The performance of roof cavity vents

Some roof spaces can accumulate moisture. BRANZ investigated the performance of commercially available vents and the effectiveness of vents installed around the eaves. The most effective way to provide weathertight roof-space ventilation is to install vents in the soffit and at the ridge rather than above the fascia board.

Cold roof designs, where the roof envelope is separated from the thermal insulation in the ceiling by a cavity (such as a pitched roof with an attic space or a skillion roof), can accumulate moisture if they are not adequately ventilated and if internal moisture levels are too high.

The main source of moisture is usually from the living space below. Indoor household activities, such as cooking, showering and drying clothing, release moisture into the air. If the moisture is not managed through adequate ventilation, it can find its way into the roof space, especially if the ceiling level is not airtight. In new buildings, construction moisture can also be a significant source. Moisture trapped inside a roof cavity causes problems such as mould growth and deterioration of the roof components.

Providing deliberate openings to allow passive ventilation is one way of reducing the overall moisture content in a roof space. This involves mixing the air in the roof with air from outside, which is often drier.

Depending on the roof design, vents installed around the eaves of the building and along the roof ridge enable passive air exchanges between the roof cavity and outdoors (Figures 1 and 2). Airflow across an opening is caused by a difference in pressure across it. This pressure drop is a result of wind action around the dwelling. Temperature differences can also drive airflow.

It is important to ensure that vents installed into a roof space would provide enough airflow to resolve moisture issues in the roof space and that they would be weathertight.

Pitched roofs with a ridge vent need to have sufficient vents placed around the eaves as inlets to avoid an additional pressure drop across the ceiling.

Investigating airflow across different vents

Airflow through a roof cavity vent or gap is mainly driven by wind action around the building. The wind causes a pressure difference across the vent, and this drives the air through the opening.

However, not all vents are created equal. They have different shapes and widths and hole configurations, so different vents under the same air pressure difference can give different airflow rates. Knowing how vents perform is essential for the detailed design of a ventilation system, but this information is not always given by the manufacturers.

BRANZ tested a range of vents currently available on the market to find out how easily air passes through them.

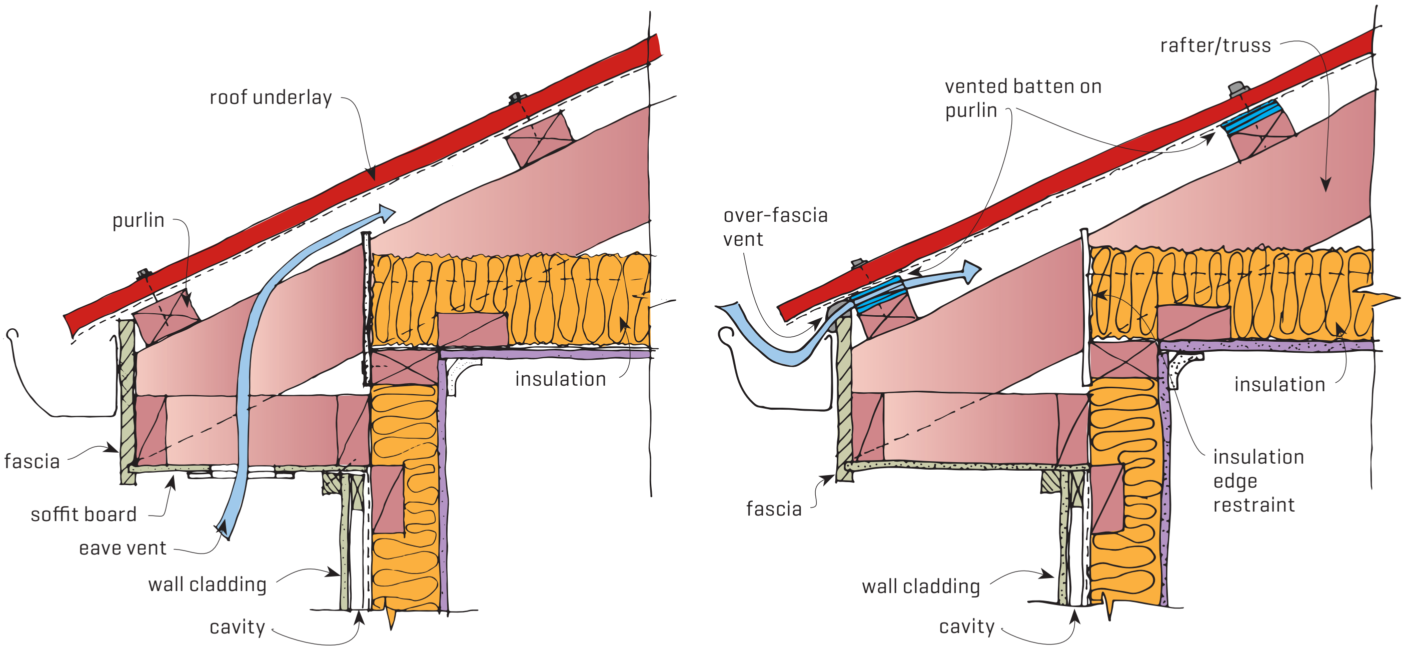


Figure 1. Possible ventilation openings around the eaves of a building. Left: opening in the soffit board. Right: opening above the fascia board with adjacent vented batten on top of the purlins.

Figure 2. Example of circular soffit board vents during construction.

The test procedure is fairly straightforward. The vent element is mounted in a test rig and increasing airflow passed through it. At the same time, the pressure drop, Δp, across the vent element is recorded for each air flow rate.

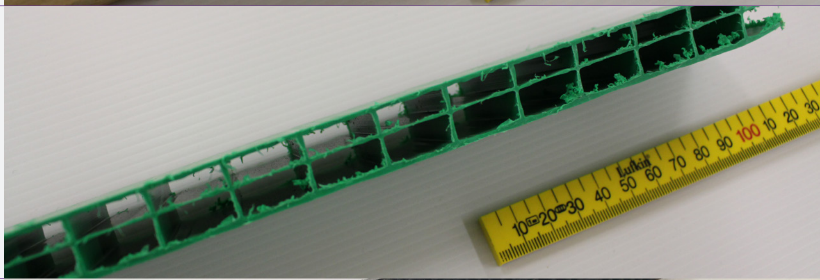
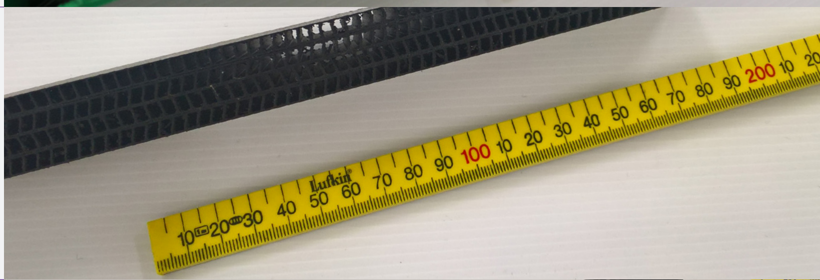
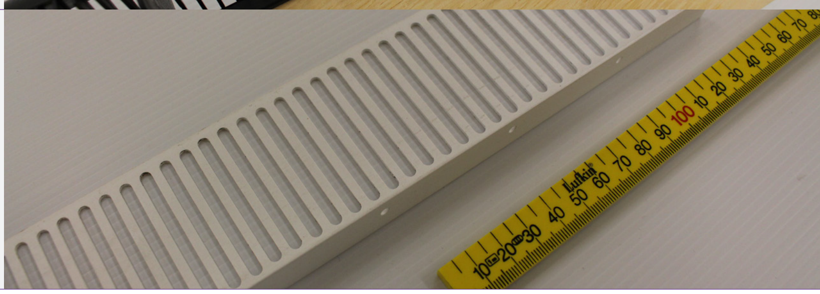
The airflow, Q, is given in litres per second per linear metre of vent element, and $Q = c \cdot \Delta p^n$. This means that plotting the observed airflow, Q, and the pressure drop, Δp, and fitting the data will allow the calculation of two characteristic constants, c and n, to describe each vent element sufficiently (Table 1).

Modelling the effectiveness of the vent position

The performance of vents is not the only consideration for roof ventilation design. The location of the vent will also determine its effectiveness in delivering outside air into the roof space. Different locations around the building will have different pressure gradients due to the same wind action. Entering this localised pressure difference into the airflow formula above determines what the airflow will be through a vent element in a particular location.

To find out the effectiveness of roof vents in different locations (on top of the fascia board and installed into the soffit board), BRANZ created

Table 1. Results of testing various commercially available roof vents. The exponent value n describes how turbulent the airflow is, ranging from a turbulent system at value 0.5 through to laminar (layered and smooth, not turbulent) flow at 1.0. The coefficient c describes the volumetric flow characteristics or how well air flows through each vent.

VENTILATION ELEMENT AND DIMENSIONS		COEFFICIENT *c*	EXPONENT *n*
Castellated batten (timber) w=20 mm d=45 mm l= 1 m cut-out area: 22 x 4 mm²		1.75	0.553
Vented batten A w=17 mm d=45 mm l= 1 m		8.89	0.534
Vented batten B w=20 mm d=45 mm l= 1 m		5.12	0.629
Over-fascia vent – small		9.11	0.501
Over-Fascia vent – large		14.32	0.504
Soffit board vent – linear		25.1	0.49

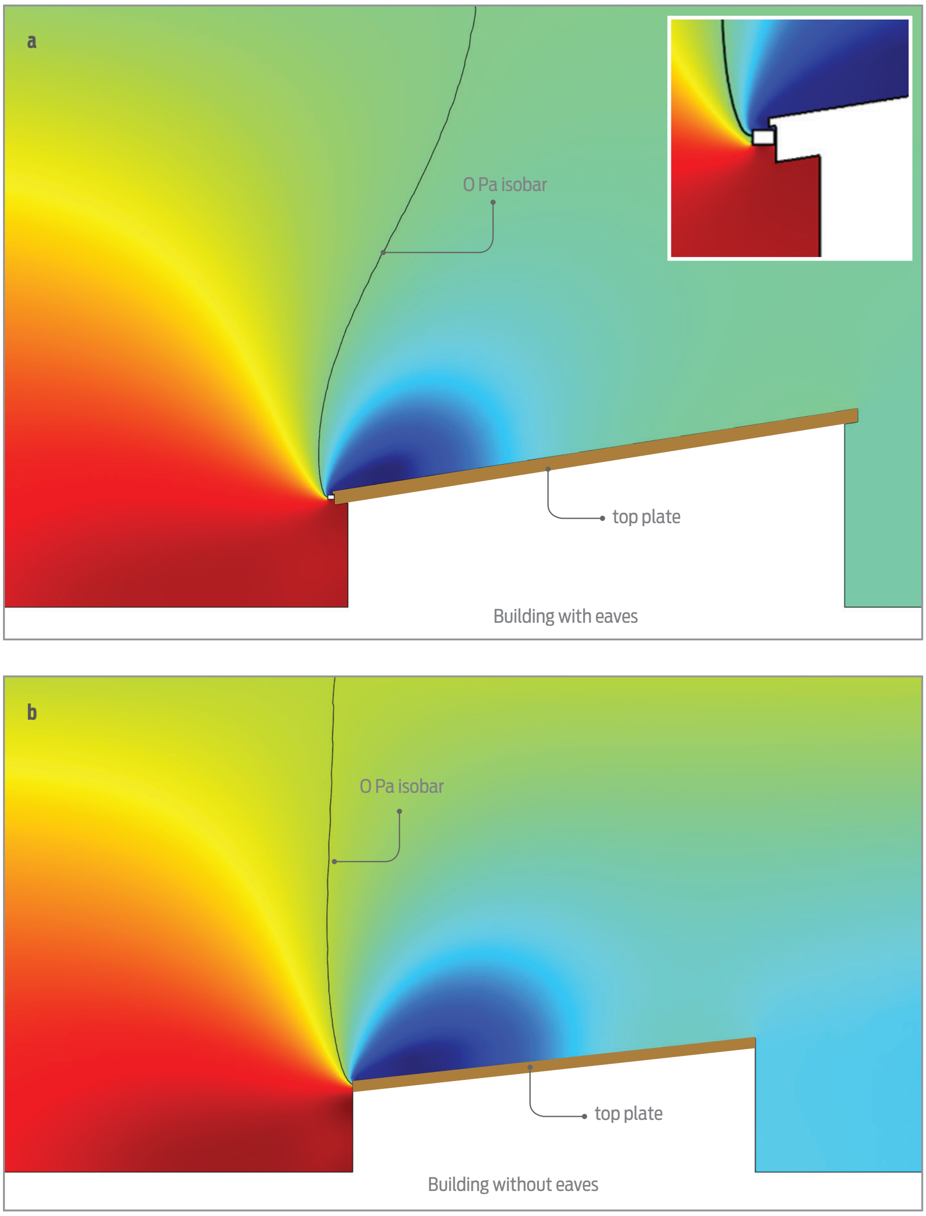


Figure 4. Simulation of wind-induced pressures around a dwelling a) with eaves and b) without eaves. Red = positive pressures, blue = negative pressures. Inset shows a close-up of the pressure experience around the eaves.

two-dimensional computer simulations (using a software package, COMSOL) of a building with a 12 m long, monopitch skillion roof. The speed and direction of the wind was assumed to be a constant 2 m/s with no gusts.

The air pressures on the roof from the wind were simulated for a building with and without eaves. Overall, the air pressure maps look similar (Figure 4). This was expected as overall shape of the building does not change other than at the eaves.

The point of difference in this modelling is the location of the highest air pressure (which is also the best place for roof ventilation). The fascia board often sees lower pressure values, while larger pressures occur under the eaves.

This means that passive vents installed in the soffit board would give significantly higher airflow rates than over-fascia vents in the roof with eaves (assuming identical vent characteristics).

Testing for weathertightness

Any vent installed around the eaves must be weathertight to avoid rainwater entering the roof and other parts of the building. In New Zealand, the usual qualitative tests for roof component weathertightness are documented in AS 4046.9-2002 *Methods of testing roof tiles - Determination of dynamic weather resistance*. BRANZ has tested a number of vents following this standard, but with some additional features to allow water ingress to be better measured. See BRANZ Study Report SR427 for details.

The testing found that vents installed above the fascia boards can leak significant amounts of water into the soffit space under certain adverse conditions.

Recommendations

These observations taken together suggest that the most effective way to provide roof-space ventilation is through vents installed into the soffit (with ridge vents to let the air out). Installing vents in this location maximises airflow and minimises the risk of rainwater entering the vent.

More information

BRANZ Study Report SR427 *Performance aspects of roof cavity ventilation elements*

BRANZ Facts: *Roof ventilation #1 Roof space ventilation in New Zealand houses*

BRANZ Facts: Roof ventilation #2 *Testing the airtightness of residential roof spaces in three dwellings*

BRANZ Facts: Roof ventilation #3 *Air permeability of common New Zealand ceilings and ceiling penetrations*

BRANZ Facts: Roof ventilation #4 *Moisture and ventilation in skillion roofs*