Modern Corrosion Protection Systems
Jeff Carlson
Corrosion Protection and Durability Resources

There are several proven ways to protect steel bridges from corrosion, and no single solution is best for all circumstances.

The first consideration when selecting one of these techniques is, of course, a bridge’s anticipated exposure to corrosive elements over its lifetime. In addition, teams must consider initial and life-cycle costs, fabrication, productivity, and long-term performance and maintenance when choosing a corrosion protection approach for a given bridge.

General resources:

- Volumes 19 of the FIPPA Steel Bridge Design Handbook focus on corrosion protection.
- AASHTO’s National Transportation Product Evaluation Program (NTPP) offers a wealth of information about various structural steel coatings.
- The Society for Protective Coatings (SSPC) issues and maintains many coating standards, including the SSPC Good Painting Practice and Systems and Specifications Manuals. Both the SSPC and the National Association of Corrosion Engineers (NACE) provide training and certification for coatings inspections as well as coating contractors. These certifications help establish a quality threshold for the coatings industry.
Mitigation Strategies for Steel Bridges
What’s Right For you?

• Uncoated Weathering Steel (UWS)
• Liquid Applied Coatings
• Thermal Spray Coatings (TSC, aka - Metallizing)
• Hot-Dip Galvanizing (HDG)
• A709-50CR (previously known as A1010)
From ASTM A709

- Grade designations ending in “W” are weathering grades.
  - They develop a stable patina that provides barrier corrosion protection
  - The patina controls the rate that oxygen can reach the bare steel underneath

### Uncoated Weathering Steel (UWS)

<table>
<thead>
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<th>Grade</th>
<th>Yield Strength (ksi)</th>
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<tbody>
<tr>
<td>36</td>
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<tr>
<td>50</td>
<td>50</td>
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<tr>
<td>50S</td>
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<tr>
<td>QST 65</td>
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<tr>
<td>QST 70</td>
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Well formed patina has a dark-chocolate, almost purple hue. Also has fine pinholes.

Provides “barrier” protection
ASTM A709-50CR

- ~11% chrome
- Ferrite / tempered martensite (formally it’s a martensitic stainless steel)
- Develops a brown colored patina like weathering steel

6yr. exposure McLean, VA (vertical)
3 yr. exposure Hampton Roads, VA (horizontal)
9 mo. And 3 yr. (inset) exposure North Topsail, NC (vertical)
Types & Definitions:

- **IOZ** – Inorganic Zinc Primer
- **OZ** – Organic Zinc Primer
- **E** – Epoxy (intermediate coat)
- **U** – Urethane (topcoat)

Source: VDOT

Source: FHWA
The Misperception Dilemma

Whittier Bridge - Massachusetts

This bridge utilized the old lead paint systems prior to implementation of current practices.
The Colorful History of Steel Bridge Paint Systems

1960 - 1977: Lead (Alkyd) Paints Widely Used

1990 - 2021: Modern Systems Widely Adopted
The Colorful History of Steel Bridge Paint Systems

- **1960 - 1977**: Lead (Alkyd) Paints Widely Used
- **1977 - 1989**: Lead Still Used Via Exclusion
- **1980 - 1990**: Zinc Rich Primers Adopted
- **1985 - 1990**: Benefits of Surface Preparation Realized
- **1990 - 2021**: Modern Systems Widely Adopted

**Key Events**

- **1960**: Zinc Rich Primers Introduced
- **1975**: Lead Paints Banned
- **1977**: VOC Regulations - Eliminate Vinyl Paint, Blasting Regulation Implemented

**Timeline**

- 1960
- 1967
- 1974
- 1981
- 1988
- 1995
- 2002
- 2009
- 2016
- 2016
Old Liquid Applied Coatings
Liquid Applied Coatings

- Primarily “barrier” protection, however zinc-rich primer provides “cathodic” protection if exposed

Source: Chris Stuvel
Liquid Applied Coatings – Cost Implications

Source: VDOT

- Cost Implications

Source:
Random selection of qualified systems from http:\\data.ntpep.org\SSC (except for single-coat IOZ)

Source:

Consult With Local Fabricator
Liquid Applied Coatings

Workhorse systems
• 3-coat, OZ/Epoxy/Urethane
• 3-coat, IOZ/Epoxy/Urethane

Innovative systems
• IOZ only
• IOZ with acrylic topcoat
• 2-coat, OZ/polyaspartic
Thermal Spray Coatings (TSC) – aka Metallizing

Common Alloys

Aluminum (Al)
85/15 (Zn/Al) ................. Most common
Zinc (Zn)

Source: VDOT

Source: R. Kogler

Molten metal droplets propelled towards steel substrate

Steel Substrate with Blasted Surface Anchor Profile
Thermal Spray Coatings (TSC)

Source: VDOT
Source: R. Kogler
Source: FHWA
Thermal Spray Coatings (TSC)

- TSC are porous – sealing is common, but not necessary
- Sealers are low-viscosity, liquid applied coatings meant to penetrate through pores
- Mechanical process, whereas HDG is chemical process

Mostly “cathodic” protection
Hot-Dipped Galvanizing

- Dipping steel in ~830°F zinc creates a metallurgical bond

Both “barrier” and “cathodic” protection
Hot-Dipped Galvanizing

Surface Preparation

- Degreasing
- Rinsing
- Pickling
- Rinsing
- Flux solution

Drying
Zinc bath
Cooling and inspection

Source: AGA
Hot-Dipped Galvanizing – Surface Preparation

• Thorough cleaning is necessary as zinc will only react with clean steel

• Three cleaning solutions:
  • **Degreasing** – removes dirt, oils, organic residue
  • **Pickling** – removes mill scale and oxides
  • **Fluxing** – mild cleaning, protective layer

• Unclean areas will not grow zinc coating
Thank you
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