THE SUPPORTWORKS NEWSLETTER FOR DESIGN PROFESSIONALS

GroundED

Supportworks

FALL 2019

40

Zinc Coating Versus Powder Coating for Corrosion Protection of Helical Piles

Protective coatings for steel piling include, among others, coal tar epoxy, fusion-bonded epoxy, zinc coatings and powder coatings. Of these, only zinc and powder coatings are allowed for corrosion protection of helical piles, as outlined within the International Code Council (ICC) Acceptance Criteria (AC) for Helical Pile Systems and Devices (AC358). AC358 specifies that zinc coatings comply with ASTM A123/A153, B633 or B695 for hot-dip galvanizing (HDG), electrodeposited zinc or mechanically-deposited zinc, respectively. The powder-coated finish allowed in AC358 must be a polymer ethylene and acrylic acid (EAA) and comply with ICC AC228 (Acceptance Criteria for Corrosion Protection of Steel Foundation Systems Using Polymer (EAA) Coatings), with an exception that the coating thickness be at least 18 mils (0.018 inch) versus the 10 mil ± 2 mil thickness allowed in AC228.

Hot-dip galvanizing is by far the preferred method of both helical pile manufacturers and design professionals for protecting helical pile components from corrosion. That said, there remains some confusion about the use of powder coating, how it compares to HDG and, ultimately, its effectiveness to provide the corrosion resistance advertised.

Processes:
The process of hot-dip galvanizing starts with dipping the steel in a caustic solution of high alkalinity to remove organic residues. The part is then rinsed with water and put into a pickling bath of hydrochloric or sulfuric acid. The pickling removes surface oxides and mill scale from the steel. After pickling, the part is rinsed in water again and put into a molten zinc bath with flux to fuse zinc to the parent material. Finally, the part is inspected for surface imperfections and coating thickness.

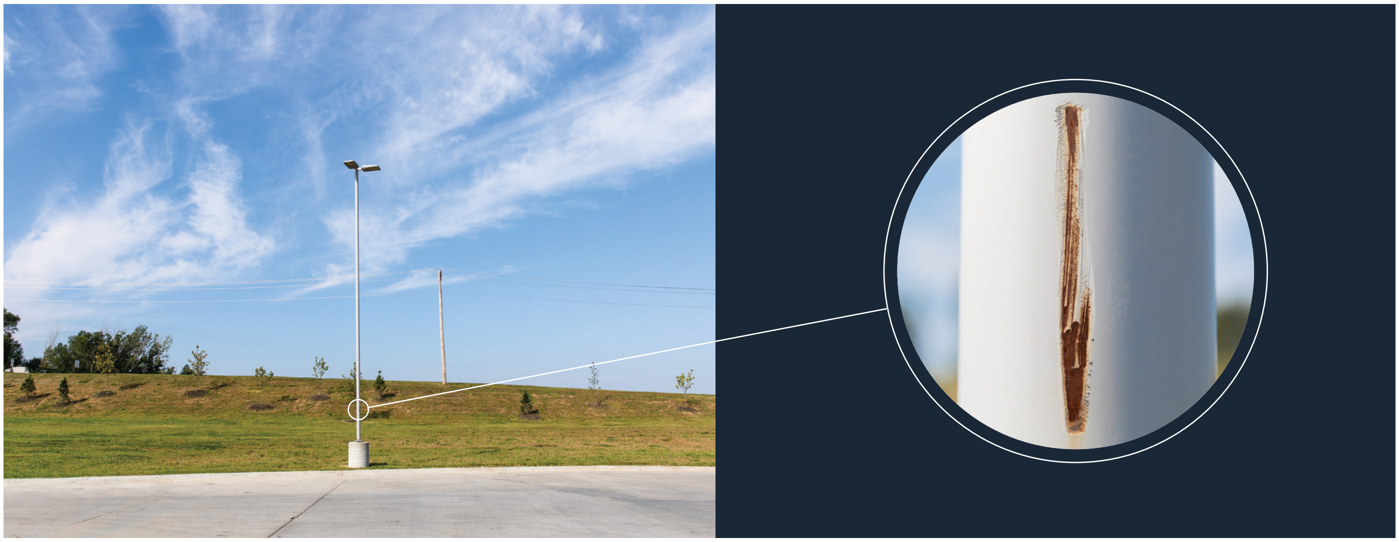
Helical piles removed from the zinc bath

Polymer powder is made from polymer resin that is combined with curatives, pigments, leveling agents, flow modifiers and other additives that are melted, mixed and then ground into a powder form after cooling. The powder coating process with EAA copolymers involves surface preparation of the steel to remove contaminants followed by application of the powder via a spray gun. The steel part is electrically grounded and the spray gun applies an electrostatic charge to the powder which creates an electrical attraction between the powder and the steel surface. After the powder coating is applied, the part is put into a curing oven to complete the bonding and setting process.

A fundamental difference between zinc and powder coating is the way each protects the base metal from corrosion.

Fundamental Difference:
A fundamental difference between zinc and powder coating is the way each protects the base metal from corrosion. Zinc coatings are considered sacrificial elements where the fused zinc layer is depleted during the corrosion process. Corrosion is an electrochemical process where the zinc acts as an anode, the base steel is the cathode, and the corrosive soil (and moisture) is the electrolyte that completes the electrical circuit. The anode (zinc coating) has a more active voltage than the base metal which creates a difference in potential between the two, allowing the zinc to corrode in preference to the base metal. Even in situations where the zinc coating has been damaged, exposing the bare steel, the bare steel will not corrode until all of the electrically-connected zinc is consumed.

On the other hand, powder coatings are simply inert, protective barriers on the surface of the base metal. Therefore, if the powder coating is compromised during product storage, transport or installation, the exposed area will immediately begin to rust.



New light pole rusting where inert coating was damaged

The above photos show a recently installed light pole with a damaged inert coating. Rust is present on the exposed bare metal.

Durability:
AC228 requires several performance tests to verify the strength of the powder coating, including abrasion, adhesion, impact and salt spray testing. What is not known is if the level of testing sufficiently replicates conditions of a typical installation of helical piles, let alone conditions where piles are installed through rubble fill, cobbles, gravel, sand or other common soil types that would be particularly aggressive and likely to damage the coating. Aggressive, abrasive soils aside, helical piles often experience the highest stress during installation from the applied torque. Field testing has shown that, even under fairly low strain conditions, the powder coat can debond and flake off the shaft. The photo on the left shows a 2.875-inch outside diameter, powder-coated helical pile being installed at a torque less than the shaft torsional rating. Obviously, if this occurs, there is no corrosion protection remaining for the base steel.

Powder coat flaking off helical pile during low strain conditions of installation

In the HDG process, zinc is fused to the parent material, providing superior protection even in the conditions described above. Additionally, as already discussed, due to the sacrificial nature of zinc coatings on steel, any minor imperfections or damage in the surface coating has minimal impact on the corrosion protection provided to the steel part.

Summary:
Zinc and powder coatings are the only processes allowed in AC358 for corrosion protection of helical piles.

Since zinc coating acts as a sacrificial element, there is less concern of coating imperfections or loss during pile installation than with a powder-coated pile. The zinc coating continues to provide corrosion protection to any areas of bare steel until all of the zinc is depleted. Corrosion starts immediately when areas of bare steel are exposed on powder-coated piles.

The zinc on HDG product is fused to the base material, providing a durable coating even under conditions of impact, installation through abrasive soils and under the torsional strain levels of typical helical pile installations. Inert, protective barriers applied to the surface of the steel simply do not perform as well in these same conditions, often leaving some of the steel surface exposed.

Supportworks offers HDG helical pile and bracket components, and either zinc-plated or HDG fasteners. Please feel free to reach out to the Supportworks engineering staff if you have questions regarding corrosion protection of our products.

DON DEARDORFF, SENIOR APPLICATION ENGINEER

Upcoming Webinar Opportunities

- An Introduction to Helical Foundation Systems

  1st Wednesday of every month 11:30 am (CT) and 1:30 pm (CT)
- An Introduction to Polyurethane Foam Injection

  2nd Wednesday of every month 11:30 am (CT) and 1:30 pm (CT)
- An Introduction to Hydraulically Driven Push Pier Systems

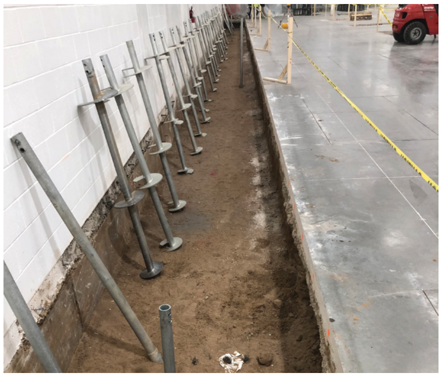
  3rd Wednesday of every month 11:30 am (CT) and 1:30 pm (CT)

Project: **Mendards Mezzanine Addition**
Location: **La Crosse, WI**
Pier Installer: **Foundation Supportworks® of Wisconsin**

Challenge: A 12,000 square foot mezzanine addition was planned inside the existing Menards home improvement store in La Crosse, Wisconsin. Foundations for an elevator addition and racking system were also required below the new mezzanine. The mezzanine and elevator additions would be supported using deep foundations at 40 new pile cap locations and the new rack system would be supported on deep foundations incorporated into a thickened slab. Some of the existing footings required additional piling to increase capacity for the mezzanine support. A boring advanced in the area showed about 11 feet of sandy rubble fill underlain by very loose to loose sand to a depth of about 45 feet where it transitioned to loose to medium dense sand to the termination of the boring. Groundwater was observed at a depth of about 10 feet. Timber piles with a design working compression load of 26 kips were originally specified for the new foundation support; however, concerns associated with constructability, noise and possible damage to existing foundations during driving prompted consideration of an alternative deep foundation system.

Solution: Helical piles were selected as the preferred deep foundation alternative since the piles could be installed in the limited access area and near existing foundations without concern of damage due to vibration. The helical piles could also be installed with smaller, quieter equipment than what would have been required for a driven pile system. Foundation Supportworks® of Wisconsin was contracted to install 209 helical piles for the mezzanine, elevator and racking system additions. The helical pile design consisted of the Model 288 (2.875-inch OD by 0.276-inch wall) hollow round shaft with a 10” 12”-14” helix plate configuration. The helical piles were installed to lengths ranging from 70 to 110 feet after achieving torque-correlated ultimate capacities of at least 2 times the design working load of 26 kips. Predrilling through 9 to 14 feet of rubble fill was required at 35 pile locations. Foundation details for the elevator addition, new racking system and mezzanine included 8, 39 and 162 piles, respectively. The 209 helical piles were installed in less than three weeks with multiple mobilizations required.

Installing helical piles in pile cap



Helical piles at rack addition location

Helical piles with new construction caps and reinforcement

Completed mezzanine addition

To sign up, email us at training@supportworks.com with the following information:

- Name of the firm
- Location of firm
- Approximate number of engineers/architects/GCs that will be in attendance

Supportworks® Inc. is an approved provider of continuing education credits through the AIA, RCEP and the Florida State Board of Engineers.

HelixPro® 2.0 Design Software

A state-of-the-art program that allows you to calculate bearing and uplift capacities of Supportworks helical piles as well as tension capacities of Supportworks helical tiebacks as they pertain to specific site and soil parameters.

Register today to use this FREE program: www.helixpro.supportworks.com

YOUR LOCAL DEALER

For more information about Supportworks, Inc.,
or to locate a Supportworks dealer in your area,
please visit supportworks.com or call 800.281.8545.

Supportworks

GroundED

What's Inside

40

FALL 2019

Zinc Coating Versus Powder Coating for Corrosion Protection of Helical Piles

---

FEATURED CASE STUDY:

Mendards Mezzanine Addition – La Crosse, WI
Foundation Supportworks® of Wisconsin

DISTRIBUTION
CHECKLIST

☐ ____________ ☐ ____________ ☐ ____________ ☐ ____________ ☐ ____________