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® CC4 - Anode Type 2A - galvanic anodes embedded within drilled holes to provide corrosion control and corrosion prevention for concrete structures.

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 Type 2A embedded galvanic anodes.

B. Embedded galvanic anodes are designed to provide corrosion control in chloride-contaminated or carbonated concrete. When placed in drilled holes at the appropriate spacing, the anodes will mitigate corrosion and extend the service life of the concrete structure.

1.3 References

A. ACI/ICRI Concrete Repair Manual

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

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

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

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

F. ASTM C 309 Curing Compounds for Concrete

*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*](http://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 3.5.***

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 minimum 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 constituents, 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.

*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 1.5.*

1.5 Anode Manufacturer Corrosion Technician

A. 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).

B. The qualified corrosion technician shall have verifiable experience in the installation and testing of embedded galvanic protection systems for reinforced concrete structures.

C. 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.

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.*

Embedded galvanic anodes shall be Anode Type 2A with the following nominal dimensions (diameter x length) 36 x 100 mm (1.4 x 4 in.). The anode units shall bepre-manufactured with zinc in compliance with ASTM B418 Type II cast around an uncoated, non-galvanized steel lead wire 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. The anode size and spacing shall deliver a minimum current density to the steel adjacent to the repair of [0.6mA/m2 (0.07mA/ft2)] [1.2mA/m2 (0.13mA/ft2)] [2.4mA/m2 (0.26mA/ft2)] for the 20-year design life taking into account an anode aging factor calculated from previous field installations and the in-service environment.

*Note to Specifier regarding Anode Spacing: Anode spacing is dependent upon the reinforcing steel density, the level of corrosion risk (i.e. amount of chloride and the corrosively of the local environment, etc). Typical spacing for Galvashield CC4 ranges from 13 -28 in. (325-700 mm).*

*The published anode spacing tables for the Galvashield CC Product Line (December 2021 edition) are based on achieving a minimum current density for 20 years in environments with average annual temperatures 10-15oC (50-60oF). To achieve this, a galvanic anode aging factor of 12.5-year half-life is utilized.*

|  |  |  |
| --- | --- | --- |
| ***Corrosion Risk Category*** | ***Chloride Level*** | ***Minimum Current Density*** |
| *Low to Moderate* | *<0.8%* | *0.6mA/m2 (6.5mA/ft2)* |
| *High* | *0.8%-1.5%* | *1.2mA/m2 (12.9mA/ft2)* |
| *Extremely High* | *>1.5%* | *2.4mA/m2 (25.8mA/ft2)* |

*Cold and/or drier conditions will reduce the anode current. In warmer or more corrosive conditions such as marine exposure, Galvashield CCX is recommended to achieve the 20-year anode life.*

*For more information on the design methodology or to receive a custom design, contact Vector.*

Embedded galvanic anodes shall be Galvashield® CC4 available from Vector Corrosion Technologies (www.vector-corrosion.com or vector-corrosion.eu), USA (813) 830-7566, Canada (204) 489-6300, 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

1. The galvanic anode shall contain no intentionally added constituents corrosive to reinforcing steel or detrimental to concrete, e.g. chloride, bromide, etc.
2. The anode manufacturer shall provide documented performance data from field installations showing that the anodes have remained active for a minimum of 10 years in service.
3. Project design calculations showing that the minimum specified current density will be achieved 20 years after installation. The design calculations shall take into consideration expected in-service temperature and humidity conditions in the environment in which the anodes are to be placed in service and use a galvanic anode aging factor derived from field monitoring for at least one anode half-life (time until the current halves).  *[The aging factor for Galvashield is 12.5 years at average annual temperature of 10-15oC (50-60oF)]*
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 an uncoated, non-galvanized, non-spliced steel lead wire for making a durable steel-to-steel connection.
6. Third party product evaluation, such as from Concrete Innovations Appraisal Service, BBA, etc.

2.2 Grout

A. Grouting material shall be Vector Galvashield Embedding Mortar from Vector Corrosion Technologies or approved equal.

2.3 Anode Connections

A. To connect each anode directly to the steel, use Vector Rebar Connection Kit and Vector Setting Tool from Vector Corrosion Technologies or approved equal.

B. To connect a group of anodes in series to the steel, use the Vector Anode Connection Kit or Galvashield CC Rivet Connector Kit from Vector Corrosion Technologies or approved equal.

2.4 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 Anode Layout

1. Using a suitable rebar locator, the location of the reinforcing grid should be determined and marked out in areas where anodes are to be installed.

*Note to Specifier: Refer to Galvashield CC product data sheet for product selection and spacing guidelines. Specify maximum grid dimensions in 3.1.B.*

1. Mark out locations for anode installation. The anodes shall be installed with a maximum spacing of *[enter maximum grid dimension]* on center *[(in a single line) (on a grid pattern)]*. When possible, anodes shall be installed in the center of the reinforcing grid or a minimum 100mm (4 inches) away from reinforcing steel.
2. Mark out location of rebar connections. If the anodes are to be individually connected, one rebar connection per anode is required. If the anodes are to be installed in series, two rebar connections per string of anodes are required with a maximum of 20 anodes per string.

3.2 Drill Holes and Saw Cuts

1. Rebar Connection – Electrical connections shall be established as per the design using Vector Rebar Connection Kit, Galvashield CC Rivet Connectors or drill and tap methods.
2. If using the Vector Rebar Connector, at the location of the rebar connections, drill 12mm diameter (½ in.) holes from the concrete surface until contact is established with the top surface of the rebar. Let the drill bit spin on top of the bar to provide a clean contact area.
3. If using Galvashield CC Rivet Connectors, chip 50 mm (2 in.) holes to expose steel reinforcement in two locations per string of anodes.

B. Anode Location – Drill a hole a minimum of 42mm in diameter x 130 in depth (1 3/4 in. x 5-1/8 in.) in close proximity to marked out location to accommodate the anode. Do not damage rebar when drilling holes.

C. Saw cuts – All saw cuts into the concrete surface between the anode installation holes and the rebar connection holes shall be approximately 6 mm (¼ in.) wide by 13mm (½ in.) deep.

1. If anodes are to be individually connected, saw cut grooves between the anode installation hole and the rebar connection hole for each anode location.

2. If anodes are to be installed in series, saw cut a single continuous groove between the anode installation holes and the rebar connection holes.

1. All holes and saw cuts shall be cleaned of debris and concrete dust.

3.3 Rebar Connections

A. If using one Vector Rebar Connectors, place the weighted end of the connector into the drilled hole until the steel coil contacts the top of the steel. Feed the steel connector wire through the Vector Setting Tool and set into place by striking with a hammer.

B. If using the Galvashield CC Rivet Connector Kits, electrical connection to the steel shall be established by drilling a 6mm (¼ in.) deep hole into the steel using the 3.5mm (0.14 in.) drill bit provided. A 3.2mm (1/8 in.) stainless steel pop rivet is used to connect the connecting wire to the steel. The connection shall be insulated by a neutral cure sealant or epoxy.

C. Proper connection and rebar continuity for each rebar connection shall be verified between two installed rebar connectors using a multi-meter. Maximum resistance between the two locations shall be less than 1 ohm.

3.4 Galvanic Anode Installation

1. Holes shall be in a saturated-surface dry condition prior to anode placement.
2. Presoak anodes in a small volume of water for a minimum of 10 and a maximum of 20 minutes. Remove from water bath immediately prior to installation.
3. Complete wiring between the anodes and the rebar connections.

1. If anodes are to be connected individually:

a. Insert the end of the rebar connection wire though the open side of the button-type wire connectors and the steel anode wire into the terminated side. Crimp the button connector until it is flush with its casing and cut off the excess rebar connection wire.

b. Verify continuity between steel anode wire and rebar connection wire with a multi-meter. Resistivity of 1 ohm or less is acceptable.

2. If anodes are to be installed in series:

a. Cut the coated wire supplied in the Vector Anode Connection Kit or the Galvashield CC Rivet Connector Kit leaving enough length to interconnect the anodes and two rebar locations along a single string.

b. Insert the interconnecting coated wire though the open side of the button-type wire connectors supplied in the connector kits and the steel anode into the terminated side. With the anode alongside of the installation hole, crimp the button connector to cut through the wire coating until the connector is flush with its casing.

c. Connect the ends of the interconnecting cable and reinforcing steel connector wires using the same procedures as outlined above in 3.4.C.2.b and trim off the excess rebar connection wire.

d. After all anodes along the string are connected to the interconnecting cable, verify continuity between anodes and rebar connections with a multi-meter. Resistivity of 1 ohm or less is acceptable.

1. Mix one 44 lb (20 kg) bag of embedding mortar with 0.8 to 1.0 gallons (3.2 to 3.7 liters) of potable water. After removing excess water from the presoaked holes, fill each anode installation hole approximately 2/3 full with mixed embedding mortar.
2. Insert an anode into each hole, forcing the embedding mortar to fill the annular space from the bottom up. Top off the hole with embedding mortar or other approved mortar and strike off excess flush with the concrete surface. Minimum cover over the top of the anode shall be 1 in. (25 mm).
3. Bury all wiring into the saw cuts and drilled holes with embedding mortar or other material approved by the owner *[owner’s representative]* and strike off flush with the concrete surface.

*Note to Specifier: It is important that the Galvashield CC anodes be grouted into place with the specially formulated Galvashield Embedding Mortar. Saw cuts and rebar connection holes can be backfilled with the Galvashield Embedding Mortar or other cementitious or polymer-based materials.*

1. Wet cure cement-based mortar or cure with two coats of a membrane-forming concrete curing compound meeting the requirements of ASTM C309.
2. Protect area from traffic for 24 hours.

END OF SECTION