

ZINC *Protects!*

Zinc Coatings

How They Work and How They Are Applied

Roger Wildt



For over a century, zinc has enhanced the longevity and performance of steel. Zinc coatings provide the most effective and economical way of protecting steel against corrosion. Zinc-coated (galvanized) steel offers a unique combination of positive features, of which the ones of key interest to residential construction are as follows:

- high strength, determined by the steel substrate
- formability, a key feature for roll forming coated steel sheet
- light weight of steel framing and roofing, as compared to competitive materials
- corrosion resistance, for both long life and the maintenance of esthetic appearance
- recyclability, both for the scrap materials of construction and end-of-life demolition
- low cost, competitive with all construction materials of matching quality.

For these reasons, galvanized steel is an ideal material for a multitude of building applications. In the residential construction market, galvanized steel has particular and cost-effective applications in framing, roofing, rainware (gutters and downspouts), ductwork (heating/cooling and venting) and household appliances.

Galvanized steel resists corrosion. Since, for the industrialized nations, at least 4% of GDP is lost to corrosion each year, the trend of at least the past fifteen years has been toward customer and manufacturer demands for increased protection through both higher contents of zinc and additional applications of zinc-coated steel.



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1. How Zinc Protects

When left unprotected, steel will corrode in almost any environment. Zinc coatings stop corrosion by providing two protections - a physical barrier and cathodic action.

Barrier Protection

Zinc coatings provide a continuous, impervious metallic barrier that does not allow moisture to contact steel. Without direct moisture contact, there is no corrosion. However, since zinc gradually erodes due to its much slower degradation in the presence of water and atmospheric pollutants in open air applications, barrier life is proportional to coating thickness. This subject has been researched for many years and the literature is well supplied with reports on zinc's performance in different climates, with different alloy additions to the coating and at different coating thicknesses.

Within the interior of a structure (wall framing and roof trusses) corrosion is not a consideration provided the exterior membrane maintains its integrity.

Barrier coating longevity can be improved a number of ways other than by just increasing coating thickness. The addition of aluminum for alloy coatings called Galfan® and Galvalume®, or the application of paint, individually or in combination, will significantly and economically extend the life of coated steel sheet.

Cathodic Protection

Another outstanding protection mechanism is zinc's remarkable ability to galvanically protect steel. When bare steel is exposed to moisture, such as at a cut edge or surface scratch, steel is protected by the sacrificial loss of zinc in the vicinity of the exposed steel. In the immediate presence of zinc, steel will not corrode until all the zinc has been sacrificed. This is particularly important for coated steel sheet since corrosion will continually undercut both aluminum or paint barrier coatings.

The presence of zinc is the key to cathodic protection. All zinc-containing metallic coatings, including Galfan® and Galvalume®, share this beneficial characteristic.

2. Formability and Adhesion

For residential framing and roofing applications, all zinc coatings are continuously applied by dipping pre-treated, pre-heated sheet steel in a bath of molten zinc or zinc alloy, a process called "Continuous Galvanizing".

The bond between the zinc and steel is metallurgical so that a coil of zinc-coated steel can be cut, punched and formed without damaging the zinc coating. (There are steel thickness, bending radius and coating weight limitations, but they are well known and respected by the producers of coated steel sheet, framing and roofing products.)

3. The Coating Products and their Definitions

Galvanized

A zinc coating, usually hot-dipped, in which the zinc and steel form a metallurgical bond. The thickness of a hot-dipped coating can be varied from a thin zinc/iron alloy layer to heavy applications suitable for extended outdoor exposure.

Electrogalvanized

Also a zinc coating, but applied in a cold, electrolytic bath rather than a molten zinc bath. Traditionally the coatings are thinner than hot-dipped and not suitable for extended outdoor exposure.

Galvanneal

A zinc-iron coating produced by post-heating a hot-dipped coating. It is often used where paint is to be applied to the coated sheet.

Galfan[®]

A proprietary zinc alloy coating (5% aluminum) with improved corrosion resistance and formability compared to zinc alone.

Galvalume[®]

A proprietary zinc alloy coating (55% aluminum) with superior corrosion resistance.

4. The Continuous Galvanizing Process

Globally, some 550 continuous galvanizing lines produce about 70 million metric tons of zinc-coated steel each year. For many years the capacity for applying zinc coatings has been in a growth mode.

In the continuous hot-dip galvanizing process, coils of rolled steel are continuously unwound and fed through cleaning and annealing sections before entering a molten zinc bath at speeds of up to 200 metres/minute (650 feet/minute). As the steel exits the molten steel bath, coating thickness is controlled by gas "knives" which wipe excess zinc from the steel sheet. The steel sheet then undergoes a number of mechanical and chemical treatments specified by the customer.

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adopted a
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This process is a very capital-intensive, high-speed, precise, factory-controlled operation that controls not only the coating, but the strength and formability of the steel substrate.

5. Sustainable Development

Zinc is natural and fully recyclable. It is an element essential for life and the 17th most common element in the earth's crust. Today, over 80% of the zinc available for recycling is recycled. The presence of zinc coating on steel does not restrict steel's recyclability and all types of zinc-coated products are recyclable, both from the construction phase (job-site scrap) and the demolition phase (end-of-life scrap). Zinc coated steel is recycled along with other steel scrap during the steel production process - the zinc volatilises and is then recovered.

Zinc coating is an energy-efficient process. Zinc residues from the galvanizing process are recycled. Zinc coating extends the life of all steel products and thus improves steel's life-cycle performance and removes the need for regular maintenance normally associated with paint and other coatings. Today's technology enables thinner zinc coatings to provide higher performance. Moreover, as observed in many industrialised countries, zinc coatings now last even longer thanks to decreasing levels of atmospheric sulphur dioxide.

Specifying a zinc coating is in step with today's need for sustainable materials.

Need More Information?

The information contained in this leaflet has been drawn from an IZA publication titled "Zinc Coatings - Protecting Steel". Single copies of the reference document may be obtained free of charge from International Zinc Association.

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