



TECHNICAL GUIDE

ASTM Galvanizing & Corrosion Defense Guide

ASTM A123 hot-dip galvanizing for structural steel carports: what the standard requires, how long the coating lasts, and how to specify, inspect and repair it

Summary. ASTM A123/A123M sets the minimum zinc coating for fabricated structural steel. For rolled structural shapes (W-beams, channels, angles) 1/4 in thick or more, the required minimum average is **coating grade 100 (100 μ m, about 3.9 mils)**; HSS tubes fall in the pipe-and-tubing category, which requires **grade 75 (75 μ m, about 3.0 mils)** at 1/8 in and thicker. Zinc protects steel twice - as a barrier and sacrificially - and the American Galvanizers Association estimates more than 70 years to first maintenance for structural shapes 1/4 in and thicker even in industrial air (HSS, with its thinner grade-75 coating, somewhat less). A good result depends on what happens before the dip: steel chemistry, venting and drainage, and detailing under ASTM A385, A384 and A143.

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1. How galvanizing protects steel

In batch hot-dip galvanizing, fabricated steel is cleaned (caustic degreasing, acid pickling, flux) and immersed in molten zinc at about 840 °F (450 °C). The zinc reacts with the iron to form a series of zinc-iron alloy layers - gamma, delta and zeta - topped by a layer of nearly pure zinc (eta). The coating is metallurgically bonded, and the alloy layers are harder than the base steel, which makes it resistant to handling and erection damage.

- **Barrier protection.** The zinc layer separates the steel from moisture and oxygen, and zinc itself corrodes at roughly 1/30 the rate of steel (AGA).
- **Cathodic (sacrificial) protection.** Where the coating is scratched or cut, the surrounding zinc corrodes preferentially and protects the exposed steel.
- **Zinc patina.** Over the first months the surface forms zinc oxide, hydroxide and finally a stable, adherent zinc carbonate film that slows further corrosion.
- **Complete coverage.** Immersion coats inside hollow sections, corners and edges that paint struggles to reach - provided the piece is vented and drained.

2. The ASTM standards family

Standard	Scope	Why it matters for carports
ASTM A123/A123M	Zinc (hot-dip galvanized) coatings on fabricated iron and steel products	Main specification: coating thickness, finish, appearance, adherence
ASTM A153/A153M	Zinc coatings on iron and steel hardware	Bolts, nuts, washers and small hardware
ASTM A385/A385M	Practice for providing high-quality zinc coatings	Design and detailing: venting, drainage, weld cleaning, overlapping surfaces
ASTM A384/A384M	Safeguarding against warpage and distortion	Thin or asymmetric members, long tubes
ASTM A143/A143M	Safeguarding against embrittlement	Cold-worked and high-strength steel
ASTM A780/A780M	Repair of damaged and uncoated areas	Field touch-up after cutting, welding or handling damage
ASTM E376	Measuring coating thickness by magnetic-field methods	The usual inspection method
ASTM D6386 / D7803	Preparing galvanized surfaces for paint / powder coat	Duplex systems for color or severe exposure

3. ASTM A123 coating thickness requirements

A123 Table 1 sets a *minimum average* coating thickness grade (in micrometers) by material category and measured steel thickness. There is no maximum. The two rows that matter for carports are:

Steel thickness (measured)	< 1/16 in	1/16 to < 1/8 in	1/8 to 3/16 in	> 3/16 to < 1/4 in	1/4 to < 5/8 in	≥ 5/8 in
Structural shapes - coating grade (µm)	45	65	75	75	100	100
Structural shapes, approx. mils	1.8	2.6	3.0	3.0	3.9	3.9
Pipe and tubing, incl. HSS (µm)	45	45	75	75	75	75

- **Assign the right category.** Wide-flange beams, channels and rolled angles are structural shapes. HSS columns and beams are **pipe and tubing**, even when used structurally, and must be checked against that row of Table 1.

Members built from welded plate fall under **plate**.

- **Per-specimen tolerance.** Any single specimen may be one coating grade below the Table 1 value (for example grade 85 where 100 is required), provided the average of all specimens meets the full requirement.
- **Measurement.** Normally by magnetic thickness gauge (ASTM E376); at least five readings per specimen, spread over the piece, with the number of specimens set by lot size.
- **Finish and adherence.** The coating must be continuous, reasonably smooth and uniform, free of bare spots and of lumps or runs that interfere with use, and must adhere when tested with a stout knife.
- **Factory repair limits.** The galvanizer may repair uncoated areas only within the limits set by A123 (small individual areas and a small fraction of the surface), using the A780 methods, to the coating thickness required for the item.

4. How long it lasts

Zinc corrodes at a roughly steady rate in the atmosphere, so service life scales with coating thickness. The American Galvanizers Association's Time to First Maintenance (TFM) chart, built from real-world data and the Zinc Coating Life Predictor model, defines first maintenance as 5% rusting of the steel surface. On that basis, galvanized structural steel over 1/4 in thick reaches about 72-73 years to first maintenance even in the most corrosive of its five environments (industrial).

ISO 9223 gives zinc corrosion rates by corrosivity category. The estimate below divides a grade-75 coating (HSS) and a grade-100 coating (W-shapes) by those rates; it ignores the extra life left after 5% rusting and is a planning range only.

ISO 9223 category	Typical carport setting	Zinc loss (μm/yr)	Years, 75 μm (HSS)	Years, 100 μm (W-shapes)
C2 - low	Arid inland: Las Vegas, Phoenix, inland California	0.1-0.7	100+	140+
C3 - medium	Most U.S. urban and suburban sites	0.7-2.1	36-107	48-143
C4 - high	Industrial areas; coastal sites a few miles inland	2.1-4.2	18-36	24-48
C5 - very high	Seafront, salt spray, heavy industry	4.2-8.4	9-18	12-24
CX - extreme	Tropical surf zone, offshore	8.4-25	3-9	4-12

For NextSpan markets. Desert sites in Nevada, Arizona and inland California fall in C2-C3, where galvanized steel will outlast the PV system several times over. Coastal California, Hawaii and Gulf Coast sites can reach C4-C5; there, specify a heavier coating where the steel allows, or a **duplex system** (galvanizing plus paint or powder coat), which the AGA reports lasts 1.5-2.3 times the combined life of the two systems alone.

5. Designing steel for galvanizing

Most galvanizing defects start on the drawing board. ASTM A385 and A384 set out the practices; the points that matter most for carports:

- **Vent and drain every hollow section.** HSS columns, beams and closed brackets need vent and drain holes at both ends so molten zinc can flow in and air and steam can escape. Unvented closed sections are a safety hazard in the kettle and come out with bare interiors. Agree hole sizes and locations with the galvanizer.

- **Steel chemistry.** Silicon and phosphorus control how thick and how bright the coating grows. Steels with silicon roughly 0.04% or less or 0.15-0.25% give the most predictable coatings; silicon in between, or high phosphorus, can give thick, dull grey and more brittle coatings. Coating thickness is still compliant, but appearance varies.
- **Welds.** Remove all weld slag - pickling does not remove it, and it leaves bare spots. Use low-silicon filler where appearance matters.
- **Overlapping and tight surfaces.** Avoid tight lap joints and skip-welded overlaps where pickling acid can be trapped; seal-weld or leave a gap large enough for zinc to flow.
- **Distortion.** Long, thin or asymmetric members can warp at 840 °F. Use symmetric sections, similar thicknesses across a weldment and adequate size relative to the kettle (A384).
- **Embrittlement.** Severe cold work and high-hardness steels can embrittle (A143). ASTM F3125 Grade A490 bolts must not be hot-dip galvanized; use galvanized A325 / F3125 Grade A325 bolts with galvanized nuts.
- **Kettle size.** Check the galvanizer's kettle dimensions early. Members longer than the kettle can be progressively dipped, but at higher risk of distortion and a visible overlap line.

6. Inspection, repair and the field

- **At the galvanizer.** Inspect before shipping: visual check for bare spots, runs and dross; magnetic thickness readings to A123 sampling; adherence check where in doubt; galvanizer's certificate of compliance.
- **Storage and wet-storage stain.** Freshly galvanized members stacked tightly in wet conditions can form white rust. Store elevated, sloped and with spacers so water drains and air circulates.
- **Field repair (ASTM A780).** Three methods: zinc-rich paint, zinc-based solder, or zinc metallizing (thermal spray). Repairs should reach the coating thickness required by A123 for the member, and zinc-rich paint needs a high zinc content in the dry film. Clean the area first.
- **Field welding and cutting.** Grind off zinc before welding for weld quality and fume control, then restore the coating per A780 after welding.
- **Mixed-metal contact.** Use galvanized or stainless fasteners with appropriate isolation; avoid contact with copper (e.g., grounding conductors) without suitable lugs and isolation.
- **Concrete embedment.** Galvanized steel is compatible with concrete. Columns embedded in or set on concrete should have a sealed, sloped joint at grade to keep standing water off the base.

7. Sample specification language

All structural steel members, bracing and connection plates shall be hot-dip galvanized after fabrication in accordance with ASTM A123/A123M, with coating thickness per Table 1 for the applicable material category and steel thickness. Bolts, nuts and washers shall be galvanized per ASTM A153/A153M or ASTM F2329. Fabrication shall follow ASTM A385/A385M, A384/A384M and A143/A143M; hollow sections shall be vented and drained as agreed with the galvanizer. The galvanizer shall furnish a certificate of compliance. Damaged or field-modified areas shall be repaired per ASTM A780/A780M to the coating thickness required by ASTM A123 for the member. [For sites in ISO 9223 category C4 or above, add: Exposed galvanized surfaces shall receive a duplex coating, prepared per ASTM D6386 (paint) or D7803 (powder).]

References

- ASTM A123/A123M, A153/A153M, A143/A143M, A384/A384M, A385/A385M, A780/A780M, E376, D6386, D7803, F2329, F3125 (current editions).
- American Galvanizers Association: "ASTM A123/A123M" knowledge base; "2024 Revision of ASTM A123"; "Specifying Galvanized Structural Pipe and Tube"; "HDG Corrosion Rates for ISO Categories C1-C5/X"; Time to First Maintenance chart (galvanizeit.org).
- ISO 9223:2012, *Corrosion of metals and alloys - Corrosivity of atmospheres - Classification, determination and estimation*.

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