SHARPENING CORROSION BOUNDARIES

A map showing the corrosivity of the atmosphere in different locations is essential for the specification and selection of materials. Currently, New Zealand has two corrosion maps with different boundaries, but with BRANZ's help, that may change.

By Zhengwei Li, BRANZ Corrosion Scientist, Materials Group

In New Zealand, specifications for metallic claddings, fixings, fasteners and surface coatings for structural steels are based on the atmospheric corrosion exposure zones mapped in NZS 3604:2011 *Timber-framed buildings* and NZS 3404:2009 *Steel structures standard*. However, the exposure zone definitions in these maps are not quite the same, making reliable material selection difficult. BRANZ is working to solve the problem.

Corrosion costs dearly

When a metal is exposed to the atmosphere, water vapour interacts with it to form a thin water layer. Gaseous and solid pollutants can dissolve into this water layer and provide suitable conditions for atmospheric corrosion where electrochemical reactions can consume the metal. This is the dominant degradation mechanism for infrastructure and contributes to more than 50% of corrosion costs. These costs have been estimated at 2–6% of GDP for many developed countries.

An exposure rack carrying mild and galvanised steel panels installed at MetService's meteorological station at Kelburn, Wellington.

Many factors define corrosion zones

Atmospheric corrosivity, influenced by climatic parameters such as ambient temperature, time of wetness, rainfall, solar radiation, prevailing wind direction and also type and distribution of atmospheric pollution, is highly specific to geographic location.

As New Zealand has long coastlines, its atmospheric corrosivity is heavily influenced by the prevailing westerly winds carrying airborne sea salt particles far inland. New Zealand also has regions of geothermal activity that release highly corrosive hydrogen sulphide gas into the air.

A corrosivity map that accurately defines the atmospheric corrosion exposure zone boundaries is fundamental to the specification of cost-effective materials to give acceptable performance for building and construction. It is also very useful for selecting suitable protective coatings and defining the maintenance intervals for metallic structures exposed to the atmosphere.

Many countries have programmes dedicated to the understanding, monitoring and mapping of atmospheric corrosivity.

Two different maps

Currently, different corrosivity maps are included in two New Zealand standards.

BRANZ MAP IN NZS 3604

The first map was established by BRANZ using atmospheric corrosion rate data for mild steel and galvanised steel panels exposed for 1 and 2 years at more than 100 sites spread through New Zealand.

This map was incorporated into the NZS 3604:1999 *Timber framed buildings* and used for selection of durable metallic cladding and fastening components. The environment of New Zealand was classified into five exposure zones: sea spray zone – severe marine or very severe, zone 1 – marine or severe, zone 2 – moderate, zone 3 – mild, zone 4 – geothermal.

In NZS 3604:2011, these zones were redefined: sea spray zone as category D, zone 1 as category C, zones 2 and 3 as category B to align with AS/NZS 2312 and ISO 9223.

HERA MAP IN NZS 3404

Another corrosivity map for New Zealand was established by the Heavy Engineering Research Association (HERA) based on the first year macroclimate corrosion rates of carbon steel. The data was determined theoretically from equations based upon meteorological variables, for example, average daily temperature, time of wetness, annual rainfall and distance from the coast.

The map was used in NZS 3404:2009 to estimate corrosion rates for any steel surface and to specify coating systems for the protection of steel.

SOME DIFFERENCES

Atmospheric corrosion exposure zone boundaries in these two maps are somewhat different, especially in Auckland, Wellington, Christchurch and Dunedin – the main population centres. Discrepancies between the two are not clearly understood, but it is clear that the experimental corrosion rate data was derived about 25 years ago. Climate change could have influenced the environment over the past decades.

The coexistence of two different corrosivity maps for New Zealand will inevitably lead to confusion, although it can be argued that they are targeted at different industrial sectors. That said, a clear boundary cannot be established between the structures defined in these two standards. More risk or more cost may be incurred in areas where the maps don't match.

Research focuses on climate and corrosion data

Current BRANZ research aims to develop solid experimental data and a unified map for end-users. This research funded by the Building Research Levy started in 2011 and should be completed by March 2013. Currently, it is focusing on two aspects:

- Analysing climatic data. Data of representative climatic elements, for example, ambient temperature, relative humidity, rainfall and wind speed, are being sourced and downloaded from the CliFlo database of the National Institute of Water and Atmospheric Research (NIWA). The trends of change over the period of 1980s–2000s will be established and form a baseline for this research.
- Collecting current corrosion data. Critical sites where the maps in NZS 3604 and 3404 disagree substantially have been located. A network of corrosion tests using mild steel and galvanised steel panels has been established at 40 sites mainly in Auckland, Wellington and Dunedin. Samples will be retrieved for corrosion rate measurement in September 2012.

Data collected will be analysed to examine if there are recognisable changes in metal degradation rates over the past few decades. Any changes, if observable, will be compared to the changes in climatic parameters to determine their potential correlations.

Data collected in BRANZ's previous and current experimental studies will be compared with the theoretical predictions to assess the credibility and applicability of the current pair of maps – NZS 3404 and 3604 – to the New Zealand environment and to clarify whether a unified atmospheric corrosivity map can be derived through further large-scale experimental work and collaborative investigations on modelling of critical climatic and geographic parameters.

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