Atmospheric corrosion challenges

New Zealand's unique environment, with its long coastline and geothermal areas, provides challenges for building material durability. To help, a BRANZ pilot study has made progress towards a unified atmospheric corrosivity map.

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ACCORDING TO the New Zealand Building Code, components used in buildings must meet or exceed specific durability requirements. New Zealand's atmospheric corrosivity maps must be used in the selection of building components, particularly metallic ones such as claddings, flashings and fixings.

The two current maps differ

There are two corrosivity maps for New Zealand, one in NZS 3404.1:2009 *Steel structures Standard - Materials, fabrication, and construction*, and the other in NZS 3604:2011 *Timber-framed buildings* (see *Build* 130, pages 50-51).

Corrosion zone boundaries have been defined in somewhat different ways within these two maps, particularly for New Zealand's cities. This may potentially affect the selection of materials for building components.

With the objective of establishing a unified, updated atmospheric corrosivity map, BRANZ started a multi-year project to experimentally collect metal corrosion rate data from selected locations. The pilot study is now complete.

Metal corrosion findings

At most test sites, measured metal corrosion rates were similar to BRANZ's last measurements in the 1980s. However, significant changes were observed at some sites:

- At Auckland Airport, the first-year corrosion rate for mild steel increased from 298 to 491 g/m^2/year and for zinc from 13 to 33.3 g/m^2/year.
- At Greymouth, the first-year corrosion rate for mild steel decreased from 511 to 342 g/m^2/year while the zinc corrosion rate appeared to be unchanged.
- At Tiwai Point, the mild steel corrosion rate slightly decreased while the zinc corrosion rate decreased markedly from 15.4 to 4.7 g/m^2/year.

Some changes in climate identified

Atmospheric corrosion of metals depends on environmental conditions. Changes of climatic factors over the period 1980-2010 were analysed, including ambient temperature, precipitation, relative humidity and wind speed.

IMAGE COURTESY OF NIWA – DAVE ALLEN.

Comparisons between two short periods of 1987–88 and 2011–12 were also made, when possible.

An increase in annual air temperature of ~0.01–0.03°C per year was calculated from the 12 exposure sites where reasonably complete data could be obtained. Relative humidity trends were very complicated, but significant changes were not observed.

Most sites had a decreasing trend of annual rainfall, wet days and mean wind speed over the last 30 years.

No clear link between corrosion changes and climate

Extensive analysis of changes in individual climatic factors and metal corrosion rates revealed no strong relationships. Consequently, the potential effects of climatic variations over the past 30 years on atmospheric corrosion remain unclear. However, it is obvious that there aren't any significant changes or strong effects.

More racks have been installed to explore the mechanisms behind the large variations that were observed.

Corrosivity map may need tweaking

Checking the atmospheric corrosion zone boundaries using the new data revealed that the NZS 3604:2011 map may have limitations in some regions.

Auckland region

Testing in the central area of northern Auckland supported current zone definitions. Meanwhile, data obtained at Ardmore, Hunua and Tuakau indicated that smaller areas might fall within Zone C in the south Auckland region than are shown by the current NZS 3604:2011 map.

Results imply that it might be reasonable to move the boundary to the east and north slightly. Further testing is being carried out in Warkworth, Dairy Flat, Albany, Drury, Karaka, Paerata and Pukekohe to confirm these hypotheses.

Wellington region

Current measurements confirm that the Wellington metropolitan region is completely classified as Zone C, supporting the NZS 3604:2011 map.

The atmospheric corrosivity in the city region is possibly a result of the strong prevailing northwest winds, as well as wind from the north and south directions. Strong winds could carry salt from rough seas a long way inland.

Dunedin region

In the Dunedin area, the corrosion rates derived at several locations within Zone C, as defined by the NZS 3604:2011 map, could be comfortably allocated into the typical range of Zone B.

This implies that the boundary of Zone C in the Dunedin region could be moved slightly towards the coast. Further, metal corrosion rates obtained at Highcliff and Taiaroa Head are within the range of

Zone C. These results imply that the corrosivity of the atmosphere over the Otago Peninsula is higher than that of the urban area. However, classification into Zone D might not be appropriate.

Christchurch not checked

The atmospheric corrosivity map was not checked for Christchurch in the pilot study due to earthquakes at the time. Over a dozen exposure racks were installed by October 2013 to determine whether the current maps are defining the zone boundaries reasonably accurately.

Geothermal areas quite different

In the North Island, a region spanning from White Island to Ohakune/Waiouru is influenced by geothermal and volcanic activity. Covering about 4% of New Zealand's land area, this region has more than 55,000 dwellings occupied by approximately 120,000 people (Statistics NZ, 2006 Census figures).

This region was defined as the geothermal zone, or Zone 4, in the atmospheric corrosivity map in NZS 3604:1999. This zone was removed from the 2011 edition on the grounds that it comprised microclimates that required special engineering design (SED).

Geothermal emissions and fumes containing hydrogen sulphide (H_2S) and/or sulphur dioxide (SO_2) can produce volcanic smog and acid rain. This creates conditions that can be radically different from those encountered in other environments. Consequently, deterioration and interactions of materials can be very different.

Be wary in geothermal areas

Corrosion of metals within geothermally affected regions has been investigated to a limited extent by BRANZ and other New Zealand organisations. Short-term corrosion testing with aluminium has also been completed by the University of Hawaii, USA, in a mixed volcanic-marine environment.

Results from these discrete studies were highly variable as they had different objectives. Overall, they delivered little guidance to building practitioners, except a general warning to be wary. Meanwhile, the use of designs based on experience and guidelines from other environments has the potential to result in cost and durability issues.

New geothermal impacts project

BRANZ has just begun a multi-year research project to deliver an improved understanding of geothermal environment characteristics and their impacts on material degradation. It will examine failure mechanisms and service lives to support the construction of buildings with better environmental performance and resilience over a wider range of New Zealand's geographic regions.

For more These projects are supported by the Building Research Levy. BRANZ also thanks MetService, NIWA and property owners for allowing the installation of exposure racks on their premises.

For further information, refer to BRANZ Study Report SR288 *Update of New Zealand's atmospheric corrosivity map*, available from www.branz.co.nz.