International Best Practice in Low Slope Roof Insulation

"Warm Roofs"

by Brendon Sutton, Sales and Marketing Manager
Viking Roofspec, a division of Viking Group Ltd

Before I plough into the intricacies of modern low-slope roofing insulation, I think it's important to reflect on New Zealand's brief insulation history.

Up until 1978, it was not mandatory to insulate a building in New Zealand. But strangely enough, with the benefit of over 30 years of hindsight, there were some up sides. Aside from the non-existence of insulation costs, condensation (and consequent mould) weren't an issue because the internal temperature was closer to the outside due to heat dissipating through the roof, walls, draughty single-glazed windows and doors. Kiwis achieved warmth through blankets, hot water bottles; woollen underwear… (and fat and hairy people were considered blessed).

But when energy costs rocketed in the mid seventies (including car-less days being imposed upon us), the need for general energy savings came to the forefront of our minds. We were also becoming progressively softer; expecting higher levels of comfort from our homes. These factors contributed to the imposition in 1978, of mandatory insulation in houses. However despite this new code, apparently approximately one third of the 900,000 houses built before 1978 in New Zealand, are still inadequately insulated today.

Nearly 20 years later (in 2007), the Department of Building and Housing introduced "H1" – the Building Code requirements for housing insulation, the aim of which was to decrease the amount of heating energy required by 30% to achieve healthy indoor temperatures. This was approached by increasing the minimum R-value (thermal efficiency) requirements for a dwelling. *(See Figure 1 showing the zones and minimum R-values expected for the various dwelling components.)*

TIMBER-FRAMED HOUSE INSULATION REQUIREMENTS

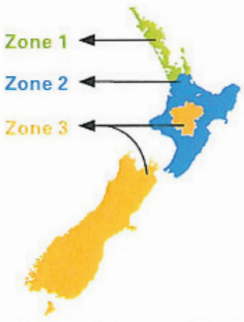
TABLE 1	ZONES 1 AND 2	
Map of climate zones 	Roof Walls Floor Heated floors Windows Skylights	R 2.9 R 1.9 R 1.3 R 1.9 R 0.26 R 0.26
	ZONE 3	
	Roof Walls Floor Heated floors Windows Skylights	R 3.3 R 2.0 R 1.3 R 1.9 R 0.26 R 0.31

Figure 1

There are several ways of insulating a building. I just want to focus on the insulation of a low-slope roof:

Warm roofs

The global confusion surrounding the definition of a "warm roof" is astounding. But it probably doesn't matter what the system is called, as long as it:

(i) is thermally efficient;
(ii) meets the building code;
(iii) keeps the dew-point on the outside of the building envelope; and my own added point –
(iv) isn't financially prohibitive to have installed.

The most commonly accepted definition of a warm roof (for low slope roofs) is "a roof where the insulation is installed **on top of** the roof structure" i.e.: insulated from the outside of the building. Products used for warm roofs include rigid (EPS) Extruded Polystyrene or Polyisocyanurate (closed-cell foam) sheets on top of which the waterproofing membrane is adhered.

In contrast to this technique, the mainstream method of insulating roofs in New Zealand is what's commonly referred to as the "cold-roof" method where the insulation – (usually glass wool), is stuffed between rafters / joists in the ceiling cavity i.e.on the inside of the building – *(see Figure 2)*. But there are a number of shortfalls with this system:

- A consequence of technological progress in heating and draught-proof windows and doors has seen higher internal moisture levels than ever before in our modern buildings. (We even have dehumidifiers to counter this). Any excess moisture rises up through gaps such as down-lights into the roof cavity. If the roof cavity is insufficiently vented, the moist air finds its dew point (condenses) when it meets the underside of the roof substrate – the "cold deck". Accordingly, condensation can lead to rotting roof substrates; damp ceilings and wet insulation (which eventually renders it ineffective). Cross-ventilation of the cavity void is therefore also required to track moist air out to soffit vents on the underside of the fascias, or up through

mushroom vents on top of the roof *(as shown in Figure 2)*.

- Even if the roof cavity is sufficiently vented a great deal of heat can be lost in the process.
- The maximum thickness of the wool insulation is restricted by the depth of the rafters / joists.

With a correctly designed warm roof *(see Figure 3)*,

- The dew point is on the outside of the building = no damp or rotten materials inside
- No ventilation of the ceiling cavity is required.
- Thermal bridging is avoided.
- The roof cavity is clear for wiring (not stuffed with insulation)
- The energy savings from air conditioning and heating hugely shortens the amortisation period of the initial roof cost.
- Rigid insulation sheets add further structural integrity to the roof.
- Significantly higher R-values are achieved (uniformly across the entire roof, not just in parts)
- Warm roof insulation systems can easily be retrofitted onto an existing building.

W.I.I.F.M?

I could put my socially-responsible cap on and thrash out our collective obligation to sustain the planet (don't get me wrong – as a member of the Green Building Council, I acknowledge this is very important), but it's too soon after Christmas to get holistic (and I'm still underwhelmed by the flaccid outcome of the Copenhagen summit). So let's look at warm roofs with our "w.i.i.f.m." – (what's in it for me) caps on.

Return on Investment

One factor overwhelmingly overrides the rest from the w.i.i.f.m. perspective – return on investment. On most buildings, the roof is the largest wall of the five and the most exposed to the elements. Most buildings in the USA for example, are two storeys or less. I assume New Zealand (hardly the high-rise capital of the world), would be similar. Accordingly, the installation of a correctly designed warm roof system using polyisocyanurate panels for example, can save home and commercial building owners approximately 15% in energy usage compared to a traditional cold roof. Polyisocyanurate insulation has the highest R-value of any insulation type.

Example: The premium outlaid (above cold roof insulation costs) to insulate a 100m² flat roof using the warm roof method with polyisocyanurate panels to a minimum R-Value of 2.9 (H1's minimum requirement for a timber home) comes to $2600.00. If the home owner saves 15% off his $250-per-month energy bill as a result ($37.50 month), then the extra $2600.00 outlaid would be amortised in less than six years after which time the system begins to make a positive financial contribution. (This financial example does not include the further savings from not having to possibly repair or even replace deteriorated ceilings).

Figure 2: Cold Roof

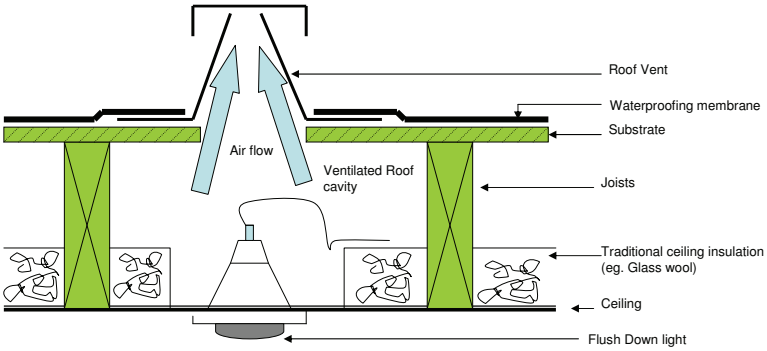
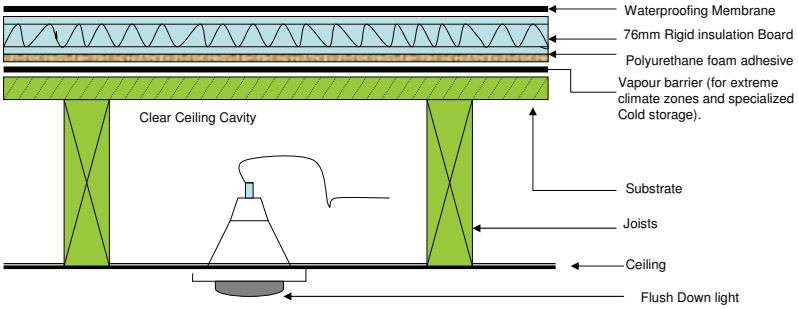


Figure 3: Warm Roof



What components are in a warm roof?

Vapour Barrier – (optional) is laid between the substrate and insulation (to prevent condensation and/or moisture from moving from the interior building, up into the insulation board). This barrier is used in very cold geographic areas and/or for specialist cool stores – especially when installed on a steel roof. (Vapour barriers would be required less than 15% of the time in New Zealand).

Insulation – In the case of polyisocyanurate or EPS polystyrene, these come in sheets – usually 1200 x 2400 with differing thicknesses. The thicker the insulation, the greater the R-value achieved. 25mm of polyisocyanurate gives an R-value of 1.2, so 75mm thick product renders an R-value of 3.6 which exceeds the H1 insulation code's minimum requirement of 2.9 (or 3.5 for solid concrete homes). Polyisocyanurate is also available in tapered (sloped) sheet profiles to positively channel water down to a desired receptacle such as a drain.

Fixing – the best method of fixing insulation board to the substrate is via a low-rise two-pack polyurethane foam adhesive - applied by a spray or specialised battery-powered caulking gun. The beauty of the adhesive system is that.-

(i) it alleviates potential thermal bridging that can take place with mechanical

continued on next page

continued from previous page

fixings when extreme temperature differences exist between outside and inside and

(ii) the adhesive has insulation properties of its own which can take care of the gaps between the insulation sheets when a single layer of insulation is being installed. (A second layer of board installed on top in a staggered pattern can also plug any thermal creep).

Membrane – any sheet waterproofing material can be installed onto polyisocyanurate or EPS polystyrene provided the facer material on the insulation board surface (of which, in the case of polyisocyanurate there are many such as bituminous paper, foils, coated glass etc) is compatible with the membrane system being installed on top of it. My recommendation is to install wide sheet membranes such as EPDM rubber or TPO thermo-plastic (to minimise the number of seams) – the latter of which has the added advantage of.-

(i) heat-weldable seaming technology and proprietary detailing accessories for added waterproofing integrity, and

(ii) white or light grey surfaces to reflect solar radiation.

Is it easy to install?

…like falling off a chair. Simply adhere the insulation board in a brick-bond pattern using the recommended polyurethane adhesive system. If a second layer of insulation board is required on top to make up the desired thickness, this layer is to be offset by half a sheet-width to plug the sheet joins of the bottom layer. The layer of adhesive sandwiched between the two boards will also help achieve this. Then install the membrane system (compatible with the facer surface material) on top as per a normal waterproofing installation.

In summary, the New Zealand construction industry is constantly evolving in the area of building insulation and in the area of roofing, the "warm roof" method (currently deemed as International Best Practice), in my opinion, will soon make the transition from being the boutique alternative, to becoming the mainstream method of insulating a roof in this country.

If you wish to discuss further, please feel free to call me on 0800 729 799.

Editor's note: *there are various warm roof systems on the market so talk to your supplier about the correct installation method as they are all different.*