BUILD WITH WARM ROOFS

INTRODUCTION

New Zealand, home to some of the best things in the world - L&P, the Lord of the Rings, the All Blacks, Mānuka honey, Weetbix (largely protested by the Aussies) etc etc. But unfortunately there is something that Kiwis' do not win on the international scale, in fact NZ barely follows international best practice for one of the most significant assets most will ever own - their home. And more specifically the roof that shelters them within their home.
Oculus believes that all Kiwis have the right to live in a warm, dry and comfortable home, and this resource outlines why a cold roof simply doesn't work (unless you add a lot of extra parts to make it work), and why building a warm roof is the best option.

ROOFING IN NEW ZEALAND EXPLAINED

New Zealanders love their metal, tile and membrane roofs, however, most people who own these homes or even designers of these homes don't fully understand the complications that can arise with these systems. For many years we've been told that if we insulate the ceilings, we will keep the interior space warm. While this is correct, there are other considerations to keep in mind. Adding ceiling insulation has an impact on temperature and moisture movement which can result in interstitial condensation in your attic space.

There are only two roof systems that reduce interstitial condensation* in your attic space:

*__Interstitial condensation__ = condensation occurring between layers of the construction. In this case: in the attic space.

- A warm roof
- A cold roof with a vapour control layer at the ceiling line fully taped around every
- penetration and sealed to the adjacent wall assemblies

Despite this, the most common type of roof built in New Zealand is also the most problematic:

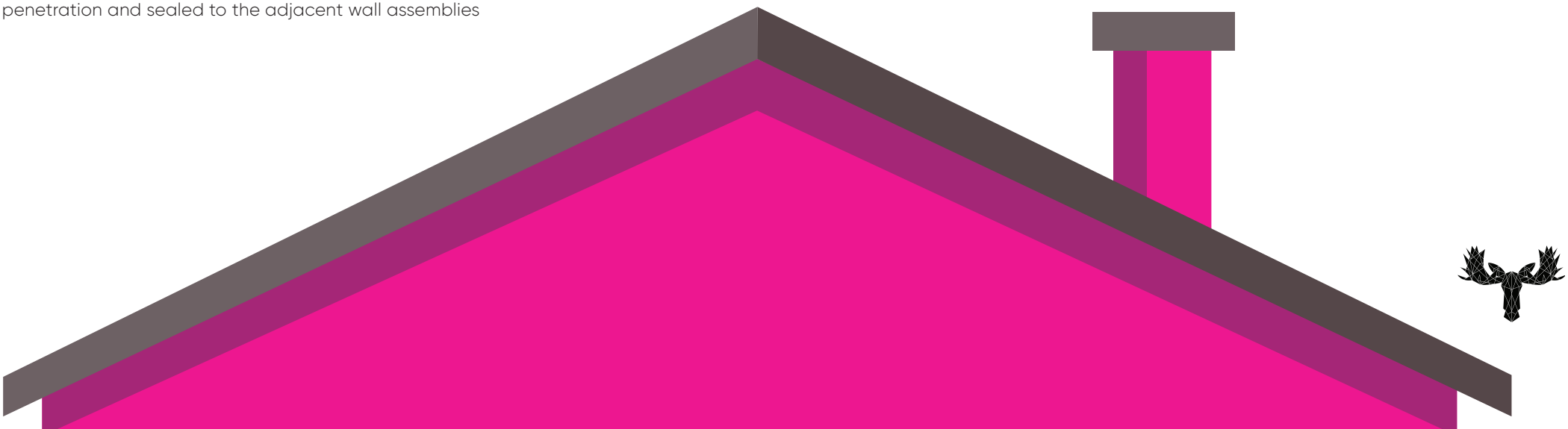
- A cold roof without a vapour control layer

The cold roof system has "worked" in New Zealand for decades, mostly by accident. Back in the day when there was no insulation, heat simply left through the ceiling and into the attic space and roof. Therefore, the roof cavity (attic space) was warm because of the heat rising. Hence, condensation or mould growth was not an issue, as this heat warmed attic surface temperatures and allowed incoming air to heat up, absorb and remove excess moisture that was present.
From 1977, insulation was added into our homes with the purpose of keeping its residents warm inside. This was a good thing, but other factors such as controlling moisture to keep your home healthy, were not considered.

The design of a house should be approached holistically including:

- Ventilation to control moisture (relative humidity ideally between 40-60%)
- Insulation to control the temperature (ideally between 20 – 25 Degrees Celcius)
- Airtightness to prevent unwanted draughts and energy loss
- Window design to control natural light and temperature

You must consider all elements that separate the inside from the outside. Since your roof is on the top of your building it's one of the most important components to get right.



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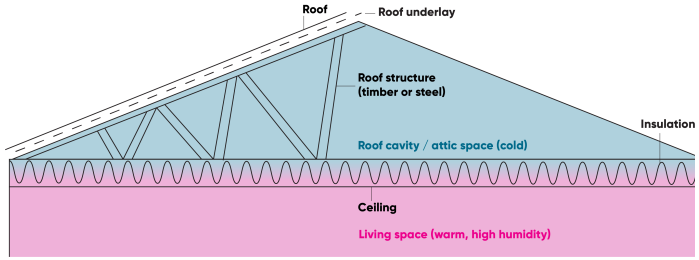
THE COMPARISON

COLD ROOF



A cold roof means that insulation is installed at the ceiling line, keeping the house warm but the attic space cold. The majority of NZ houses have a cold roof.

There are two main concerns with a cold roof system:

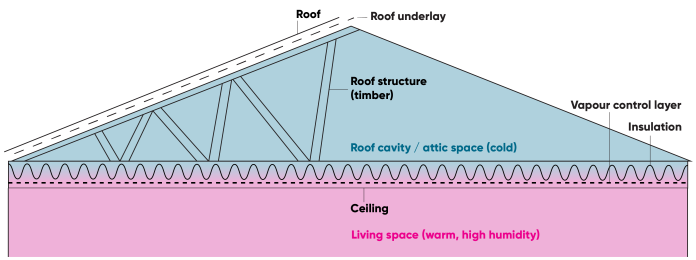
1. Water vapour is rising up and condenses in the attic space

Because there is insulation at the ceiling line, the temperature inside the house is warm and the attic space is cold. Water vapour is created by people cooking, washing and breathing in the house. This means the absolute humidity inside the house is significantly higher than that of the attic. This creates a vapour pressure difference between the living space and the attic, which causes moisture to rise up through the ceiling where it condenses when it touches a cold surface (like the steel roof or structure holding it). If this condensation occurs over a long period of time, it will lead to mould growth and rot in your roof framing, insulation and ceiling. The problem can be made significantly worse where downlights and other services do not form an airtight seal to the ceiling as thermal buoyancy creates a pressure forcing air through. We recommend retrofitting a vapour control layer if you already have a cold roof or decide to build a house with a cold roof.

2. Night sky radiation with steel framed roofs

On clear nights, radiative cooling causes the temperature of the roof to drop below the air temperature. This causes condensation to form on the cold surfaces below the roof and in the attic. Condensation on the exterior surface of the roof is not a problem as it runs down and into the gutters. Neither is the condensation on the inside surface of the roof, as it will collect on the roof underlay and drain into the gutter. However, if the underlay is hard up against the steel, condensation forms under the underlay, and if the roof framing is steel, condensation will form on the framing inside the attic. This means it is likely to drip and run off the framing onto services and ultimately onto the insulation and ceiling, aiding rot and mould growth. Although ventilation is always needed in a cold roof, it should be noted that ventilation is unlikely to solve the problem, due to high ambient humidity in winter.
You can't dry out an attic with cold wet air.

COLD ROOF WITH VAPOUR CONTROL LAYER

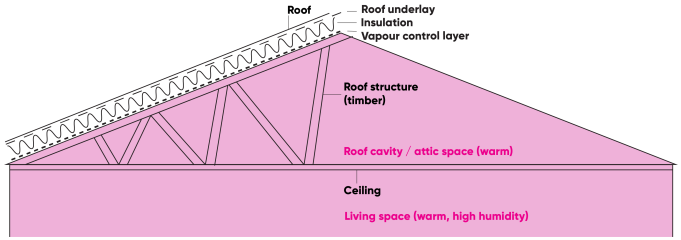


As the name indicates, a cold roof with a vapour control layer is a cold roof with a special membrane installed below the insulation at the ceiling line. A vapour control layer (V.C.L.) prevents water vapour molecules moving through it.

Typically, ceilings are made of gypsum board which lets water vapour pass through uninterrupted. (Paint may help slow the vapour down, but it is not reliable). As this membrane is being installed above the ceiling it prevents large amounts of moist air and water vapour moving into the attic space. Keep in mind that this vapour control layer needs to be fully sealed around downlights, service penetrations and inter-tenancy walls, which can be very difficult and expensive to achieve in practice.
This type of roof system requires mechanical ventilation in the attic space that is triggered by high humidity. Ideally this mechanical ventilation would have both supply and extract, as an extract-only system would help draw air and moisture from the internal space below.

Ultimately, Oculus will always recommend a warm roof. We will only allow a cold roof with a vapour control layer if the roof framing is timber. Timber framing is less conductive and therefore doesn't cool as quickly as steel. It is able to absorb condensation when it occurs (which isn't perfect but at least it might be able to dry out the next day).

WARM ROOF



A warm roof has its insulation installed above the roof structure. This keeps the attic space and structure (timber or steel) warm. Therefore, the roof structure doesn't suffer through daily temperature fluctuations and subsequently prevents condensation as the surfaces remain warm.

In a warm roof design you do not need a vapour control layer at the ceiling line because the attic within the warm roof system is an interior space. There is a vapour control layer below the insulation above the structure to prevent condensation within the insulation layer.

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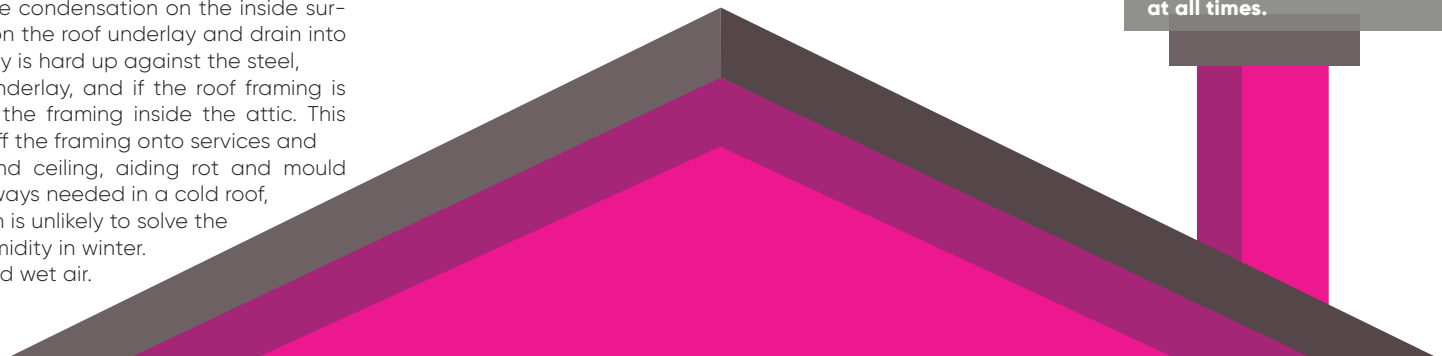
The common belief that "warm roofs are too expensive" does not take into account the true costs of creating a cold roof that prevents condensation occurring.
Warm roofs that are designed correctly can not only be more affordable to build than a cold roof, but the long-term benefits of thermal efficiency are greatly enhanced making a warm roof by far the smarter, healthier and cost-effective solution. One thing is for sure, knowledge is key. Make sure your designer or architect fully understands building science to ensure the design of your roof assembly mitigates any potential for interstitial condensation.
This approach to building a roof will keep your home healthy at all times.



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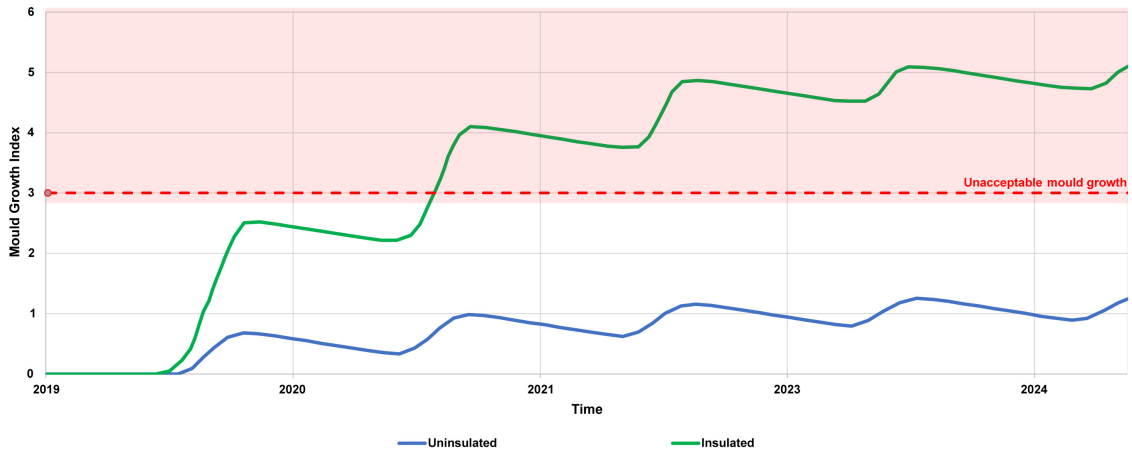
WHY COLD ROOFS DON'T WORK – BACKED BY SCIENCE

This graph shows that the uninsulated cold roof system (blue line on graph) used in the past did not lead to excessive mould growth. The blue line stays below the threshold (the red dotted line) and ebbs and flows, which is acceptable. However, when we started adding insulation at the ceiling line (green line on graph) mould started growing exponentially because the warm summer months are not countering the winter mould growth. The green line passes the threshold after only 1 ½ years, entering the unacceptable mould growth area. This demonstrates that adding insulation without considering moisture movement does not work in the long run.



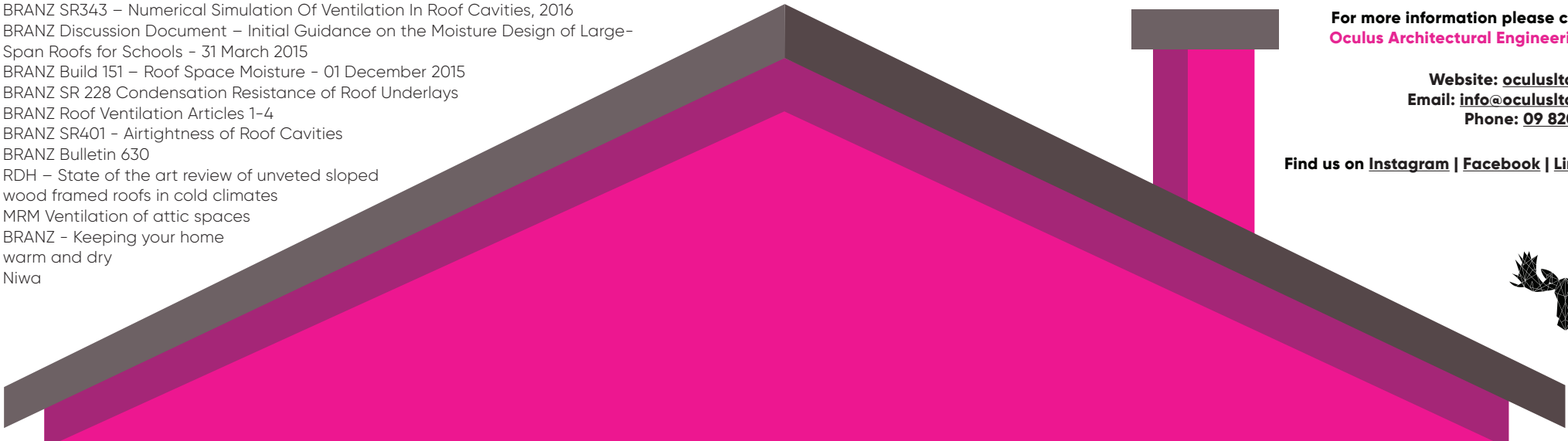
Uninsulated (the blue line) is the old-style roof with no insulation and good ventilation.
Insulated (the green line) is the common cold roof with insulation at ceiling level – there is ventilation provided equivalent to 1m2 of ventilation to 150m2.
The Y axis of the graph is the mould growth index
1-2 is only visible under a microscope
3 or above is where mould becomes visible and is deemed unacceptable by ASHRAE 160
4–5 serious visible mould
In the case of the common cold roof the model predicts visible mould will be evident after 1 1/2 years. (Modeling based on a Wellington climate)

OCULUS ROLE

Traditionally façade engineers have not provided design guidance on anything other than vertical façade elements and typically only for code clauses B1, B2 & E2. We have expanded our service offering to include additional code clauses C3, E3, H1, G4. This means we can cover the entire building envelope and allows us to design better buildings in New Zealand. However, in doing so we take on additional liability should issues relating to these additional code clauses arise. Oculus cannot take on the risk of a cold roof failure in light of the growing body of evidence that shows the issues with insulated cold roofs.

RESOURCES

- BRANZ SR289 – Remediating Condensation Problems in Large-Cavity, Steel-Framed Institutional Roofs 2013
- BRANZ SR343 – Numerical Simulation Of Ventilation In Roof Cavities, 2016
- BRANZ Discussion Document – Initial Guidance on the Moisture Design of Large-Span Roofs for Schools - 31 March 2015
- BRANZ Build 151 – Roof Space Moisture - 01 December 2015
- BRANZ SR 228 Condensation Resistance of Roof Underlays
- BRANZ Roof Ventilation Articles 1-4
- BRANZ SR401 - Airtightness of Roof Cavities
- BRANZ Bulletin 630
- RDH – State of the art review of unveted sloped wood framed roofs in cold climates
- MRM Ventilation of attic spaces
- BRANZ - Keeping your home warm and dry
- Niwa



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