Standard Method of Test for

Electrical Resistivity of a Concrete Cylinder Tested in a Uniaxial Resistance Test

AASHTO Designation: TP 119-15 (2019)[1]

Technical Subcommittee: 3c, Hardened Concrete

Release: Group 1 (April)

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1. SCOPE

1.1. This test method covers the determination of the electrical resistivity of concrete to provide a very rapid indication of its resistance to the penetration of chloride ions. This test method is applicable to types of concrete where correlations have been established between this test procedure and long-term chloride ponding procedures, such as those described in ASTM C1556. Examples of such correlations are discussed in the references (Sections 15.2. and 15.3).

1.2. The values stated in SI units are to be regarded as the standard.

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

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards*:

- R 39, Making and Curing Concrete Test Specimens in the Laboratory
- T 23, Making and Curing Concrete Test Specimens in the Field
- T 24M/T 24, Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

2.2. *ASTM Standards*:

- C670, Standard Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
- C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
- C1556, Standard Test Method for Determining the Apparent Chloride Diffusion Coefficient of Cementitious Mixtures by Bulk Diffusion

3. SUMMARY OF TEST METHOD

3.1. This test method consists of measuring the resistivity of 200-mm (8-in.) or 300-mm (12-in.) nominal length, and 100-mm (4-in.) or 150-mm (6-in.) nominal diameter cores or cylinders through the longitudinal axis of the geometry. Alternative geometries can be used, with proper determination of the geometry factor. A set of stainless steel plates is used as the electrodes, between which the test sample is placed. An AC current is applied to the plates, and the corresponding voltage is measured. From this, the resistance is determined and normalized by the ratio of cross-sectional area to the length, termed uniaxial resistivity. The resistivity is related to ion penetration resistance.

3.2. This method highlights how uniaxial resistivity can be determined using a commercially available Wenner probe array. This equipment consists of a four pin array of electrodes used in the measurement of surface resistivity. Current is passed between the outer probes, while potential is measured between the inside probes. The electronic display of these units most often directly calculates the apparent surface resistivity. In these cases, to compute uniaxial resistivity, an additional factor of $2\pi a$ is needed, where a represents the spacing of the probes. This is described in more detail in Section 11.1.

4. SIGNIFICANCE AND USE

4.1. This test method covers the laboratory evaluation of the uniaxial electrical resistivity of concrete samples to provide a very rapid indication of their resistance to chloride ion penetration. Research has shown a good correlation between resistivity and chloride exposure tests, such as ASTM C1556, on companion cylinders cast from the same concrete mixtures (Sections 15.2 and 15.3). Resistivity can be related to the diffusion coefficient of chloride ions by the Nernst-Einstein equation (Section 15.4).

4.2. The electrical resistivity of concrete is a material property that depends on the resistivity of the solution within the pores, the pore structure, and the degree of saturation.

4.3. This test method is suitable for evaluation of materials and mixture proportions for design purposes and research and development.

4.4. The numerical results (resistivity, in kohm·cm) from this test method must be used with caution, especially in applications such as quality control and acceptance testing. The qualitative terms in the left-hand column of Table 1 can be used in most cases unless otherwise noted by the specifying agency. Values in the right-hand column in Table 1 were developed using Ohm's law from the classification provided by ASTM C1202 and show good agreement with relationships provided in literature (Section 15.7).

Table 1—Chloride Ion Penetrability Classification

Chloride Ion Penetrability Classification[a]	Uniaxial Resistivity (kohm·cm)
High	<5.2
Moderate	5.2–10.4
Low	10.4–20.8
Very Low	20.8–207
Negligible	>207

[a] Established by ASTM C1202.

4.5. The details of the test method apply to 100-mm (4 in.) and 150-mm (6 in.) nominal diameter specimens. Other specimen diameters or geometries may be tested with appropriate changes in the geometry factor employed in the calculating equation. (See Reference 15.8.)

4.6. Sample age may have significant effects on the test results, depending on the type of concrete and the curing procedure. Most concretes, if properly cured, become progressively and significantly less permeable (more resistive) with time.