ZINC
Associate of International Zinc Association

83
galvanize
February 2021

Asia Pacific Edition
HOT DIP GALVANIZED STEEL

BEST PRACTICE CORROSION PROTECTION FOR BCA VOLUME 2 PART 3.4.4.4

In this issue

Editorial
Peter Golding
Prepared by
Galvanizers Association of Australia

Introduction

This issue of Galvanize provides additional advice to the Building Code of Australia for the corrosion protection of structural steel in housing and related applications. It deals with the common issues but cannot describe all situations and independent professional advice must be sought if there is any doubt.

The National Construction Code 2019 Building Code of Australia – Volume 2 (Amendment 1) [(1)] sets out the requirements for corrosion protection of certain structural steel members such as:

- Bearers supporting a timber floor or non-loadbearing stud wall
- Strutting beams supporting roof and ceiling loads
- Lintels supporting a roof, ceiling, frame, and timber floor
- Columns

galvanizers
ASSOCIATION OF AUSTRALIA

Table 3.4.4.4 of the Building Code of Australia (BCA) sets outs the minimum requirements for protective coatings where the degree of corrosion protection is determined by the described environment and location. The BCA rules relating to external environments and the minimum corrosion protection required do not fully describe the corrosivity experienced by structural steel in all common situations and can lead to poor outcomes for service life of the coating and, in some cases, early failure of structural steel members, even if they have been supplied and installed to the requirements of the BCA.

Users should also be aware there are multiple types of coatings that are claimed by their suppliers to be a form of galvanizing. Most of the common coatings available in Australia will not meet the minimum requirements of the BCA, except in moderate internal exposures or with the addition of a paint topcoat. **Only batch hot dip galvanized steel coatings produced to AS/NZS 4680 [2] always meet the minimum requirements of the BCA for structural steel members without the addition of a topcoat.** It is important that the correct specification is selected and supplied to ensure adequate performance of the galvanized coating. In addition, if a paint coating option is selected, the BCA does not provide a full specification and it may be difficult to assess conformance to the requirements of the BCA without an expert opinion.

Note: Section 3.4.4.4 of the BCA does cover structural steel members used in masonry construction but does not cover corrosion protection of structural steel built into a masonry wall such as lintels. For lintels and other structural steel elements built into masonry, specifiers must refer to AS 3700 [3], the AS 2699 [4] series, and Part 3.3.5 of the BCA.

National Construction Code

The National Construction Code (NCC) is Australia's primary set of technical design and construction provisions for buildings. It is a self-described performance-based code which primarily applies to the design and construction of new buildings and is used by architects, builders, building surveyors, engineers and other building related professions and trades. The NCC is given legal effect through relevant State and Territory legislation and the applicability of the NCC for a particular situation should be assessed against the relevant local legislation.

The Building Code of Australia (BCA) makes up 2 volumes of the NCC, with Volume 2 the subject of this issue of Galvanize. Volume 2 primarily covers the design and construction of houses, small sheds, carports, and some other associated structures. The NCC allows either a *Performance Solution* or a *Deemed-to-Satisfy Solution* to meet the requirements of the BCA. The differences can be complex, and these are described in Part A2 of Volume 2 of the BCA.

Part 3 of Volume 2 deals with acceptable construction for *Deemed-to-Satisfy Solutions*. It is this aspect that is clarified in this issue of Galvanize. The guidelines discussed here are not a *Performance Solution* but do provide more information that will assist professionals in the development of a suitable corrosion protection system for structural steel in some common applications.

Structural steel members in the BCA

A range of structural steel members are included in the Acceptable Construction Practice section of Part 3.4.4 of the BCA. Hot formed sections included are a range of taper flange beams, universal beams, parallel flange channels, taper flange channels, equal angles, and unequal angles. Cold formed sections in the BCA structural steel section include a range of standard tubular sections (rectangular, square, and round hollow sections). Structural steel members covered vary in thickness from 1.6mm for a limited selection of tubular sections to well over 6mm thickness on various hot formed sections. The steel thickness is important as it affects the hot dip galvanized (HDG) coating thickness formed on batch hot dip galvanized sections which, in turn, directly influences the durability of the structural steel member and therefore the durability of the structural steel member.

Corrosion protection of structural steel members in the BCA

The BCA provides for mandatory corrosion protection of structural steel members in Volume 2 Part 3.4.4.4 where two atmospheric environments (*moderate* and *severe*) are described (Table 1 of this document). In addition, the concept of *breaking surf* is introduced, and a definition of *heavy industrial areas* is provided. The BCA does not provide any mandatory requirements related to micro-environments, except where steel in the roof space is exposed to moist exhaust gases from kitchen or bathroom fans.

A *moderate* environment is defined as being more than 1km from breaking surf or more than 100m from salt water not subject to breaking surf or non-heavy industrial areas.

A *severe* environment is defined as being within 1km of breaking surf or within 100m of salt water not subject to breaking surf or heavy industrial areas.

A *severe* environment is defined as being within 1km of breaking surf or within 100m of salt water not subject to breaking surf or heavy industrial areas.

Breaking surf is defined as any area of salt water where waves break on an average of 4 days per week but does not include white caps or choppy water. This normally occurs in open seas and would usually preclude sheltered locations in the vicinity of Port Philip Bay, Sydney Harbour and near coastal rivers such as Derwent, Swan, and Brisbane Rivers.

Heavy industrial areas are defined as the industrial environments around major industrial complexes. Corrosion of steel from industrial effects is no longer an important factor as heavy industrial areas are relatively few in Australia and are known from surveys to be restricted to the areas nearby to the processing plants at Mt Isa and Port Pirie (see AS 4312 [5] for more information).

Structural steel members in the outer leaf and cavity of an external masonry wall of a building, including walls under open carports are external environments for the purpose of the BCA, while a part of an internal leaf of an external masonry wall which is in the roof space is considered to be in an internal wall. For lintels and other structural steel elements built into masonry, specifiers must use AS 3700, the AS 2699 series, and Part 3.3.5 of the BCA.

Figure 1 A severe environment located within 1km of breaking surf.

Table 1: BCA Volume 2 Table 3.4.4.7 Protective coatings for steelwork

Environment	Location	Minimum protective coating
Moderate *More than 1 km from breaking surf or more than 100 m from salt water not subject to breaking surf or non-heavy industrial areas*	Internal	No protection required in a permanently dry location
	External	Option 1. 2 coats alkyd primer Option 2. 2 coats alkyd gloss Option 3. Hot dip galvanize to 300 g/m^2 min Option 4. Hot dip galvanize to 100 g/m^2 min **plus** - 1 coat solvent based vinyl primer; or 1 coat vinyl gloss or alkyd
Severe *Within 1 km from breaking surf or within 100 m of salt water not subject to breaking surf or heavy industrial areas*	Internal	Option 1. 2 coats alkyd primer Option 2. 2 coats alkyd gloss
	External	Option 1. Inorganic zinc primer plus 2 coats vinyl gloss finishing coats Option 2. Hot dip galvanize to 300 g/m^2 min Option 3. Hot dip galvanize to 100 g/m^2 min **plus** - 2 coats solvent based vinyl primer; or 2 coats vinyl gloss or alkyd

Additional Notes (from the BCA):

1. Where a paint finish is applied to the surface of the steel, work must be hand or power tool cleaned to remove any rust immediately prior to painting.
2. All zinc coatings (including inorganic zinc) require a barrier coat to stop conventional domestic enamels from peeling.
3. Refer to the paint manufacturer where decorative finishes are required on top of the minimum coating specified in the table for the protection of the steel against corrosion.
4. For applications outside the scope of this table, seek specialist advice.

The description of paints (alkyd primer, alkyd gloss, solvent based vinyl primer, vinyl gloss and inorganic zinc primer) in the above table are considered by the GAA to be incomplete and unsatisfactory for a specification. This is because there is no coating thickness requirement, the surface preparation requirement is inadequate and will allow the steel surface to be poorly prepared (while conforming to the instructions in note 1 above), often leading to early corrosion, and not all the paint types are available. Users should request that a performance solution be prepared if the drawings recommend a painted solution for structural steel members.

Hot Dip Galvanizing

Hot dip galvanizing is the process of dipping a structural steel member or fabrication into molten zinc. The process forms a metallurgical bond between the zinc and the steel to create a long lasting and abrasion resistant coating that protects against corrosion in atmospheric conditions. More detail on the process can be found at the GAA's website (www.gaa.com.au).

For all hot formed structural steel members (taper flange beams, universal beams, parallel flange channels, taper flange channels, equal angles, and unequal angles), hot dip galvanizing can only be applied by the batch hot dip galvanizing process governed by Australian Standard AS/NZS 4680 (Table 2). Batch hot dip galvanized tubular sections are also covered by AS/NZS 4680. Although other galvanized coating solutions are marketed in Australia, none of the continuous galvanized coatings applied over SHS or RHS tubular sections meet the coating mass and thickness requirements of the BCA without the addition of a paint topcoat.

Hot dip galvanizing is the process of dipping a structural steel member or fabrication into molten zinc.

Table 2 Hot dip galvanized coating thickness requirements for AS/NZS 4680

Steel thickness (mm)	HDG coating thickness average minimum (μm)	HDG coating mass average minimum (g/m²)
> 6	85	600
> 3 to ≤ 6	70	500
≥ 1.5 to ≤ 3	55	390

Note: The coating thickness is the usual method of checking compliance of a galvanized coating application and can be converted to mass by multiplying by 7.14. The galvanized coating mass is rounded for convenience of description.

The requirements of AS/NZS 4680 are such that even the thinnest batch HDG coating will exceed the requirements of Table 3.4.4.7 of the BCA, and the actual thickness received will provide for a HDG coating service life significantly more than envisaged in the BCA.

As noted above, other types of hot dip galvanized coatings are readily available for tubular sections with most of these tubular sections not meeting the minimum requirements for hot dip galvanized steel in the BCA (300 g/m²). Further, only hot formed sections which are hot dip galvanized to meet the requirements of AS/NZS 4680 will conform to the minimum requirements for corrosion protection shown in the BCA. It is critical that the designer specifies the correct material and the builder orders and receives the correct material to ensure long term durability of the coating.

Environmental conditions for corrosion of steel

Corrosion of steel in housing applications

The corrosion of steel in housing is generally related to the atmospheric corrosivity experienced by steel, known as the *macro-environment*, plus any localised effects, known as the *micro-environment*, such as sheltering of unwashed surfaces in corrosive locations, defects in the corrosion protection from steel fabrication or installation, and design defects.

The macro-environment

The general atmospheric condition in an area is usually the main driver affecting the corrosion rate of steel and this is known as the macro-environment. Australian Standards AS 4312 and AS/NZS 2312.2 [6] provide excellent guidance on the macro-environment in Australia.

For ease of design, the macro-environment is generally broken up into Corrosivity Zones. The zones are generally related to the distance from the coast and the type of coast, where the corrosion rate of steel increases dramatically as the distance to the coast decreases (see Figure 2 and Table 3). The type of coast is important, while the conditions around sheltered bays are usually less corrosive, exposure to surf increases the corrosion rate of steel. Category CX (as described in Table 3) mainly occurs at the shoreline of severe surf conditions and is therefore not generally applicable for domestic housing.

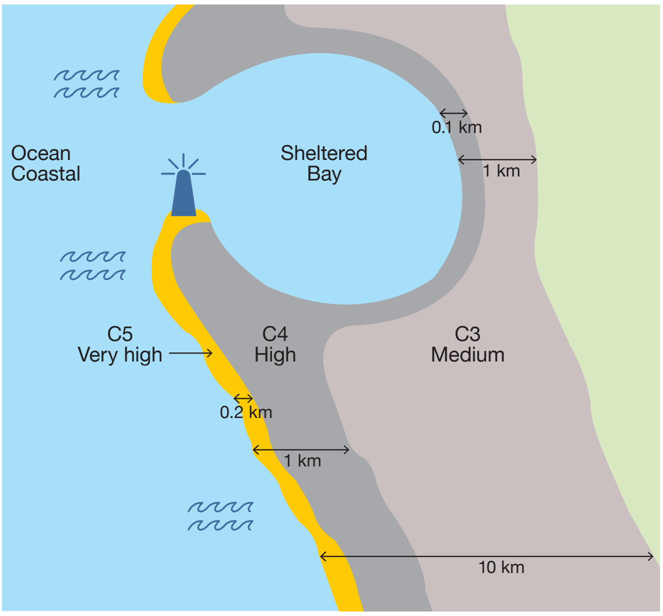

Figure 2 Corrosivity Categories as shown in AS 4312 and AS/NZS 2312.2.

Figure 3 Batch hot dip galvanized structural steel posts in combination with a continuous galvanized sub-floor located in a BCA moderate zone (more than 1km from breaking surf).

Table 3 Corrosivity in Australia as described in AS 4312 and AS/NZS 2312.2

Category		Generic examples	Specific examples
CX	Severe surf shoreline	Surf beach shoreline regions with very high salt deposition.	Some Newcastle beaches
C5	Surf Seashore	Within 200 m of rough seas & surf beaches. May be extended inland by prevailing winds & local conditions.	More than 500 m from the coast in some areas of Newcastle
C4	Calm Seashore	From 200 m to 1 km inland in areas with rough seas & surf. May be extended inland by prevailing winds & local conditions.	All coasts
		From the shoreline to 50 m inland around sheltered bays. In the immediate vicinity of calm salt water such as harbour foreshores.	
C3	Coastal	From 1 km to 10 km inland along ocean front areas with breaking surf & significant salt spray. May be extended inland to 50 km by prevailing winds & local conditions.	Metro areas of Perth, Wollongong, Sydney, Brisbane, Newcastle, & the Gold Coast
		From 100 m to 3 – 6 km inland for a less sheltered bay or gulf.	Adelaide & environs
		From 50 m to 1 km inland around sheltered bays.	Port Philip Bay & in urban & industrial areas with low pollution levels
C2	Arid/Urban Inland	Most areas of Australia at least 50 km from the coast.	Canberra, Ballarat, Toowoomba & Alice Springs
		Inland 3 – 6 km for a less sheltered bay or gulf.	Adelaide & environs
		Can extend to within 1 km from quiet, sheltered seas.	Suburbs of Brisbane, Melbourne, Hobart
C1	Dry indoors	Inside heated or air-conditioned buildings with clean atmospheres.	Commercial buildings

Table 4 Comparison of distance from salt water for BCA and AS 4312

BCA Table 3.4.4.7 (External Locations)			AS 4312		
Environment	Specified distance from salt water		Corrosivity category	Typical distance from salt water	
	Surf coast	Sheltered coast		Surf coast	Sheltered coast
Moderate	>1km	>100m	C2	>50km	>10km
			C3	10km to 50km	1km to 10km
				1km to 10km	50m to 1km
Severe	≤1km	≤100m	C4	200m to 1km	<50m
			C5	<200m	N/A

Combining the information from Table 1 (BCA) and Table 3 (AS 4312 and AS/NZS 2312.2), and assuming a conservative position for the change of C4 to C3 at 200m for sheltered coasts, designers can refine the BCA definitions into Moderate C2, Moderate C3, Severe C4 and Severe C5 (Table 4).

The distance of C2 and C3 zones from the coast do vary around Australia, and this can influence the best solution for corrosion protection. More importantly, the severe zone defined in the BCA covers a very wide range of corrosion rates for steel and galvanized coatings, directly influencing the durability of the solution. The GAA recommends that designers take the time to understand the distance of the house or structure from corrosive influences before deciding on the coating solution. This is discussed further in the next section.

Corrosion rate of steel and HDG coatings in the macro-environment

The rate of corrosion for uncoated structural steel members and HDG coatings is provided by AS 4312 and AS/NZS 2312.2 (Table 5). The corrosion rate can be compared to standard HDG coating thicknesses to determine the estimated service life of the HDG coating. Using this information and the options available in Table 3.4.4.7 of the BCA, the estimated service life of each option can be determined.

The distance of C2 and C3 zones from the coast do vary around Australia, and this can influence the best solution for corrosion protection.

Table 5 Rate of corrosion of structural steel and HDG coatings

Corrosivity category, description & typical environment			Structural steel members	HDG coatings
(AS 4312 & AS/NZS 2312.2)			Typical corrosion rate for the first year (μm/y)	
C1	Very low	Dry indoors	≤1.3	≤0.1
C2	Low	Arid/Urban inland	>1.3 to ≤25	>0.1 to ≤0.7
C3	Medium	Coastal	>25 to ≤50	>0.7 to ≤2.1
C4	High	Calm seashore	>50 to ≤80	>2.1 to ≤4.2
C5	Very High	Surf seashore	>80 to ≤200	>4.2 to ≤8.4
CX	Extreme	Ocean/Offshore	>200 to ≤700	>8.4 to ≤25

The corrosion rates shown in each Corrosivity Category of Table 5 are provided as a range where, for normal Australian washed atmospheric exposures, the distance from the coast is the driving force.

Table 6 shows the same information in the form of life to first maintenance of the galvanized coating and also shows the BCA minimum galvanized coating requirement as a comparison. For galvanized coatings this should be considered the time at which major maintenance of the item is required to reinstate corrosion protection to the steel.

Table 6 Expected range of life to first maintenance of HDG coatings in the macro-environment for commonly available corrosion protection methods according to AS/NZS 2312.2

Product and type		Steel thickness	HDG coating mass & thickness		Corrosivity category & calculated life of galvanized coating (min-max, years)			
		mm	g/m²	µm	C2	C3	C4	C5
BCA Table 3.4.4.7	HDG 300 g/m²	All	300	42	60->100	20-60	10-20	5-10
AS/NZS 4680	HDG390	>1.5-≤3.0	390	55	78->100	26-78	13-26	6-13
	HDG500	>3.0-≤6.0	500	70	>100	33-100	16-33	8-16
	HDG600	>6.0	600	85	>100	40->100	20-40	10-20
AS/NZS 4792[1]	ZB100/100	All	100	14	20->100	6-20	3-6	1-3
	ZB135/135	All	135	19	27->100	9-27	4-9	2-4
AS 4750[2]	ZE50	All	50	7	10-70	3-10	1-3	0-1

Notes:

1. AS/NZS 4792 [7] galvanized coatings are only available for cold formed tubular sections and use pre-galvanized strip which is then formed into a welded tube. The welded area is repaired by the tube manufacturer to restore corrosion protection to the AS/NZS 4792 Standard. Any subsequent fabrication will also require repair to this Standard.
2. AS 4750 [8] ZE50 is the Australian Standard for electrogalvanized tubular sections commonly available in Australia. While the coating mass (50 g/m²) does not meet the minimum requirements of the BCA for hot dip galvanizing before paint topcoats are applied, the life of the electrogalvanized coating according to AS/NZS 2312.2 is included here for information. Electrogalvanized coatings are also not strictly hot dip galvanized as the coating is mechanically bonded to the underlying steel and does not form the hard, abrasion resistant zinc-iron alloy layers formed by other galvanized methods. These coatings would generally be only suitable for internal applications or with an engineered performance solution with additional paint coatings.

Using the data in Table 6, products conforming to the BCA could provide as little as 5 years galvanized coating life (HDG 300 g/m²) in a severe (C5) environment, and over 100 years for the same product in a moderate (C2) environment. While complete consumption of the galvanized coating after 5 years does not mean the structural failure of the steel member, it would almost certainly attract the ire of most homeowners, purely on appearance. A simple extrapolation of the corrosion rates for steel indicates the structural steel member, once fully exposed in the top end C5 environment, loses 1mm of section on each exposed face every 5 years, and this certainly provides a risk of structural failure. The two questions that then need answering are:

1. What is an acceptable life for the coating and the structural member?
2. What maintenance to the galvanized coating can be reasonably expected by a homeowner?

To answer these questions, we need to understand the accessibility of the member for maintenance, the difficulty in providing the required maintenance and/or the cost of simply replacing the member.

Examples of structural steel members which are generally **not accessible or economical** to replace are floor piers/stumps embedded in concrete and load bearing steel members within the building envelope. These structural members should reasonably be expected to last 50 years, or the life of a normal building, with minor maintenance of the accessible areas.

Examples of structural steel members which have **moderate ease of access** but are difficult or costly to repair include floor piers/stumps which are bolted to a base plate or attached to, but not embedded in, a concrete footing. These structural members should reasonably be expected to last 15 years with minor maintenance including regular maintenance of the coating. A house on tall piers will be easier to maintain than one where the piers are close to the ground and a degree of common sense is required.

Examples of structural steel which is **readily accessible and economical** to maintain or replace include verandah posts. However, if the verandah post is embedded into a tiled verandah (Figure 4), corrosion may occur due to a micro-environment out of sight of the homeowner and failure could occur relatively early in the expected structural life.

Figure 4 A verandah post embedded into a tiled floor in a wet area. Water has seeped into the gap between the tile and the steel through capillary action, leading to accelerated corrosion and early failure. This is a design defect where separation of the water from the steel was not considered.

Figure 5 The galvanized structural steel members (verandah posts and edge members) have good access and would be expected to provide structural support with regular maintenance of the galvanized coating for 50 years in moderate locations, while regular maintenance, plus repairs to the galvanized coating would be expected during the life of the building in severe environments.

The micro-environment

Buildings are known to offer a shielding effect when the steel is fully enclosed, and the corrosion rate of steel when it is fully enclosed (for example, in the dry roof space of a house) is very low, even in the harshest of external environments.

If the steel is not fully enclosed in the building and is exposed to wind-driven salt in an area which is not exposed to cleansing rain (for example a beam under a verandah or an edge column of a subfloor), the corrosivity of the micro-environment can be significantly higher than the overall, or macro-environment. This aspect is critical for estimating the design life of structural steel. The BCA instructs designers to consider structural steel members in the outer leaf and cavity of an external masonry wall of a building, including walls under open carports as external environments, while a part of an internal leaf of an external masonry wall which is in the roof space can be considered to be in an internal wall. This means that the tops of verandah posts should be generally considered external, as should any structural members in the open roof space of an open carport.

Design of the ground/steel interface is also critical as ponding of moisture can significantly accelerate the corrosion of the coating and the structural steel. This effect is known as *ring barking* or *collar corrosion* and is common where water or moisture can pond at the base and in areas where water can seep into gaps around the steel post and soil, concrete, paved, or tiled joints.

Defects in the corrosion protection can also lead to accelerated corrosion. For example, this can occur when hot dip galvanized steel has been welded and not properly repaired, or when a painted steel member has had the paint coating damaged on installation or during use, or when the paint used was not appropriately specified and applied.

Figure 6 The top floor of this house overlooking the ocean is enclosed, while the underside of the balcony is open providing for different micro-environments in the same house. In addition, the plants may offer sheltering from rain but not wind-blown salt, leading to a complex corrosion design.

Figure 7 This large post bolted to a concrete pad will finish below the ground level and will be at risk of collar corrosion reducing the durability of the structure.

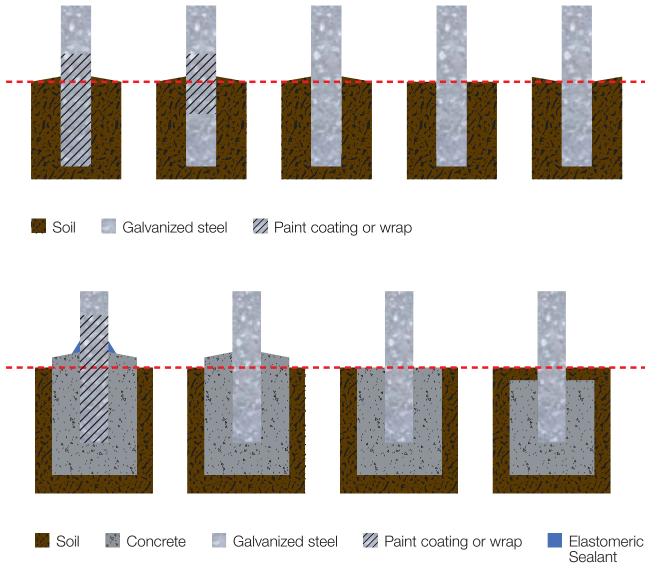

Figure 8 Showing the best design (left) to worst design (right) for galvanized steel embedded in soil and concrete. See also Figure 11 for more details on the best design practice for posts embedded in concrete in a corrosive location.

Increasing durability at the Soil/Concrete/Galvanized steel interface

The galvanized steel to concrete and galvanized steel to soil interface is a common site of accelerated corrosion in external environments, especially when the corrosivity of the local micro-environment is C3 or higher. This failure is known as ring barking or collar corrosion. Numerous steps can be taken to help a galvanized steel member embedded in concrete and soil reach the desired service life. Some or all the following measures may be required depending on the corrosivity of atmospheric environment and potential issues identified during the design process.

Embedded structural steel members

If water can pool at the interface between the galvanized steel and concrete or soil, a localised corrosion cell forms which results in higher-than-expected corrosion rates. Ponding can be minimised by building up concrete or soil around the interface to promote a natural water run-off, and by preventing water from running down the member to the interface. If ponding cannot be avoided through a design change, additional barrier protection is recommended at the interface. Figure 8 shows examples of the range from best to worst protection of the galvanized coating in soil and concrete.

Additional barrier protection

Hot dip galvanized structural steel members are embedded in concrete footings to extend life and provide a higher tolerance to the overturning moment. For this design to be effective the concrete/steel/air interfaces must be designed and built correctly. This includes extending the concrete below the bottom of the pier, according to the engineer's specification, ensuring the concrete extends above the natural ground level and slopes away from the steel by at least 10° to prevent ponding, and adding additional barrier protection when the exposed atmospheric corrosivity category is C3 or above (Figure 10 and Figure 11). This method is especially useful when long-term corrosion protection is required in a corrosive atmosphere and for housing posts, piers or stumps which are at the perimeter of a sub-floor.

Concrete, bricks, and mortar are susceptible to corrosion in acid sulfate soils and will not provide significant protection in these circumstances unless the concrete is designed for these soils. The best solution is to modify the fill and/or increase the cover if concrete use is required (see also GAA Advisory Note AN 42 [9]). If the concrete footing finishes below the finished ground level, then the protection of the galvanized steel to soil interface with a barrier coating is always recommended to increase the durability of the steel structure.

Figure 9 A galvanized post without additional protection at the steel and concrete interface showing accelerated corrosion which has reduced the overall durability of the structure. Note the galvanized coating above the ground remains in excellent condition.

Figure 10 Denso Ultraseal tape wrapped around the base of a newly embedded post.

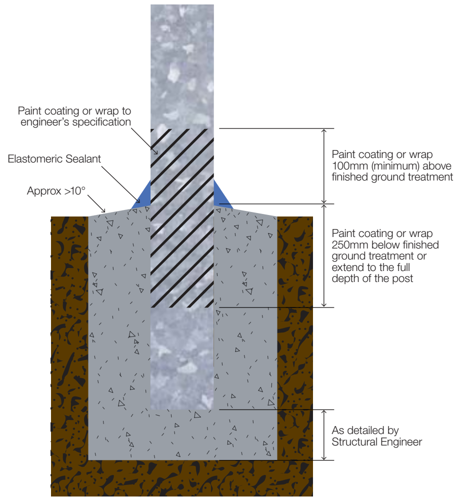

Figure 11 Recommended design for protection of steel to concrete interfaces for long-term durability.

There are several options for protecting the galvanized steel with an additional barrier at the galvanized steel and concrete or soil interface. The normal methods are by using a suitably thick paint or tape wrapping, such as Denso "Ultraseal" cold applied bituminous tape [10] (Figure 10). Tapes and paint allow the concrete base to end at or below the interface to the atmosphere, but it will be necessary to consider the corrosivity of the soil in these designs. The barriers are also more susceptible to accidental damage in use. For this application, while probably more expensive than a paint coating, the Denso Ultraseal is easier to apply in the field than other tapes, faster to apply than paint coatings with little to no curing time and has the additional benefit of being able to be selectively overcoated where required.

As noted above, there are several suitable alternative solutions for barrier coatings and the best solution will vary depending on the exposure environment, aesthetic requirements, and availability of materials. If the micro-environment is C3 or higher, including an aggressive internal location, the GAA recommend embedding the steel in concrete and:

1. Apply to at least 100mm above the finished height of the concrete or soil and at least 250mm below the concrete:
    a. a non-conductive abrasion resistant high build epoxy paint layer at approximately 350μm dry film thickness (DFT) without zinc or aluminium pigment (AS/NZS 3750.14 [11]), or
    b. Denso Ultraseal tape wrapped around the structural steel section
2. Slope the concrete surface away from the steelwork to facilitate drainage of water away from the steel to concrete interface
3. Once the concrete has cured apply an elastomeric sealant around the interface of the concrete to seal any existing shrinkage cracks

Installing posts on elevated concrete pads

An alternative to embedding structural steel into concrete footings is to bolt the steel to concrete pads. This means that there is no chance of collar corrosion but does introduce other corrosion design issues that need to be resolved.

The underside the base plate needs to be protected to ensure water is not drawn into the inevitable gap between the galvanized steel base plate and concrete pad. This can be done using a suitably thick epoxy paint coat on the underside of the base plate or a plastic spacer.

A base plate will be either welded or bolted to the upright steel section. In the welded case this should be done before galvanizing to ensure the best protection of the welded area, or the welded areas will need repair with a suitable zinc-rich paint. Almost certainly a post-galvanized welded area will require more regular maintenance, so this should not be done unless access to the repaired area is easy or the welded area is in a very low corrosion area (that is, internal to the building). For bolted connections, all swarf from drilled holes needs to be removed to avoid unsightly rust spots and any cut structural steel will also need to have bare steel repaired to avoid edge corrosion. For tubular sections exposed to rainwater it may also be necessary to seal the joint at the top and between the base plate and the tube with an elastomeric sealant to stop water entry.

Figure 12 A galvanized steel subfloor (with inbuilt ant caps) where the hot dip galvanized posts bolted down onto elevated concrete pads.

HDG Steel in contact with timber

In structural applications in atmospheric or embedded conditions, galvanized steel may be required to be isolated from timber through suitable paints, wraps or other isolating barriers to increase the durability. A common application here is as I-beam or channel retaining wall posts with timber sleepers, where the timber facing elements are painted with an isolating paint.

The Engineered Wood Products Association of Australia [12] says timber products treated with cured copper-based preservatives (ACQ, CCA, CuAz) are suitable for use with galvanized steel where the building is protected by a eve overhang of minimum 600mm, average rainfall does not exceed 1000mm (e.g. Melbourne, Adelaide & Perth but not Sydney or Brisbane) and the building or structure is designed and built to exclude 'moisture traps' both during erection and in subsequent use.

Boron treated timber is suitable for indoor applications only and galvanized steel of all types is well suited for use in this application.

LOSP treated products are excellent for use with galvanized steel, although exposure of products to coastal areas will reduce durability of the structure and is not recommended.

HDG steel is not recommended for use to support decks in the wet zones around saltwater pools due to the high risk of salt saturated wet timber resulting in accelerated corrosion of the galvanized coating and structural steel.

HDG steel is not recommended for use to support decks in the wet zones around saltwater pools due to the high risk of salt saturated wet timber resulting in accelerated corrosion of the galvanized coating and structural steel.

Figure 13 An example of galvanized steel posts being used in combination with a traditional timber frame and subfloor.

Summary

The BCA sets outs the minimum requirements for corrosion protection using protective coatings for structural steel members. Hot dip galvanized coatings of 300 g/m^2 are identified as the minimum requirements for an unpainted structural steel member in external moderate and severe environments.

Only hot dip galvanized coatings meeting the requirements of AS/NZS 4680 can meet the requirements of the BCA without the addition of paint topcoats. Maintenance of the galvanized coating will be required in some environments to maintain structural performance.

A moderate environment covers both C2 and C3 Corrosivity Categories, while the severe environment includes the C4 and C5 Corrosivity Categories. Additional protection will be required for housing located in the C5 Corrosivity Category (that is severe environments within 200m of surf) and may also be required when accessibility for maintenance is impossible or difficult and the local environment is also severe.

For house piers and other structural steel embedded in the ground, additional barrier protection of the galvanized coating is required at the concrete interface, extending 100mm above and 250mm below the concrete surface. In addition, the bottom of the pier should be fully encased in concrete according to the engineer's specification, and the top of the concrete sloped to prevent ponding.

References

1. **Australian Building Codes Board.** *NCC 2019 Building Code of Australia.* Amendment 1. Canberra : (C) Commonwealth of Australia and the States and Territories 2020 Published by the Australian Building Codes Board, 2019. Vol. 2.
2. **Standards Australia & New Zealand Standards**. *Hot dip galvanized (zinc) coatings on fabricated ferrous articles.* Sydney & Wellington : Standards Australia & New Zealand Standards, 2006. AS/NZS 4680.
3. **Standards Australia**. *Masonry Structures.* Sydney : Standards Australia, 2018. AS 3700.
4. —. *Built-in components for masonry construction (3 parts).* Sydney : Standards Australia, 2020. AS 2699.
5. —. *Atmospheric corrosivity zones in Australia.* Sydney : Standards Australia, 2019. AS 4312.
6. **Standards Australia & New Zealand Standards**. *Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings, Part 2: Hot dip galvanizing.* Sydney & Wellington : Standards Australia & New Zealand Standards, 2014. AS/NZS 2312.2.
7. **Standards Australia and Standards New Zealand**. *Hot-dip galvanized (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialized process.* Sydney & Wellington : Standards Australia and Standards New Zealand, 2006. AS/NZS 4792.

8. **Standards, Australian**. *Electrogalvanized (zinc) coatings on ferrous hollow and open sections*. Sydney : Standards Australia, 2003. AS 4750.
9. **Galvanizers Association of Australia**. Technical Publications (Advisory Notes). *Galvanizers Association of Australia*. [Online] [Cited: 21 January 2021.] https://gaa.com.au/technical-publications/. AN 42.1 Hot dip galvanized steel embedded in soil.
10. **Denso**. Denso Ultraseal Tape. [Online] [Cited: 21 January 2021.] http://densoaustralia.com.au/pdfs/DensoBitumenButylTapes/Denso-Ultraseal-Tape.pdf.
11. **Standards Australia and Standards New Zealand**. *Paints for steel structures High-build epoxy (two-pack)*. Sydney & Wellington : Standards Australia and Standards New Zealand, 1997 (R 2013). AS/NZS 3750.14.
12. **Engineered Wood Products Association of Australia**. Suitable Fasteners, Metal Flashings, Studs and Joists for use in Conjunction with EWPAA Branded Preservative Treated Cladding, T&G Flooring and Structural Plywood. [Online] [Cited: 15 February 2015.] https://ewp.asn.au/technical-resources.

"House in Hamilton" by Phorm Architecture + Design (Australia) and Tato Architects (Japan) using 100% Australian-made steel. This project was an entrant into the Queensland 2016 ASI Steel Excellence Awards and received a Commendation in the 2016 National Architecture Awards: Residential Architecture – Houses (New) category. Image by Christopher Frederick Jones.

Other images by Galvanizers Association of Australia and/or its members and courtesy Uni-Pier Australia Pty Ltd.

GALVANIZE MAGAZINE

galvanize is a free magazine produced by the Galvanizers Association of Australia and features projects from Australia and around our region. To have your project featured simply email us some details at gaa@gaa.com.au.

You can also view the current issue and back copies at the Case Studies tab on our website **www.gaa.com.au**.

To request your own free subscription or to update an existing subscription simply email us at **gaa@gaa.com.au.**


ZINC
Associate of International Zinc Association
82
galvanize
February 2020
Asia Pacific Edition
HOT DIP GALVANIZED STEEL

INNOVATIVE USE OF DUPLEX COATED GALVANIZED STEEL WINS 2019 SOREL AWARD

In this issue
1 Innovative Use of Duplex Coated Galvanized Steel Wins 2019 Sorel Award
3 North Western Program Alliance: Frankston Train Station Upgrade
5 The Level Crossing Removal Project (Carnegie, Clayton, Hughesdale, Murrumbeena and Noble Park)
8 CDC Data Centre
10 Civmec Main Assembly Hall

Welcome to the latest edition of Galvanize! This edition profiles the 2019 Sorel Award winners, with detailed case studies illustrating the skill and expertise clearly present in each of the award-winning projects.

SOREL AWARD
WINNER 2019
galvanizers ASSOCIATION OF AUSTRALIA

The Sorel Award is designed to highlight the high standards of design, fabrication, construction and corrosion protection achieved when hot dip galvanizing features as a key component of a project. In 2019, there were four entries into the Sorel Awards, all of which were evaluated by our expert judges, Arun Syam (InfraBuild) and Peter Dove (GHD).

According to Syam and Dove, "All projects showed innovation in handling and service, while several projects delivered outstanding market development potential."

Entered by **Geelong Galvanizing**, the **North Western Program Alliance – Frankston Train Station Upgrade** in Melbourne won the 2019 Sorel Award.

As a major hub linking the Mornington Peninsula to the city of Melbourne, Frankston Train Station was upgraded as part of the Victorian Government's $6.9 billion Level Crossing Removal Project. This project is highly innovative, demonstrating the use of an array of duplex coated galvanized steel to deliver one of the most durable and visually striking structures in Frankston.

Prepared by
Galvanizers Association of Australia
Peter Golding
Sally Wood, wordly.com.au

To read other Galvanize stories
Go to our website **www.gaa.com.au**

Continued on page 2

galvanizers ASSOCIATION OF AUSTRALIA

galvanizers
ASSOCIATION OF AUSTRALIA
ABN 60 004 579 828

We provide information, publications and assistance on all aspects of design, performance and applications of hot dip galvanizing.
124 Exhibition Street Melbourne Victoria 3000 Telephone **03 9654 1266**
Email **gaa@gaa.com.au** Website **www.gaa.com.au**