Designation: C876 – 22b

Standard Test Method for Corrosion Potentials of Uncoated Reinforcing Steel in Concrete[1]

This standard is issued under the fixed designation C876; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the estimation of the electrical corrosion potential of uncoated reinforcing steel in field and laboratory concrete, for the purpose of determining the corrosion activity of the reinforcing steel.

1.2 This test method is limited by electrical circuitry. Concrete surface in building interiors and desert environments lose sufficient moisture so that the concrete resistivity becomes so high that special testing techniques not covered in this test method may be required (see 5.1.4.1). Concrete surfaces that are coated or treated with sealers may not provide an acceptable electrical circuit. The basic configuration of the electrical circuit is shown in Fig. 1.

1.3 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
G3 Practice for Conventions Applicable to Electrochemical Measurements in Corrosion Testing
G16 Guide for Applying Statistics to Analysis of Corrosion Data
G193 Terminology and Acronyms Relating to Corrosion
G215 Guide for Electrode Potential Measurement

3. Terminology

3.1 For definitions of terms used in this test method, refer to Terminology G193.

4. Significance and Use

4.1 This test method is suitable for in-service evaluation and for use in research and development work.

4.2 This test method is applicable to members regardless of their size or the depth of concrete cover over the reinforcing steel. Concrete cover in excess of 75 mm (3 in.) can result in an averaging of adjacent reinforcement corrosion potentials that can result in a loss of the ability to discriminate variation in relative corrosion activity.

4.3 This test method is not applicable to reinforced concrete structures with epoxy-coated reinforcement.

4.4 This test method is not applicable to reinforced concrete structures in which waterproofing membranes are located between the reinforcement cage and the concrete surface as they can prevent the conduction of electricity and result in erroneous readings.

4.5 This test method may be used at any time during the life of a concrete member after the concrete has set, although it is generally most useful for evaluating mature reinforced concrete that is suspected to be susceptible to corrosion.

4.6 The results obtained by the use of this test method shall not be considered as a means for estimating the structural properties of the steel or of the reinforced concrete member.

---

[1] This test method is under the jurisdiction of ASTM Committee G01 on Corrosion of Metals and is the direct responsibility of Subcommittee G01.14 on Corrosion of Metals in Construction Materials.

Current edition approved Oct. 1, 2022. Published October 2022. Originally approved in 1977. Last previous edition approved in 2022 as C876–22a. DOI: 10.1520/C0876-22B.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

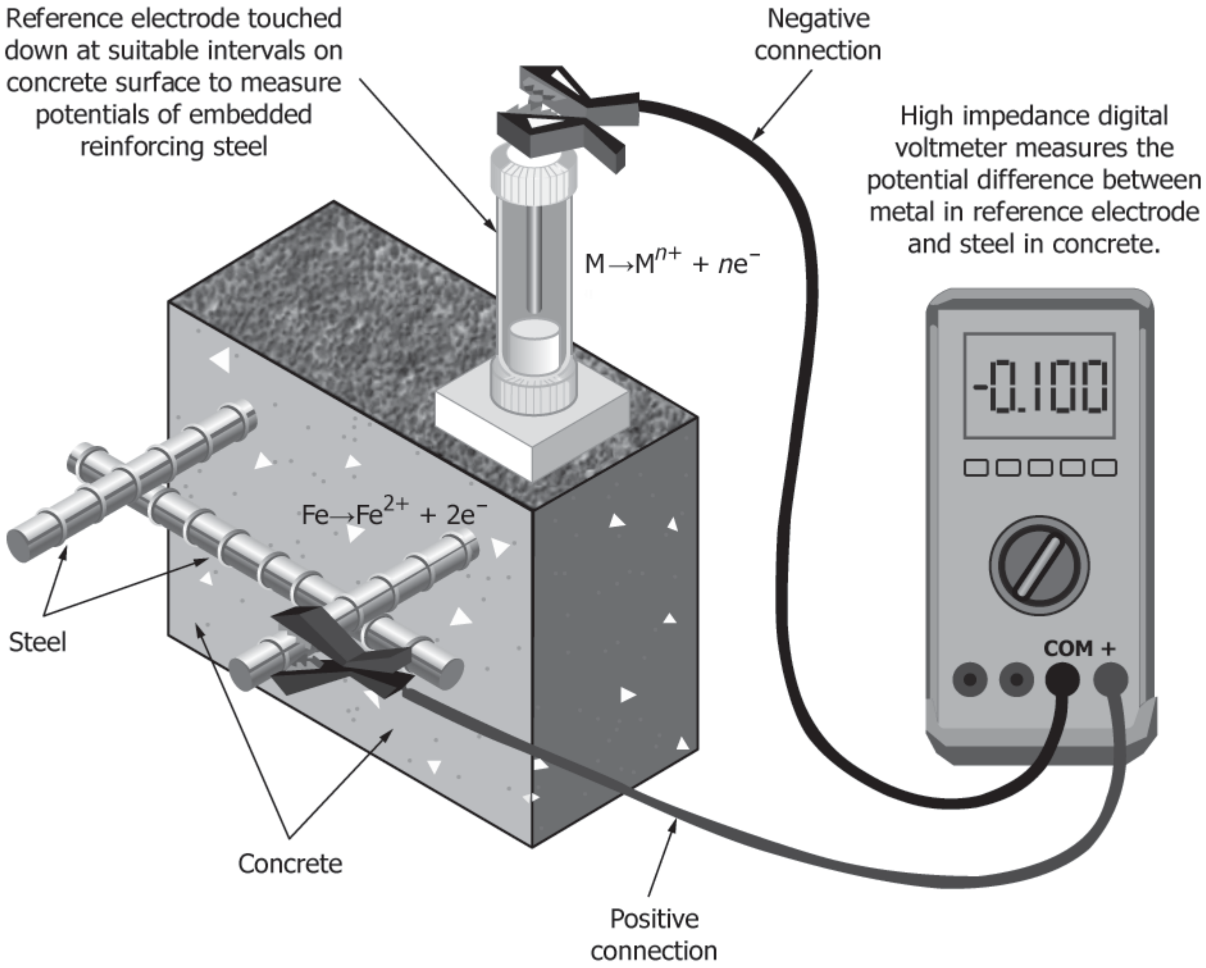

FIG. 1 Reference Electrode Circuitry

4.7 Temperature and humidity can impact potential readings. This is particularly important for periodic testing of the same test location. An increase in the temperature leads to increasing ionic mobility, which in turn affects the reference electrode's potential. The temperature influence can be neglected if the measurements are taken within the range of 22.2 °C ± 5.5 °C (72 °F ± 10 °F). Otherwise, the temperature-dependency of the measurements must be taken into account.

4.8 The potential measurements should be interpreted by engineers or technical specialists experienced in the fields of concrete materials and corrosion testing. It is often necessary to use other complementary data such as chloride contents, depth of carbonation, delamination survey, rate of corrosion, and environmental exposure conditions, in addition to corrosion potential measurements, to formulate conclusions concerning corrosion activity of embedded steel and its probable effect on the service life of a structure.

5. Apparatus

5.1 The testing apparatus consists of the following:

5.1.1 *Reference Electrode:*

5.1.1.1 The reference electrode selected shall provide a stable and reproducible potential for the measurement of the corrosion potential of reinforcing steel embedded in concrete over the temperature range from 0 °C to 49 °C (32 °F to 120 °F).

5.1.1.2 For the purposes of this test method, corrosion potentials shall be based upon the half-cell reaction Cu→ Cu++ + 2e- corresponding to the potential of the saturated copper-copper sulfate reference electrode as referenced to the hydrogen electrode being –0.30 V at 22.2 °C (72 °F) (**1**).[3] The copper-copper sulfate reference electrode has a temperature coefficient of approximately 0.0005 V more negative per °F for the temperature range from 0 °C to 49 °C (32 °F to 120 °F).

5.1.1.3 Additional information regarding measuring electrode potential can be found in Guide G215.

5.1.1.4 Other reference electrodes having similar measurement range, accuracy, and precision characteristics to the copper-copper sulfate electrode may also be used. Calomel reference electrodes have been used in laboratory studies. For concrete submerged in seawater, using silver-silver chloride reference electrodes avoids chloride contamination problems

---

[3] The boldface numbers in parentheses refer to the list of references at the end of this standard.

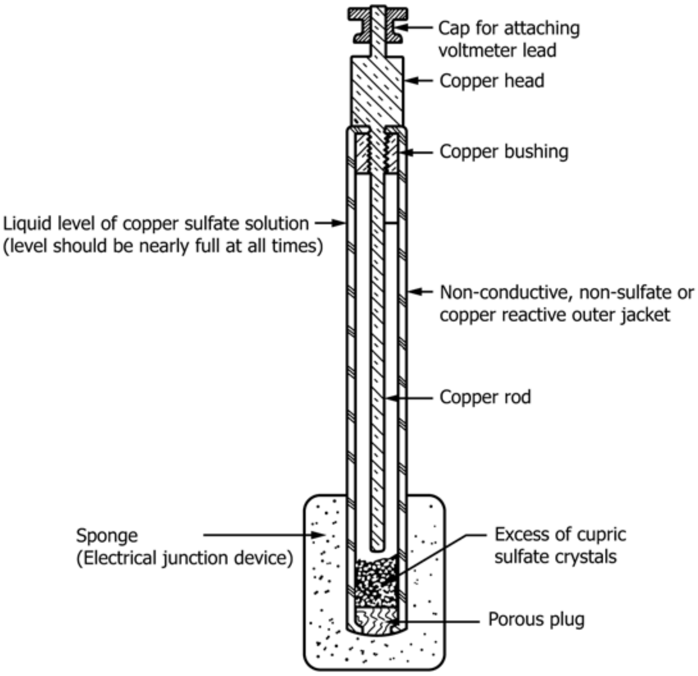

FIG. 2 Sectional View of a Copper-Copper Sulfate Reference Electrode

that may occur with copper-copper sulfate electrodes. Silver-silver chloride/potassium chloride reference electrodes are also applied to atmospherically exposed concrete. Potentials measured by reference electrodes other than saturated copper-copper sulfate should be converted to the copper-copper sulfate equivalent potential. The conversion technique can be found in Practice G3 and *Reference Electrodes Theory and Practice* by Ives and Janz (2).

5.1.2 *Electrical Junction Device*—An electrical junction device shall be used to provide a low electrical resistance liquid bridge between the surface of the concrete and the reference electrode. It shall consist of a sponge or several sponges pre-wetted with a low electrical resistance contact solution. The sponge may be folded around and attached to the tip of the reference electrode so that it provides electrical continuity between the porous plug and the concrete member. The minimum contact area of the electrochemical junction device shall be the area equivalent of a circle with 3× the nominal diameter of the concrete coarse aggregate to a maximum of 0.01 m^2 (16 $in.^2$).

5.1.3 *Electrical Contact Solution*—In order to standardize the potential drop through the concrete portion of the circuit, an electrical contact solution shall be used to wet the electrical junction device. One such solution is composed of a mixture of 95 mL of wetting agent (commercially available wetting agent) or a liquid household detergent thoroughly mixed with 19 L (5 gal) of potable water. Under working temperatures of less than about 10 °C (50 °F), approximately 15 % by volume of either isopropyl or denatured alcohol must be added to prevent the clouding of the electrical contact solution, since clouding may inhibit penetration of water into the concrete to be tested. Conductive gels may be employed to reduce drift in the measured corrosion potential that can derive from dynamic liquid junction potentials. On large horizontal reinforced concrete structures, such as bridge decks, preliminary cleaning of the concrete surface with "street sweepers" has proven successful.

5.1.4 *Voltmeter*—The voltmeter shall allow DC voltage readings, have the capacity to be battery operated, and provide adequate input impedance and AC rejection capability for the environment where this test method is applied.

5.1.4.1 Prior to commencing testing, a digital voltmeter with a variable input impedance ranging from 10 MΩ to 200 MΩ may be used to determine the input impedance required to obtain precision readings. The use of a meter with variable input impedance avoids meter loading errors from high concrete resistivity. An initial reading is taken in the 10 MΩ position, and then switching to successively higher impedances while watching the meter display until the reading remains constant through two successive increases. Then decrease the impedance on setting to reduce noise and provide the most precise readings. If the voltmeter does not display a constant reading through 200 MΩ, then the use of a galvanometer with an input impedance of 1 GΩ or 2 GΩ should be considered. Logging voltmeters may also be used.

5.1.4.2 Electromagnetic interference or induction resulting from nearby AC power lines or radio frequency transmitters can produce an error. When in the proximity of such interference sources, the readings may fluctuate. An oscilloscope can be used to define the extent of the problem and be coupled with the DC voltmeter manufacturer's specification for AC rejection capability to determine the resolution of induced AC interference with successful application of this test method.

5.1.5 *Electrical Lead Wires*—The electrical lead wire shall be of such dimension that its electrical resistance for the length used will not disturb the electrical circuit by more than 0.0001 V. This has been accomplished by using no more than a total of 150 m (500 linear ft) of at least AWG No. 24 wire. The wire shall be coated with a suitable insulation such as direct burial type of insulation.

5.1.6 In addition to single reference electrodes connected to a voltmeter, multiple electrode arrays, reference electrodes with a wheel junction device and logging voltmeters that record distance and potential may also be used.

6. Calibration and Standardization

6.1 *Care of the Reference Electrode*—Follow the manufacturer's instructions for storage, calibration, and maintenance. Electrodes should not be allowed to dry out or become contaminated. The porous plug shall be covered when not in use for long periods to ensure that it does not become dry to the point that it becomes a dielectric (upon drying, pores may become occluded with crystalline filling solution).

6.2 *Calibration of the Reference Electrode*—Reference electrodes shall be calibrated against an approved standard traceable to a national standard at regular intervals as specified by the manufacturer or when the solution is changed. If cells do not produce the reproducibility or agreement between cells described in Section 12, cleaning may rectify the problem. If reproducible and stable readings are not achieved, the reference electrode should be replaced.

6.3 *Calibration of the Voltmeter*—The voltmeter shall be calibrated against an approved standard traceable to a national standard at regular intervals specified by the manufacturer.

7. Procedure

7.1 *Spacing Between Measurements*—While there is no pre-defined minimum spacing between measurements on the surface of the concrete member, it is of little value to take two measurements from virtually the same point. Conversely, measurements taken with very wide spacing may neither detect corrosion activity that is present nor result in the appropriate accumulation of data for evaluation. The spacing shall therefore be consistent with the member being investigated and the intended end use of the measurements (Note 1).

NOTE 1—A spacing of 1.2 m (4 ft) has been found satisfactory for rapid evaluation of structures with large horizontal surfaces like bridge decks. Generally, larger spacings increase the probability that localized corrosion areas will not be detected. Measurements may be taken in either a grid or a random pattern. Spacing between measurements should generally be reduced where adjacent readings exhibit reading differences exceeding 50 mV (areas of high corrosion activity). Cracks, cold joints, and areas with dynamic structural activity can produce areas of localized corrosion activity where the corrosion potential can change several hundred millivolts in less than 300 mm (1 ft). Therefore, care must be given that relatively large spacing between readings does not miss areas of localized corrosion activity. For small, lightly reinforced members, it may be advantageous to map the reinforcement locations with a cover meter and place the reference electrode over the bars on a suitable grid.

7.2 *Electrical Connection to the Steel:*

7.2.1 The type of connection used will depend on whether a temporary or permanent connection is required. Make a direct electrical connection to the reinforcing steel by means of a compression-type ground clamp, by brazing or welding a protruding rod, or by using a self-tapping screw in a hole drilled in the bar. To ensure a low electrical resistance connection, scrape the bar or brush the wire before connecting to the reinforcing steel to ensure a bright metal to bright metal contact. In certain cases, this technique may require the removal of some concrete to expose the reinforcing steel. Electrically connect the reinforcing steel to the positive terminal of the voltmeter. Special care should be exercised with prestressing steels to avoid serious injury, and only mechanical connections should be made. Where welding is employed to make connections to conventional reinforcing steel, preheating will be necessary to avoid forming a brittle area in the rebar adjacent to the weld. Such welding should be performed by certified welders.

7.2.2 Attachment must be made directly to the reinforcing steel except in cases where it can be documented that an exposed steel member is directly attached to the reinforcing steel. Certain members, such as expansion dams, date plates, lift works, scuppers, drains, and parapet rails, may not be attached directly to the reinforcing steel and, therefore, may yield invalid readings. Electrical continuity of steel components with the reinforcing steel can be established by measuring the resistance between widely separated steel components on the test section. The resistance values should be in the range below 1 Ω to ensure electrical continuity. Where duplicate test measurements are continued over a long period of time, identical connection points should be used each time for a given measurement.

7.2.3 Care should be taken that the whole area of the reinforcing mat being measured is electrically continuous by checking electrical continuity between diagonally opposite ends of the area surveyed.

7.3 *Electrical Connection to the Reference Electrode*—Electrically connect one end of the lead wire to the reference electrode and the other end of this same lead wire to the negative (ground) terminal of the voltmeter.

7.4 *Pre-Wetting of the Concrete Surface:*

7.4.1 Under most conditions, the concrete surface or an overlaying material, or both, must be pre-wetted by either of the two methods described in 7.4.3 or 7.4.4 with the solution described in 5.1.3 to decrease the electrical resistance of the circuit.

7.4.2 A test to determine the need for pre-wetting shall be made as follows:

7.4.2.1 Place the reference electrode on the concrete surface and do not move.

7.4.2.2 Observe the voltmeter for one of the following conditions:

(1) The measured value of the corrosion potential does not change or fluctuate with time.

(2) The measured value of the corrosion potential changes or fluctuates with time.

7.4.2.3 If condition *(1)* is observed, pre-wetting the concrete surface is not necessary. However, if condition *(2)* is observed, pre-wetting is required for an amount of time such that the voltage reading is stable (±0.02 V) when observed for at least 5 min. If pre-wetting cannot obtain condition *(1)*, either the electrical resistance of the circuit is too great to obtain valid corrosion potential measurements of the steel, or stray current from a nearby direct current traction system or other fluctuating direct current, such as arc welding, is affecting the readings. In either case, the reference electrode method should not be used.

7.4.3 *Method A for Pre-Wetting Concrete Surfaces*—Use Method A for those conditions where a minimal amount of pre-wetting is required to obtain condition *(1)* as described in 7.4.2.2. Accomplish this by spraying or otherwise wetting either the entire concrete surface or only the points of measurement as described in 7.1 with the solution described in 5.1.3. No free surface water should remain between grid points when potential measurements are initiated.

7.4.4 *Method B for Pre-Wetting Concrete Surfaces*—In this method, saturate sponges with the solution described in 5.1.3 and place on the concrete surface at locations described in 7.1. Leave the sponges in place for the period of time necessary to obtain condition *(1)* described in 7.4.2.2. Do not remove the sponges from the concrete surface until after the reference electrode potential reading is made. In making the corrosion potential measurements, place the electrical junction device described in 5.1.2 firmly on top of the pre-wetting sponges for the duration of the measurement.

7.5 *Underwater, Horizontal, and Vertical Measurements:*

7.5.1 Potential measurements detect corrosion activity, but not necessarily the location of corrosion activity. The precise location of corrosion activity requires knowledge of the electrical resistance of the material between the reference electrode and the corroding steel. While underwater measurements are possible, results regarding the location of corrosion must be interpreted very carefully. Underwater, or other situations where the concrete is saturated with water such as tunnels, often have very low oxygen concentrations at the surface of the reinforcement. Reduction of oxygen availability will shift the rebar corrosion potential significantly in the electronegative direction. Often it is not possible to precisely locate points of underwater corrosion activity in saltwater environments because potential readings along the member appear uniform. Take care during all underwater measurements that the reference electrode does not become contaminated with salt water and that no electrically conductive part other than the porous tip of the copper-copper sulfate electrode reference electrode comes in contact with water, including use of cable connectors specifically designed for use with submerged reference electrodes.

7.5.2 Perform horizontal and vertically upward measurements exactly as vertically downward measurements. However, additionally ensure that when using a copper-copper sulfate electrode that the solution in the reference electrode makes simultaneous electrical contact with the porous plug and the copper rod at all times.

8. Recording Corrosion Potential Values

8.1 Record the electrical corrosion potentials to the nearest 0.01 V. Report all corrosion potential values in volts and correct for temperature if the reference electrode temperature is outside the range of 22.2 °C ± 5.5 °C (72 °F ± 10 °F). The temperature coefficient for the correction is given in 5.1.1.4.

9. Data Presentation

9.1 Test measurements may be presented by one or both of two methods. The first, an equipotential contour map, provides a graphical delineation of areas in the member where corrosion activity may be occurring. The second method, the cumulative frequency diagram, provides an indication of the magnitude of the affected area of the concrete member.

9.1.1 *Equipotential Contour Map*—On a suitably scaled plan view of the concrete member, plot the locations of the corrosion potential values of the steel in concrete and draw contours of equal potential through points of equal or interpolated equal values. The maximum contour interval shall be 0.10 V. An example is shown in Fig. 3.

9.1.2 *Cumulative Frequency Distribution*—To determine the distribution of the measured corrosion potentials for the concrete member, follow the procedures outlined in Guide G16.

10. Interpretation of Results (See Refs 3-10 and Appendix X1)

10.1 Corrosion potentials are normally interpreted using a Numeric Magnitude Technique, or a Potential Difference Technique, or a combination of the two. Information on these techniques is presented in Appendix X1.

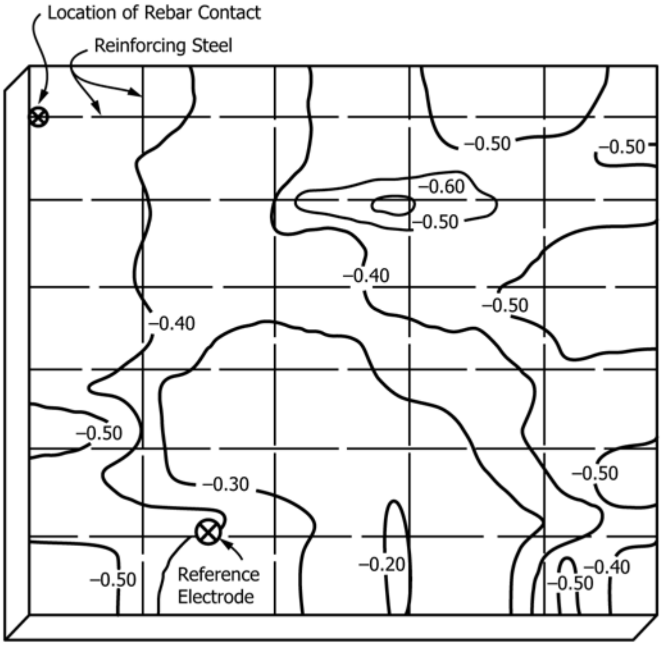

FIG. 3 Equipotential Contour Map

10.2 The numeric magnitude of the potential usually provides an indication of the presence or absence of corrosion of steel embedded in uncarbonated and atmospherically exposed portland cement mortar or concrete, and near the reference electrode tip, provided that the steel does not have a metallic coating, for example, is not galvanized. The numeric magnitude does not indicate the corrosion rate of the steel. The Numeric Magnitude Technique is not applicable to concrete structures that are water-saturated or in near-saturated conditions as may be found in tunnels, basements, water tanks, and submerged situations.

10.3 Potential Difference Technique (Potential Funnel) can provide a sense of the magnitude of the corrosion problem and the presence of localized corrosion, which may not be identifiable by traditional techniques like sounding. Localized corrosion typically manifests considerable change in potential over relatively short distances (hundreds of millivolts over a few hundred millimeters). Relatively negative potentials with little deviation may indicate corrosion is possible, but that oxygen availability is very limited and that absence of oxygen significantly impedes the corrosion rate.

10.4 The interpretations of corrosion potentials under conditions where the concrete is saturated with water, where it is carbonated at the depth of the reinforcing steel, where the steel is coated, and under many other conditions, requires an experienced corrosion engineer or specialist, and may require analyses for carbonation, metallic coatings, halides such as chloride or bromide, and other factors. Guidelines and test methods issued by ASTM Committee G01 and AMPP, The Association for Materials Protection and Performance (formerly NACE International) can be very useful in investigations involving corrosion potential determinations.

TABLE 1 Electrode Potentials and Standard Deviations of Steel Rods in Concrete Slabs Versus Saturated Copper-Copper Sulfate Reference Electrode

NOTE 1—All values in mV.

Slab No.	Ave. Electrode Potential	Repeatability SD s_r	Reproducibility SD s_R
1	–520.3	19.3	20.8
2	–173.5	11.8	14.7
3	–461.0	15.6	26.1
4	–557.5	11.3	12.0
5	–535.0	21.7	21.7

TABLE 2 Electrode Potentials and Standard Deviations of Steel Rods in Concrete Slabs Versus Saturated KCl Silver-Silver Chloride Reference Electrode

NOTE 1—All values in mV.

Slab No.	Ave. Electrode Potential	Repeatability SD s_r	Reproducibility SD s_R
1	–393.9	20.2	24.8
2	–47.6	8.3	16.3
3	–334.0	14.1	24.8
4	–426.1	11.1	23.9
5	–405.6	22.6	33.2

10.5 Corrosion potentials may or may not be an indication of corrosion current. Corrosion potentials may in part or in whole reflect the chemistry of the electrode environment. For example, increasing concentrations of chloride can reduce the ferrous ion concentration at a steel anode, thus lowering (making more negative) the potential. Unless such chemistry, and the presence or absence of competing electrode reactions, is known, a reference electrode potential should not be interpreted as indicative of corrosion rate, or even as indicative of a corrosion reaction.

11. Report

11.1 Report the following information:

11.1.1 Type of cell, used including calibration details and KCl solution concentration for Ag/AgCl/KCl reference electrodes,

11.1.2 The estimated average temperature of the reference electrode during the test,

11.1.3 The method for pre-wetting the concrete member and the method of attaching the voltmeter lead to the reinforcing steel,

11.1.4 An equipotential contour map, showing the location of reinforcing steel contact, or a plot of the cumulative frequency distribution of the corrosion potentials, or both,

11.1.5 The percentage of the total corrosion potentials that are more negative than −0.35 V or other suitable lower threshold, and

11.1.6 The percentage of the total corrosion potentials that are less negative than −0.20 V or other suitable lower threshold.

12. Precision and Bias[4]

12.1 *Precision*—Precision is the closeness of agreement between the test results obtained under prescribed conditions. In the discussion below, two types of precision are discussed: repeatability and reproducibility. Repeatability is within laboratory variability when the same operator uses the same equipment on identical specimens in sequential runs. Reproducibility is the variability that occurs when identical specimens are run in different laboratories.

12.1.1 The precision of Test Method C876 was evaluated by means of an interlaboratory test program in which the corrosion potential of five slabs of concrete with embedded steel rods were each measured at twelve points in a three-by-four grid pattern. Six laboratories collected data using the saturated copper-copper sulfate reference electrode. In addition, four laboratories also used the saturated KCl silver-silver chloride reference electrode with the same procedure. The results of this program were analyzed according to the Practice E691 procedure.

12.1.2 *Repeatability*—The repeatability standard deviations for each slab using the copper-copper sulfate reference electrode are shown in Table 1. The repeatability standard deviations for these slabs using the KCl saturated silver-silver chloride reference electrode are shown in Table 2. The variations are not significantly different, so a pooled repeatability standard deviation was calculated, representing the result for the program of 15.9 mV. The repeatability limit for the program was also calculated as 2.8 s_r, 45 mV.

12.1.3 *Reproducibility*—The reproducibility standard deviations for each slab using the copper-copper sulfate reference electrode are shown in Table 1. The reproducibility standard deviations for these slabs using the saturated KCl silver-silver chloride reference electrode are shown in Table 2. The variations were not significantly different, so a pooled standard deviation was calculated representing the result of this program of 20 mV. The reproducibility limit for the program was also calculated as 2.8 s_R, 57 mV.

---

[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:G01-1027. Contact ASTM Customer Service at service@astm.org.

NOTE 2—The saturated KCl silver-silver chloride reference electrode has a standard potential of +196 mV versus the Standard Hydrogen Electrode (SHE) while the saturated copper-copper sulfate electrode has a standard potential of +300 mV (Practice G3, Table X2.1). The average potential difference between the copper-copper sulfate reference electrode and silver-silver chloride reference electrode was 128 mV in this study rather than 104 mV as predicted by Practice G3. The reason for this difference was not determined.

12.2 *Bias*—There is no bias in the potentials measured by this method because the potentials measurements are defined only in terms of this method.

13. Keywords

13.1 concrete-corrosion activity; concrete-corrosion of reinforcing steel; corrosion; corrosion activity; corrosion potentials

APPENDIX

(Nonmandatory Information)

X1. NOTES ON THE CORROSION POTENTIAL TEST

X1.1 *Numeric Magnitude Technique*—Laboratory testing (partial immersion in chloride solutions) and outdoor exposure (including chloride exposure) of various reinforced concretes aboveground in an area in which the precipitation rate exceeded the evaporation rate, indicate the following regarding the significance of the numerical value of the potentials measured. Voltages listed are referenced to the copper-copper sulfate reference electrode (CSE). Other criteria may apply in other situations (see, for instance, 10.2).

X1.1.1 If potentials over an area are more positive than −0.20 V CSE, there is a greater than 90 % probability that no reinforcing steel corrosion is occurring in that area at the time of measurement.

X1.1.2 If potentials over an area are in the range of −0.20 V to −0.35 V CSE, corrosion activity of the reinforcing steel in that area is uncertain.

X1.1.3 If potentials over an area are more negative than −0.35 V CSE, there is a greater than 90 % probability that reinforcing steel corrosion is occurring in that area at the time of measurement.

X1.1.4 These criteria should not normally be utilized under the following conditions unless either experience or destructive examination of some areas, or both, suggest their applicability:

X1.1.4.1 To evaluate reinforcing steel in concrete that has carbonated to the level of the embedded steel,

X1.1.4.2 To evaluate indoor concrete that has not been subjected to frequent wetting unless it has been protected from drying after casting,

X1.1.4.3 To compare corrosion activity in outdoor reinforced concretes of highly variable moisture or oxygen content, or both, at the embedded steel, and

X1.1.4.4 To formulate conclusions concerning changes in corrosion activity with time on a rehabilitated structure in which the rehabilitation caused the moisture or oxygen content, or both, at the embedded steel to change with time (for example, installation of a low permeability overlay or waterproof membrane on a chloride-contaminated bridge or parking deck).

X1.1.5 The −0.20 V to −0.35 V CSE thresholds may vary for different structures and different exposure conditions.

X1.2 *Potential Difference Technique (Potential Funnel)*—Where large areas of electrically interconnected, embedded steel exist, for example, in bridge decks, reinforced columns, or beams, careful measurement of potentials in a closely spaced grid pattern and the subsequent plotting of equipotential contour maps may allow identification of high versus low corrosion rate areas (see Refs **3-10**).

REFERENCES

(1) Hampel, C. A., *The Encyclopedia of Electrochemistry*, Reinhold Publishing Co., New York, 1964, p. 433.

(2) Ives, D. J. G., and Janz, G. J., *Reference Electrodes Theory and Practice*, Academic Press, NY, 1961.

(3) Spellman, D. L., and Stratfull, R. F., "Concrete Variables and Corrosion Testing," *Highway Research Record 423*, 1973.

(4) Stratfull, R. F., "Half-Cell Potentials and the Corrosion of Steel in Concrete," *Highway Research Record 433*, 1973.

(5) Clear, K. C., and Hay, R. E., "Time to Corrosion of Reinforcing Steel in Concrete Slabs," Vol. 1, *Federal Highway Administration Report FHWA-RD-73-32*, Washington, DC, April 1973.

(6) Clear, K. C., "FCP Annual Progress Report-Year Ending September 30, 1981, Project 4K: Cost Effective Rigid Concrete Construction and Rehabilitation in Adverse Environments," Federal Highway Administration, Washington, DC, 1981.

(7) Virmani, Y. P., Clear, K. C., and Pasko, T. J., Jr., "Time-to-Corrosion of Reinforcing Steel in Concrete Slabs," Vol. 5, *Federal Highway Administration Report FHWA/RD-83/012*, Washington, DC, September 1983.

(8) ACI Committee 222, "Corrosion of Metals in Concrete," *ACI 222R-85*, American Concrete Institute, Detroit, MI, 1985.

(9) "Durability of Concrete Bridge Decks," *NCHRP Synthesis of Highway Practice 57*, Transportation Research Board, Washington, DC, May 1979.

(10) Chamberlain, W. P., Irwin, R. J., and Amsler, D. E., "Waterproofing Membranes for Bridge Deck Rehabilitation," *Report No. FHWA-NY-77-59-1*, FHWA, 1977.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, Tel: (978) 646-2600; http://www.copyright.com/

Copyright by ASTM Int'l (all rights reserved) Sat Nov 04 15:19:56 GMT 2023
Downloaded/printed by
EPFL - Ecole Polytechnique Federale de Lausanne pursuant to License Agreement. No further reproductions authorized.