

Note to Specifier: This document is intended to provide assistance in developing a specification for the use of embedded zinc anodes and should be modified as appropriate to accommodate project specific conditions and applications. For additional information, contact Vector Corrosion Technologies.

Galvashield® XPT - Anode Type 1A Class P - galvanic anodes embedded within concrete patch repairs to provide corrosion prevention.

SECTION 03700 – EMBEDDED GALVANIC ANODES

PART 1 GENERAL

1.1 Related Documents

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

- A. This Section includes furnishing all labor, tools, materials, equipment and services necessary to properly install embedded galvanic anodes.
- B. Embedded galvanic anodes are designed to provide localized corrosion protection. 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.

1.3 References

- A. ACI/ICRI Concrete Repair Manual
- B. ACI Guideline No. 222 – Corrosion of Metals in Concrete
- C. ACI 562-13 Code Requirements for Evaluation, Repair and Rehabilitation of Concrete Buildings
- D. ACI Repair Application Procedure (RAP) Bulletin 8 – Installation of Embedded Galvanic Anodes (2010)
- E. ICRI Guideline 310.1R-2008 Guide for Surface Preparation for the Repair of Deteriorated Concrete resulting from Reinforcing Steel Corrosion
- F. ASTM B418-12 – Standard Specification for Cast and Wrought Galvanic Zinc Anodes

Note to Specifier: Vector provides a standard limited warranty against defects in materials and workmanship of the manufactured product. This is included in the standard terms of sale and can be downloaded from the Vector website at www.vector-corrosion.com/warranty.pdf.

An extended limited project-specific warranty is also available that covers anode activity over a five year period. Eligible projects shall be professionally designed by a licensed architect or engineer and include manufacturer supplied site training.

If a project is to require an extended limited warranty, contact Vector's Business Development Manager prior to final design and include the information in Section 1.4 and Section 3.4.G.

1.4 Manufacturer Extended Limited Warranty

- A. Contractor shall provide a Limited Warranty with a notarized signature from a corporate officer of the anode manufacturer.
- B. The Limited Warranty shall state the following:
 - 1. The published anode spacing guidelines for anode size and spacing are based on an estimated 10-20 year anode service life.
 - 2. The galvanic anodes will remain electrochemically active and produce galvanic current in relation to the environment in which it is installed for a minimum of 5 years from the date of anode installation.
 - 3. The anode unit, including its constitutes, does not include intentionally added substances that may cause corrosion to reinforcing steel over the life of the structure.
 - 4. The galvanic anodes meet all building and repair code requirements.

PART 2 PRODUCTS

2.1 Embedded Galvanic Anodes

Note to Specifier regarding Anode Nomenclature:

Type: Anode Type is a two-character code

The first character indicates where the anode is installed:

- 1 - Embedded in concrete repairs, or*
- 2 - Embedded into sound concrete.*

The second character denotes the type of zinc activation utilized:

- A - Alkali-activated using high pH, or*
- H - Halide-activated using corrosive salts.*

Class: This indicates the intended use of the anode.

- C – Corrosion control (reducing existing active corrosion) and corrosion prevention (preventing the initiation of corrosion), or*
- P - Corrosion prevention only.*

Embedded galvanic anodes shall be Anode Type 1A Class P with the following nominal dimensions: 4.9 in. long by 1.0 in. wide by 1.0 in. deep (125 mm x 25 mm x 25 mm). The anodes shall be pre-manufactured with a nominal 60 grams of zinc in compliance with ASTM B418 Type II cast around a single uncoated, non-galvanized steel tie wire which extends from the anode in two locations, and encased in a highly alkaline cementitious shell with a pH of 14 or greater.

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. Embedded galvanic anodes shall be Galvashield® XPT available from Vector Corrosion Technologies (www.vector-corrosion.com) USA (813) 830-7566, Canada (204) 489-9611 or approved equal.

Application for approved equals shall be requested in writing two weeks before submission of project bids. Application for galvanic anode approved equals shall include verification of the following information:

1. The zinc anode is alkali-activated with an alkaline cementitious shell with a pH of 14 or greater.
2. The galvanic anode shall contain no intentionally added constituents corrosive to reinforcing steel, e.g. chloride, bromide, etc.
3. The anode manufacturer shall provide documented test results from field installations showing that the anodes have achieved a minimum of 10 years in service.
4. The galvanic anode shall have been used in a minimum of ten projects of similar size and application.
5. The galvanic anode units shall be supplied with solid zinc core (ASTM B418) cast around a single uncoated, non-galvanized, non-spliced steel tie wire for wrapping around the reinforcing steel and twisting to provide a durable steel to steel connection between the tie wire and the reinforcing steel.
6. The anode manufacturer shall provide third party product evaluation, such as from Concrete Innovations Appraisal Service, BBA, etc.

2.2 Repair Materials

- A. Repair mortars, concrete and bonding agents shall be portland cement-based materials with suitable electrical conductivity less than 15,000 ohm-cm. Non-conductive repair materials such as epoxy, urethane, or magnesium phosphate shall not be permitted. Repair materials with significant polymer modification and/or silica fume content may have high resistivity. Insulating materials such as epoxy bonding agents shall not be used unless otherwise called for in the design.
- B. If higher resistance repair materials are used, or the resistivity is unknown, use Galvashield Embedding Mortar to create a conductive bridge to the substrate prior to repair material installation.

2.3 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.

PART 3 EXECUTION

3.1 Concrete Removal

- A. Remove loose or delaminated concrete.
- B. 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 $\frac{3}{4}$ inch (19 mm) or $\frac{1}{4}$ inch (6 mm) larger than the top size aggregate in the repair material, whichever is greater.
- C. 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.

Note to Specifier: if concrete removal will not continue until clean steel is encountered as per ICRI Guideline 310.1R-2008 Guide for Surface Preparation for the Repair of Deteriorated Concrete resulting from Reinforcing Steel Corrosion, use Galvashield XP2 or XP4 anodes at the corrosion control spacing for the appropriate level of corrosion risk.

3.2 Cleaning and Repair of Reinforcing Steel

- A. Clean exposed reinforcing steel of rust, mortar, etc. to provide sufficient electrical connection and mechanical bond.
- B. If significant reduction in the cross section of the reinforcing steel has occurred, replace or install supplemental reinforcement as directed by the engineer of record.
- C. Secure loose reinforcing steel by tying tightly to other bars with steel tie wire.
- D. Verify electrical continuity of all reinforcing steel, including supplemental steel, as per Section 3.4.F.
- E. If the reinforcing steel is to receive a barrier coating, do not coat the reinforcing steel within 1 in. (25mm) of the anode and do not apply coating to any surface of the anode or the steel tie wires.

3.3 Edge and Surface Conditioning of Concrete

- A. Concrete patches shall be square or rectangular in shape with squared corners per ICRI Guideline 310.1R-2008.
- B. Saw cut the patch boundary $\frac{1}{2}$ inch (13 mm) deep or less if required to avoid cutting reinforcing steel.
- C. Create a clean, sound substrate by removing bond-inhibiting materials from the concrete substrate by high pressure water blasting or abrasive blasting.

3.4 Galvanic Anode Installation

- A. Install anode units and repair material immediately following preparation and cleaning of the steel reinforcement.

Note to Specifier: Galvanic anodes can be used at the interface of new and old concrete to provide targeted protection around the perimeter of repairs and slab replacements or at the interface of new and old concrete such as joint repairs, structure widening/extension, etc.

In some cases, it is preferred to use anodes on a grid pattern throughout the entire repair area for more complete protection. Examples may include partial depth repair where a second mat of steel remains in chloride contaminated concrete, or where all steel in the patch area should be protected due to low cover or corrosive exposure conditions.

- B. Galvanic anodes shall be installed [along the perimeter of the repair] [along the interface between new and old concrete] [in a grid pattern throughout the entire repair area] at a maximum spacing of [x in. (x mm)].

Note to Specifier: Anode spacing is dependent upon the reinforcing steel density, the level of corrosion risk (i.e. amount of chloride and the corrosivity of the local environment, etc). Typical spacing for Galvashield XPT ranges from 17 -28 in. (430-700 mm). The maximum anode spacing guidelines for a 10-20 anode service life can be found on the Galvashield XPT data sheet. Anode spacing should be adjusted for aggressive service conditions or for an extended anode service life.

- C. Place the galvanic anodes as close as possible to 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 or mortar cover over the anode of 1 in. (25mm). If necessary, increase the size of the repair cavity to accommodate the anodes.
1. Place the anode such that the preformed BarFit™ groove fits along a single bar or at the intersection between two bars and secure to each clean bar.
 2. If less than 1 in. (25 mm) of concrete cover is expected, place anode beneath the bar and secure to clean reinforcing steel.
- D. Wrap each end of the tie wire around the clean reinforcing steel at least one full turn in opposite directions, one clockwise and the other counterclockwise. Bring the two free ends together and twist tight for secure connection.
- E. If repair materials with resistivity greater than 15,000 ohm-cm are to be used or if the resistivity is unknown, pack Galvashield Embedding Mortar between the anode and the substrate concrete to create a conductive grout bridge ensuring no voids exist.
- F. Electrical Continuity
1. Confirm electrical connection between anode tie wire and reinforcing steel by measuring DC resistance (ohm Ω) or DC potential (mV) with a multi-meter.
 2. Electrical connection is acceptable if the DC resistance measured with the multi-meter is 1 Ω or less or the DC potential is 1 mV or less.
 3. Confirm electrical continuity of the exposed reinforcing steel within the repair area. If necessary, electrical continuity shall be established by tying discontinuous steel to continuous steel using steel tie wire.

4. Electrical continuity between test areas is acceptable if the DC resistance measured with multi-meter is 1 Ω or less or the potential is 1 mV or less.

Note to Specifier: If the project designer or owner requires that the anode manufacturer provides an experienced corrosion technician for on-site contractor training, or if an extended warranty will be required (per Section 1.4) include the language in Section 3.4.G.

G. Manufacturer Corrosion Technician

1. The contractor will enlist and pay for a technical representative employed by the galvanic anode manufacturer to provide training and on-site technical assistance during the initial installation of the galvanic anodes. The technical representative shall be a NACE-qualified corrosion technician (Cathodic Protection Technician–CP2 or higher).
2. The qualified corrosion technician shall have verifiable experience in the installation and testing of embedded galvanic protection systems for reinforced concrete structures.
3. The contractor shall coordinate its work with the designated corrosion technician to allow for site support during project startup and initial anode installation. The corrosion technician shall provide contractor training and support for development of application procedures, verification of electrical continuity, and project documentation.

3.5 Concrete or Mortar Replacement

- A. If the repair procedures require the concrete surface to be saturated with water, do not damage the anode nor allow the anode units to be soaked for greater than 20 minutes.
- B. Complete the repair with the repair material, taking care not to damage, loosen or leave voids around the anode.

END OF SECTION