Water management/rainscreen strategies for wall claddings

Claddings for mid-rise buildings must deal with the same fundamental forces that apply to all other buildings. For the designer, the challenge is choosing a strategy and then demonstrating how that strategy is employed throughout the design.

COMPARED WITH LOW-RISE buildings, the magnitude of the forces affecting a mid-rise building may be different and the consequences of failure are likely to be more expensive, but the principles to follow are the same.

A 2006 document from MBIE, *External Moisture – An introduction to weathertightness design principles,* provides good insight on the forces that drive water penetration.

Basic wall types in terms of water management

External Moisture – An introduction to weathertightness design describes these wall systems:

- **Mass walls** (Figure 1), which rely on thickness to provide sufficient absorption in the outer wall without affecting inner surfaces.
- **Barrier walls** (Figure 2), which aim to stop all water penetration at the outside surface and have joints designed to stop water entry.
- **Rainscreen systems** (Figure 3), which assume some water will penetrate the cladding. This water must be managed by drainage and drying. For mid-rise buildings, rainscreen systems are likely to be a common choice, but there are several variations within this category. At one end are traditional weatherboards, and at the other end are specifically engineered systems where the goal is to achieve high levels of pressure moderation.

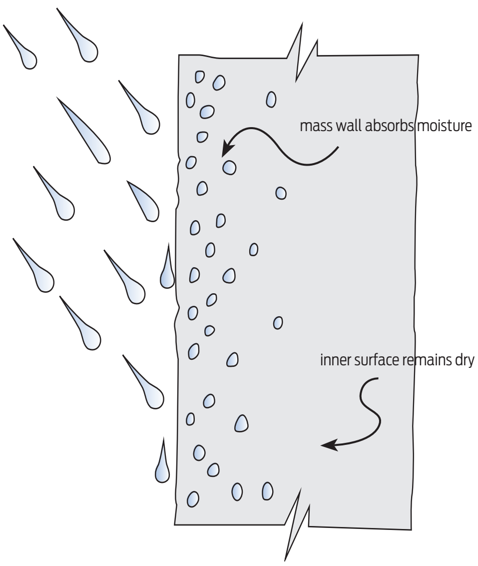

Figure 1. Mass wall.

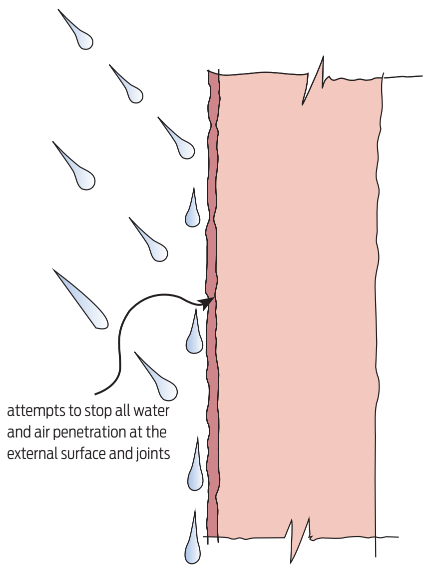

Figure 2. Barrier wall.

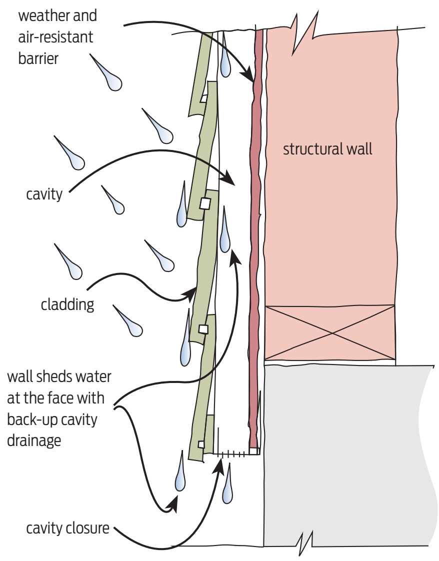

Figure 3. Weatherboard rainscreen system.

The 4Ds framework

In New Zealand, the 4Ds framework – deflection, drainage, drying and durability – is used for assessing the ability of a wall system to manage water penetration. Using this framework, it is easy to understand how a wall with a drained and vented cavity will cope better than a monolithic cladding that is directly fixed to timber framing. However, underneath the 4Ds, there is a degree of subtlety about how drainage and drying are achieved.

This fact sheet looks at the differences between various venting configurations for rainscreen systems.

E2/AS1

Acceptable Solution E2/AS1 is a deemed-to-comply prescriptive document that, if followed, covers the weathertightness of the building envelope.

It is limited to the materials, products and processes described in the Acceptable Solution and to buildings within the scope of NZS 3604:2011 *Timber-framed buildings*. These are buildings up to 3 storeys, with the height measured from the lowest ground level adjacent to the building and a maximum design wind speed of 55 m/sec. External walls are vertical, and roofs are 60º or less above the horizontal. Mid-rise buildings are typically outside the scope of the Acceptable Solution as they typically exceed the height limit.

Water management

For buildings within its scope, E2/AS1 gives these definitions:

- A **cavity wall** is a term used to describe a wall that incorporates a drained cavity.
- A **drained cavity** is a nominal 20 mm space immediately behind the cladding that has vents at the base of the wall, also known as a drained and vented cavity.

Other descriptors of cladding options for mid-rise buildings include the following:

- A **drained and ventilated cavity** is a wider cavity space (40–70 mm) immediately behind a masonry veneer cladding. It has vents at the top and the base of the wall to deal with the drainage and drying of moisture that will migrate through the veneer cladding.
- An **open-vented rainscreen** may have openings but does not incorporate a full rainscreen.
- A **pressure-moderated cladding** typically has an engineered cavity that has been compartmentalised (specific design) with the aim of reducing the pressure difference across the outer cladding.

E2/VM1

Verification Method E2/VM1 is a test method used to determine whether a cavity wall system complies with NZBC E2.3.2.

E2/VM1 comprises several water and pressure tests. Broadly speaking, a wall system is non-compliant if water hits the plane of the wall underlay.

The final part of the E2/VM1 procedure is known as the wetwall test, where a pressure difference of 50 Pa is placed across the outer cladding (the wetwall). In terms of the 4Ds, E2/VM1 is mainly testing drainage – does the cavity drain water away before it hits the underlay? The wetwall test, on the other hand, is testing the deflection characteristics of the cladding itself – does the outer cladding, with no additional performance provided by the underlay or air barrier, provide a degree of weathertightness?

Rainscreen configurations

Figures 4–8 describe several configurations of a rainscreen. In the diagrams, the air barrier is located at the back of the cavity. This doesn't necessarily have to be the case, but given that most mid-rise buildings use a rigid underlay, it is likely to be a common situation.

An indicative pressure distribution acting on the wall is also shown. In reality, the distribution would be more complex. Purely for explanatory purposes, we assume that the pressure acting on the outside of the cladding varies. There is high windward pressure near the top of the wall, higher pressure at mid-height and lower pressure at the bottom.

Bottom-only vents (E2/AS1 nominal 20 mm cavity, lightweight cladding)

A wall with a typical drained cavity only has deliberate vents at the bottom of the wall. In theory, airflow behind the cladding (ventilation) is limited in such a wall, being controlled by natural convection.

Experiments at BRANZ show that the ventilation levels are greater than this and have the capacity to remove significant amounts of moisture from the back of the cladding.

The BRANZ experiments suggest infiltration paths exist around the wall, which allow the pressure difference between the top and bottom of the wall to drive airflow through the vents along the cavity.

Because the infiltration paths represent a smaller vent than the cavity closer, the average pressure behind the cladding will be close to that at the bottom vent. The actual pressure difference across the cladding will depend on the pressure distribution on the outside of the cladding.

This wall relies on drainage and drying to remove water that enters the wall.

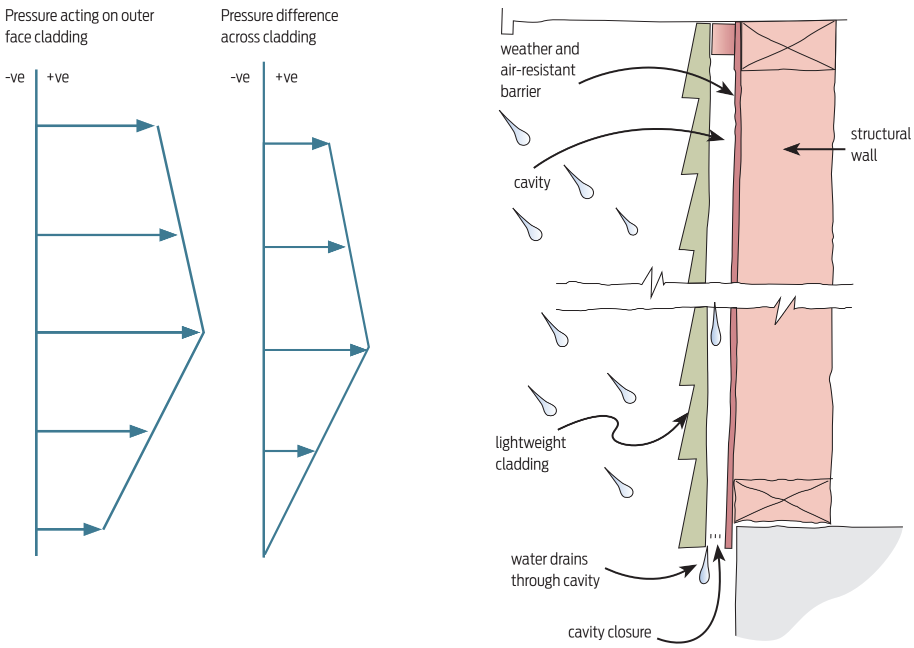

Figure 4. Bottom-only vents (E2/AS1 nominal 20 mm cavity, lightweight cladding).

Top and bottom vents (masonry veneer, back of veneer wet)

A wall vented at the top and bottom has a much easier path for the pressure difference (between the top and bottom of the wall) to drive air through. Therefore, the drying potential of such a wall is higher than the bottom-only vented cavity.

A cover to the top vent would prevent momentum-driven water hitting the underlay.

In this example, because the vents are of comparable size and have a higher flow resistance than the main cavity, the cavity pressure will be the average of the vent pressures. This fictional pressure difference acting on the cladding leads to pressure difference distribution that is uniformly lower compared with the bottom-only vent case.

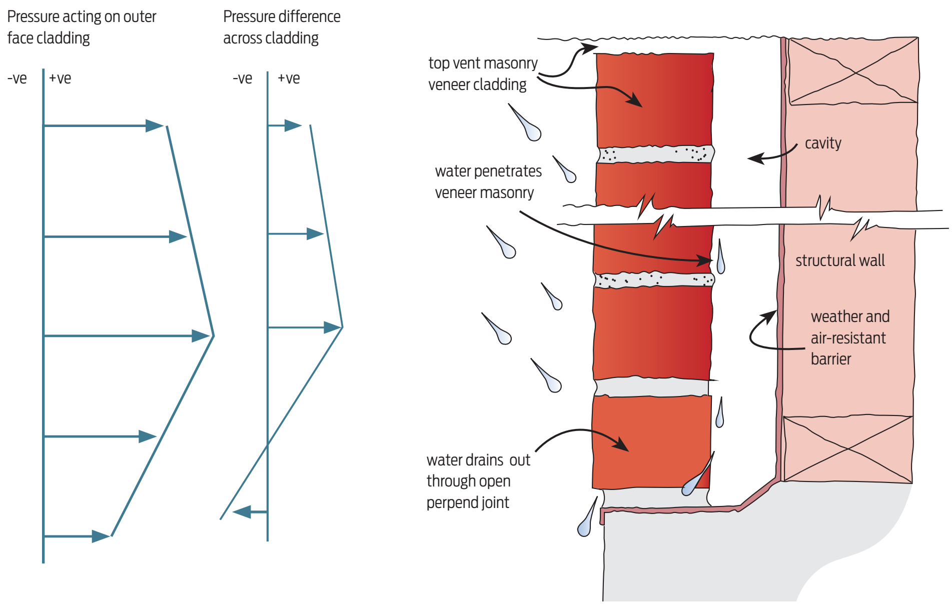

Figure 5. Top and bottom vents (masonry veneer, back of veneer wet).

Pressure-moderated (compartmented) rainscreen

A pressure-moderated cladding typically has a cavity that has been compartmentalised, with the aim of reducing the pressure difference across the outer cladding.

There is also likely to be less pressure difference driving any ventilation flow in each cavity. This situation relies on pressure equalisation to reduce water entry and on drainage to remove any water that does enter the cavity. The drying potential of such a system will be less than the previous two cases.

For effective pressure moderation, the venting area (the openings in the cladding) should be much larger than the leakage area (any openings, both deliberate and inadvertent, in the air barrier). The pressure moderation performance can be measured using AAMA (American Architectural Manufacturers Association) 508-14 *Voluntary test method and specification for pressure equalized rain screen wall cladding systems.*

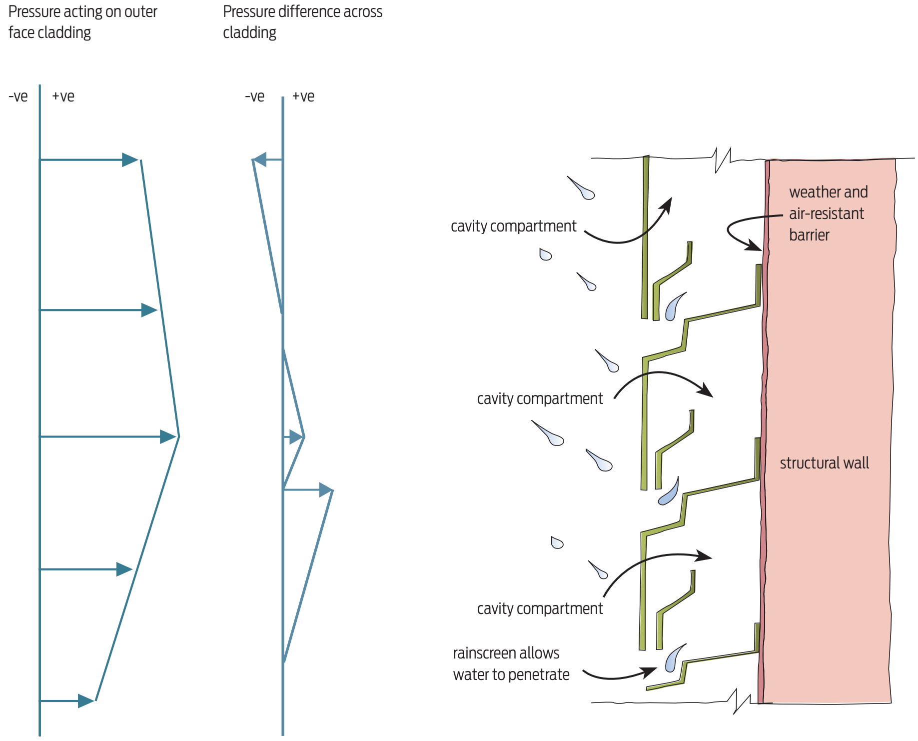

Figure 6. Pressure-moderated (compartmented) rainscreen.

Pressure-equalised joints

Joint design can also use the principle of pressure equalisation. In this kind of joint, it is usually imperative to keep the air seal dry (for durability reasons). Hence, the air seal is on the dry side of the joint and it is protected from momentum-driven water by a rainscreen.

This principle is often used in curtain walls with impervious panels – a barrier system with pressure-equalised joints between the panels. These joints are also known as open and drained joints or two-stage joints.

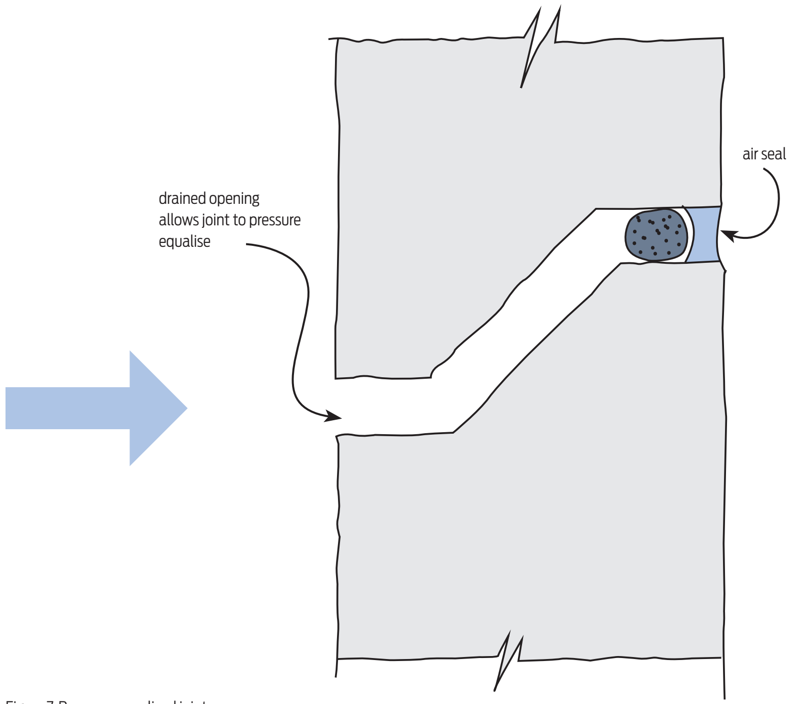

Figure 7. Pressure-equalised joints.

Open-vented rainscreen

Some claddings may have openings that do not incorporate a full rainscreen. (Note that such a wall is unlikely to pass the wetwall component of an E2/VM1 test.)

How pressure is moderated across the cladding will be highly dependent on the actual geometry. Where a wall is not compartmentalised, there will be pressure differences driving flow up and down (and in and out) of the cavity. These will be constantly changing as the wind fluctuates. In this case, there is likely to be a lot of drying potential from this flow.

One way to think of this system is that the outer cladding is just there to dramatically reduce the amount of water that reaches the 'real' cladding, which in this case is the underlay. It provides a degree of deflection in the same way eaves might. Underlay chosen must have high water resistance, UV resistance and appropriate vapour permeability.

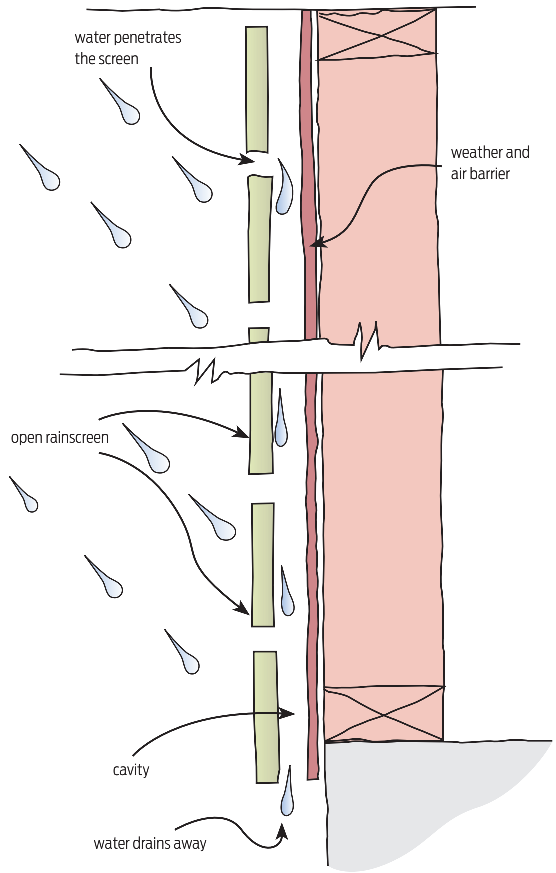

Figure 8. Open-vented rainscreen.

The approach taken in E2/VM1 is a relatively conservative one.

The National Building Code of Canada (NBCC) recognises that the wall underlay may at times have to perform as a second layer of defence. This means water on the underlay is acceptable provided there is appropriate provision for drainage, drying and durability as a whole. The range of approaches can be shown on a spectrum as shown in Figure 9. (Note that direct-fixed claddings are unlikely to be used on mid-rise buildings.).

Whichever approach is taken, the method should be explained to the consenting authority and managed throughout the design and build process (see Mid-Rise Buildings #2 *Showing compliance*).

Questions for the designer to address

- How does your design/system manage the water on the face of the building?
- If water does enter the cladding system, what is the strategy for removing that water?
- What are the critical features this method relies on? How is that criticality managed?

Further information

External Moisture – An introduction to weathertightness design principles www.building.govt.nz/building-code-compliance/e-moisture/e2-external-moisture/an-introduction-to-weathertightness-design-principles/

E2/AS1 and E2/VM1 www.building.govt.nz/building-code-compliance/e-moisture/e2-external-moisture/

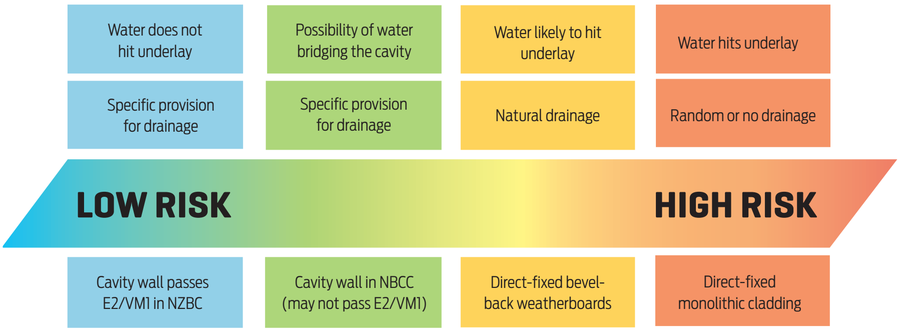

Figure 9. Drainage, drying and durability spectrum.