Hot-Dip Galvanized Steel vs. Weathering Steel

Hot-dip galvanized steel is produced by dipping bare steel in a bath of molten zinc metal. A protective coating is formed by a metallurgical reaction between iron and zinc, providing both a barrier and cathodic protection that protets steel from corrosion.

HDG steel electrical distribution pole

No corrosion products

Hot-Dip Galvanized Steel	Performance & Condition	Weathering Steel
Unaffected by weathering	Fatigue Life	Reduced by weathering
Protects substrate steel from corrosion	Constant Wetting	Corrodes the same as unprotected carbon steel
Provides excellent corrosion protection	Faying Surfaces	Corrodes the same as unprotected carbon steel
Prepare via sweep blast or solvent cleaning	Painting	Expensive preparation and excessive paint absorption
Protected inside and out	Tubular Shapes	Traps moisture inside, resulting in increased corrosion rate
Visual and/or magnetic gauge	Inspection	Can't distinguish patina rust from loose corrosion products of accelerated corrosion
Easily estimated for most environments	Corrosion Rate	Unknown
Good protection of substrate steel	Road Salt Effect	Accelerated corrosion/loss of mass
No visible corrosion products	Appearance Problems	Stains concrete
90' long x 6' wide (approx.)	Size Limitations	None
Environmental Exposure		
Good corrosion protection	Sea Coast	Poor corrosion protection, chlorides cause pitting
Good corrosion protection	Chemical (Airborne)	Poor corrosion protection, accelerated patina consumption
Excellent corrosion protection	Vegetation	Moisture may accelerate corrosion, especially on faying surfaces, enough to exert excessive force on bolted connections
Widely-used, no arcing	Electrical Industry	Corrosion products cause arcing
Excellent corrosion protection	High-humidity/Fog	Poor corrosion protection

Weathering steel is a corrosion-resistant steel that initially corrodes. The presence of corrosion products then limits any further oxidation of the metal.

Weathering steel electrical distribution pole

Significant corrosion products

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Performance & Condition Notes

Fatigue Life

- Weathering steel is progressively corroding, sometimes at an increasing rate if moisture is prevalent. Thus, there is a loss of steel mass and the fatigue strength is lessened. This means that a design using weathering steel may require thicker sections in order to account for the loss of cross-section.
- Hot-dip galvanized (HDG) steel protects the substrate steel and there is no loss of steel mass.

Constant Wetting

- Weathering steel exposed to constant wetting will corrode the same as unprotected carbon steel. Weathering steel needs to have a 50-50 wet/dry cycle in order to form the stable patina of tightly-bound corrosion products.
- HDG steel will protect the underlying substrate for many years, regardless of the exposure to moisture.

Painting

- Weathering steels are high-strength steels but, in general, are used because of their corrosion properties. Painting would seem to counteract the logic of using weathering steels. However, weathering steel can be painted, but the patina is difficult to remove and the clean steel tends to require excessive paint material in order to deliver a decent coating appearance.
- HDG steel does require preparation and, depending on the age of the coating, may range from a sweep blasting or solvent wipe to an economical hot-water/steam pressure wash.

Tubular Shapes

- Serious corrosion occurs on the inside of tubular/enclosed shapes of weathering steel. Weathering steel will condense moisture inside, or design characteristics will allow moisture to enter the enclosure and accelerate corrosion. There are light poles that have failed, causing fatal consequences, and bridges exhibiting excessive corrosion.
- Regardless of moisture level, HDG steel provides corrosion protection both inside and out.

Inspection

- It is impossible to distinguish between the patina rust that minimizes the corrosion rate of weathering steel and the voluminous rust that occurs when the weathering steel is losing significant mass. Extensive and expensive testing is required to determine if weathering steel has the design strength during the intended lifetime of the structure.
- HDG steel is inspected visually, and any substrate corrosion is obvious. Repairs can be made immediately to extend the life of the steel. To determine the expected life of the coating, a simple magnetic thickness measurement can be taken using inexpensive, hand-held tools.

Corrosion Rate

- Weathering steel corrodes at unpredictable rates and corrosion will accelerate when moisture is prevalent. Since corrosion is constantly occurring and the weathering steel is losing cross-sectional thickness, planning maintenance is unknown.
- Based on extensive studies of HDG steel in virtually every atmospheric condition, HDG steel has over 80 years of history, and corrosion rates can easily be estimated. More often than not, hot-dip galvanizing protects steel beyond the expected life of a structure.

Road Salt Exposure

- Weathering steel is adversely affected by exposure to road salts. Corrosion rates are accelerated, and the design strength is lessened.
- The chlorides in road salts make an aggressive attack on the zinc coating of hot-dip galvanized steel, but protection of the substrate steel from corrosion is still achievable.

Appearance

- Weathering steel will develop a dark brown, rather consistent, patina over a three-to-five-year period. However, because the appearance often has an architecturally aesthetic purpose, it is necessary to blast or wire brush the surface in order to establish a uniform initial appearance. When in contact with concrete, the corrosion products of weathering steel bleed onto the concrete and create an unsightly stain.
- HDG steel initially exhibits a bright silver-gray appearance and then progresses within six to 24 months to the matte gray look that lasts for decades. The corrosion of zinc is slow, and the corrosion products are virtually invisible to the naked eye.

Environmental Exposure Notes

Sea Coast Exposure

- Weathering steel performs poorly when exposed to salt air. Pitting and accelerated corrosion may compromise steel integrity.
- The zinc coating of HDG performs well in salt air exposure.

Chemical Exposure (airborne)

- Weathering steel does not perform well when corrosive airborne chemicals are abundant. The patina is rapidly consumed and the steel corrodes at rates approximated to that of unprotected steel.
- Chemicals can be aggressive to HDG steel as well, but only after a number of years will the entire zinc coating be consumed. HDG steel is often painted in order to achieve a long-lasting coating to protect the substrate steel.

Vegetation

- The buildup of vegetation and organic material on and around weathering steel concentrates moisture. Constant exposure to moisture is adverse to the patina and excessive corrosion will occur.
- HDG steel is unaffected by the presence of vegetation or organic material.

Electrical Industry

- The buildup of weathering steel corrosion products may allow arcing of electrical current from pole to pole. This may cause fires and power failures.
- HDG steel is used extensively by the power industry for generation, transmission, and distribution, without incident.

High Humidity/Fog Exposure

- Weathering steel exhibits accelerated corrosion when frequent high humidity and/or fog conditions exist.
- HDG steel is unaffected by such conditions as the stable zinc patina is unreactive.