Hot Dip Galvanizing

The best protection inside and out

www.galvanizing.org.nz

GALVANIZING ASSOCIATION

The Galvanizing Association of New Zealand (GANZ), established in 1985, is an incorporated society comprising New Zealand's leading hot dip galvanizers.

About the GANZ

GANZ provides independent advice to coating specialists, architects, engineers, and fabricators on all matters relating to hot dip galvanizing. As a member of the Galvanizers Association of Australia (GAA), we have access to full-time metallurgical and engineering specialists and an extensive reference library of technical publications from around the globe.

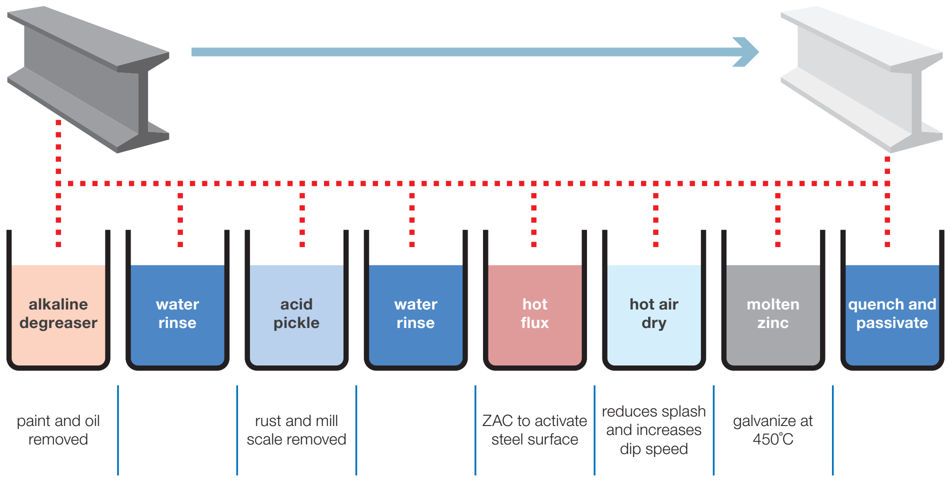
GANZ is proud to support the wider New Zealand steel industry as members of HERA, Metals New Zealand and the Sustainable Steel Council as well as standing on the Standards New Zealand committee for hot dip galvanizing.

Cover: Craigieburn Train Maintenance Facility (Architect:HBO + EMTB, Photographer: Dianna Snape).

This page: Qantas Sound Wall, Sydney Airport by Woolacotts Consulting Engineers.

Hot dip galvanizing process

The hot dip galvanizing process starts by suspending steel articles and dipping them into a series of cleaning baths. Once cleaned, the steel is lowered at an angle into a bath of molten zinc. Immersing the steel on an angle allows air to escape from vented tubular shapes or pockets that may be within the design and permits the molten zinc to displace the air. The steel reacts with the molten zinc to form the galvanized coating. After being withdrawn from the zinc, the final step in most hot dip galvanizing processes is a quench to promote passivation of the zinc surface.

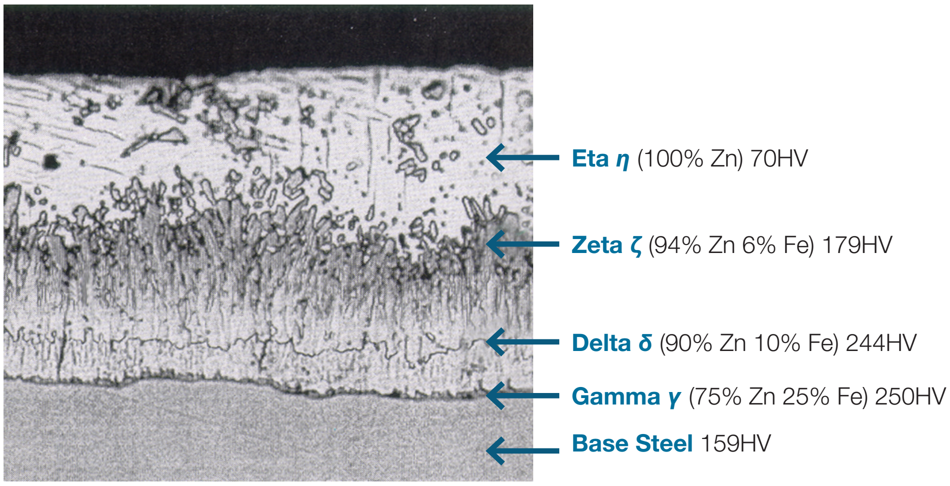


Structure of coating

The formation of the galvanized coating on the steel surface is a metallurgical reaction, where the zinc and steel combine to form a series of hard intermetallic layers. The outer layer is, typically, 100% zinc which covers the surface after withdrawal from the molten zinc bath.

The gamma, delta and zeta alloy layers are all harder than the base steel they are metallurgically bonded to, which gives hot dip galvanizing its great abrasion resistance.

The galvanizing process naturally produces coatings on the corners and edges which are at least as thick as the coating on the rest of the article. As the reaction between iron and zinc is a diffusion reaction, the crystalline structure of the coating forms perpendicular to the steel surface.



Specification of hot dip galvanizing

AS/NZS 4680 is the Australian/New Zealand Standard for hot dip galvanized (zinc) coatings on fabricated ferrous articles. It specifies the requirements of the coating and includes information on coating mass and thickness, appearance and freedom from defects as well as suitable repair methods.

Coating thickness

Table 1 and Table 2 of AS/NZS 4680 state the requirements for coating thickness and mass, which are based on the steel article thickness.

Compliance to Standard is easily confirmed

Good design allows for higher quality coatings and increased durability

TABLE 1

Requirements for coating thickness and mass for articles that are not centrifuged.

Article thickness (mm)	Minimum local coating thickness (µm)	Minimum average coating thickness (µm)	Minimum average coating mass (g/m²)
1.5 or less	35	45	320
Over 1.5 to 3	45	55	390
Over 3 to 6	55	70	500
Over 6	70	85	600

TABLE 2

Requirements for coating thickness and mass for articles that are centrifuged.

Article thickness (mm)	Minimum local coating thickness (µm)	Minimum average coating thickness (µm)	Minimum average coating mass (g/m²)
Less than 8	25	35	250
8 and over	40	55	390

Note: The thickness of hot dip galvanized coatings on threaded fasteners is specified in AS 1214

Inspection

Inspecting galvanized steel is a simple process. Zinc will not adhere to or react with unclean steel; therefore, a visual inspection of the product provides a good assessment of the quality of the coating. The coating thickness is usually tested using a magnetic thickness gauge. The testing and sampling requirements are contained in the appropriate specification for the product (AS/NZS 4680 and AS 1214).

Freedom from defects

A galvanized coating should be continuous, adherent, as smooth and evenly distributed as possible, and free from any defect that is detrimental to the stated end use of the coated article. The integrity of the coating can be determined by visual inspection and coating thickness measurements. A galvanized coating should be sufficiently adherent to withstand normal handling during transport and erection.

Christchurch Airport carpark

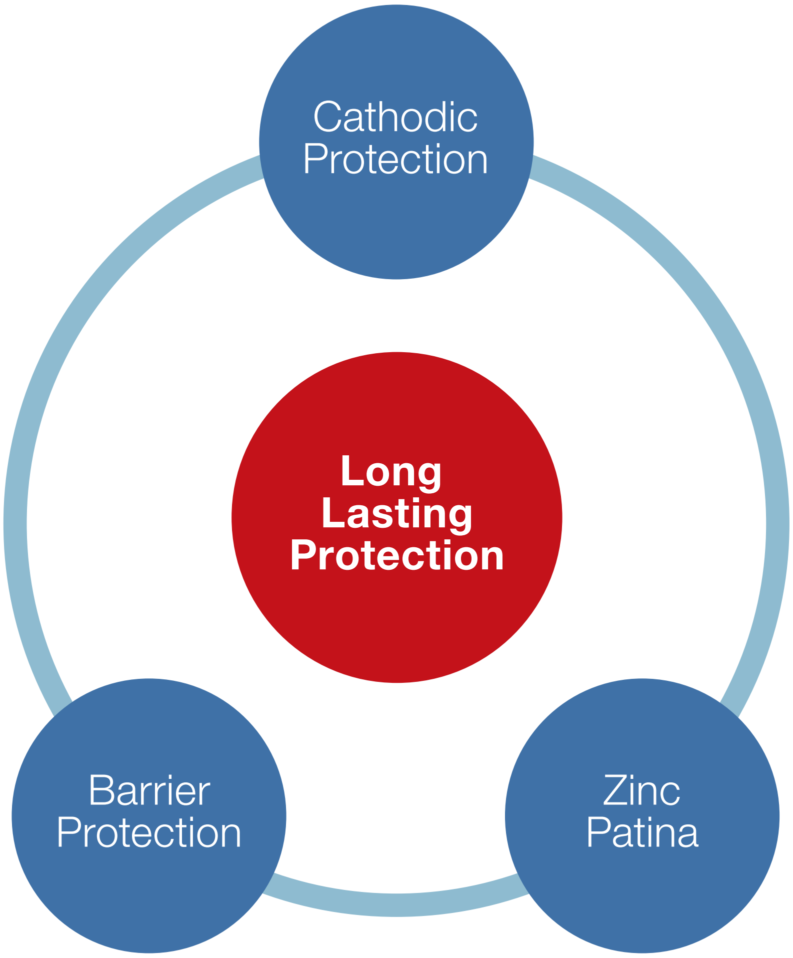
Three types of protection

Barrier protection, cathodic protection and the zinc patina are what provide the galvanized coating its long-lasting protection.

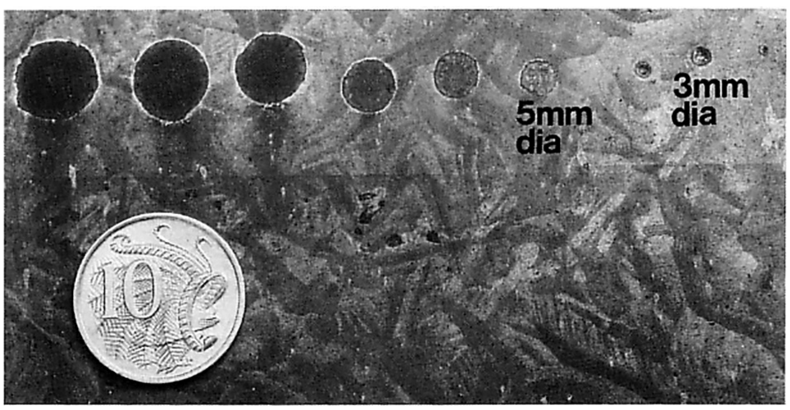
1 The galvanized coating provides complete coverage of all steel surfaces and acts as a **barrier** protecting the steel from the surrounding environment.

2 The galvanized coating **cathodically protects** the steel from coating imperfections caused by accidental abrasion, cutting, drilling, or bending.

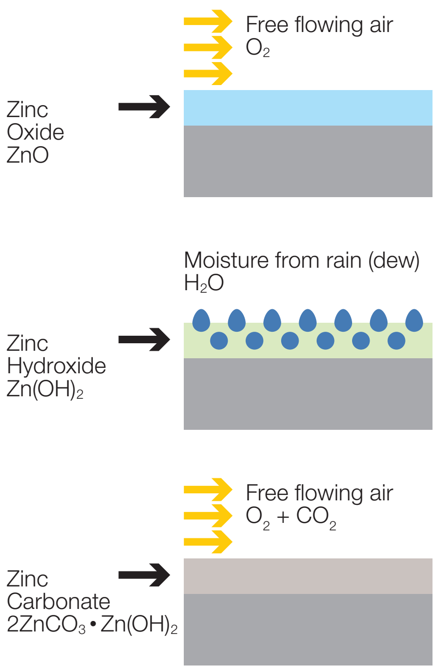
3 The **zinc patina** is insoluble and passive, which slows the corrosion rate of the zinc. The zinc patina is a critical part of the galvanized coating's longevity and requires natural wet and dry cycles to form.



Only hot dip galvanizing can provide barrier protection to this bridge rail, inside and out.



The galvanized steel test piece has had circular areas of the coating removed before exposure in a severe industrial environment. Sacrificial protection is provided by the surrounding galvanized coating and has prevented corrosion of the exposed circles up to 3mm diameter and minimised corrosion of the 5mm circle. Larger circles also exhibit corrosion-free annular areas adjacent to the surrounding coating.



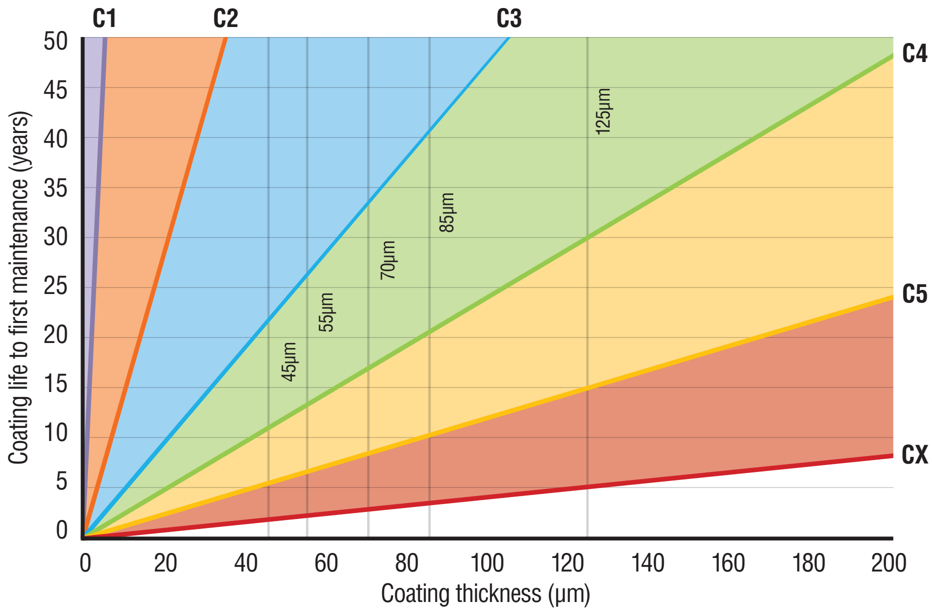
Above: The zinc patina begins its development with exposure to oxygen in the atmosphere. Moisture from rain or humid air reacts with this layer to form zinc hydroxide. This layer then reacts with carbon dioxide present in the atmosphere to form the tightly adherent, insoluble zinc patina.

Durability of hot dip galvanized coatings

Hot dip galvanizing has proven to be more serviceable and predictable than all other steel protective coatings in the New Zealand atmosphere. Its excellent performance is due to its inherent corrosion resistance, high tolerance to mechanical damage and inertness to the high UV levels prevailing over all of New Zealand.

The corrosivity of particular environments have been widely researched and the corrosion rates of both steel and zinc are classified in International and New Zealand Standards as a function of the temperature, relative humidity, the amount of airborne salinity and the amount of airborne pollution present.

The life of a hot dip galvanized coating is (to a first approximation) proportional to its thickness, which is normally a function of the article's steel thickness.



The chart shows that steel with an initial coating thickness of 85µm in a C4 corrosivity zone will have an expected life to first maintenance of 20 – 40 years.

Typical corrosivity categories and corrosion rates of steel and zinc				**Typical service life (years) for hot dip galvanized articles to AS/NZS 4680**				
Corrosivity category and typical environment		**Corrosion rate (µm/year)**		**Fabricated article thickness (mm) and coating specification as per AS/NZS 4680**				
				≤ 1.5	**> 1.5 and ≤ 3.0**	**> 3.0 and ≤ 6.0**	**> 6.0**	**>> 6.0***
		Mild steel	**Zinc**	**45 µm 320 g/m²**	**55 µm 390 g/m²**	**70 µm 500 g/m²**	**85 µm 600 g/m²**	**125 µm* 900 g/m²**
C1	Dry indoors	≤1.3	≤0.1	100+	100+	100+	100+	100+
C2	Arid/Urban inland	>1.3 to ≤25	>0.1 to ≤0.7	64-100+	78-100+	100+	100+	100+
C3	Coastal or industrial	>25 to ≤50	>0.7 to ≤2.1	21-64	26-78	33-100	40-100+	60-100+
C4	Calm sea-shore	>50 to ≤80	>2.1 to ≤4.2	11-21	13-26	17-33	20-40	30-60
C5	Surf sea-shore	>80 to ≤200	>4.2 to ≤8.4	5-11	7-13	8-17	10-20	15-30
CX	Off-shore	>200 to ≤700	>8.4 to ≤25	2-5	2-7	3-8	3-10	5-15

The actual coating thickness achieved on steel articles is typically in excess of the minimum average values specified in AS/NZS 4680.

* Although coatings thicknesses greater than 85µm are not specified in AS/NZS 4680, if the specification of a thicker coating is desired, consultation with the galvanizer is recommended to discuss how a thicker coating can be achieved.

Initial and life cycle cost benefits

Hot dip galvanizing has a low initial cost and is nearly always the cheapest long term cost solution for corrosion protection of steel. GANZ has a micro-site which allows users to calculate the initial and total life costs of more than 30 other corrosion protection systems against hot dip galvanized steel.

Go to http://lccc.gaa.com.au/ for more information.

Based on the information the user provides, the Life-Cycle Cost Calculator (LCCC) will generate a customized report detailing all estimated costs associated with maintaining the structure over the desired project service life, including the time value of money.

Painting over hot dip galvanizing

Painting of hot dip galvanized steel is sometimes required for decorative purposes, to provide an identifying colour or to enhance the service life of the article.

GANZ can provide guidelines which direct specifiers and applicators to recommended paint systems and advice on surface preparation and application practices that will provide a durable paint finish over galvanizing for a particular application. Where a paint or similar type coating is to be applied to the galvanized coating, the galvanizer should be advised at the time of order.

The Moment by Damien Vick. Paint over galvanized steel sculpture in Melbourne, Australia

Life cycle cost website

GANZ website

We provide information, publications and assistance on all aspects of design, performance and applications of hot dip galvanizing.

Email **enquiry@galvanizing.org.nz**
Web **galvanizing.org.nz**

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