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Corrosion Protection of Steel

Introduction

Carbon steel is widely used in all aspects of building construction due to its low cost, high strength and ease of fabrication. Corrosion is an inevitable phenomena that must be controlled to prolong the life of carbon steel components.

Corrosion

Corrosion is the natural process of the iron in steel combining with oxygen to form iron oxide. Corrosion occurs when steel is exposed to oxygen and water, which may be in the form of humid air. There are a number of factors that affect the rate of corrosion including the composition of the steel alloy and environmental conditions (e.g. temperature, humidity, salinity, pH, pollution).

Corrosion is accelerated when carbon steel is in contact with a more cathodic metal, such as copper or stainless steel. Corrosion is detrimental for a number of reasons including:

- Corrosion weakens an item by replacing high-strength steel with lower-strength iron oxide, thereby reducing the effective area and cross section.
- Iron oxide occupies greater volume than steel, so steel expands as it corrodes. Expansion can cause damage in many condition including connections, imbeds and when encased in concrete.
- Discoloration and staining is unsightly and damages finish materials. Discoloration and staining are invaluable however, as indicators of corrosion in concealed spaces and should be investigated.

Corrosion Protection

An integral part of using carbon steel in building construction is specifying protection to control corrosion. Common methods of protection include:

- Segregating the steel from air and water using coatings. Coatings can be effective but must adhere to and cover the entire assembly and become ineffective if damaged.
- Use of alternate corrosion-resistant materials, including weathering steel and stainless steel. These are effective but are cost prohibitive for many applications.
- Reducing cathodic corrosion by separating dissimilar metals or using Impressed Current Cathodic Protection (ICCP). ICCP uses DC electric current to forestall electrochemical corrosion.
- Galvanizing, which is the use of a zinc coating to serve as a sacrificial anode to protect the underlying steel. Galvanizing is durable, cost effective and is available for a wide range of steel shapes and components.

Galvanizing

During galvanization steel is immersed in a bath of molten zinc and processed to provide a uniform zinc coating. Zinc is a reactive material that will corrode over time, so the protection provided is proportional to the coating thickness. Figure 1 lists common commercially available galvanized coatings used for cold-formed steel framing members.

Coating Designation	Minimum Requirement Total Both Sides		Thickness Nominal per Side	
	(oz/ft^2)	(g/m^2)	(mils)	(microns)
Galvanized				
G40/Z120	0.40	120	0.34	8.5
G60/Z180	0.60	180	0.51	12.7
G90/Z275	0.90	275	0.77	19.4

Figure 1: Zinc Coatings Weights and Thickness[1]

If the zinc coating is damaged during fabrication or installation the area should be coated with zinc-rich paint or another accepted repair method.

Interior Applications

The risk of corrosion should be assessed and galvanized steel used accordingly. The expected corrosion rate in most building interiors is relatively low due to the controlled environment. Many laboratory areas, however, are subject to high humidity, exposure to water and chemicals, frequently washed-down and otherwise are at a higher corrosion risk so galvanized components should be specified. In very high risk areas alternate materials, like stainless steel, masonry or fiberglass, should be considered in lieu of galvanized steel.

Exterior Applications

Galvanized steel in exterior building components should be protected from water contact if possible. Vapor barriers and thermal breaks should protect wall members from moisture and condensation. Exposed elements should be painted or protected by a weatherproof enclosure. Elements which are not otherwise protected should have an appropriately heavy galvanized coating.

The following ASTM standards provide specifications for the performance of galvanized steel:

ASTM-A653, *Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process*

ASTM-A924, *Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process*

ASTM-A153, *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*

ASTM A780, *Standard Practice for Repair of Damaged and Uncoated Areas of Hot-dip Galvanized Coatings*

References

[1]Durability of Cold-Formed Steel Framing Members, Cold-Formed Steel Engineering Institute