SP-150069
(New)

SPECIAL PROVISIONS
FOR
GALVANIC CORROSION PROTECTION SYSTEM

Linn County
MBIN-380-6(552)20--0M-57

Effective Date
March 15, 2016

THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

150069.01 DESCRIPTION.

A. Summary.

The work under this specification consists of supplying all materials and labor to properly install embedded discrete galvanic anodes or distributed galvanic units; including connections to existing reinforcing, tools, equipment, testing services, and technical assistance to ensure a properly operational corrosion protection system.

Discrete embedded galvanic anodes are designed to provide localized corrosion protection to pier cap concrete repair areas. When placed at the appropriate spacing along the perimeter of concrete patches or along the interface between new/existing concrete, the anodes mitigate active corrosion and the formation of new corrosion sites in the adjacent existing concrete.

Distributed galvanic anode units are connected to the column reinforcing steel and encased in a concrete jacket with a minimum of 2 inches of clear concrete cover over the anode units. After the anodes are installed and encased in concrete, the anodes will provide galvanic protection to the embedded steel in the column.

B. References.

1. ACI/ICRI Concrete Repair Manual.

2. ACI Guideline No. 222 – Corrosion of Metals in Concrete.

3. ASTM B6 - Standard Specification for Zinc.

4. ASTM B69 - Standard Specification for Rolled Zinc.

5. ACI 562-13 Code Requirements for Evaluation, Repair and Rehabilitation of Concrete Buildings.

6. ACI Repair Application Procedure (RAP) Bulletin 8 – Installation of Embedded Galvanic Anodes (2010).

7. ICRI Guideline 310.1R-2008 Guide for Surface Preparation for the Repair of Deteriorated Concrete resulting from Reinforcing Steel Corrosion.

8. ASTM B418-12 – Standard Specification for Cast and Wrought Galvanic Zinc Anodes.

C. Submittals.

Shop drawings showing typical galvanic corrosion protection system installation details, such as type, size and spacing of anodes, type and location of anode standoff spacers, and reinforcing connections shall be prepared by the Contractor and submitted for approval prior to installation.

150069.02 MATERIALS.

A. Discrete Galvanic Anodes.

1. Embedded galvanic anodes shall be alkali-activated zinc, designed for corrosion control with nominal dimensions of 4.3 inches long by 2.2 inches wide by 1.2 inches deep. The anodes shall be pre-manufactured with 160 grams of zinc in compliance with ASTM B 418 Type II cast around a pair of uncoated, non-galvanized steel tie wires and encased in a highly alkaline cementitious shell with a pH of 14 or greater.

2. The galvanic anodes shall be alkali-activated and shall contain no intentionally added chloride, bromide, or other constituents that are corrosive to reinforcing steel as per ACI 562-13. Anode units shall be supplied with integral unspliced wires for directly tying to the reinforcing steel.

B. Distributed Anode Units.

1. Distributed galvanic anode units shall be alkali-activated zinc with nominal exterior dimensions of approximately 1.875 inches The distributed anode unit shall consist of 1.2 pounds of zinc per lineal foot of anode. The zinc anode shall be manufactured in compliance with ASTM B 418 Type II and ASTM B69 Rolled Special High Grade Zinc using zinc in compliance with ASTM B6 Special High Grade with iron content less than 15 ppm.

2. The zinc shall be alkali-activated with a pH greater than 14. The anode unit shall contain no constituents that are corrosive to reinforcing steel as per ACI 222R such as chlorides, bromides, or other halides. The anode unit shall be supplied with a minimum of two lead wires of sufficient length to make connections between anodes and the reinforcing steel.

C. Patching Materials.

1. Use materials meeting the requirements of Section 2426.02, B, of the Standard Specifications.

2. Repair mortars, concrete and bonding agents shall be portland cement-based materials with suitable electrical resistivity less than 15,000 ohm-cm. Non-conductive repair materials such as epoxy, urethane, or magnesium phosphate shall not be permitted. Patch materials with significant polymer modification, fly ash, ground granulated blast furnace slag (GGBFS) or silica fume content may have high resistivity and may require additional testing and approval by the galvanic anode manufacturer. Insulating materials such as epoxy bonding agents shall not be used unless otherwise called for in the design.

D. Storage.

Deliver, store, and handle all materials in accordance with manufacturer's instructions. Anode

units shall be stored in dry conditions in the original unopened containers in a manner to avoid exposure to extremes of temperature and humidity.

150069.03 CONSTRUCTION.

A. Manufacturer Technical Assistance.

1. Enlist and pay for the services of a technical representative employed by the galvanic anode manufacturer to provide training and on-site technical assistance during the installation of the galvanic protection system. The technical representative shall be a NACE-qualified corrosion technician (Cathodic Protection Technician-CP2 or higher).

2. Ensure the qualified corrosion technician has verifiable experience in the installation and testing of embedded galvanic protection systems for reinforced concrete structures.

3. Coordinate work with the designated corrosion technician to allow for site support during project startup and initial anode installation. The technician shall provide contractor training and support for development of application procedures, shop drawing submittals, anode installation, reinforcing steel connection procedures, and verification of electrical continuity of embedded steel.

B. Concrete Removal.

Apply Section 2426 of the Standard Specifications.

1. Remove loose or delaminated concrete.

2. Undercut all exposed reinforcing steel by removing concrete from the full circumference of the steel as per ICRI R310.1R. The minimum clearance between the concrete substrate and reinforcing steel shall be 3/4 inch or 1/4 inch larger than the top size aggregate in the repair material, whichever is greater.

3. Column vertical reinforcing steel need not be undercut if the concrete is sound and at least one-half of the bar perimeter is bonded to the existing concrete. See concrete repair details in the contract documents.

4. Concrete removal shall continue along the reinforcing steel until no further delamination, cracking, or significant rebar corrosion exists and the reinforcing steel is well bonded to the surrounding concrete as per ICRI R310.1R.

C. Cleaning, Repair and Testing of Reinforcing Steel.

1. Clean all exposed reinforcing steel according to Article 2426.03, B, 3 of the Standard Specifications.

2. Secure loose reinforcing steel by tying tightly to other bars with steel tie wire.

3. Verify electrical continuity of all exposed reinforcing steel. All new or supplemental steel installed shall also be electrically tied to the existing reinforcing steel.

- **a.** Test visible and exposed existing reinforcing bars within the repair areas with a DC multi-meter to be reasonably confident that continuity exists between the existing bars including longitudinal bars and hoops/stirrups. If continuity does not exist, establish continuity by mechanically tying discontinuous steel to continuous steel by steel tie wire or other approved means.
- **b.** Electrical connection between test areas is acceptable if the DC resistance measured with the multi-meter is 1 ohm or less or the DC potential is 1 mV or less.

D. Installation of Discrete Galvanic Anodes.

1. Place anode units and concrete repair material immediately following preparation and cleaning of the steel reinforcement.

2. Install galvanic anodes along the perimeter of the repair and/or in a grid pattern throughout the entire repair area as specified in the contract documents.

3. Place the galvanic anodes within 4 inches of the patch edge while still providing sufficient clearance between anodes and substrate to allow the repair material to fully encase the anode with a minimum concrete cover over the anode of 1 inch. If necessary, increase the size of the repair cavity to accommodate the anodes.

4. Wrap tie wires around the cleaned reinforcing steel at least one full turn in opposite directions and then twisted tight to create a secure electrical connection and allow no anode movement during concrete placement. The minimum concrete cover over the anodes should be 3/4 inch.

5. Electrical Continuity.
- **a.** Confirm electrical connection between anode tie wire and reinforcing steel by measuring DC resistance (ohms) or DC potential (mV) with a multi-meter.
- **b.** Electrical connection is acceptable if the DC resistance measured with the multi-meter is 1 ohm or less or the DC potential is 1 mV or less.

6. Complete the concrete repairs taking care not to damage, loosen or leave voids around the anode.

E. Installation of Distributed Anode Units.

1. The Contractor shall directly connect each anode unit to exposed reinforcing steel on each column receiving corrosion protection. Alternately, the anodes can be wired together and connected to a minimum of two electrical (negative) connections per column. Whenever possible, electrical connections should be located at repair areas where reinforcing steel is exposed. If no exposed steel exists after preparation of the column, a small area of concrete shall be removed to expose a tie. Electrical connections to the reinforcing steel shall be established to spiral or hoop ties using mechanical ties or other approved techniques. Proposed electrical connection details shall be approved by the anode manufacturer and shall be detailed on the shop drawing submittal.

2. All reinforcing steel connections shall receive a coat of 100% solids, non-conductive epoxy such that no wire connections will be in contact with the concrete when patching is complete. The Contractor shall verify continuity between the connections and the reinforcing steel, as noted above, prior to coating with epoxy.

3. Distributed galvanic anode units shall be installed with an even spacing around the column surface. The anodes shall be secured against plastic spacers that provide minimum clearance between the existing concrete surface and the anode unit of 1 inch or as sufficient to allow complete consolidation of the concrete around the anode.

4. Filling of the annulus between the column and the exterior form shall be completed in accordance with the contract documents. Concrete can be pumped through ports installed into the bottom of the forms or poured from the top assuring that no segregation or air voids exist after concrete placement. After the concrete has sufficiently cured, all temporary form support and/or bracing shall be removed from the columns.

150069.04 METHOD OF MEASUREMENT.

A. Measurement for the quantities involved in pier repairs will be as provided in the following sections:

1. Structural Concrete: Article 2403.04 of the Standard Specifications applies.

2. Reinforcement: Article 2404.04 of the Standard Specifications applies.

3. Concrete Repair: Article 2426.04 of the Standard Specifications applies.

B. No measurement will be made for the galvanic corrosion protection system.

150069.05 BASIS OF PAYMENT.

A. Payment for the quantities involved in pier repairs will be as follows:

1. Structural Concrete: Article 2403.05 of the Standard Specifications applies.

2. Reinforcement: Article 2404.05 of the Standard Specifications applies.

3. Concrete Repair: Article 2426.05 of the Standard Specifications applies.

B. The Contractor will be paid the contract lump sum price for the Galvanic Corrosion Protection System. Payment is full compensation for:

- Furnishing all material including discrete galvanic anodes and distributed anode units,
- Continuity testing of existing reinforcing steel,
- Establishing continuity if necessary (including furnishing and installing all wire ties),
- Making electrical connections,
- Obtaining corrosion technician services,
- Testing electrical resistivity of concrete mix design (if required), and
- All equipment and labor to install the galvanic anodes in accordance with the contract documents.