

# Hot-Dip Galvanized Coating Anatomy and Corrosion Protection Guide

Technical reference for HDG coating layers, corrosion mechanisms, appearance variation, and storage control.

## Why this guide matters

Hot-dip galvanized coating is not a single pure zinc film. It is a layered reaction product formed when clean steel is immersed in molten zinc. The inner zinc-iron alloy layers provide metallurgical bonding and hardness, while the outer zinc layer supplies the weathering surface and sacrificial protection.

Technical note: Layer profile, thickness and surface color vary with steel chemistry, steel thickness, surface condition, immersion time and bath practice.

## HDG Coating Cross-Section (Simplified)

Layer thickness and appearance vary with steel chemistry and galvanizing practice.



### What it shows

- metallurgical bond
- alloy layer hardness
- outer zinc protection
- patina after weathering

**Reading the diagram:** Zinc-iron layers grow outward from steel; outer zinc supplies the weathering surface.

## Coating Layer Function Summary

Layer / Zone	Position in Coating	Practical Function
Base steel	Steel substrate	Provides structural strength and load capacity. The coating protects this steel from atmospheric corrosion.
Gamma layer	Closest zinc-iron reaction layer near steel	Creates the initial metallurgical bond between steel and the growing zinc-iron coating.
Delta layer	Middle zinc-iron alloy layer	Contributes hardness and abrasion resistance during handling and installation.
Zeta layer	Outer zinc-rich alloy layer	Supports coating thickness and durability; may influence gray or matte appearance on reactive steels.
Eta layer	Outer mostly pure zinc layer	Provides the main weathering surface and sacrificial zinc source in atmospheric exposure.
Zinc patina	Weathered outer surface after exposure	Stable zinc corrosion products help reduce the long-term zinc corrosion rate.

# How the HDG Coating Protects Steel

HDG performance comes from more than coating thickness alone. Protection is provided by physical separation, electrochemical sacrificial behavior, and gradual formation of a stable weathered zinc surface.

**1 Barrier Protection**

Zinc coating separates steel from oxygen, moisture, salts and industrial atmospheric contaminants.

**2 Cathodic Protection**

When small scratches expose steel, surrounding zinc corrodes preferentially and helps protect the steel.

**3 Zinc Patina Protection**

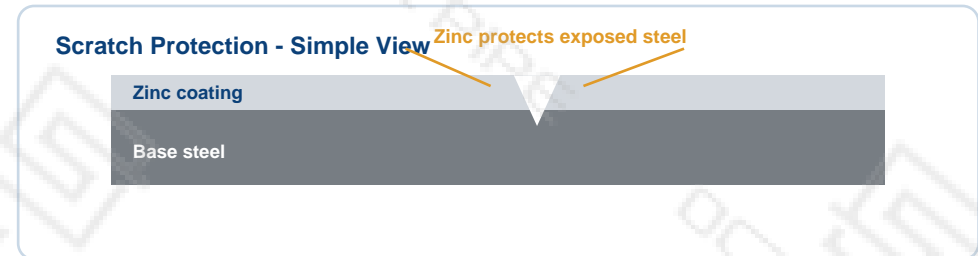
Weathered zinc forms stable corrosion products that slow the corrosion rate during atmospheric exposure.

## Appearance Variation and Acceptance Focus

Bright, spangled, dull gray or matte surfaces can all appear on hot-dip galvanized steel. Dull gray coating is often related to faster zinc-iron alloy growth, especially where steel chemistry contains reactive levels of silicon or phosphorus. Appearance alone should not be used as the acceptance basis.

Practical acceptance should focus on coating thickness, surface continuity, adhesion where required, bare areas, repair condition and the specified standard.

## Scratch and Edge Protection



## Storage and White Rust Control for Galvanized Parts

Newly galvanized steel should not be tightly stacked and left wet. White rust is usually related to trapped moisture and poor air circulation during storage or transport, especially before a stable zinc patina has developed.

Control Point	Recommended Practice
<b>Airflow between parts</b>	Use spacers or stacking methods that leave air gaps and drainage paths between galvanized surfaces.
<b>Wet storage risk</b>	Avoid tight wet bundling, plastic wrap that traps moisture, or long storage in standing water.
<b>Hollow sections</b>	Check drainage from tube, pipe, frames and closed sections before packing or shipment.
<b>Chemical contact</b>	Separate galvanized parts from aggressive chemicals, acidic residues, fertilizer, or incompatible metals during storage.
<b>Pre-installation review</b>	Inspect visible coating condition, repair areas, and storage stain before installation or release.

Engineering Takeaway	Inspection Takeaway	Shipment Takeaway
<b>HDG coating is a layered zinc-iron reaction system, not a paint film.</b>	Judge by thickness, continuity, adhesion, bare areas, and repair condition - not brightness alone.	Keep parts dry, ventilated, drained, and separated to reduce wet storage stain and white rust risk.