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Ecolibrium

Cool runnings

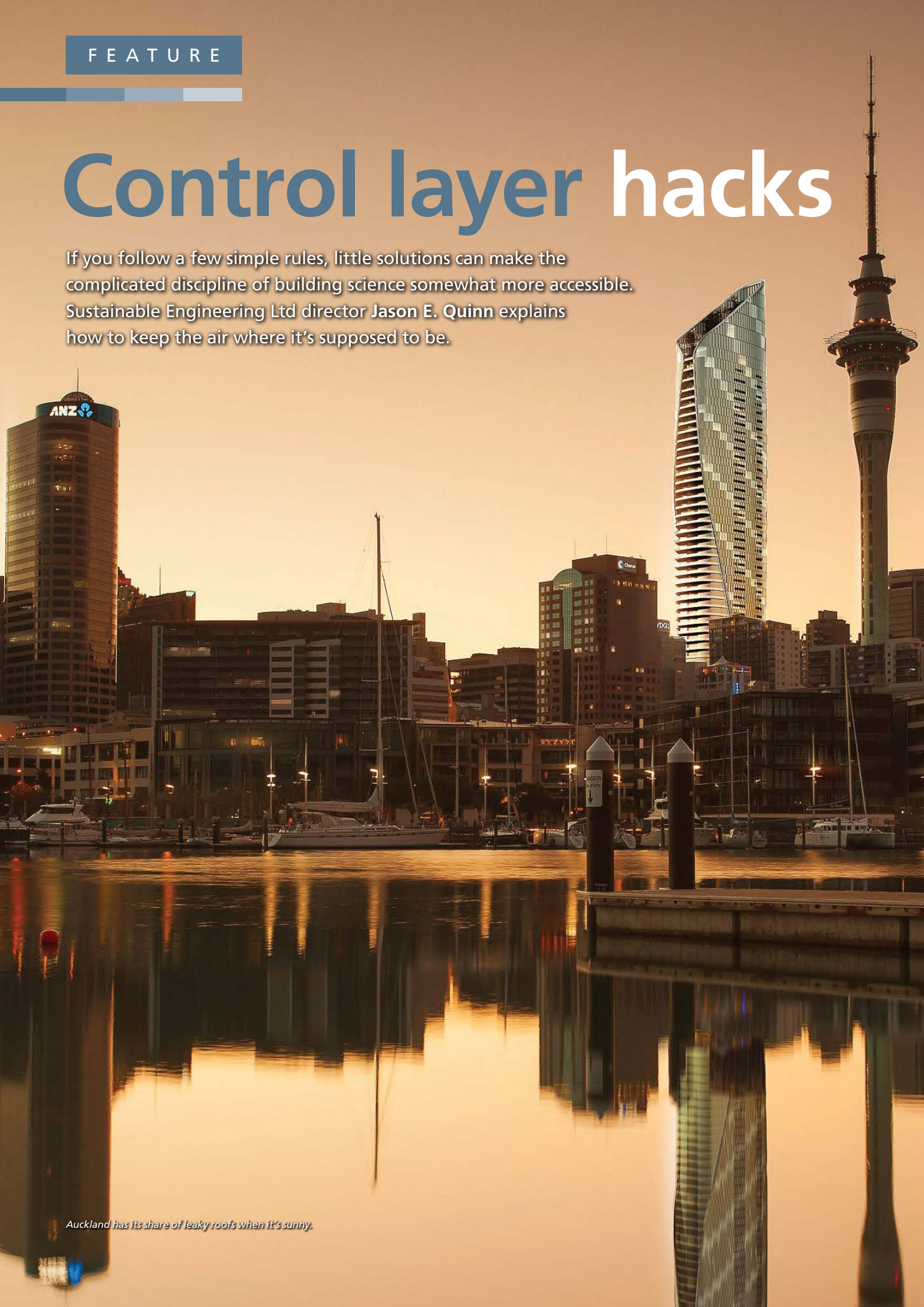
Refrigeration innovation at SA's purpose-built motorsport park.

AIRAH

FEATURE

Control layer hacks

If you follow a few simple rules, little solutions can make the complicated discipline of building science somewhat more accessible. Sustainable Engineering Ltd director **Jason E. Quinn** explains how to keep the air where it's supposed to be.



Auckland has its share of leaky roofs when it's sunny.

A friend of mine called me the other day and asked about his building. He was concerned about where his air control layer was located – and wasn't his water-resistive barrier (WRB) in the roof his air control layer anyway (i.e., the underlay on the roof)? So, I had him send me the drawings to the building and we looked at them together on the phone. The way it was installed in that building, the WRB was definitely not an air control layer.

Wait! Isn't the water-resistive barrier in the roof or the underlay on the roof an air control layer? Sometimes it is … and that is not always a good thing.

Building science is quite a complicated topic, but if you just follow a few simple rules, a lot of the solutions that fall out just tend to be the ones that keep you out of trouble. They are your little life hacks!

And there's just one giant building science hack to keep yourself out of trouble: Understand the control layers in your building.

SO, WHAT ARE A BUILDING'S CONTROL LAYERS?

The control layers can be found in a building's enclosure. It's the thing that separates the inside environment from the outside "natural" environment. The enclosure includes everything from the paint on the outside of the wall cladding to the finish surface on the inside (including any wall-mounted mirrors). Sometimes the building enclosure is called the building envelope.

There are four main control layers in a building's enclosure:

Water control layer

First, the external water-control layer is the most important of the four control layers. It keeps the lovely rain out of the building. If you get this wrong, the occupants call you up – in the middle of the night – so this is mostly sorted at this point.

You want to keep the air where it's supposed to be

Air control layer

Second is the air control. You want to keep the air where it's supposed to be. If it's air inside the building, it needs to stay inside; if it's outside air, it needs to stay outside. This doesn't mean you can't open the windows because you need ventilation; it means you don't want air leaking through your building enclosure and dripping moisture on its way out.

Poor air control and the resulting air leaks result in not only higher heating bills but, more importantly, carry moisture into the building enclosure. There have been many failures due to

air leakage from a building interior carrying moisture into the walls and roof structures, where it condensed and caused damage.

In New Zealand, this has caused much of the recent "leaky roofs when it is sunny" issues in schools in both the North and South Islands. I'm aware of or have worked on residential and office building roofs that have had this failure in Wellington, Auckland, and Queenstown.

In Australia air leaks in the southern climates will cause similar issues. Up north, air leaks from the outside to the inside can condense in the building assemblies of air conditioned buildings.

Walls have these failures as well as roofs, but the damage is typically hidden. Most of the time, the drips do not rain into the occupied space, so the resulting mould or damage is not found unless a wall is opened up for other work.

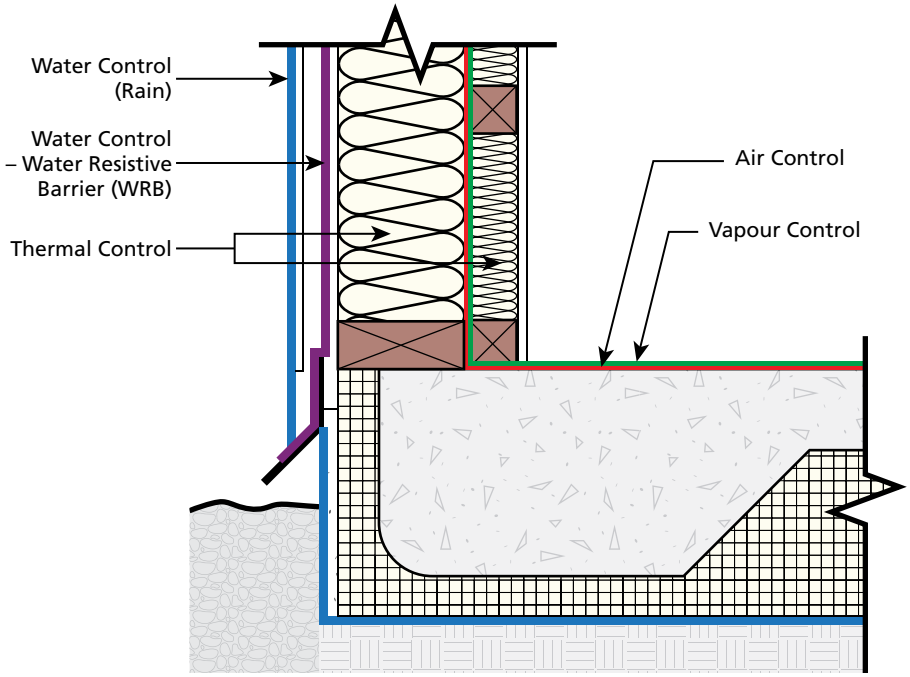
Vapour control layer

The third control layer is the vapour control layer, which controls how moisture transfers directly through materials (not air leakage). A sheet of gypsum wall board (GWB), for example, is a great air control layer, but moisture can pass through GWB at a certain rate. It is important to make sure that the vapour control layer resistance is appropriate for the wall and roof structures. Most often the air and vapour control layer are the same physical layer but they do not need to be. Typically, in a heating climate the vapour control layer needs to be towards the interior of the building, and in a cooling climate towards the exterior.

A good vapour control layer should manage moisture levels in the assembly to prevent condensation and allow increased drying potential.

Buildings in colder climates face increased condensation risk, mainly because of the need for higher insulation levels. Generally, an increase in the level of insulation in building assemblies translates to less drying potential due to the reduction in energy going through the assemblies. And with many modern materials not allowing as much vapour flow as traditional materials, the risk of condensation in well-insulated assemblies is increased even more. As we add insulation, we need to add drying potential to our building assemblies.

Buildings in hot climates also face increased condensation risk, with many adding air conditioning as well as increasing exterior temperatures and humidity. Professor Hartwig Kunzel pointed out at the AIRAH Building Physics Forum conference in Wollongong (November, 2018) the temperature difference from inside to outside is usually lower in cooling climates but the vapour pressure drive is even higher. This pushes moisture into the assembly, and if the control layers are not set up correctly for those conditions the building assemblies can mould.



Thermal control layer

The fourth and final control layer is the thermal control layer. It's the least important control layer when it comes to building durability, but it receives the most attention due to our cultural focus on saving money on energy and the increase in thermal comfort. However, until the water, air, and vapour control layers are defined and implemented correctly, this should receive the least attention.

In general, it is best for heating climates (i.e., southern Australia) for the air and vapour control layers to be inside of the thermal control layer or at least most of the way inside. This practice of keeping the air and vapour control layers to the inside prevents moist interior air from contacting surfaces that are cold, due to being outside the thermal control layer, and condensing. (The outside surface of the thermal control layer is often referred to as the thermal envelope.)

Way up north in cooling-only climates, the air and vapour control layers flip location and should be outside of the thermal control layer. In between – where you both air condition and heat seasonally – it depends on the assembly construction.

With the thermal control layer, you just have to make sure they're contiguous. In other words, the thermal control layer fits at the roof wall junction, around the windows to the insulation gap between the glass, and that all line up and work well.

CONTINUITY IS THE KEY

Now, with reference to the scenario presented at the beginning, how should all these layers fit together so that we can say we've got them installed in the building right and that we have a solid air control layer?

If you look at these four control layers in the illustration with a wall joining a floor junction, you can see that the exterior weather-resistive barrier (in purple) runs down and joins to the one that's onto the slab. And the air control layer (red) joins to the top surface of the concrete slab up to the inside surface of the membrane that's in this wall. (This membrane should be airtight, of course.)

Next, you've got the vapour control layer (green) which, in this case, is the same point in those wall assemblies. And then lastly, you've got your thermal layer where

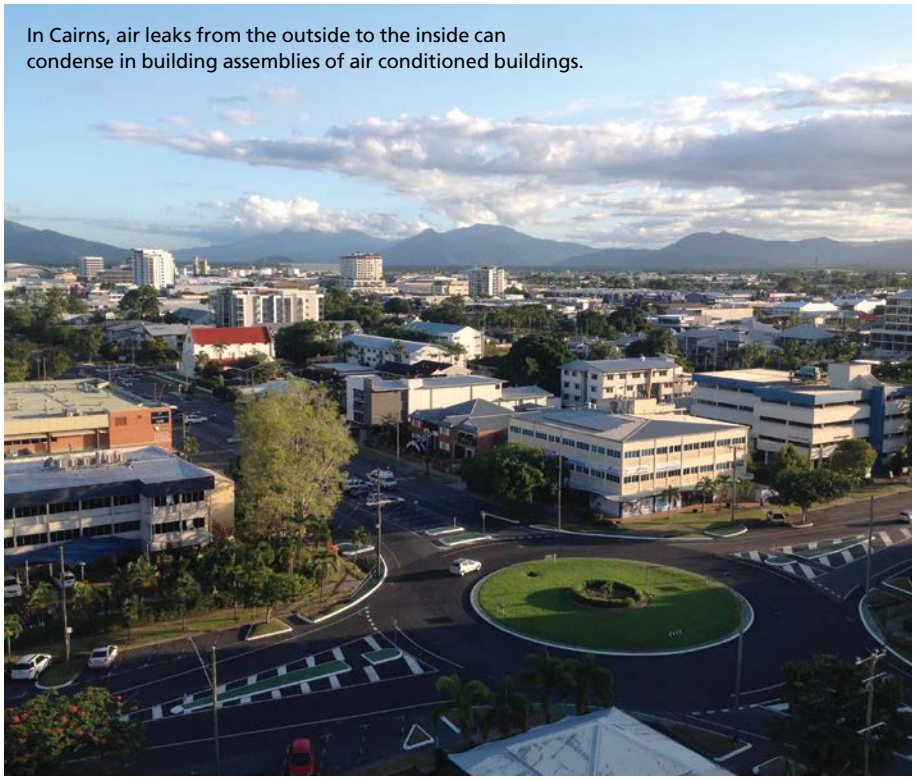
you can see—except for that small bit of timber bottom plate—you've got a nice contiguous thermal control layer.

These four control layers must wrap completely around the building enclosure (including underneath). At each and every junction in the building, the designer must understand how the control layers are kept continuous across the detail. If it is not understood at the design stage and communicated via drawings, it will not be built correctly.

PARTING WORDS

Understanding the building enclosure and the four control layers that make up the building enclosure is vital to understanding how the building enclosure will perform. Trace your control layers on your drawings, and if they're identifiable and continuous, you are 90 per cent done.

If you have anything crazy, let us know at www.SustainableEngineering.co.nz



In Cairns, air leaks from the outside to the inside can condense in building assemblies of air conditioned buildings.