Comparing rates of corrosion in vented and unvented roof cavities

Passive ventilation in roof cavities in New Zealand is unlikely to impact the long-term performance of galvanised metal fixtures in these spaces. BRANZ investigated corrosion in steel samples placed inside vented and unvented roof spaces in a test structure on the south coast of Wellington. After 1 year, the observed corrosion in all samples was low. Samples in the ventilated area were slightly more corroded than those in the unvented area.

Roofs in New Zealand are generally built as cold roofs. Within the space between the ceiling lining and the roof cladding, the insulation is placed above the ceiling lining so the roof space is outside of the thermal envelope of the building.

The conditions in the roof space are influenced both by the climate outside and to some degree by the conditions inside. In cold roof structures, the roof space experiences more temperature extremes than the rest of the building's interior, depending on the air exchange with the outside and warming from the sun (solar gains). Significant amounts of moisture may condense and accumulate from air rising upwards from inside the building where the ceiling linings are not airtight and the inside conditions are too moist. Problems in the roof space can arise if this moisture is not removed.

One solution to manage accumulating moisture is to provide adequate ventilation in the roof space by designing and installing vent openings around the eaves and ridge of the roof. Although the New Zealand Building Code does not require this, BRANZ recommends it.

However, increasing the rate of air exchange in the roof could have other consequences, including an increase in corrosion of metal fixtures such as nail plates, especially in marine environments. To find out whether this would be an issue under New Zealand conditions, BRANZ investigated the difference in rates of corrosion in steel in vented and unvented roof spaces.

The research approach

Steel samples were mounted inside and outside a test structure on the south coast of Wellington about 70 m from the shoreline (Figure 1). Based on previous findings elsewhere, the differences in the corrosion rate between the indoor samples were anticipated to be small. This extremely harsh environment was chosen so that any differences over a year would be detectable and measurable.

Figure 1. Test structure located on the south coast of Wellington used to measure rates of corrosion of steel samples placed in the roof cavity.

The test structure 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. Samples were also installed outside the structure for comparison as a reference point.

The site is very close to the beach, and wind-blown sand was an issue. Any damp sand accumulating around the roof ventilation openings or on the outside samples was removed during regular visits.

Corrosion rates in New Zealand

Rates of corrosion in metal fixtures in buildings depend on their exposure to the local environment. Environmental corrosivity in New Zealand is mainly caused by wind-blown marine salt deposits (depending on the building's distance from the sea and the prevailing winds). New Zealand has relatively low levels of manmade pollutants to influence corrosion in buildings compared with other countries. The corrosive effect of geothermal gases in some parts of the country was not considered in this study.

BRANZ evaluates and maps corrosion rates in metals exposed to the atmosphere across New Zealand on a regular basis, so rates are reasonably well known. These are classified into exposure zones denoting the expected level of corrosion (Table 1). Wellington is classified as corrosion exposure zone C. Areas within 500 m of the coast are usually classified as zone D.

Results

The overall impact on corrosivity of ventilating a roof space appears to be low, especially for the galvanised steel samples.

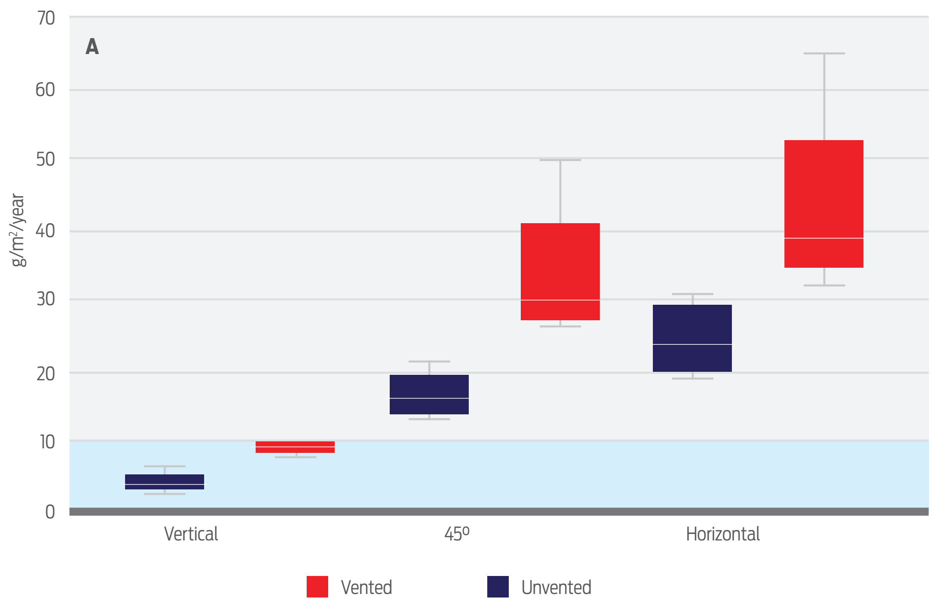
As expected, the reference samples installed outside were corroded after a year. The measured corrosion rate in five of these six samples falls into the CX Extreme category (Table 1). The corrosion in the remaining mild steel sample (horizontally placed) was at the high end of the C5 Very high range. This sample may have been protected by the sand often deposited on its surface.

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 (Figure 2 and Table 1) so the difference between vented and unvented is small. The slightly higher rate of corrosion in the vented area may be because the increased air exchange within the roof cavity leads to a higher exposure to salt aerosols in the air.

These results mean that, for most areas in New Zealand, the installation of passive ventilation openings to roof cavities should not have a negative effect on the long-term performance of galvanised metal fixtures in these spaces. Further work would be needed in New Zealand's geothermal areas.

Table 1. Classification of atmospheric corrosion based on corrosion rates after one year (g/m²/year) defined in ISO 9223:2012 *Corrosion of metals and alloys – Corrosivity of atmospheres – Classification, determination and estimation.*

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	



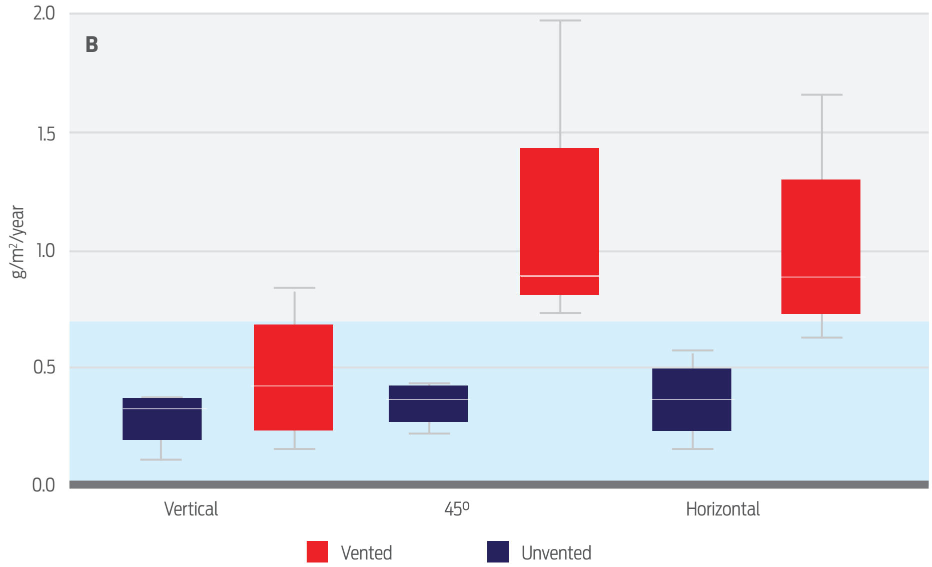


Figure 2. Measured corrosion for all (a) mild steel samples and (b) galvanised steel samples at vertical, 45⁰ and horizontal orientations inside the vented and unvented areas of the roof test structure. In both graphs, blue corresponds to C1 Very low corrosion and grey shows C2 Low corrosion (see Table 1). The white horizontal bar indicates the median value, the upper and lower limits of the box give the 75% and 25% quartiles (the middle half of sample values) and the whisker lines show the highest and lowest rates of corrosion observed.

More information

BRANZ Study report SR462 *Comparative Study of Corrosion Rates in Vented and Unvented Roof Cavities*

BRANZ Study Report SR325 *Update of New Zealand's atmospheric corrosivity map (part 2)*

BRANZ Study Report SR114 *Survey of nail plate corrosion in the roof space of houses near the coast*

AS/NZS 2312:2014 *Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings*

ISO 9223:2012 *Corrosion of metals and alloys – Corrosivity of atmospheres – Classification, determination and estimation*