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Evaluation of Coatings Containing Conductive Carbon Additives for Use as an Anode on Atmospherically Exposed Reinforced Concrete

ABSTRACT

This standard provides a test method to evaluate coatings containing conductive carbon additives for use as an anode on atmospherically exposed reinforced concrete. These coatings are commonly applied to steel-reinforced concrete surfaces for the purpose of supplying cathodic protection (CP) current to the embedded steel. The coating systems used for this purpose are intended to serve as an anode material and are not intended to provide a protective barrier coating to the concrete. This standard is intended for use by consultants, suppliers, and users of CP systems intended to reduce corrosion of embedded steel in atmospherically exposed reinforced concrete. This standard is expected to be used primarily to qualify coatings containing conductive carbon additives as an anode material, rather than as a quality control procedure.

KEYWORDS

Reinforced concrete, cathodic protection, conductive carbon additive, conductive coating anode, coatings, electrochemical test, TG 045.

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Foreword

This standard provides a test method to evaluate coatings containing conductive carbon additives for use as an anodes on atmospherically exposed reinforced concrete. Coatings containing conductive carbon additive are commonly applied to steel-reinforced concrete surfaces for the purpose of supplying cathodic protection (CP) current to the embedded steel. The conductive coating systems used for this purpose are intended to serve as an anode material and are not intended to provide a protective barrier coating to the concrete.

This standard is intended for use by consultants, suppliers, and users of CP systems intended to reduce corrosion of embedded steel in atmospherically exposed reinforced concrete. This standard is expected to be used primarily to qualify coatings containing conductive carbon additive as an anode material, rather than as a quality control procedure.

This standard was originally prepared in 2005, revised in 2012, reaffirmed in 2016, and revised in 2018 by NACE Task Group (TG) 045,"Reinforced Concrete: Anode Test Procedures," which is administered by Specific Technology Group (STG) 01, "Reinforced Concrete" and sponsored by STG 05, "Cathodic/Anodic Protection." It is issued by NACE under the auspices of STG 01.

In NACE standards, the terms ***shall, must, should,*** and ***may*** are used in accordance with the definitions of these terms in the NACE Publications Style Manual. The terms ***shall*** and ***must*** are used to state a requirement, and are considered mandatory. The term ***should*** is used to state something good and is recommended, but is not considered mandatory. The term ***may*** is used to state something considered optional.

Evaluation of Coatings Containing Conductive Carbon Additives for Use as an Anode on Atmospherically Exposed Reinforced Concrete

Section 1: General

1.1 This standard provides a test method to evaluate coatings containing conductive carbon additive for use as an anode on atmospherically exposed reinforced concrete. The test method primarily consists of exposing concrete test panels coated with the conductive coating to an electrochemical (EC) test under defined laboratory conditions that are intended to simulate the conditions present when cathodic protection (CP) current discharges from the anode in a working CP system. The evaluation of the coating is based on determination of coating properties (i.e., appearance, adhesion, resistivity, visual inspection, and water vapor transmission) before and after the EC test.

1.2 Accelerated tests are not possible because of the nature of coatings containing conductive carbon additive used as anodes. Therefore, this test does not reflect the accelerated whole-life performance of a conductive coating anode.

1.3 Full round-robin testing on a wide range of coatings containing conductive carbon additive has not been performed, but a number of products were tested in the original test program on which this test method is based and by a laboratory in Europe.[1]

1.4 The results of this test method cannot be used to guarantee the performance of a product in any given field exposure condition. The product also should be field tested, or existing field performance data should be collected whenever possible to demonstrate its suitability for the particular application intended.

Section 2: Test Panels

2.1 Three concrete test panels shall be prepared for each conductive coating anode to be tested.

2.2 The concrete mix used to prepare the test panels shall be as follows:

2.2.1 Cement (ASTM[(1)] C150 / C150M[2] Type 1): 385 kg/m^3 (649 lb/yd^3).

2.2.2 Potable Water: Water-to-cement ratio = 0.45.

2.2.3 Fine aggregate (ASTM C33/C33M[3]) silica sand: 961 kg/m^3 (1,620 lb/yd^3).

2.2.4 Crushed limestone aggregate ((ASTM C33/C33M[3] Size number 8 or 89 [nominal 10 mm]): 777 kg/m^3 (1,310 lb/yd^3).

2.2.5 Chloride: 2.0% by mass of cement (7.7 kg/m^3 [13 lb/yd^3]) added as sodium chloride.

2.2.6 Air-entraining additive (ASTM C260[4]): Used in accordance with the air-entraining additive manufacturer's directions to provide an air content of 3 to 5%.

2.3 Test panel dimensions shall be as shown in Figure 1. A 13 x 13 mm (0.50 x 0.50 in) ± 1% steel wire mesh grid matching the dimension of the panel shall be embedded near the surface of the test panel on one 750 x 750 mm (30 x 30 in) side to act as the cathode. The anode shall be applied to the surface of the bottom (form side) of the test panel opposite the cathode once the panel has been demolded. To make the electrical connection, a contact point for the wire mesh grid shall extend beyond the edge of the test panel. Test panel construction details are shown in Figure 1.

2.4 The test panels shall be cured 28 days in accordance with the following cycle: 7 days wet cure (95 to 100% relative humidity [RH]) followed by 21 days at 50% ± 5% RH).

2.5 After the concrete has been cured and removed from the form, the surface of the form side used for the anode (the side next to the form during casting) of each test panel shall be prepared for coating with a light grit blast (ICRI[(2)] 310.2 CSP 3-4[5]), or in accordance with the conductive coating anode manufacturer's recommendations to remove surface laitance and provide sufficient roughness to promote coating adhesion. The surface shall then be vacuum cleaned.

2.6 A nonconductive epoxy coating such as ASTM C881 Grade 3 Class E Type VI or VII[6] shall be applied to all four 50 mm (2 in) edges of each test panel and cured according to the epoxy coating manufacturer's application instructions.

2.7 Before the conductive coating anode is applied, a primary anode shall be attached at one point of each test panel, as shown in Figure 1. Acceptable primary anode materials are platinum-clad, copper cored titanium ribbon or wire. Other primary anode materials may be used based on the conductive coating anode manufacturer's recommendations. The

[(1)] ASTM International (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.
[(2)] International Concrete Repair Institute, Inc. (ICRI), 1000 Westgate Drive, Suite 252, St. Paul, MN 55114.