# Exposed issues – steel corrosion

Mild steel exposed to atmospheric moisture will corrode unless it is adequately detailed, has the right level of protection for the location and is well maintained.

**CORROSION OF METAL** is essentially an electrochemical reaction.

The key issue with steel is the extent to which the exposed steel will receive rainwashing when in service. If steel is not exposed to rainwashing, durability is significantly reduced unless other regular maintenance measures are adopted.

In the absence of rainwashing, contaminants will build up on the surface. Dirt and salt building up on the surface are hygroscopic and maintain elevated moisture on the surface of the steel for longer periods.

New Zealand also has a high-humidity marine climate, and this will result in dirt and salt deposits on steel remaining humid or damp for long periods.

Regular maintenance washing can mitigate the absence of rainwashing. However, maintenance washing is not considered as effective as rainwashing because it is typically infrequent, either due to inadequate attention to maintenance or the inaccessibility of the area.

Exposed steel is common in modern building design but has the potential to be a maintenance disaster and not achieve Code performance requirements if there is insufficient provision for cost-effective and safe maintenance access. Frequently, exposed steel may get 90% rainwashed, but the remaining 10% may be sheltered and will deteriorate quickly if it does not receive very regular and thorough maintenance cleaning.

Areas that will not receive rainwashing need a higher level of corrosion protection to the parts that do get rainwashed.

Deterioration of mild steel can be worse where:

- construction details or steel profiles trap moisture or dirt such as an exposed flange that is near horizontal or a junction between two members
- the applied corrosion protection (paint, galvanising) has been damaged during erection or afterwards
- galvanised or painted surfaces are modified on site such as cutting or grinding to make it fit or welding on an extension
- the steel is difficult to access for inspection and cleaning/maintenance
- the wrong or inadequate coating system for the location and environment has been used
- poor application of applied coatings – not following the supplier's recommended process for number of coats and sequence of application
- poor preparation of the original steel before coating – this means that the coating won't stick well to the steel.

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## Standards

### AS/NZS 2312:2014

AS/NZS 2312:2014 *Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings* provides advice on methods for the corrosion protection of structural steel. The standard is in three parts:

- Part 1 covers paint systems – liquid applied paint.
- Part 2 covers hot-dip galvanising (HDG), duplex (paint and galvanising) coatings, mechanically plated and electrodeposited coatings.
- Part 3 (in preparation) will cover thermally sprayed metallic coatings.

AS/NZS 2312.2:2014 references the latest international corrosivity (ISO 9223/ISO 9224) and design standards for HDG (ISO 14713). It

also includes information on how the chemical composition of some steels can react with elements in the HDG process to cause excessively thick coatings. In addition, when initial aesthetic appearance is important, the advice can be used to provide information on the typical coating characteristics.

The durability of an HDG coating is now calculated from the minimum average coating thickness in AS/NZS 4680:2006 *Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*, which also means non-standard HDG thicknesses can be easily assessed for the estimated life to first maintenance.

### SNZ TS 3404:2018

SNZ TS 3404:2018 *Durability requirements for steel structures and components* is a technical specification that:

- covers the corrosion protection of structural steelwork exposed to New Zealand atmospheric and non-atmospheric environments – this includes above ground and below ground
- updates the information contained in section 5 of NZS 3404.1:2009 *Steel structures standard – Materials, fabrication, and construction* and is republished as a stand-alone technical specification
- simplifies the design procedure for durability determination given in Heavy Engineering and Research Association Report R4-133:2011 *New Zealand Steelwork Corrosion and Coatings Guide*
- should be used together with AS/NZS 2312.1:2014 and AS/NZS 2312.2:2014.

### NZS 3404:1997

NZS 3404:1997 *Steel structures standard* includes two parts:

- Part 1 *Materials, fabrication and construction* sets out the minimum requirements relating to the design, fabrication, erection and modification of structural steelwork in accordance with either the limit state design method or the alternative design method outlined in the standard. It applies to building structures, bridges and composite steel and concrete beams and columns.
- Part 2 provides background material to the requirements of Part 1.

The aspects of the standard that relate to corrosion resistance and protection include:

- selection of protective coatings for the New Zealand environment
- a means of categorising the finishing requirements of architecturally exposed steelwork.

### New Zealand Steelwork Corrosion and Coatings Guide

The *New Zealand Steelwork Corrosion and Coatings Guide* (NZCCG) published by HERA (Report R4-133) provides guidance on the selection of appropriate and cost-effective coatings systems for structural steelwork. The guide is written to be used in conjunction with AS/NZS 2312:2014 and covers:

- basis of protective coatings
- general steps to determining an appropriate coatings system using the corrosion protection standard
- determining the atmospheric corrosivity category for external and internal steelwork
- determining the years to first maintenance
- types of protective coatings, their appearance and indicative costs
- use of the coatings selection tables in AS/NZS 2312:2014
- specification of coatings systems
- important factors to consider
- guidance on the inspection of coatings systems before, during and after application
- maintenance and recoating
- protection of steel in non-atmospheric environments
- design corrosion rates for steel piles
- macroclimate steel corrosion rates for New Zealand.

### Specifying steel

When specifying steel, the following must be identified before deciding on the appropriate level of corrosion protection:

- Access for inspection and maintenance.
- Environmental conditions now and in the future.
- Detailing – avoiding any flat surfaces or debris traps.
- Whether all work can be done in factory conditions or whether it is likely the steel will need to be modified and therefore recoated on site.

Options for mild or carbon steel protection:

- Hot-dip galvanising after fabrication – note that any modification after galvanising will destroy the coating. Galvanising may be used with an additional coating system, typically described as a duplex coating system. Hot-dip galvanising without additional paint application will often be insufficient corrosion protection in many situations in New Zealand.
- Specialised corrosion-resistant paint (such as epoxy, polyurethane, zinc-silicate, urethane-acrylic, chlorinated-rubber) system – a number of specific coats applied in the correct order to the prepared steel.
- Polyester powder coating.
- Steel primer and acrylic or alkyd finish coat(s) for dry interior locations where there is no risk of moisture affecting the steel.
- Metallisation plus paint anti-corrosion protection consisting of thermal spraying of zinc/aluminium, sealing of the pores and application of a finishing layer with liquid paint.
- Thermally (hot) sprayed coatings of zinc, aluminium and zinc-aluminium alloys to give long-term corrosion protection to steel structures in aggressive environments.

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Zinc spray protection is less durable than hot-dip galvanising and is vulnerable to insufficient surface preparation. It is not recommended for exposed steelwork.

## Detailing

Good details:

- avoid dirt and moisture traps as shown in Figure 1
- where possible, use an RHS section rather than a channel or PFC
- separate materials where there is a risk of galvanic corrosion (Figure 2)
- avoid crevices or joints that also trap dirt and moisture
- have rounded rather than sharp edges to steel sections to allow a full coating build to corners.

## Protected lightweight steel framing

Buildings that are built with zinc-coated mild-steel frames will meet durability requirements provided the steel is:

- located within a dry enclosed environment – for example, lightweight steel house framing
- not exposed to the exterior environment or water entry when in use.

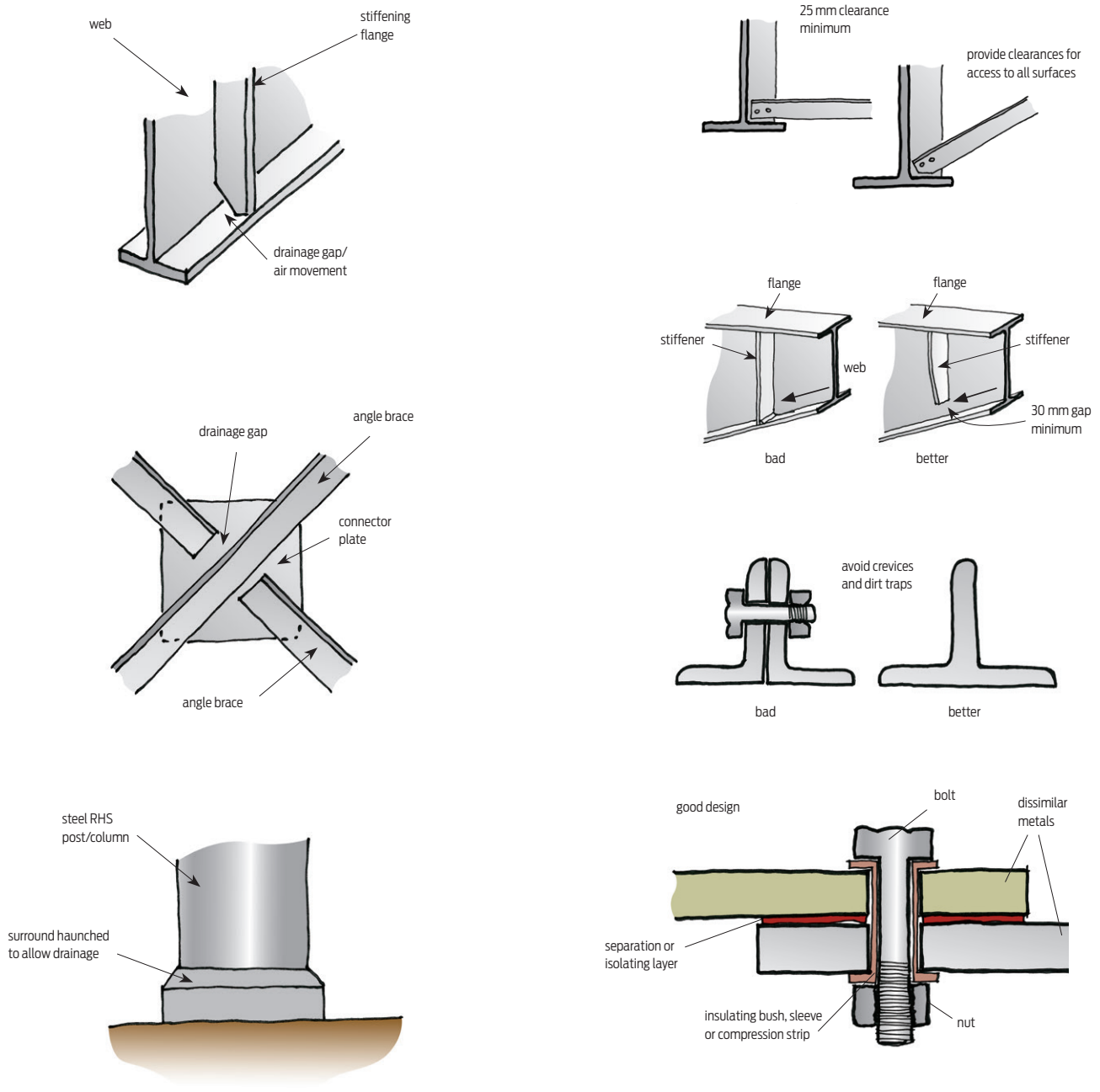


Figure 1. Avoiding dirt and moisture traps.




Figure 2. Avoiding galvanic corrosion.

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