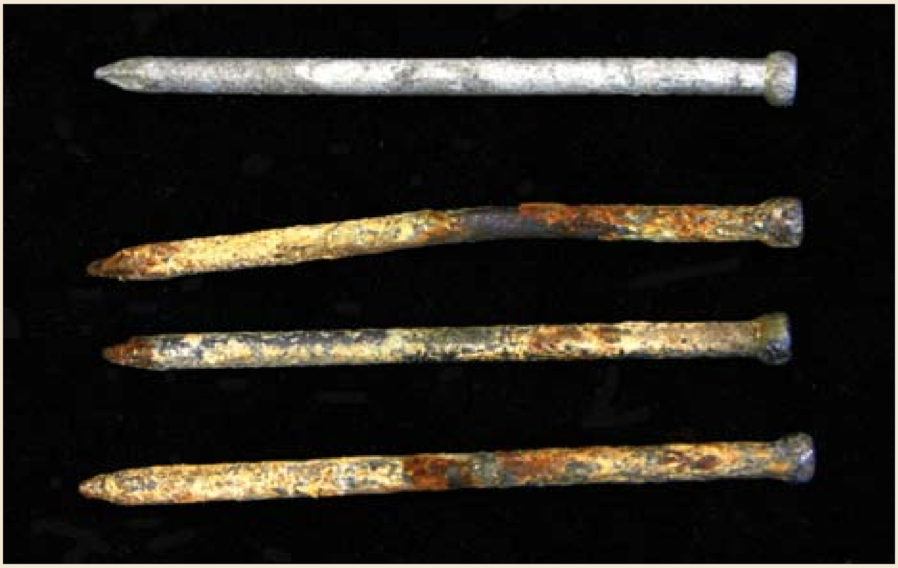
Use stainless steel with new timber treatments

Possible health hazards associated with chemicals in CCA preservatives for treated timber have led to revised codes of use in some countries. New research by BRANZ into the durability of galvanised steel shows work still needs to be done on reducing the corrosivity of preservative-treated timbers.

By Gareth Kear, BRANZ Senior Materials Scientist

For many years, copper-chrome-arsenate (CCA) water-based preservatives have been used to treat most timber used in external structures. The durability of this class of preservative is well known and in New Zealand, at least, we are still using it for most things outdoors.

However, perceived environmental health hazards associated with arsenic and chrome within the treated wood have led to revised codes of use in the USA, Europe and Australia. In these countries, CCA-treated timber is no longer specified for decks, picnic tables, playground equipment, etc. Although the number and severity of documented ill-effects related to timber-based chrome and arsenic is extremely low, the 'better safe than sorry' approach has been enforced overseas.



Hot-dipped galvanised nails may not last as long as expected in CuAz- or ACQ-treated timber. Lower three nails shown after 7 years of ACQ exposure in rural Auckland's corrosion zone 1.

International sales of the alternative copper azole-based (CuAz) and alkaline copper quaternary-based (ACQ) preservatives are increasing, as they are being marketed as environmentally-friendly alternatives to chrome and arsenic. Copper naphthenate-based (CuN) preservatives are also specified in New Zealand for the H3.2 hazard class (see NZS 3640: 2003 *Chemical preservation of round and sawn timber*), but these aren't currently in high demand.

In the CuAz and ACQ preservatives, large organic molecules deal with the copper-tolerant species of moulds or fungi traditionally kept in check by chrome and arsenic. Unfortunately, for those of us interested in using metal with treated timbers, the specified levels of retained copper in the CuAz- and ACQ-treated timber are many times higher than in the CCA-treated products. Elevated levels of copper are not ideal with other metals because of corrosion affecting their durability.

It has been known for many years that CCA-treated timber produces greater corrosion rates in metal than untreated timber. At moisture contents greater than 18–20% (weight of water/weight of dry density wood), a galvanised steel fastener coating can be expected to degrade twice as fast as usual. There are also recommendations restricting water run-off from CCA-treated timber onto materials such as aluminium, coil-coated steel and most zinc-based products (refer to the New Zealand Building Code E2/AS1, Table 22 and NZS 3604: 1999 *Timber framed buildings*, Table 4.5). E2/AS1 also describes the inherent incompatibility of these materials with CCA-treated timber.

Durability of fasteners with CCA treatments

Fasteners coated with zinc-based materials can be used with CCA-treated timber but important restrictions apply. Care must be taken choosing the materials for each specific application considering the corrosion zone and/or environment to which the fasteners will be subjected, and the durability requirements of the components being connected (see section 4 of NZS 3604: 1999).

Table 4.3 in NZS 3604: 1999 allows hot-dipped galvanised nails (to AS/NZS 4680: 2003) and/or mechanically zinc-plated screws (to AS 3566.2: 2002) to be used in two applications:

1. framing in 'sheltered' and 'exposed' areas (50-year durability)
2. non-structural cladding (15-year durability).

These coatings can be used in all NZS 3604: 1999 corrosion zones but only in these situations.

Durability of fasteners with CuAz and ACQ

CCA has relatively low levels of copper compared to CuAz and ACQ, which raises more questions about the durability of fastening materials when used with these two treatments.

Unlike CCA, CuAz- and ACQ-treated timbers are not specifically included in material compatibility charts or tables in either NZS 3604: 1999 or the Building Code Clause E2/AS1. BRANZ recently conducted some research, funded by Building Research, to help fill this gap. This work has included accelerated (49 ± 1°C; two weeks) and non-accelerated (21 ± 2°C; one year) corrosion testing of mild steel, hot-dipped galvanised and 316 stainless steel in direct contact with untreated, CCA-, CuAz- and ACQ-treated *Pinus radiata* (common pine).

Corrosion rates of metal specimens and commercially available panel pin fasteners were measured over a range of relative humidities, using both standard and new test methodologies. For these timber treatments, humidity values of 75%, 90% and >98% equated to approximate timber moisture contents of 10.5 ± 0.2%, 17.9 ± 0.5% and 20.3 ± 0.8% wt/wt, respectively (see Figures 1–3).

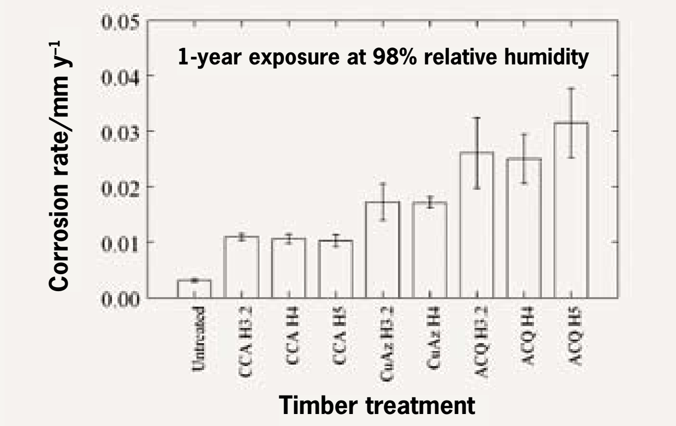


Figure 1: The corrosion rate of a hot-dipped galvanised steel plate rises significantly as the copper content of the treated timber increases.

Results show that the durability of 316 stainless steel was generally unaffected by the test conditions. However, the CuAz- and the ACQ-treated timbers were considerably more corrosive towards mild steel and galvanised steel than CCA. When averaged over 1 year, the corrosion rates for hot-dipped galvanised steel were accelerated by a range of factors of up to 20 in some extreme cases.

Where CuAz- and ACQ-treated timbers are used, BRANZ recommends fasteners should be either 304/316 grades of stainless steel or durable equivalents, such as silicon bronze.

In general, the laboratory testing showed that corrosion rates of galvanised steel in CuAz- and ACQ-treated timbers can be increased by around two to five times that of CCA. The aggressive nature of the treated timbers towards both mild steel and hot-dipped galvanised steel was classified as shown in Figure 4.

BRANZ recommends

The active corrosion of the zinc-coated fasteners will be of primary concern to the building industry as, in addition to CCA, both CuAz and ACQ preservatives are approved for use at the H3.1, H3.2, H4 and H5 hazard class levels in NZS 3640: 2003 *Chemical preservation of round and sawn timber*. These timbers will be used in many situations where the moisture content of the wood is actually higher than that examined in the study.

BRANZ is currently recommending that for both 15- and 50-year situations where CuAz- and ACQ-treated timbers are used, the fastener material of choice, including nails and screws, should be either:

- 304/316 grades of stainless steel, or
- durable equivalents, such as silicon bronze.

Given current knowledge, galvanised steel – even with additional protection – should not be considered as a durable equivalent to stainless steel. Ideally, we should be working to reduce the corrosivity of timber preservatives.→

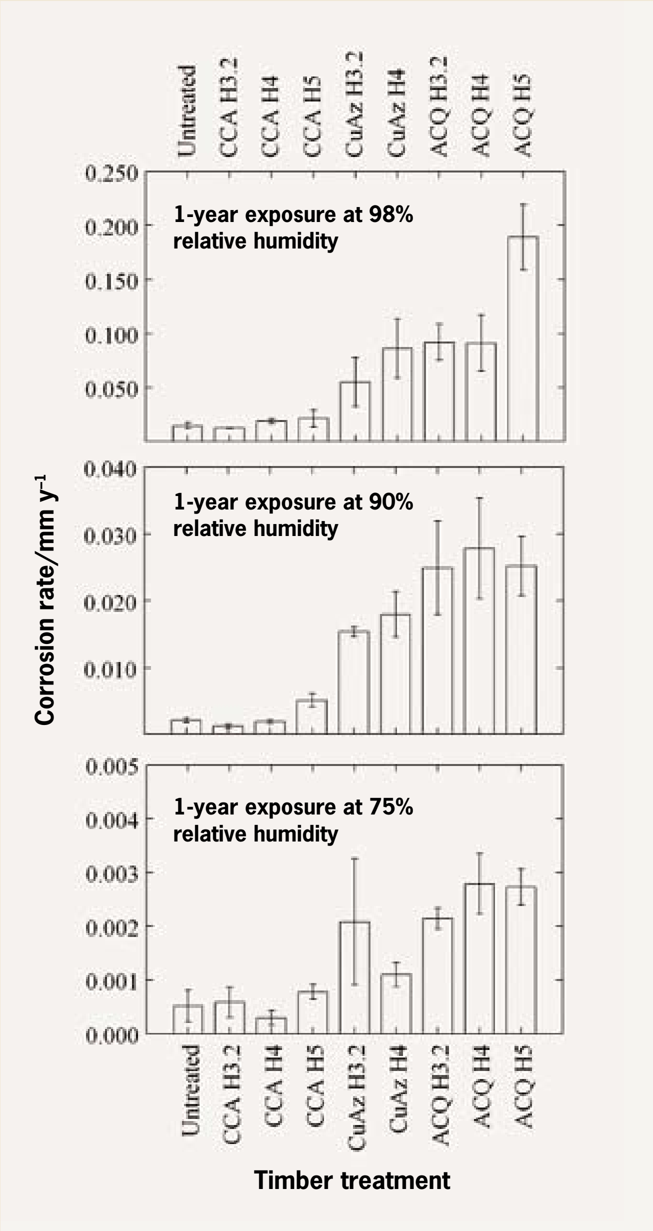


Figure 2: Corrosion rates of a hot-dipped galvanised steel panel pin change as relative humidity changes.

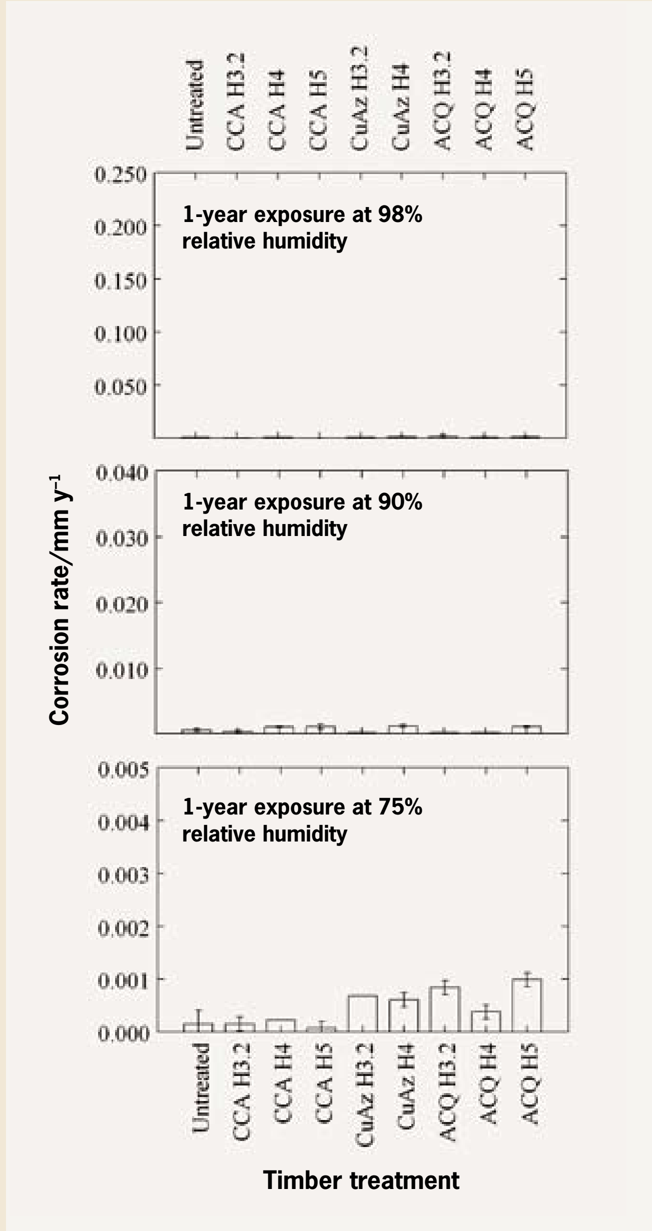


Figure 3: The 316 stainless steel corrosion rates hardly register.

Making customers aware

Considering a simple 15 m^2 deck, a cost increase from around \$30 (galvanised) to \$150 (stainless) may be on the cards, just for nails. Moreover, many retail suppliers may not be fully aware that they are selling CuAz- or ACQ-treated timbers and the chemical origin of the preservative may not be obvious to the customer simply from the trade name or the branding. This means the customer may not realise they should be choosing other more durable fasteners.

The BRANZ research results are available for free download from www.branz.co.nz.

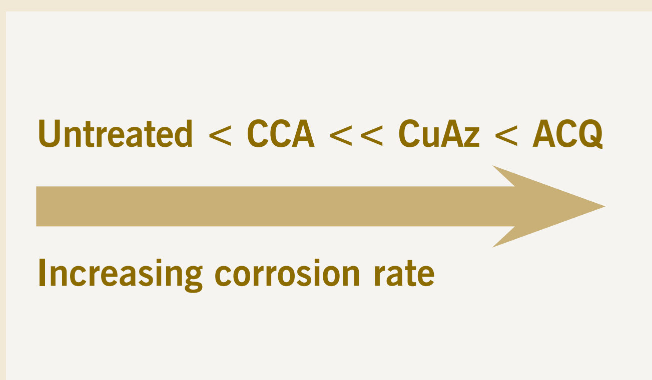


Figure 4: Corrosion rates of metals increase with different treatments.