BRANZ

ISSUE 694 BULLETIN

# RETROFITTING WALL INSULATION WHILE REPLACING THE LININGS IN HOUSES

July 2024

- Adding insulation into the external walls of existing homes can help make the homes warmer, drier and healthier to live in and potentially reduce heating costs.
- Retrofitting can also help New Zealand meet its target of a net-zero carbon economy by 2050 through reducing the operational energy use of buildings.
- The scope of this bulletin is limited to retrofitting done from inside the building with wall linings replaced as part of the work.

# 1 INTRODUCTION

**1.0.1** An estimated 570,000 houses in Aotearoa New Zealand lack external wall insulation, based on the number of houses built before 1978 when thermal insulation became a requirement nationwide. Retrofitting insulation to these houses can contribute to making warmer, drier and healthier environments for the occupants. It can potentially reduce operational energy use and costs and reduce exposure to rising fuel prices.

**1.0.2** Retrofitting thermal insulation can also help the country reach its net-zero carbon goal by 2050 – the operational energy use of buildings is estimated to account for about 20% of total greenhouse gas emissions using a consumption-based accounting approach.

**1.0.3** The scope of this bulletin is limited to retrofitting done from inside the building with old wall linings replaced as part of the work:

- Where internal wall linings are in poor condition, it is more likely to be cost-effective to install insulation and replace the linings at the same time. This will especially be the case in homes built before the mid-1920s when most walls had horizontal rough-sawn timber match linings with scrim tacked to it and wallpaper glued to the scrim. Removing the linings to retrofit insulation into the frame cavity also provides the opportunity to thoroughly inspect the condition of the framing and to repair any defects that are causing water ingress into the frame cavity instead of draining down the back of the weatherboards. Plumbing and wiring can be inspected at the same time.
- If the internal linings are sound, removing and reinstating or replacing them to allow the installation of wall insulation is unlikely to be economical.
- Unnecessary replacement of wall linings is likely to have a high carbon cost, offsetting or reversing the benefits of reducing operational carbon from adding insulation.

**1.0.4** While the basic work of any form of retrofitting insulation into wall framing seems easy, moisture transfer, weathertightness and durability risks must be understood, managed and reduced.

**1.0.5** BRANZ has conducted research projects in recent years exploring insulation retrofits and identifying how they can be carried out in a way that reduces the risks. One major piece of research is reported in this bulletin.

**1.0.6** Where wall insulation retrofitting is being planned, installing a secondary insulation layer to the internal face of external walls is another option that could be considered. You can find more information about this in *Build* 197 and the BRANZ *House insulation guide* 6th edition.

**1.0.7** The healthy homes standards for rental housing require a minimum level of roof and underfloor insulation where it is reasonably practical to install it, but there are no requirements for retrofitting external wall insulation in existing homes.

**1.0.8** While there is currently no mandatory requirement to upgrade thermal insulation in the walls or elsewhere of existing owner-occupied homes, there is growing pressure towards encouraging much more retrofitting. For example, in its advice on the direction of policy for the government's second emissions reduction plan released in 2023, the Climate Change Commission suggests (in Recommendation 14) that government should accelerate comprehensive retrofits to deliver healthy, resilient, low-emissions buildings.

**1.0.9** Retrofits are becoming mandatory in some other countries. For example, the European Union requires member states to reduce the average primary energy use of residential buildings by 16% by 2030 and 20–22% by 2035. At least 55% of the decrease must come from renovation of the worst-performing buildings.

# 2 BUILDING CONSENT

**2.0.1** While retrofitting insulation in a roof space, under a floor or into an internal wall (that is not a fire separation) is exempt from requiring a building consent (in Schedule 1 of the Building Act), the exemption does not apply to retrofitting insulation into external walls because of the potential impact on the risks around moisture transfer, durability, bracing and fire. Retrofitting insulation into an external wall requires either a building consent or documented approval from a building consent authority (BCA) that consent is not required. Some BCAs have minor works consent applications for works under a certain value.

**2.0.2** BCAs have discretion under the Building Act to exempt any proposed building work from requiring consent if it is likely to comply with the Building Code or is not likely to endanger people or buildings. Some BCAs have provided exemptions for specific systems for retrofitting insulation into external walls (not the general methods in NZS 4246:2016 *Energy efficiency – Installing bulk thermal insulation in residential buildings*). BCAs can charge fees for providing discretionary exemptions.

**2.0.3** Obtaining a building consent has the advantages that work will be inspected and a Code Compliance Certificate (CCC) issued on completion. If the owners ever want to sell the house, having a CCC may be attractive to potential buyers.

**2.0.4** The building consent application will need to demonstrate compliance with all relevant Building Code clauses. For the clause H1 *Energy efficiency* component, applications can be made as an Alternative Solution or using Building Code Acceptable Solution H1/AS1, which applies to all housing, and buildings up to 300 m². If the work is considered new building work, it must comply with the requirements of clause H1 and H1/AS1 can be used to demonstrate compliance. H1/AS1 references NZS 4246:2016 as an acceptable method for installing bulk thermal insulation, and the standard includes methods for retrofit.

# 3 BUILDING CODE, BUILDING ACT AND STANDARDS REQUIREMENTS

**3.0.1** All building work (in this case, retrofitting insulation) must comply with the Building Code to the extent required by the Building Act (section 17 of the Building Act). However, section 112(1)(b) of the Building Act also states that, with alterations to existing

buildings, the building must continue to comply with the provisions of the Building Code to at least the same extent as it did before the work began.

**3.0.2** MBIE states: "These two requirements relate to different parts of the building (i.e. new part versus existing parts); the extent of Code compliance is different; and they can relate to different Building Code performance criteria." See section 7 for links to MBIE guidance about this.

**3.0.3** Section 112 of the Building Act is especially relevant considering compliance with Building Code clauses such as B2 *Durability* and E2 *External moisture* because it requires that work associated with retrofitting insulation must not reduce a building's durability and weathertightness.

**3.0.4** NZS 4246:2016 states (in 2.2.7): "Insulation shall not be installed in ways that allow moisture to transfer through or to accumulate in wall, roof, or floor cavities in sufficient quantities to cause condensation, fungal growth, or damage to framing, claddings, or linings." The standard describes two options for walls without underlay – to install folded sections of underlay before adding the insulation or to provide a separation between the back of the cladding and the insulation (see 5.4 and Figure 18 in the standard).

Many older houses with horizontal timber match lining have already been renovated, but those that retain their original rough and air-leaky linings are usually good candidates for retrofitting wall insulation and installing new wall linings.

## 4 BRANZ RESEARCH INTO RETROFITTING WALL INSULATION

**4.0.1** BRANZ investigated retrofitting insulation into external direct-fixed timber weatherboard walls with no underlay, with particular attention to the risk of water transfer from the back of the cladding to the insulation and/or framing (see Study Report 484). The scope was limited to solutions that include removing linings.

**4.0.2** While wall underlay is a requirement for new construction with all timber weatherboard claddings in Acceptable Solution E2/AS1, many older (pre-1970s) uninsulated houses do not have an underlay. Underlays are important because:

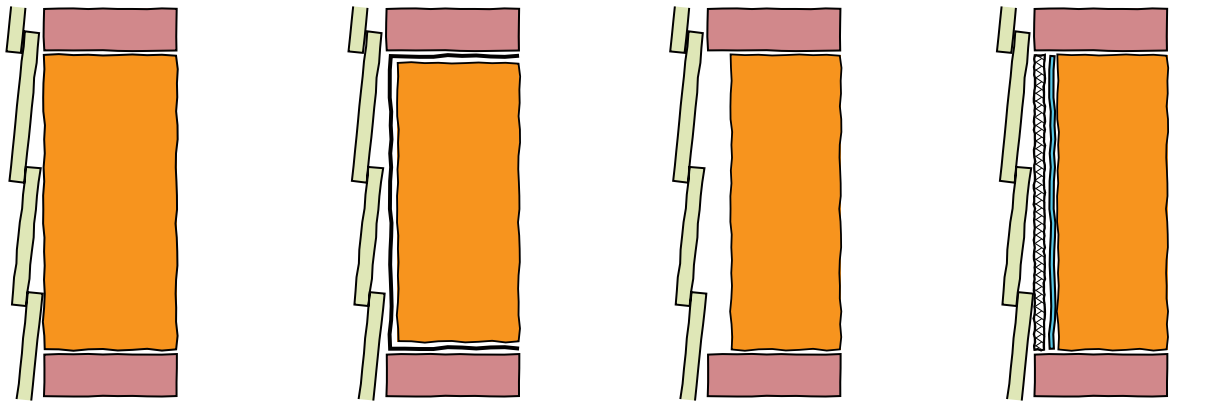
- they help restrict the movement of moisture that has got through the cladding from getting into the framing and insulation
- they temporarily absorb condensation (when an absorbent underlay material is used)
- they support the effectiveness of thermal insulation by preventing moisture moving into the insulation material.

**4.0.3** There is a risk that adding insulation to exterior walls without an effective underlay may change the path of rainwater leaks, potentially transferring moisture from the back of the wall cladding to the framing and leading to problems of mould or even rot.

**4.0.4** Four different approaches were used to evaluate water management of retrofitted walls with direct-fixed cladding:

- Without separation or underlay (Figure 1a).
- Without separation but with folded sections of underlay (Figure 1b).
- With 20 mm separation between cladding and insulation, no underlay (Figure 1c).
- With drainage plane mesh and sections of underlay (Figure 1d).

**4.0.5** Current options in NZS 4246:2016 are to either install folded sections of underlay before adding the insulation (Figure 1b) or to provide a separation between



(a) No mitigation – BBW, insulation

(b) NZS 4246:2016 method – BBW, underlay, insulation

(c) NZS 4246:2016 method – BBW, 20 mm separation, insulation

(d) Alternative method – BBW, drainage plane mesh, underlay, insulation

Figure 1. BRANZ research into techniques for retrofitting insulation in exterior bevel-back weatherboard (BBW) walls without wall underlay with direct-fixed claddings.

the back of the cladding and the insulation (Figure 1c).

**4.0.6** The BRANZ tests used a method based on Verification Method E2/VM1. Thermal imaging during testing and disassembly was used to characterise water management performance.

**4.0.7** The tests were carried out using four types of underlay (lightweight kraft paper, heavyweight kraft paper, woven synthetic underlay and non-woven synthetic underlay), three brands of glass wool insulation and two brands of polyester insulation. Overall, there was no significant difference in the outcome between the insulation materials or brand of insulation product.

**4.0.8** The most reliable mitigation measure was found to be drainage plane mesh combined with a synthetic underlay between the mesh and retrofitted insulation (Figure 1d). The most effective way to protect the bottom plate was a strip of kraft paper tucked into the gap between the framing and the back of the cladding (Figure 2).

**4.0.9** The 7–8 mm thick drainage mesh allows thicker, higher R-value insulation to be installed compared to using a 20 mm separation. Since standard wall insulation products are 90 mm thick to suit dressed framing, there is clearly space for the drainage mesh when used with 100 mm deep rough-sawn framing. Since some existing framing is only 95 mm depth (or occasionally 90 mm depth), the specific insulation product needs to be chosen to match the framing depth and the installation process.

**4.0.10** With the drainage mesh approach:
- the most effective way to install the mesh and the underlay was a neat fit without edge folds
- fixing staples should be stainless steel
- care is required in the areas where diagonal bracing is hard against the back of the weatherboards – a folded strip of kraft paper was reasonably effective at directing most of the water to the back of the cladding.

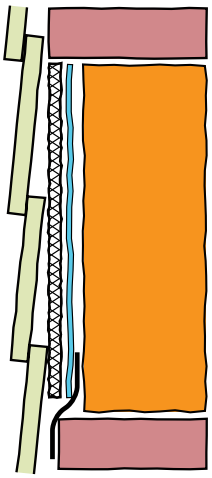


Figure 2. Approximately 100 mm high strip of kraft paper tucked into gap between framing and back of cladding.

**4.0.11** Replicating the success of this approach requires complete removal of the existing wall lining so that underlay, mesh and insulation can be properly installed in each section of wall framing. This is likely to be more cost-effective where the existing lining is in very poor condition and in need of replacement, although the long-term durability of the walls and the condition of the wiring and plumbing (which can be replaced at the same time if required) and the long-term energy cost all need to be considered.

**4.0.12** While these test results provide updated guidance, the Building Code requirements set out in section 3 must still be met to the extent required in the Building Act. Note that the options in NZS 4246:2016 – the folded sections of underlay method and the 20 mm separation – are in principle both compliant in terms of the Building Code. However, BRANZ considers that this new method of a drainage plane combined with underlay has been proven in testing to provide a more reliable method for compliance.

## 5 INSULATION MATERIALS AND UNDERLAY

**5.0.1** The BRANZ lab testing described here used glass wool and polyester insulation, but other options include sheep's wool, mineral wool or blended products. A recently introduced option is blown-in glass wool insulation retrofitted via removal of the linings and adding a transparent cloth/membrane across the internal face of the framing. The cloth/membrane holds the insulation in place during and after installation, and the internal lining is then installed over the cloth/membrane.

**5.0.2** The sustainability/carbon footprint of materials should be considered. Part of this assessment may include use of recycled materials in manufacturing. For example, some insulation products are manufactured from approximately 50% recycled material (polyester) or 80% recycled material (glass wool).

**5.0.3** How insulation is installed can have a large impact on its performance. All types of insulation materials should be protected from the weather before, during and after installation and installed without gaps around the edge. With segment/blanket materials, take great care not to compress, fold or crease them. Where possible, install insulation to the back of pipes in the wall (NZS 4246:2016 has more guidance on this) or use specific pipe insulation products.

**5.0.4** Where underlay already exists in an uninsulated wall, check its condition carefully. Small tears can be repaired with tape, but if there is more serious damage such as large tears or damage caused by moisture, the underlay should be removed and replaced with drainage plane mesh and new underlay.

## 6 WALL LININGS AND AIRTIGHTNESS

**6.0.1** When specifying replacement wall linings, consider the functions that the building must provide to comply with the Building Code. Linings should be selected for

their performance and durability and can assist with meeting the demands for specific requirements such as:

- wall and ceiling bracing – but note that, for older homes, the bracing may be provided by flush or solid timber braces in the walls
- moisture and mould resistance in wet areas and/or providing a suitable substrate for a membrane and tiling
- having a fire-resistance rating and soundproofing qualities for inter-tenancy walls between townhouses or terraced houses
- having a fire-resistance rating for external walls close to a property boundary (usually <1 m).

**6.0.2** Timber wall framing must be dry and in good condition before being enclosed by linings. The moisture content must be below 20% – check the condition and moisture level of the bottom plate in particular, which is vulnerable because of its location. Some BCAs and wall lining manufacturers require a moisture content of no more than 18% before installing internal linings so it pays to check before proceeding with work.

**6.0.3** Removing old wall linings to retrofit insulation is also the ideal time to replace any wall framing such as timber with extensive borer damage or timber that was damaged or inadequate when the house was built.

**6.0.4** It is highly likely that buildings with very old linings may also have old electrical circuits that are fragile and brittle and should be replaced with white thermoplastic insulated cables. Rewiring must be carried out by a licensed electrical worker who must also hold an annual practising licence. The electrical worker should provide a certificate of compliance after the work has been completed stating that the work is safe, complies with safety standards and codes and has been tested. (These are not issued for work such as replacing sockets and light fittings.)

**6.0.5** Airtightness should be considered in any retrofit to improve thermal performance for the simple reason that any gaps remaining in the building envelope can lead to heat loss. Flush-stopped plasterboard with minimal penetrations (such as for light switches) contributes to airtightness.

**6.0.6** In an earlier research project, BRANZ made one of its older test buildings more airtight. Simple techniques were used such as sealing small gaps and in some cases adding skirting or scotia boards where gaps were large. The work also included:

- sealing the junction between ceiling and walls (ceiling lining/wall lining), which gave the single largest improvement in increasing airtightness and reducing heat loss for that particular building – for many older houses on suspended floors, gaps in the floor-to-wall interface are likely to be just as much of an issue if not greater
- for strip flooring, inserting expanding foam between the bottom plate and the last floorboard before fitting the skirting board
- addressing the window reveal to plasterboard junctions/gaps and gaps between the window frame and the reveal itself
- sealing attic hatches with a closed-cell EPDM strip.

**6.0.7** Flush-stopped plasterboard with the minimum number of penetrations also helps reduce moisture transfer from living spaces into the roof assembly and wall assembly. BRANZ research has confirmed that air movement is the predominant means of moisture transfer in housing – much greater than moisture movement from diffusion where moisture passes through materials.

# 7 MORE INFORMATION

### BRANZ

Warmer drier healthier #1 Retrofitting insulation in weatherboard walls with linings on: Effective water management (fact sheet)

Warmer drier healthier #7: Assessing retrofitted external wall insulation techniques (fact sheet)

SR436 Linings-on retrofit insulation in weatherboard walls: Ensuring effective water management (BRANZ study report)

SR484 Assessing retrofitted external wall insulation techniques (BRANZ study report)

Insulating external timber-framed walls (*Build* article)

### MBIE

Guidance on Building Code compliance for retrofitting insulation in external walls

Building work repairs, replacements and alterations – H1 compliance

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