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Corrosion rates in vented roof cavities

BRANZ research has provided reassuring results for those wanting to add passive ventilation in roof cavities to counter condensation. Corrosion of metal fixings inside the roof space remains low, even in extreme marine environments.

OVER THE YEARS, BRANZ has released many publications on passive roof space ventilation, and the topic is still attracting a lot of interest from the industry.

BRANZ Bulletin 630 *Roof space ventilation* is a good place to start when seeking to understand the intricacies of providing a well-vented roof cavity.

Does ventilation increase corrosion in roof?

However, one aspect of ventilating a roof space is not covered in this bulletin and was at the core of a 2-year Building Research Levy-funded research project. Does an increase in air exchanges in the roof space lead to higher corrosion rates of metal fixtures, especially in marine environments?

The project was introduced in *Under the weather* (*Build* 171). Before we get to the results of that project, a quick refresher may be helpful.

Cold roofs can have condensation issues

Roofs in New Zealand are generally built as cold roofs with the insulation placed directly above the ceiling lining, creating a roof cavity that is not part of the thermal envelope of the building.

Depending on the climatic conditions at the time, this roof space and the roof cladding itself can become very cold. On clear nights especially, the roof cladding temperature can fall to temperatures below the ambient temperature through radiative energy loss into the clear sky.

If the temperature falls below the dew point temperature, condensation will occur. Further, if the moisture load in the roof space is too high or the moisture cannot be removed again during the day by adequate air exchanges, problems like mould growth can occur.

Extreme environment selected for study

Adding passive ventilation elements to a roof space can add resilience against potential moisture accumulation, but the question is are there any unintended negative side effects of increasing the air exchanges in the roof space? For instance, do we see an increased corrosion rate of metal fixtures in a vented as compared to an unvented roof cavity, especially in marine environments?

Earlier this year, we returned to the test site on the harsh south coast of Wellington to retrieve our samples. The location has previously been confirmed at the extreme end of the scale with first-year corrosion rates of around 1,600 g/m^2/year for a mild steel sample.

BRANZ evaluates and maps corrosion rates in metals exposed to the atmosphere across Aotearoa New Zealand on a regular basis, so rates are reasonably well known. These

Figure 1: Mild steel and galvanised samples were mounted inside the vented and unvented roof areas at different angles – vertically, horizontally and at 45º to vertical.

are classified into exposure zones denoting the expected level of corrosion. Wellington is classified as corrosion exposure zone C. Areas within 500 m of the coast are usually classified as zone D.

Samples left for 1 year

BRANZ has a test structure near the sea that was modified for this experiment. The dwelling has two similar-sized roof cavities - one vented and one unvented. Mild steel and galvanised samples were mounted inside the vented and unvented roof areas at different angles - vertically, horizontally and at 45° to vertical (see Figure 1).

Samples were also installed outside the structure for comparison as a reference point. All samples were retrieved after 1 year and the corrosion quantified. Essentially, this process removes all ➤

Figure 2: Heavily corroded mild steel sample after 1 year's exposure outside the structure.

corroded material using a chemical etching process before weighing the samples again.

Corrosion rates measured

The difference in weight before and after that process, normalised to the surface area of the sample, is used to calculate the first-year corrosion rate given in grams per square metre per year. Figure 2, for instance, shows the heavily corroded mild steel sample that was placed as a reference on the outside of the structure. Being exposed to the elements for a full year, the first-year corrosion rate was measured to be 1,099 g/m²/year.

The corrosion rates inside the roof cavity were found to be significantly lower. Figure 3 shows the results for the galvanised and mild steel samples in the vented and unvented cavities.

We further distinguish between samples mounted vertically, horizontally and at a 45° angle. The results are given in the form of so-called box whisker plots. The white horizontal bar indicates the median value, and the upper and lower limits of the box represent the 75% and 25% quartiles, while the whiskers give upper and lower extreme values.

Results reassuring

From the plots, we can conclude that the first-year corrosion rates were higher in the vented part of the roof space than for their counterparts in the unvented cavity for both types of steel, regardless of the orientation the sample was mounted at. This is consistent with expectations.

However, the corrosion rates for all samples placed inside the test structure fall into the C1 Very low and C2 Low ranges of corrosion (see Table 1). Given the extreme conditions at this site, these baseline results are reassuring even though not all aggravating factors could be explored. A higher time of wetness and localised salt deposits may still lead to higher corrosion rates in some places.

For more See BRANZ Study Report SR462 and BRANZ Research Now: *Roof ventilation* at www.branz.co.nz/pubs.

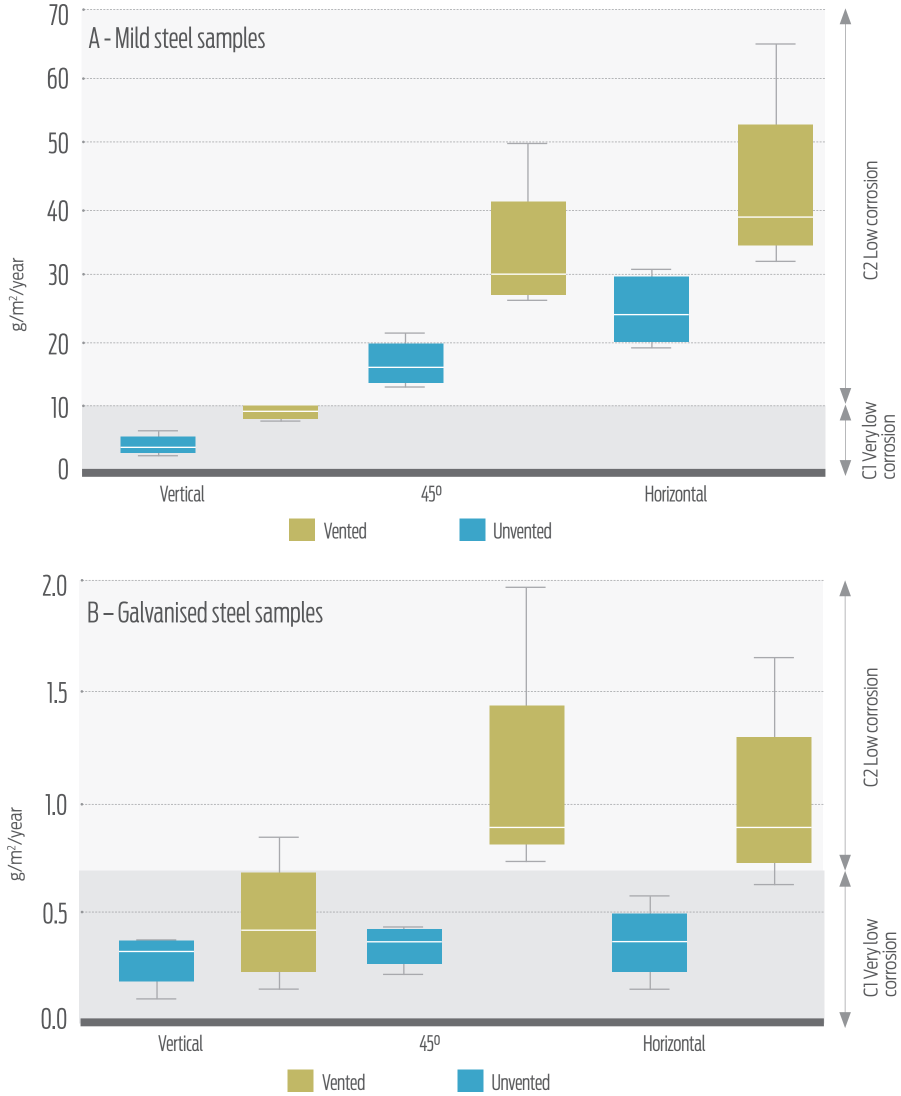

Figure 3: Measured corrosion of all mild steel and galvanised samples in the vented and unvented cavities of the roof test structure. Note: The scale on the two charts are different.

Table 1

Classification of atmospheric corrosion rates after 1 year (g/m²/year) defined in ISO 9223:2012

LEVEL OF CORROSION	CORROSION RATE (CR) IN MILD STEEL	CORROSION RATE (CR) IN ZINC (FOR GALVANISED STEEL)	EXPOSURE ZONE WHERE THIS LEVEL OF CORROSION IS OBSERVED TYPICALLY
C1 Very low	≤10	≤0.7	
C2 Low	10 < CR ≤ 200	0.7 < CR ≤ 5	B
C3 Medium	200 < CR ≤ 400	5 < CR ≤ 15	C
C4 High	400 < CR ≤ 650	15 < CR ≤ 30	D
C5 Very high	650 < CR ≤ 1,500	30 < CR ≤ 60	E
CX Extreme	1,500 < CR ≤ 5,500	60 < CR ≤ 180	