Hot Dip Galvanizing: Manufactured to last

An introduction to Standard AS/NZS 2312.2

Australian/New Zealand Hot Dip Galvanizing Standards

Design & Durability
AS/NZS 2312.2
Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings – Part 2: Hot dip galvanizing.

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Background

AS/NZS 2312, *Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings*, originated in 1967 as a guide for steel designers who needed advice on methods for the corrosion protection of structural steel.

It was recognised during the last review process that steel designers would benefit by separating the Standard into coating specific sections to avoid confusion. In particular, the relatively simple specification process for hot dip galvanizing (HDG) was often lost in the more complex process of specifying paint systems in the 2002 edition.

The revised Standard was released in 2014; with Part 1 covering paint systems and Part 2 covering hot dip galvanizing. Part 1 (Paint Systems) was further amended to fix minor errors in 2017 while Part 3 covering metal spray coatings was released in 2025. All parts use the same definitions from AS 4312 for atmospheric corrosivity categories in Australia and TS NZS 3404 in New Zealand which are based on the recognised international Standard, ISO 9223, but each part clearly recognises that the design process and durability of galvanized steel, painted steel and metal sprayed steel are very different.

Designers wishing to specify HDG need only reference two Standards: one covering the design and durability of HDG steel (AS/NZS 2312.2), and the other dealing with the manufacturing process and tolerances (AS/NZS 4680).

This document introduces the key features of the hot dip galvanizing component of the Standard.

Durability selection

AS/NZS 2312.2 references international corrosivity and design Standards for HDG. This means that the design life ("life to first maintenance") of the coating is aligned with long term performance results from Australia, New Zealand and world recognised Standards. The estimated design life for HDG coatings on structural steel in normal atmospheric exposures is shown in Table 1 for normal steels and Table 2 for ultra low reactive steels. Note that it is also possible to use the steady-state corrosion rates for zinc from ISO 9224, as discussed in AS/NZS 4680 and the GAA/GANZ Durability Guide.

Figure 1: With a specified minimum HDG coating thickness of 85 µm, AS/NZS 2312.2 can be used to estimate this bridge rail will be protected from rust for over 50 years in a C3 (medium) environment.

Table 1 Life to first maintenance of hot dip galvanized steel complying to AS/NZS 4680 (normal steels)

AS/NZS 4680 (normal steels)				AS/NZS 2312.2				
Steel thickness	Coating mass and thickness			Corrosivity category and zinc corrosion rates (µm/y)[a] & Life to first maintenance (years)				
mm	g/m²	µm	Designation	CX 8.4 – ≤ 25	C5 4.2 – ≤ 8.4	C4 2.1 – ≤ 4.2	C3 0.7 – ≤ 2.1	C2 0.1 – ≤ 0.7
> 6.0	600	85	HDG600	3-10	10-20	20-40	40->100	>100
> 3.0 to ≤ 6.0	500	70	HDG500	2-8	8-16	16-33	33-100	>100
≥ 1.5 to ≤ 3.0	390	55	HDG390	2-6	6-13	13-26	26-78	78->100
< 1.5	320	45	HDG320	1-5	5-10	10-21	21-64	64->100
>> 6.0[b]	900[b]	125[b]	HDG900[b]	5-15	15-30	30-60	60->100	>100

Notes:

a. Corrosivity categories and first year zinc corrosion rates are defined in AS 4312, NZS TS 3404, and AS/NZS 2312 Part 2. See Table 3 (Aust), Table 4 (NZ), and Figure 2 for more information. ISO 9224 provides steady-state corrosion rates that provide significantly increased durability estimates where the steady-state corrosion rates dominate the local corrosion rates. See also the GAA/GANZ Guide to the Durability of Hot Dip Galvanizing.

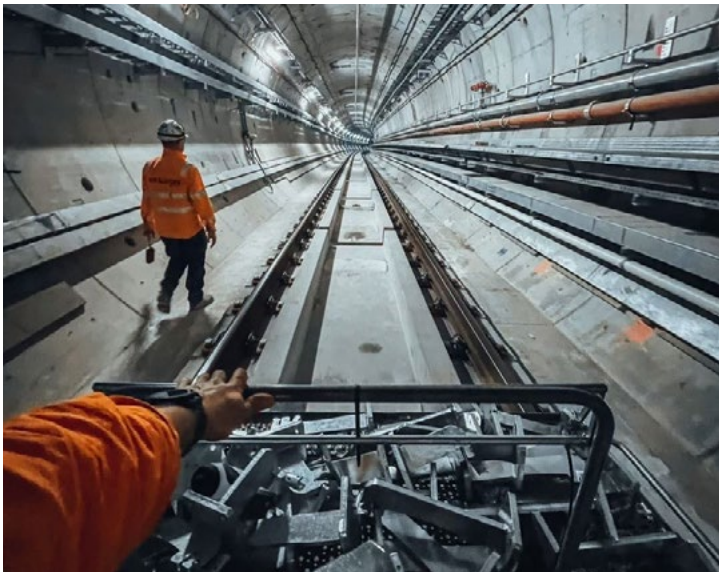
b. This designation for hot dip galvanized coatings thicker than 85 µm is not detailed in AS/NZS 4680, however by agreement with the galvanizer and where the steel has suitable chemical properties and appropriate thickness, a specification may be written for thicker coatings. By way of example, hot rolled sections above 10 mm in thickness are often suitable. See GAA/GANZ Advisory Note AN 02 for more information.

Table 2 Life to first maintenance of hot dip galvanized steel complying to AS/NZS 4680 (ultra-low reactive steels)

AS/NZS 4680 (ultra-low reactive steels)				AS/NZS 2312.2				
Steel thickness	Coating mass and thickness			Corrosivity category and zinc corrosion rates (µm/y) & Life to first maintenance (years)				
mm	g/m²	µm	Designation	CX 8.4 – ≤ 25	C5 4.2 – ≤ 8.4	C4 2.1 – ≤ 4.2	C3 0.7 – ≤ 2.1	C2 0.1 – ≤ 0.7
> 6.0	500	70	HDG500	2-8	8-16	16-33	33-100	>100
> 3.0 to ≤ 6.0	390	55	HDG390	2-6	6-13	13-26	26-78	78->100
≥ 1.5 to ≤ 3.0	320	45	HDG320	1-5	5-10	10-21	21-64	64->100

Note:

Ultra-low reactive steels are those that exhibit low reactivity with zinc (see Category ULR in Table 5). In most cases the durability reduction due to the naturally thinner coating is not significant. Options to obtain a thicker coating via blasting or duplex coating are discussed in AS/NZS 4680 and GAA/GANZ Advisory Note AN 02.



A table is provided in AS/NZS 2312.2 for designers to compare the expected durability of a wide range of readily available galvanized products, including continuously galvanized steel, allowing for simple product selection.

The durability of a HDG coating is calculated from the minimum average coating thickness in AS/NZS 4680, although non-standard HDG thicknesses can be easily assessed for estimated life to first maintenance. This can be done by using Figure 2, where the macro-environment corrosivity zone can be determined from Table 3 (Australia) or Table 4 (New Zealand) or from the simplified schematic in Figure 3. An on-line estimator for Standard coating thicknesses is available to assist in initial durability investigations in Australia, while the maps included in TS NZS 3404 provide similar assistance in New Zealand. The *Design Manual* and *Guide to the Durability of Hot Dip Galvanized Steel* available from the GAA and GANZ websites provide more information on durability in the atmosphere and other locations.

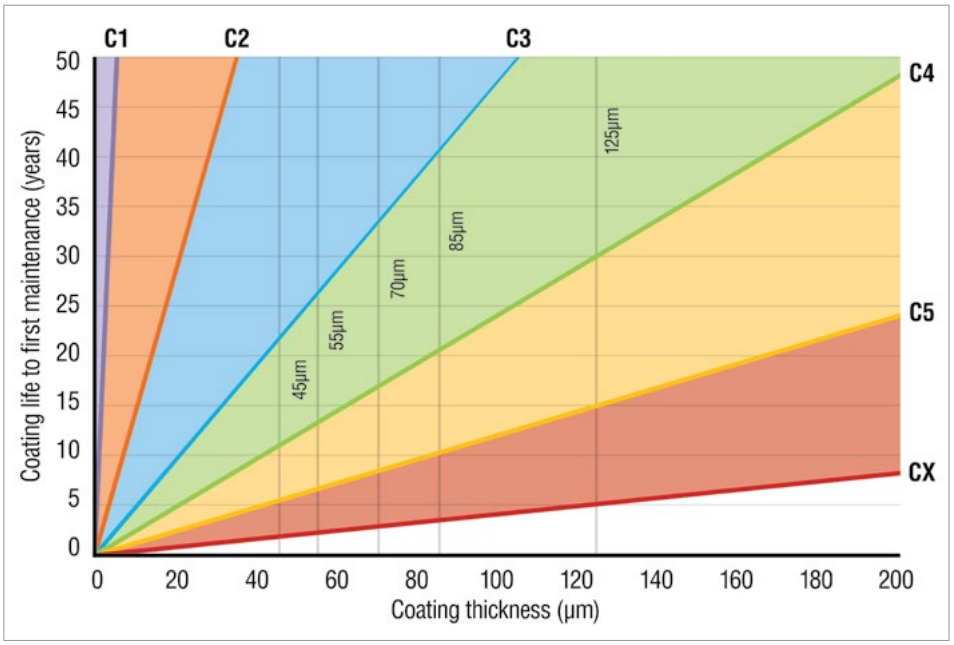


Figure 2: Calculated corrosivity rates for hot dip galvanizing from AS/NZS 2312.2 are restated in a graphical format for quick estimates. For example, a coating thickness of 85 µm can be estimated to last a minimum of 20 years to a maximum of 40 years in a C4 environment.

Table 3: Corrosivity in Australia as described in AS 4312

Category	Typical 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 Corrosivity in New Zealand as described in TS NZS 3404

Category	Typical examples	Specific examples
CX	Surf beach shoreline regions with very high salt deposition. Within 500m of some geothermal zones (testing required).	Some geothermal zones
C5	Within 200 m of breaking surf on the west and south coasts of the South Island. Within 100 m of breaking surf on west and south coasts of the North Island. Within 50 m of breaking surf on all other coasts. May be extended inland by prevailing winds & local conditions.	All coasts
C4	Within 500m inland of breaking surf. Within 50 m of calm salt water such as harbour foreshores. May be extended inland by prevailing winds & local conditions.	All coasts
C3	Within 20 km of breaking surf.	West and south coasts of South Island
	Within 5 km of salt water.	East coast of both islands, west and south coasts of North Island, and all harbours
C2	More than 20 km to 50 km from salt water.	West and south coasts of South Island
	More than 5 km to 50 km from salt water.	East coast of both islands, west and south coasts of North Island, and all harbours
C1	Inside heated or air-conditioned buildings with clean atmospheres.	Commercial buildings

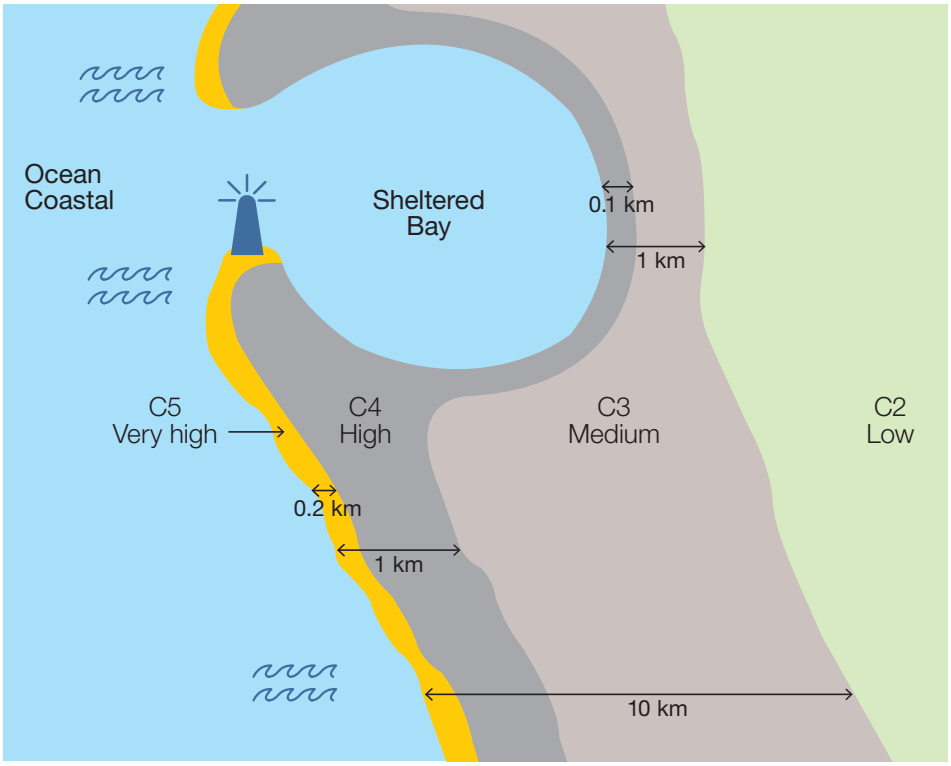


Figure 3: Simplified schematic showing the most common corrosivity zones in Australia and the typical distance from the coast where they extend in temperate regions.

Design Advice

AS/NZS 2312.2 includes design advice on how the chemistry of some steels can be used to develop thicker coatings or when more durability is required than standard. In addition, when initial aesthetic appearance is important, the advice in Table 5 can be used to provide information on the typical characteristics of a hot dip galvanized coating formed on different steels.

The GAA and GANZ websites contain detailed information on this aspect, and both AN 02 *Thicker Coatings for Specialised Applications* and AN 35 *Steel Composition* Advisory Notes are recommended reading.

Table 5 Typical coating characteristics related to steel composition

Cat.	Typical Si and P	Typical initial appearance	Initial thickness	Resistance to mech. damage
ULR	Si ≤ 0.01%	Shiny	To Table 4 of AS/NZS 4680	Excellent
A	0.01% < Si ≤ 0.04% and P < 0.02%		To Table 3 of AS/NZS 4680	
B	0.14% < Si ≤ 0.25%	Shiny, tending to mottled or grey as the thickness of the steel increases, Si content increases or both increase	Above Table 3 of AS/NZS 4680 and increases further if P > 0.035 %	Excellent
C	0.04% < Si ≤ 0.14%	Darker with coarser texture	Extra thick	Reduced
D	Si > 0.25%		Thick. Increases with increasing silicon content	

Notes:

1. This table should be used as a **guide for design and not for absolute decisions**, as the Si and P content and coating characteristics described in this table are influenced by various fabrication factors including weld heat, thermal cutting, rolling and forming. The boundaries of each range can be expected to vary under these influences.
2. Hot rolled steels with Si + 2.5P ≤ 0.09 % and cold rolled steels with Si + 2.5P ≤ 0.04% will also usually meet the characteristics of Categories ULR and A, while steels with aluminium > 0.035% are sometimes reported to also influence the coating thickness achieved.
3. The design of the article to be galvanized will also influence the coating characteristics.
4. The presence of alloying elements (e.g. nickel or aluminium) in the zinc melt can have a significant effect on the coating characteristics.

Painting over hot dip galvanizing (duplex coating)

A duplex system (paint over HDG) will increase the service life of the HDG article beyond that of the unpainted article and the total life of a properly specified, applied, and maintained duplex coating system is significantly greater than the sum of the lives of the HDG coating and the paint coating alone (by 1.5 to 2.3 times, depending on the environment).

A detailed section on the design of duplex coatings is included in AS/NZS 2312.2 with seven standard decorative and industrial paint systems providing suitable protection for most corrosivity environments. GAA and GANZ have published a guide to designing duplex systems and an accompanying paint products guide covers the readily available paint systems from every major paint supplier in Australia and New Zealand. Both documents are available from the GAA and GANZ websites.

Information on powder coating hot dip galvanized steel is available in AS 4506.

Figure 4: The Moment by Damian Vick, showing the four key stages of fabrication, galvanizing, painting, and the final structure in place. This aesthetic sculpture is an example of a complex shape with sharp edges and is therefore perfectly suited to a duplex coating.

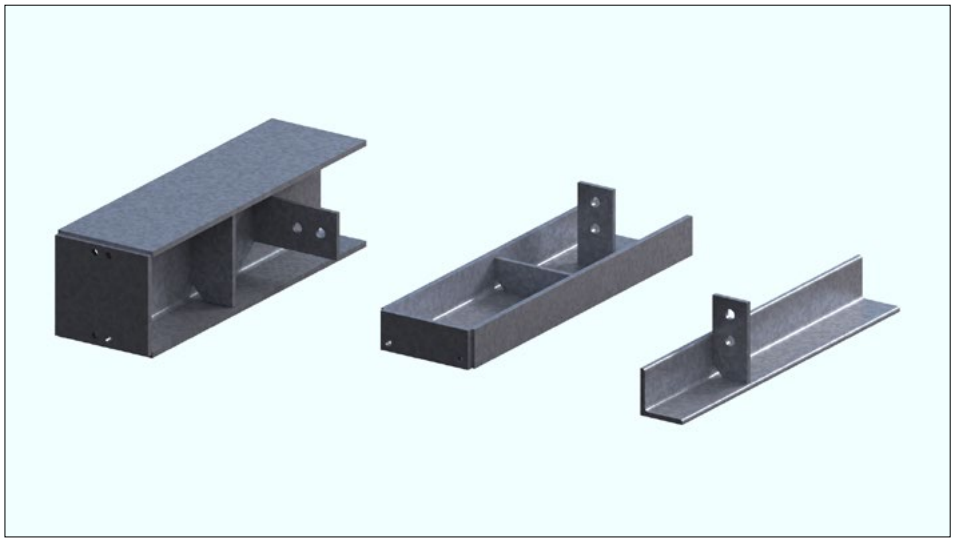


Figure 5: Illustrations in Appendix A of AS/NZS 2312.2 allow the designer to improve zinc flow in the process, which will improve the aesthetics of the finished product, reduce the cost & eliminate danger to the galvanizing plant operators.

Engineering and fabrication design details

For engineers and fabricators, the design details in AS/NZS 2312.2 are extensive. The best practice design advice that is available in the Standard provides clear guidelines to follow, such as the examples shown in Figure 5. The effect the fabricated article's condition has on the HDG process, for example the size of the article, laser cutting and other thermal processes, as well as required tolerances, are clearly described. A comprehensive free design guide is available from the GAA and GANZ websites, along with Design Notes with interactive 3D models. There is also a large poster available from all GAA and GANZ members which is suitable for fabrication workshops.

Appendices to the Standard also cover corrosion in different environments, including bimetallic corrosion and the interaction of HDG steel with soil, concrete, water, chemicals, and wood.

National Construction Code (Australia only)

AS/NZS 2312.2 and AS 2312.1 were added as *Schedule 2* – Referenced documents to the Australian National Construction Code in 2022. This means the 2014 edition of AS/NZS 2312.2 is mandatory for Deemed-to-Satisfy Provisions, Specifications and Verification Methods. More information is available in GAA/GANZ Advisory Note AN 49.

Summary

AS/NZS 2312.2 allows designers to estimate the durability of HDG coatings more accurately than ever before. In addition, the Standard provides detailed design advice for duplex coatings, the effect of the steel chemistry and illustrates good design practice. It serves as an essential design aid for engineers, architects, specifiers, and consultants.

More information and free training on the use of AS/NZS 2312.2 and hot dip galvanizing in general is available from the GAA and GANZ.

AS/NZS 2312.2 can be purchased from Standards Australia here, or from Standards New Zealand here.

We're here to help

Are you looking for more information or advice on the durability, sustainability, application, design, process, bolting, welding or painting of galvanized steel? Want advice on a specific situation or issue? You're in the right place! We would love to hear from you.

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galvanizers ASSOCIATION OF AUSTRALIA

Level 6
124 Exhibition Street
Melbourne VIC 3000
Australia

GAA website
Find a galvanizer, bath size and technical support

gaa@gaa.com.au

+61 3 9654 1266

GALVANIZING ASSOCIATION

GANZ website
Find a galvanizer, bath size and technical support

enquiry@galvanizing.org.nz