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Vents in skillion roofs

Some roof designs, such as skillion roofs, must include ventilation to manage roof moisture. Recent BRANZ research provides advice on the best place for effective vent openings in low wind zones.

IN HIGH WIND zones, the placement of vents in metal and tile clad skillion roofs might not be critical. But what about in low wind zones, particularly during winter?

Looking for answers

A BRANZ project set out to answer some common questions on skillion roof ventilation. We knew openings for roof ventilation must be included, but is vent placement important? Does vent placement make a difference to ventilation performance?

A skillion roof with tiles and profiled metal has very limited airflow space between the purlins and insulation because the air gap is only about 25 mm. What does the airflow pattern look like near the purlins of a metal roof and should that be improved? If so, how?

Skillion roof airflows modelled

Airflow simulations were carried out for a monopitch skillion roof with profiled metal roofing, with and without eaves. The building in the model has a 12 m long roof with 300 mm deep eaves. The dimensions of the building are not critical and chosen only to show the effect. Similar results would be observed with different dimensions. All simulations shown are based on a wind profile with a wind speed of 2 m/s at a reference height of 10 m.

Figures 1a and b show the air pressures on a skillion roof, with and without eaves, obtained from a computer fluid dynamics simulation. The white area is the cross-section of the building. The pressure is indicated by the rainbow going from dark red for high positive pressure to dark blue for high negative pressure.

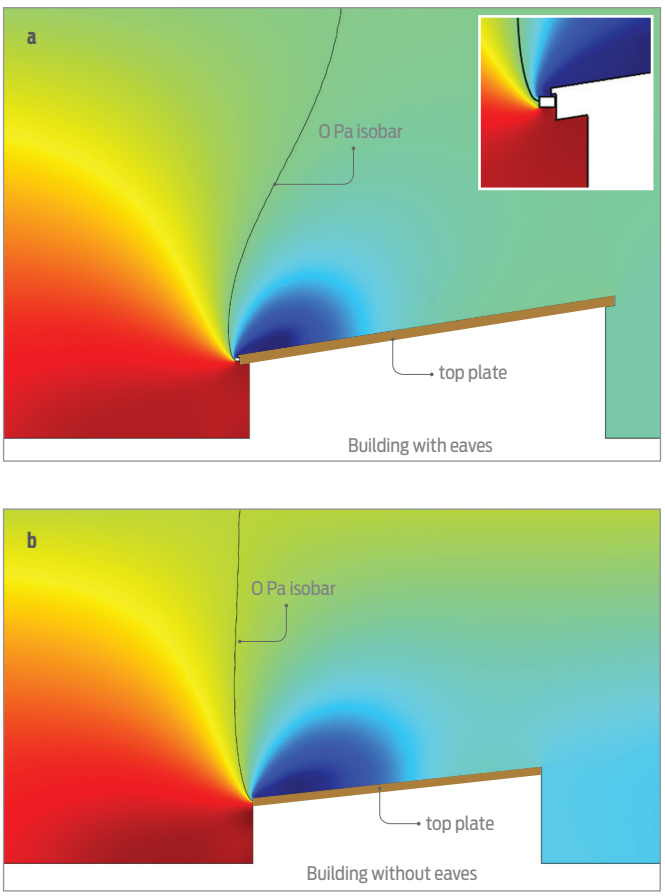

Figure 1: Air pressures on a monopitch skillion roof, (a) with and (b) without eaves. Dark red is high positive pressure, dark blue is high negative pressure.

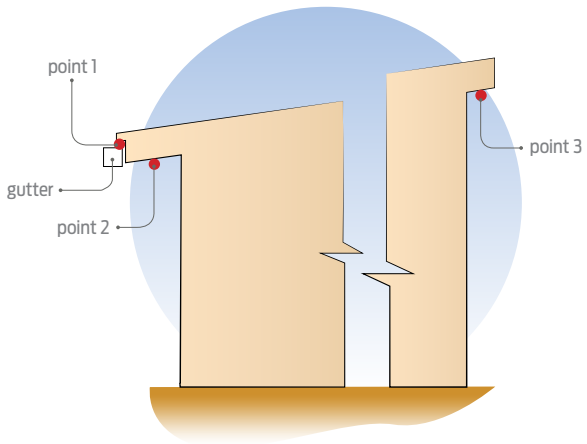

Figure 2: The location of the pressure samples on a monopitch skillion roof with eaves.

Overall, the pressure maps of both profiles look very similar. This is expected as the overall geometry of the buildings is very similar.

Highest air pressures quite different

The location of the highest air pressure, and therefore the best place for roof ventilation, however, is markedly different. The highest air pressure in the:

- roof with eaves is underneath the eaves where a ventilation opening can easily be placed without affecting weathertightness or roof insulation
- roof without eaves is below the roof structure near the top plate of the wall.

Pressure difference drives ventilation

Ventilation is not driven by pressure but pressure difference. By looking at the pressure differences at various locations where roof ventilation openings can be installed relatively easily, we can determine the effectiveness of those locations.

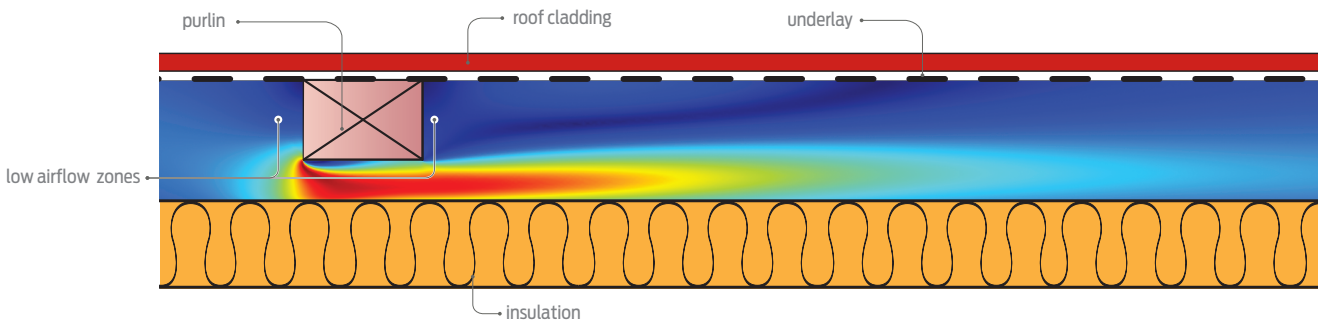

Figure 3: Airflow speed in a monopitch skillion roof near the purlin.

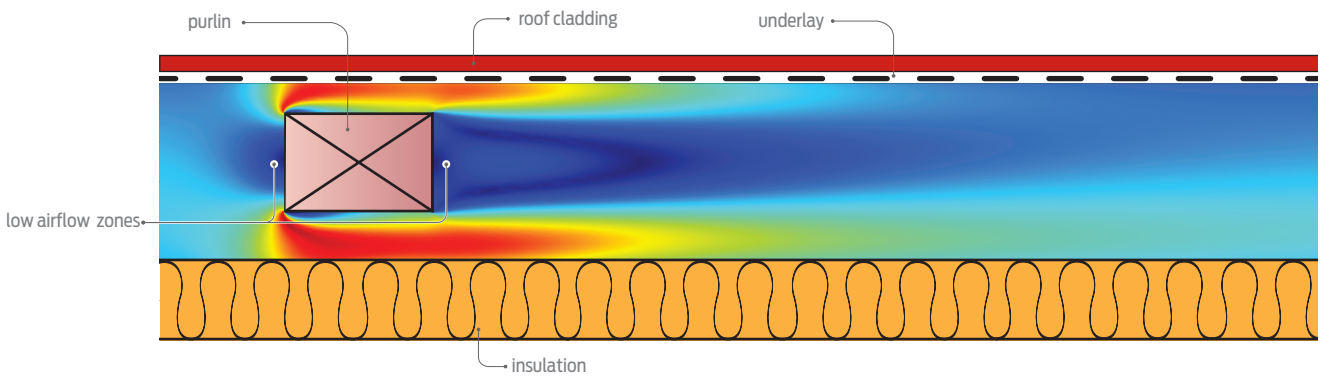

Figure 4: Airflow speed in a monopitch skillion roof near the purlin with ventilated battens.

For roofs with eaves, the two extremes are wind impacting on the low side of the roof and on the high side of the roof. The leeward side has almost even, low negative pressures while the windward side shows pressure gradients going from positive at the wall to negative pressures near the rain gutter (see Figure 1a).

This pressure gradient is driven by the airflow separation that occurs when the wind hits the edge of the roof.

Looking at airflow between vent locations

Measuring the pressure difference between a location on the leeward and windward side allows us to determine the best location for a ventilation opening given the wind direction.

Figure 2 shows the location of the pressure samples:

- Just underneath the roof cladding near a negative pressure location (point 1).
- Underneath the eave at the positive pressure location (point 2).
- A leeward location on the other side of the roof at low negative pressure (point 3).

The airflow through the roof for vents located at points 1 and 3 would be down the roof slope from 3 (leeward side) to 1 (underneath the roof cladding). For the vent locations 2 (underneath the eaves) and 3 (leeward side), the airflow is up the roof slope. The pressure differences that are driving the airflow are almost a factor 2 larger for a vent location at the eaves than underneath the roof cladding.

These scenarios do not take into account the stack effect driving air from the lower part of the roof (point 1 or 2) towards the higher part (point 3), assisting ventilation flow originating from the eave vents.

Danger area around roof purlins

Next, let's take a look inside the roof, in particular, near the purlin where the air gap between the purlin and insulation is only 25 mm wide. Figure 3 shows the air velocity in a skillion roof model.

All the ventilation air through the roof has to go past many of these small gaps. A region of low air velocity exists just in front of and behind the purlin. Any moisture in this area could be trapped there for a longer time and condense on the roof cladding.

Air gap above purlin beneficial

To avoid these moisture spots, the airflow has to get between the roof underlay and the purlin so it can remove any potentially moist air.

Figure 4 shows the airflow pattern with an additional air gap above the purlin. This can most likely be achieved with ventilated battens. In this airflow, the low velocity zone only exists behind the purlin where the condensation risk is considerably lower than near the roof cladding.

This extra air gap will also facilitate better airflow by lowering the roof's airflow resistance. It should be between the underlay and the purlin, not between the roof cladding and the underlay.

Get it right and airflow will remove lingering moisture

Locating ventilation openings in eaves assists roof ventilation in low wind conditions. Depending on how the roof is oriented towards the prevailing wind, careful location of ventilation openings can lead to better moisture management inside the roof structure.

Adding an airflow gap above the purlin reduces the potential for air trapped near the cold roof cladding and airflow resistance inside the roof by almost doubling the airflow cross-section at the purlins.