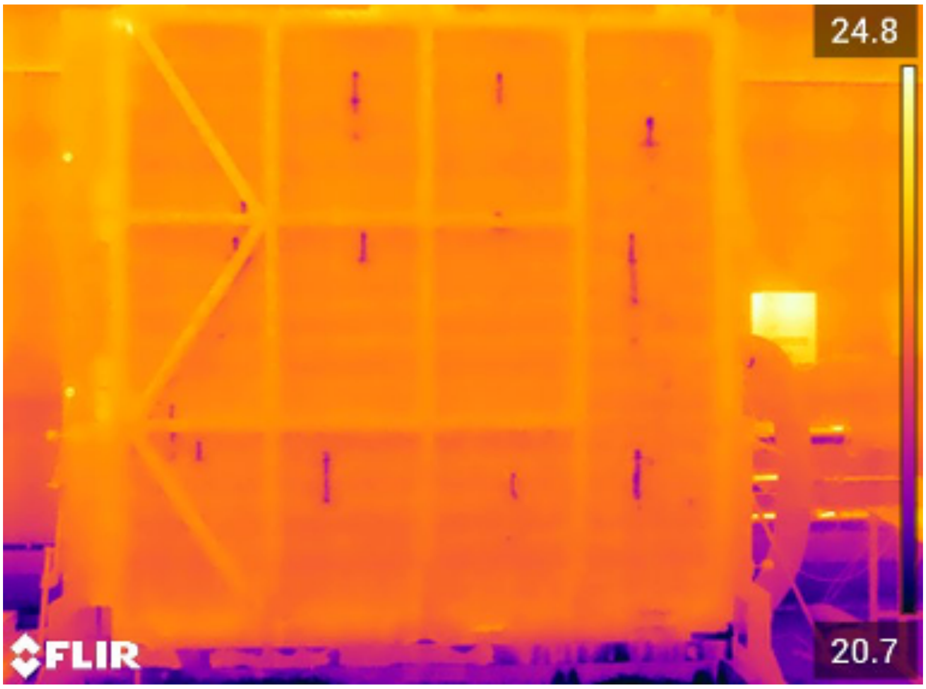

Figure 1. The baseline case – an uninsulated wall without lining.

others where water was found to transfer through the insulation to the lining (Figure 2).

The testing work shows that some loose-fill systems have a higher resistance to water transfer than others. Failing the proposed test does not necessarily mean a real-life installation will automatically fail, but passing the test does indicate that the insulation system offers a degree of protection against water ingress – the risk of frame wetting has not increased relative to the uninsulated state of the wall.

Overview of the evaluation method

The proposed evaluation method represents a test method to determine whether water can transfer off the back surface of direct-fixed weatherboard cladding without an underlay when loose-fill insulation is retrofitted by being machine blown into timber-framed walls. After repeated testing of an installation system (material, density and process), if there is no evidence of water being transferred, there can be more confidence that such installations will not compromise the water management ability of the retrofitted walls.

The test consists of subjecting a wall to a consistent leak arising from a water spray of 0.05 l/m².s over the face of the cladding, a 50 Pa air pressure difference across the cladding and a series of 6 mm diameter holes (to simulate defects) through the cladding. The time for the test is 2 hours. Thermal imagery shows whether water has transferred to the inner parts of the wall.

The wall specimen must be at least 2.4 m high by 2.4 m wide and clad with 185 mm high bevel-back pre-primed weatherboards.

This method has seven steps:

1. Initial pressure checking without water.
2. Pre-wetting without pressure.
3. Pre-conditioning with pressure and water but no leak points open.
4. Testing at 50 Pa with at least 0.05 l/m².s water spray and 15 leak points open.
5. Removal of lining and thermal imaging of insulation surface.
6. Removal and weighing of insulation from each frame cavity. Thermal imaging of empty frame cavity.
7. Visual inspection of empty frame cavity for water transfer onto framing.

Water should not reach the sides of the studs, the top and bottom surfaces of the dwangs or the top of the bottom plate. The full pass criteria are that there is a pass for two nominally identical wall samples and there is a pass for repeats of both samples.

The evaluation method also sets out what should be included in the test report.

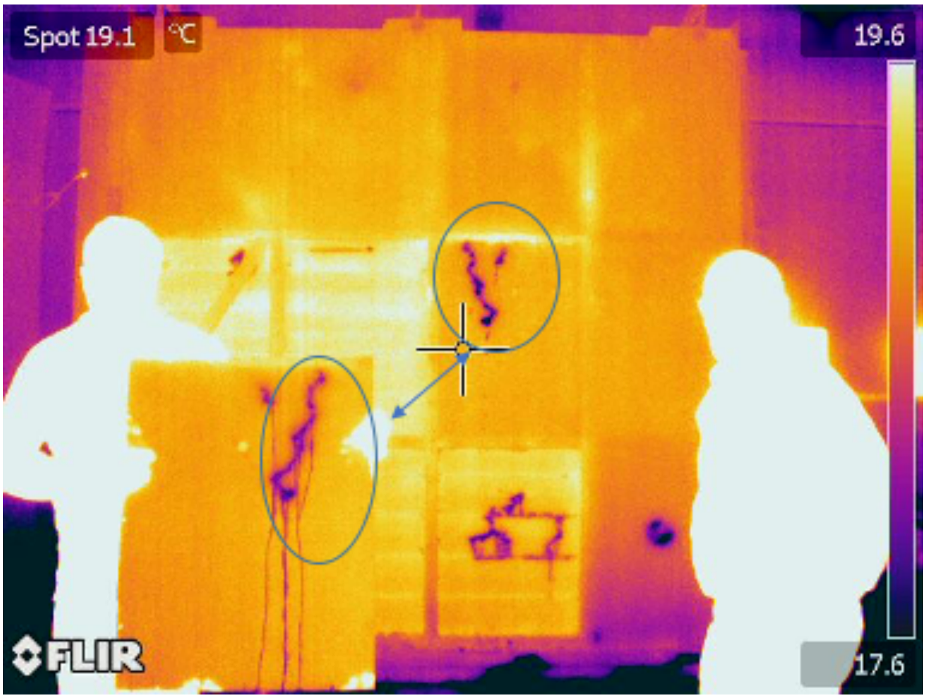

Figure 2. Disassembly of a wall where water transfer has occurred. The pattern of water on the back of the lining being held up matches the pattern on the surface of the insulation.

This test only covers leaks at the interface between the back of the cladding and the adjacent insulation (a face leak). It does not consider more complex leaks into the bulk of the insulation (a body leak) – for example, from a leaking window or door flashing.

As this is a proposed test method at this stage, certain details may change upon final publication.

Conclusion

There is significant potential to improve the energy efficiency and carbon footprints of our existing housing stock by retrofitting insulation to walls. Unfortunately, some walls are riskier to retrofit than others, particularly those without an existing underlay that is in good condition. The risk is that the insulation draws water further into the wall to the framing.

BRANZ has developed an evaluation method, based on E2/VM1, to help find approaches that avoid this problem. Testing with this method in a properly accredited facility can give more confidence that retrofitting insulation will not compromise water management in a wall. The method can be used in conjunction with both loose-fill and bulk insulation to provide confidence the systems will perform even with no underlay being present.

The work also highlights that many walls, specifically those with an underlay in place, can be viably insulated using loose-fill insulation. Figure 3 shows a decision tree for retrofitting wall insulation based on current BRANZ recommendations.

More information

BRANZ Study Report SR436 *Linings-on retrofit insulation in weatherboard walls: Ensuring effective water management*

BRANZ Study Report SR372 *Warm, dry, healthy? Insights from the 2015 House Condition Survey on insulation, ventilation, heating and mould in New Zealand houses*

Decision tree for retrofitting wall insulation

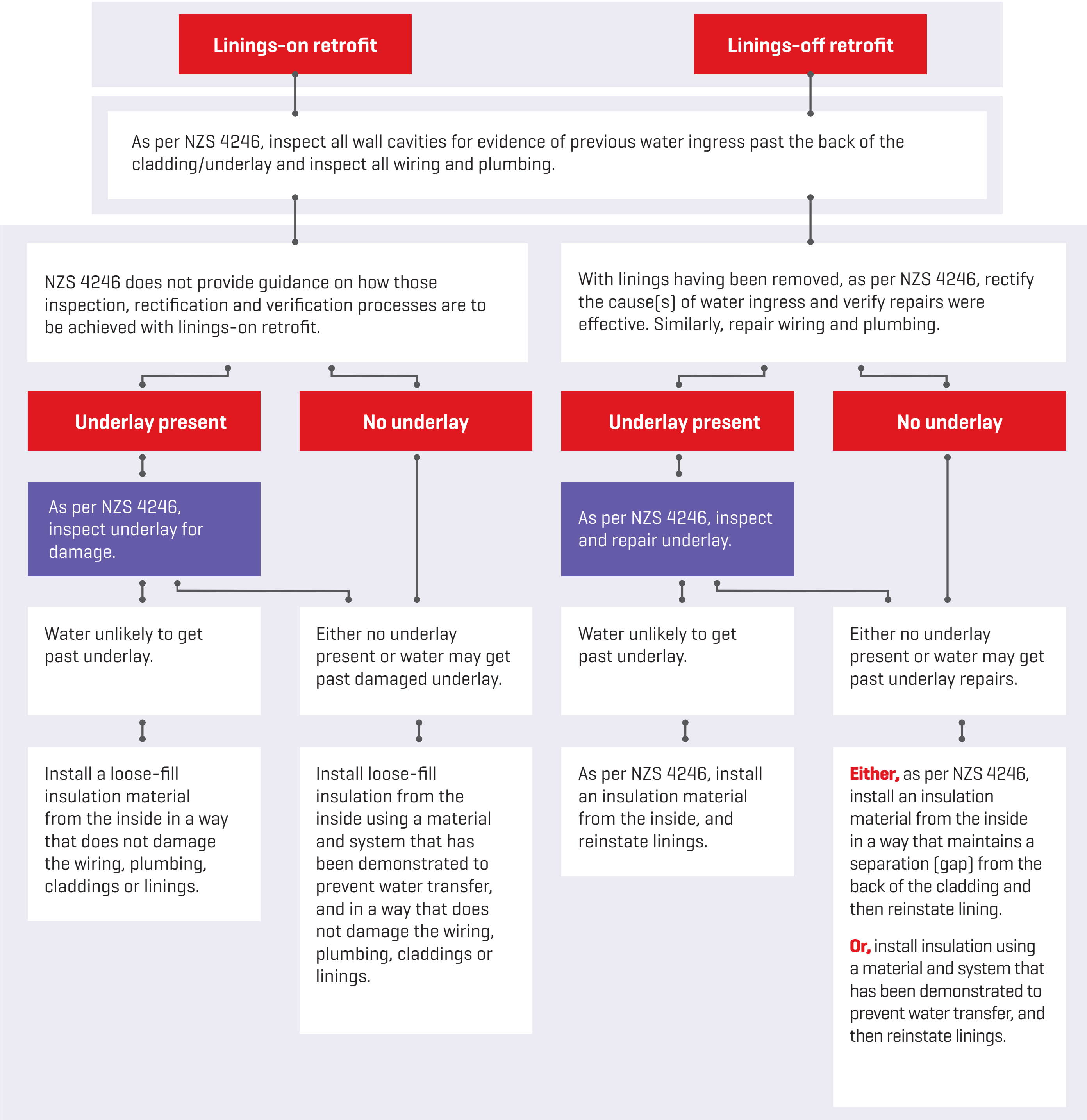

Figure 3. Decision tree for retrofitting wall insulation