BRANZ

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BULLETIN

VENTILATION DRYING BEHIND WALL CLADDINGS

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- Drying is one of four key water management processes that form the basis for weathertight design and detailing in NZBC Acceptable Solution E2/AS1.
- The most effective way of drying water absorbed on the back of a wall cladding is to allow air to pass through purpose-built vents and remove it by evaporation.
- This bulletin explains how ventilation drying can be engineered into a wall.

1.0 INTRODUCTION

1.0.1 Drying is one of the '4 Ds' of water management:

- Deflection: effective claddings, flashings and overhangs shed water off a building.
- Drainage: a drainage path on the back of the cladding drains water that has leaked through back outside.
- Drying: ventilation drying provides effective means for removing excess moisture on the back of the cladding.
- Durability: framing and other components that are sufficiently durable in their location and function.

1.0.2 Deflection, drainage, drying and durability together underpin the approach to weathertight building design taken in New Zealand Building Code (NZBC) clause E2 *External moisture* Acceptable Solution E2/AS1.

1.0.3 Walls using cavity construction can be tested using Verification Method E2/VM1. This is also underpinned by the 4 Ds, and it only applies to walls that have vents to allow for ventilation drying. The test sets criteria for water leakage through the cladding and checks that drainage paths are confined to the back of the cladding and do not bridge across the cavity.

1.0.4 This bulletin explains how ventilation drying can be engineered into cavity walls by allowing air to circulate through purpose-built vents and evaporate any water leakage that has been absorbed by the back of the cladding.

1.0.5 While some of the ventilation paths in cavity walls are engineered as part of the wall design, many other ventilation paths occur naturally such as cracks and gaps in normal construction. These non-engineered ventilation paths play an important part in ventilation behind claddings such as traditional direct-fixed weatherboard walls as well as in battened cavity walls.

1.0.6 This bulletin also compares the capacity for ventilation drying with likely rain leakage rates so that the importance of ventilation drying can be appreciated.

2.0 AIR CIRCULATION BEHIND WALL CLADDING

2.0.1 The two essentials of ventilation drying are vents – openings that allow air in behind the cladding – and air pressure differences that drive the ventilation process.

2.0.2 Vents are built in to cavity walls. Examples include weepholes and top vents in brick veneer walls, holes in the cavity closure fixed at the base of battened cavity walls or vents above windows and doors.

2.0.3 A wide variety of other gaps and cracks will also occur naturally in the building such as small gaps between weatherboards that allow air to circulate behind the cladding.

2.0.4 Both vents and the natural gaps and cracks in construction play an important part in ventilation drying.

2.0.5 The most common air pressure differences that drive ventilation drying are caused by wind. Because wind pressures vary over the cladding and can range from positive to negative, they provide most of the pressure that drives air through vents in the cladding.

2.0.6 Another driving pressure is the stack pressure difference that arises when the air in a cavity is warmer than air outside and the cavity starts to work as a chimney, drawing air in at the base of the wall and allowing damp air to escape through vents or air leakage paths at the top of the wall. If the air in the cavity is cooler than outside, the air circulates in the opposite direction.

3.0 VENTILATION BEHIND DIFFERENT CLADDING TYPES

3.1 VENTILATION IN BRICK VENEER WALLS

3.1.1 Brick veneer walls have traditionally been built as cavity walls with weepholes for drainage and ventilation drying (Figure 1). With a brick veneer cladding, top and bottom venting is required because of the amount of moisture that is likely to need removal due to the porous nature of the cladding (the bricks including the back can become wet when it rains).

3.1.2 Vents and drains are generally formed as open perpend joints at every third brick in the lowest base course of bricks and at the top of the wall as open perpend joints or a continuous 5 mm gap between the soffit and veneer. The open area of vents is nominally 1000 mm^2/m of wall but is often larger in practice.

3.1.3 The minimum 40 mm depth of the cavity is chosen to prevent mortar on the back of the veneer acting as a moisture bridge across the cavity and also to prevent any contact between the flexible wall underlay and the (wet) back face of the veneer.

3.1.4 The air shown in Figure 1 circulating around the building has been driven by the pressure differences from the positive pressures on the windward side to negative pressures on the lee and sides of the building. These unobstructed ventilation paths behind brick veneer lead to higher cavity ventilation rates than are seen in battened cavities formed behind other cladding types.

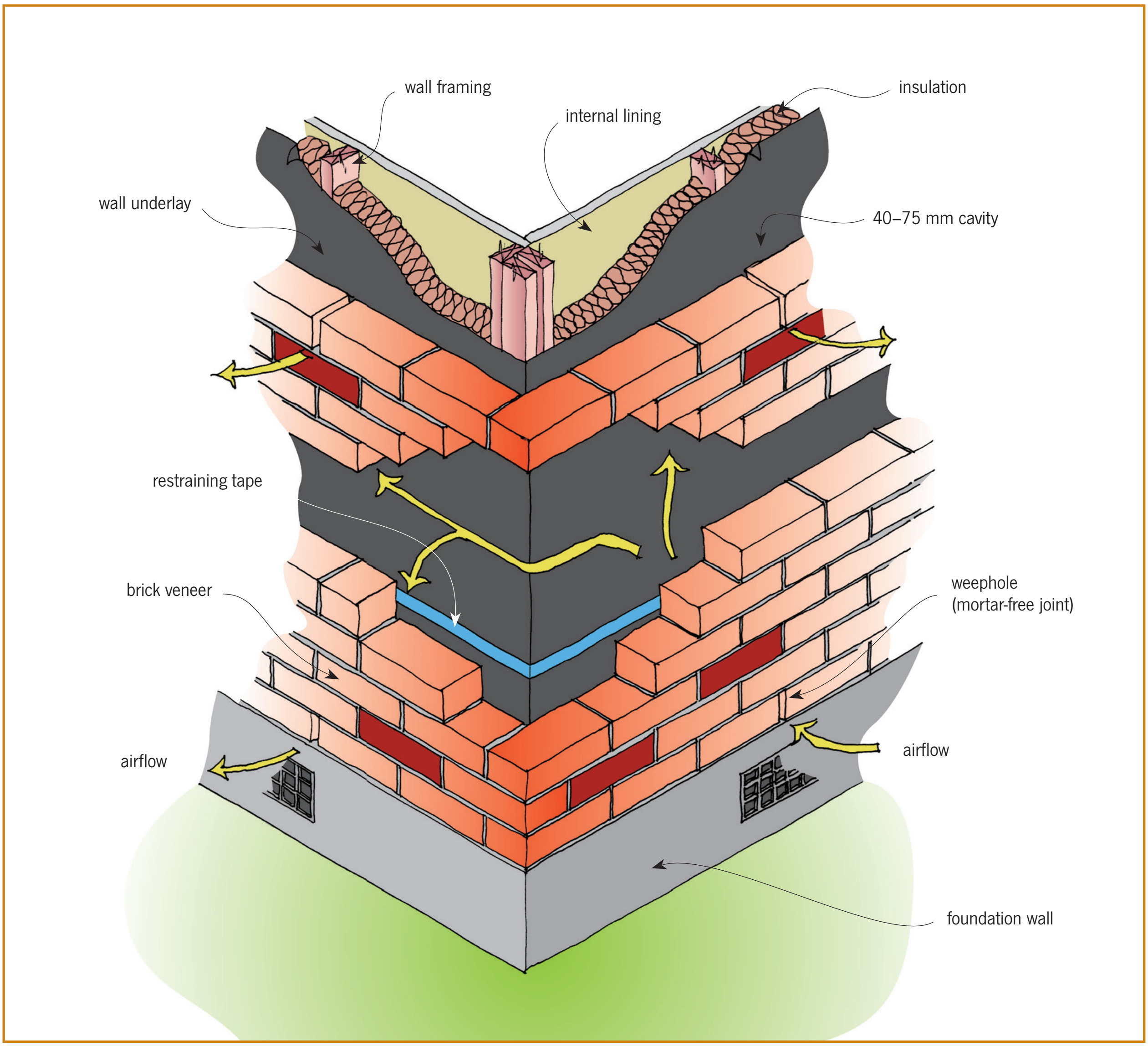

Figure 1. Air movement through the cavity in brick veneer walls.

3.2 VENTILATION IN BATTENED CAVITY WALLS

3.2.1 Battened cavity walls with a nominal 20 mm deep cavity have been widely adopted for use with a variety of claddings. In Figure 2, the cladding is a continuous sheet with purpose-built vents at the base of the wall. The illustration shows a variety of additional ventilation paths that will normally be present and play a part in ventilation drying.

3.2.2 Vents through the cavity closer at the base of the wall should have an open area of 1000 mm^2/m of wall with vent holes of 3–5 mm to allow for drainage and exclude vermin and large insects.

3.2.3 The depth of the cavity required by E2/AS1 is 18–25 mm. Flexible wall underlay must be restrained to prevent bridging across the cavity and transferring moisture to the dry side. The risk of moisture bridging is the most important consideration in determining the cavity depth.

3.2.4 Several additional ventilation paths are shown in Figure 2, such as small gaps between the batten and cladding, gaps over the top of vertical battens and gaps between the cladding and the top batten. The larger leakage paths in experimental walls were the vents at the base of the wall and the junction between vertical and horizontal walls, which are shown as heavier arrows in Figure 2. Sometimes, the junction between plastered claddings and the soffit is sealed, but many of the leakage paths in Figure 2 will be present, and it is important to remember that these have a role. They allow air to flow between vents at the base of the wall to another exit point at a different pressure, and as a result, the capacity for ventilation drying in the cavity is much larger than it would have been with only the vents in the cavity closer. An alternative to relying on these infiltration paths would be to add top vents or vented battens, but the infiltration paths in Figure 2 have been found to be sufficient.

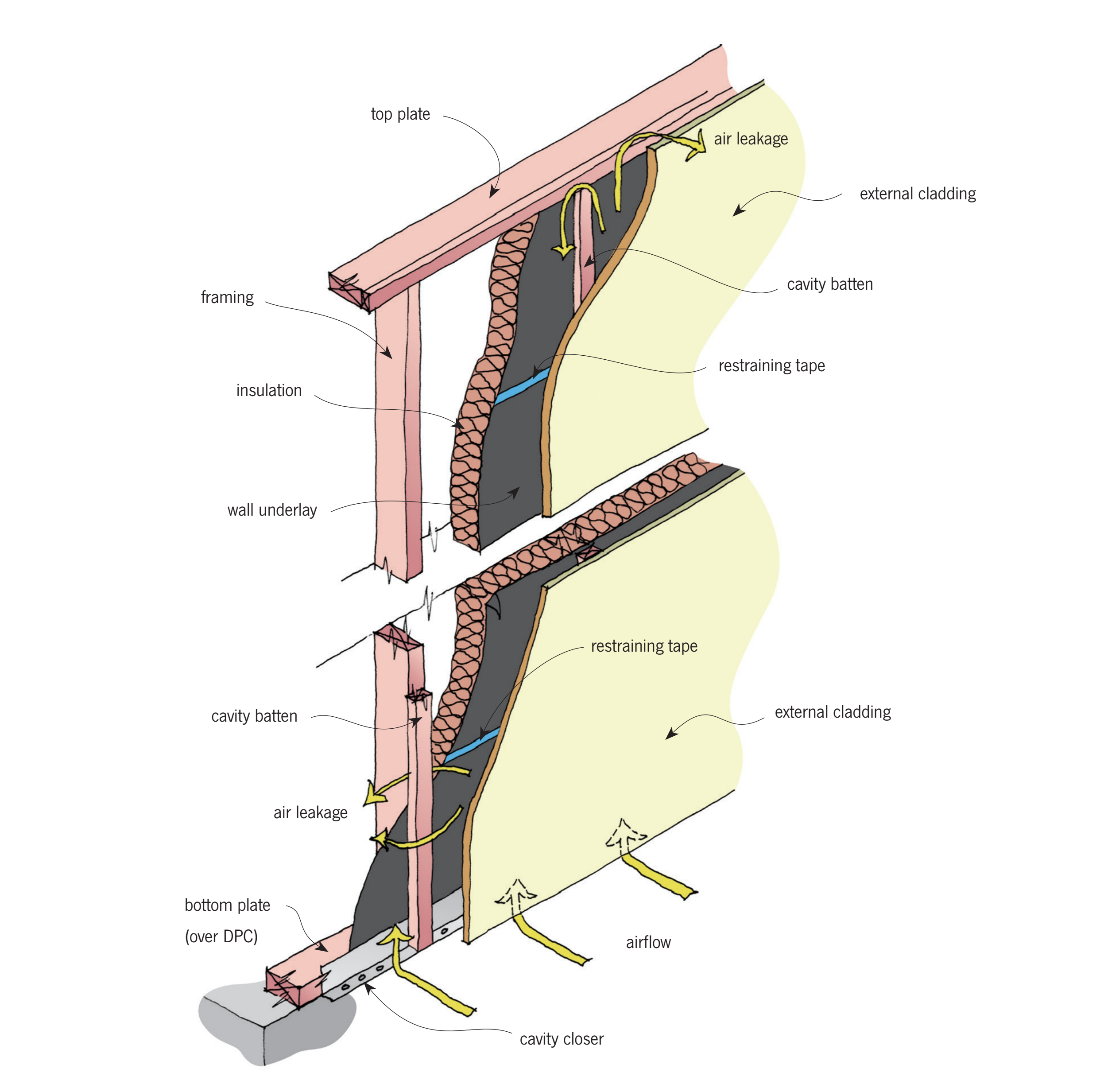

Figure 2. Air movement in a battened cavity wall.

3.3 VENTILATION BEHIND DIRECT-FIXED CLADDINGS

3.3.1 Many claddings such as timber weatherboards have been successfully direct-fixed to the timber frame and have worked well in New Zealand without any form of deliberate venting. Weatherboards, for example, have many natural air leakage paths such as gaps in the lap joints that allow the wall to 'breathe' and manage water leakage by ventilation drying (Figure 3).

3.3.2 Common natural air leakage paths in timber weatherboard walls are at lap joints and where weatherboards overlap the bottom plate. It is not uncommon to measure ventilation rates behind direct-fixed weatherboards that are in the same range as those in battened cavities.

3.3.3 Sheet claddings close off most of the leakage paths seen in weatherboard walls. Ventilation behind direct-fixed panel claddings can be as little as 1% of that in a battened cavity.

4.0 HOW MUCH MOISTURE CAN VENTILATION DRYING DEAL WITH?

4.0.1 The capacity for cavity ventilation to dry out moisture on the back of the cladding has been worked out and presented in an interactive computer program called WALLDRY-NZ. This can be downloaded from the BRANZ website (www.branz.co.nz/walldry).

4.0.2 WALLDRY-NZ allows architects and designers to compare the drying rate behind a cladding with the rain leakage rate, as illustrated in the screen shot in Figure 4. WALLDRY-NZ asks for the location of the building in New Zealand, the exposure to wind, the cladding type and whether this is direct-fixed or on a cavity. In the screen shot, the water leakage rate

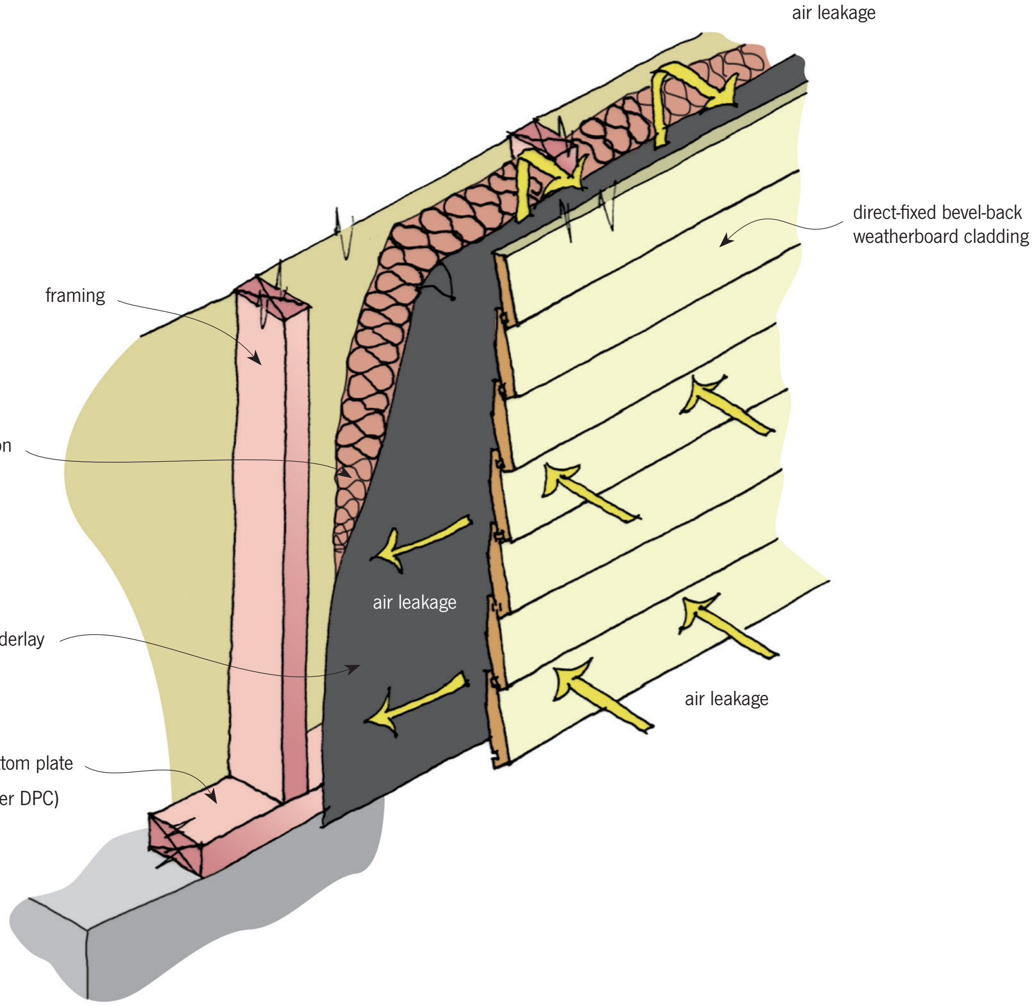

Figure 3. Natural air leakage paths in direct-fixed weatherboard cladding.

is represented in red and the capacity for ventilation drying in dark blue. For this brick veneer wall with 600 mm eaves and located on an exposed site in Wellington, the rain leakage through the cladding is less than the capacity for ventilation drying on all orientations, indicating that ventilation drying is an important part of the 4 Ds.

4.0.3 There are a number assumptions and simplifications to be aware of in WALLDRY-NZ. In particular, the rain leakage rate through claddings has been found to depend on build quality and maintenance as well as the cladding type, and this introduces a fair degree of uncertainty. Another assumption is that the water is spread out on the back of the cladding and not trapped between the cladding and battens and so on. Even with these limitations, WALLDRY-NZ gives an idea of the relative rates of water leakage and ventilation drying.

5.0 HOW DOES VENTILATION DRYING DEPEND ON THE CLIMATE?

5.0.1 The climate around a building plays an important part in ventilation drying. A selection of year-averaged drying rates have been illustrated on a map of New Zealand for comparison (Figure 5). Drying rates are represented as blue bars for north, east, south and west-facing walls.

5.0.2 Figure 5 shows that drying rates are generally highest on north and west walls because of prevailing northwest winds over New Zealand and because the northerly walls are warmed by the sun.

5.0.3 While drying rates clearly depend on location and wall orientation, the type of wall cladding and whether it is direct-fixed or on a cavity is much more important. This means that variations due to wall orientation and location can be ignored.

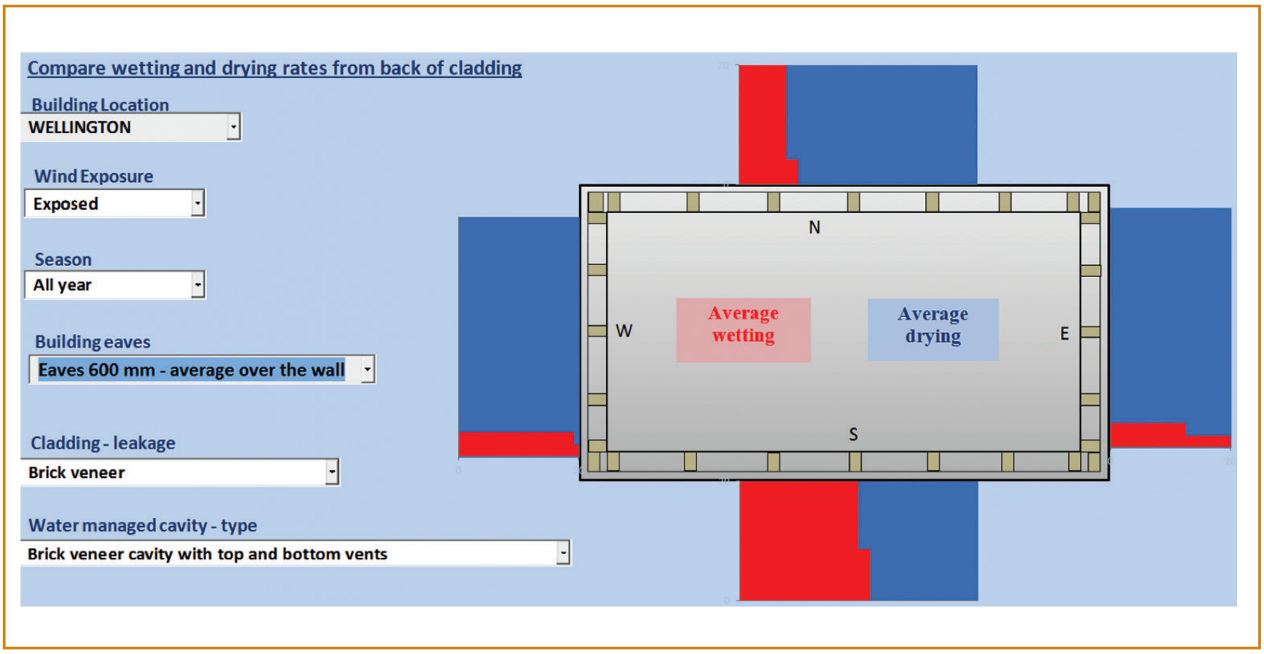

Figure 4. Screenshot from the online tool WALLDRY-NZ.

6.0 ARE SOME CLADDING TYPES MORE LEAKY THAN OTHERS?

6.0.1 Water leakage rates through many different cladding types have been measured in the laboratory. The findings show that build quality and maintenance can play a bigger part in rainwater leakage than the general cladding type. This introduces a lot of uncertainty in the rain leakage rates that have to be dealt with behind claddings. The following leakage classifications therefore account for both cladding type and level of maintenance:

- Low leakage claddings: New freshly painted weatherboard walls, well maintained continuous sheet claddings, and metal and PVC weatherboards with tight-fitting (clip together) overlaps and effective jointers at corners.
- Average leakage: Well maintained painted timber or composite weatherboards with few obvious defects. The most common water leaks for timber tend to be cracks around fixings and knots that have fallen out.
- Leaky claddings: Warped and cracked unpainted weatherboards and non-rendered brick veneers.

6.0.2 One question that is often asked is the difference between rusticated and bevel-back weatherboards. Water leakage measurements have shown no significant difference between the two profiles, but bevel-back weatherboards tend to drain out through the lap joint immediately below a water leak whereas the drainage path in rusticated weatherboard walls is more often at the base of the wall.

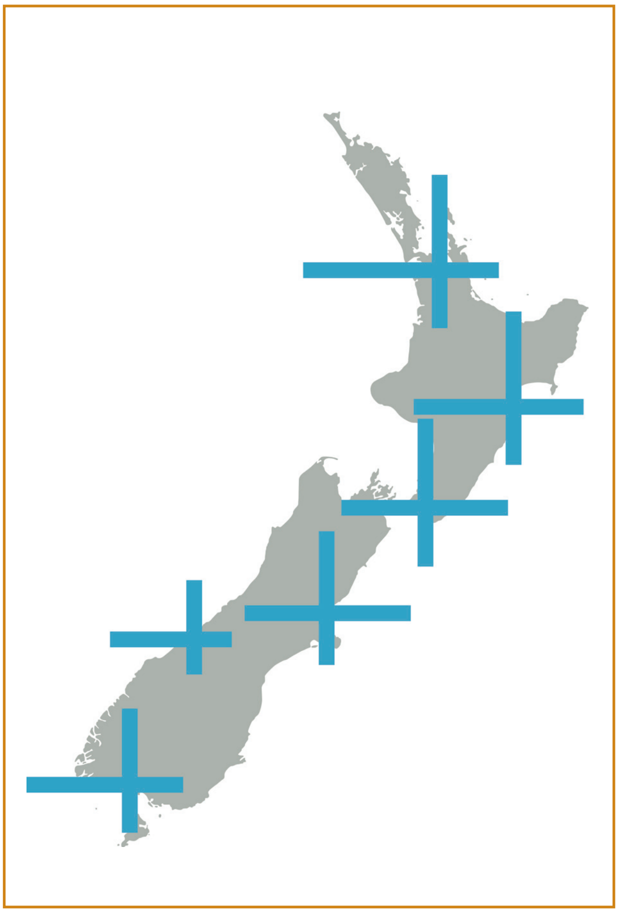

Figure 5. A comparison of average ventilation drying rates around New Zealand for north, east, south and west-facing walls. The longer the blue bar, the greater the drying rate.

7.0 VENTILATION DRYING AND RAIN LEAKAGE

7.0.1 It is possible to use WALLDRY-NZ to compare rain leakage rates with ventilation drying rates for different walls to get some idea of the importance of ventilation drying as one of the 4 Ds. In Figure 6, water leakage rates in grey are compared with drying rates in orange. In all of the examples, the capacity for ventilation drying exceeds water leakage rates through the cladding, which, in some cases, is too small to see in this illustration.

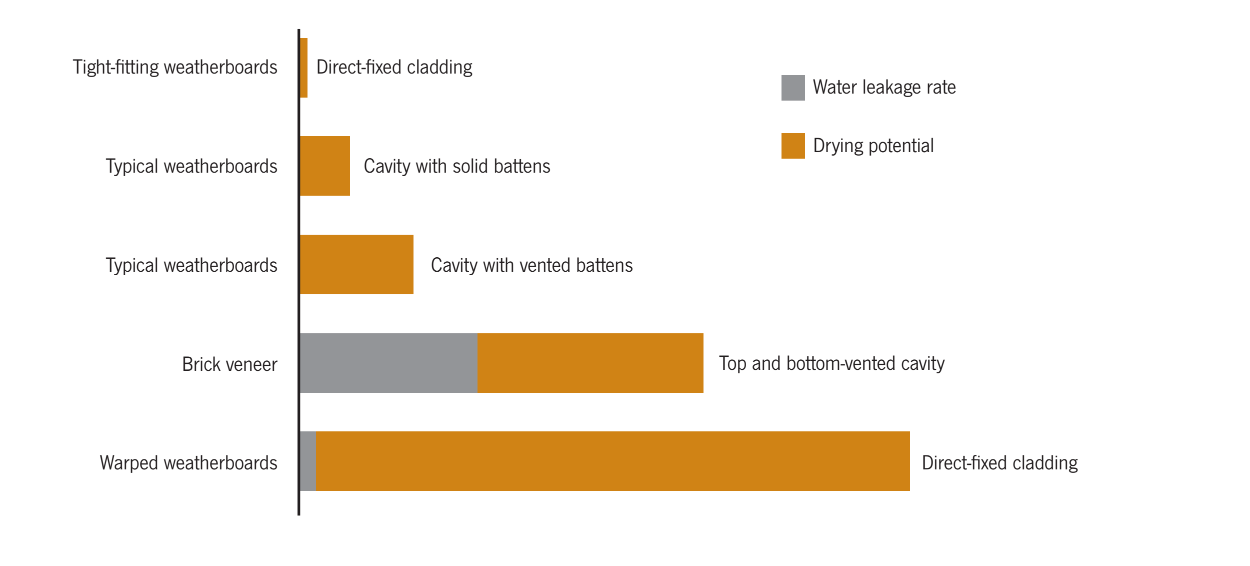

Figure 6. A comparison of water leakage rates (in grey) and ventilation drying rates (in orange) for different types of cladding. This data has been averaged over several locations in New Zealand and wind exposure classifications.

7.1 VENTILATION DRYING

7.1.1 The capacity for ventilation drying varies over a large range – at least a hundred to one – from the most airtight direct-fixed claddings to drained and ventilated cavities behind brick veneers.

7.1.2 Ventilation drying can be achieved in a number of ways. The most secure way is with a cavity with engineered vents, but ventilation drying is also present in traditional timber weatherboard wall claddings that allow some air circulation to occur.

7.1.3 Bottom-vented and battened cavity walls rely on fixed vents and other air leakage paths in the wall. The fixed vents through the cavity closer are not enough on their own to provide adequate ventilation drying. Other ventilation openings are needed at different places to allow flow-through ventilation to take place. These extra vents are the cracks and gaps that occur naturally between building materials, and they are important in bottom-vented battened cavity walls. For this reason, additional top vents are generally not required except in brick veneer walls, but there is no reason why they cannot be added as long as they are adequately protected from rain entry.

7.1.4 Vented battens (such as vertical castellated timber or proprietary perforated plastic) provide another engineered ventilation path so that cavity ventilation no longer relies on cracks and gaps in the system. Horizontal battens are best avoided if possible because they must provide for ventilation as well as prevent moisture bridging across the cavity.

7.2 VENTILATION DRYING COMPARED WITH WATER LEAKAGE

7.2.1 Water leakage rates are generally much less than the capacity for ventilation drying. This means that ventilation drying is a very important part of the 4 Ds. It is especially useful in walls with absorbent wall claddings that do not drain effectively.

7.2.2 Low ventilation drying rates behind direct-fixed panel and airtight weatherboard claddings should be seen as a risk. Although ventilation drying may exceed the water leakage rate for direct-fixed weatherboard claddings in Figure 5, there is a risk that water leaks associated with poorly installed claddings or flashings could easily exceed the available ventilation drying.

8.0 CONCLUSION

8.0.1 BRANZ research has shown that, for cavity construction, the ventilation provided via the bottom vents in a nominal 20 mm cavity and via top and bottom vents in a brick veneer cavity has the capacity to dry most of the moisture that is likely to be present on the back face of the cladding.

8.0.2 Bottom-vented battened cavities require additional ventilation paths to provide for ventilation drying. This can be engineered using top vents, vented vertical battens or by relying on natural construction tolerances in the form of gaps between weatherboards and between claddings and battens and so on. The guiding principle is to not seal everything up too much.

9.0 MORE INFORMATION

Ministry of Business, Innovation and Employment (MBIE)
New Zealand Building Code clause E2 *External moisture* and Acceptable Solution E2/AS1

BRANZ
www.branz.co.nz/walldry – the latest version of WALLDRY-NZ and an explanatory video
www.branz.co.nz/wave – Weathertightness, Air quality and Ventilation Engineering

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