Designation: C1952 – 25

Standard Test Method for Determination of Bulk Resistivity Index of Mortar Cubes using Bulk Electrical Resistivity Measurements[1]

This standard is issued under the fixed designation C1952; 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 determination of the bulk electrical resistivity of hardened mortar cubes conditioned in lime-saturated water in order to provide a rapid indication of the development of the volume and continuity of pore structure. This test is conducted on the same mortar cubes used testing for compressive strength.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.2.1 If required results obtained from another standard are not reported in the same system of units as used by this standard, it is permitted to convert those results using the conversion factors found in the SI Quick Reference Guide.[2]

1.3 The text of this standard references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of this 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.* (**Warning—**Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.*)*[3]

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:*[4]

C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50 mm [2 in.] Cube Specimens)
C125 Terminology Relating to Concrete and Concrete Aggregates
C150/C150M Specification for Portland Cement
C219 Terminology Relating to Hydraulic and Other Inorganic Cements
C305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency
C511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
C595/C595M Specification for Blended Hydraulic Cements
C618 Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
C989/C989M Specification for Slag Cement for Use in Concrete and Mortars
C1157/C1157M Performance Specification for Hydraulic Cement
C1240 Specification for Silica Fume Used in Cementitious Mixtures
C1437 Test Method for Flow of Hydraulic Cement Mortar
C1697 Specification for Blended Supplementary Cementitious Materials
C1709 Guide for Evaluation of Alternative Supplementary Cementitious Materials (ASCM) for Use in Concrete
C1810/C1810M Guide for Comparing Performance of Concrete-Making Materials Using Mortar Mixtures
C1866 Specification for Ground-Glass Pozzolan for Use in Concrete
C1876 Test Method for Bulk Electrical Resistivity or Bulk Conductivity of Concrete
C1945 Specification for Raw or Calcined Natural Pozzolan for Use in Concrete

[1] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.48 on Performance of Cementitious Materials and Admixture Combinations.

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[2] Annex A in Form and Style for ASTM Standards, https://public-admin-files.s3.us-east-2.amazonaws.com/general/Bluebook_10-18-23.pdf

[3] Section on Safety Precautions, Manual of Aggregate and Concrete Testing, Annual Book of ASTM Standards, Vol. 04.02.

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

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this standard, refer to Terminology C125 and Terminology C219.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *bulk electrical resistivity, n*—material property that quantifies how strongly the material opposes the flow of electrical charge when an electric field is applied using electrodes placed on opposite faces of a test specimen; measured in units of ohm-meter.

3.2.2 *bulk electrical resistivity index, n*—the electrical resistivity of mortar cubes containing supplementary cementitious materials expressed as a ratio of the electrical resistivity of a control mixture.

4. Summary of Test Method

4.1 The electrical resistance of Test Method C109/C109M mortar cube specimens conditioned in water saturated with calcium hydroxide is measured. Prior to test, the bulk resistivity test device is verified over the expected range of resistivity in accordance with Test Method C1876. The specimen is placed between two plate electrodes in the test device and the resistance is measured and bulk electrical resistivity is calculated. The mortar cubes cast to measure strength activity of supplementary cementitious materials are tested prior to measurement of strength and a bulk resistivity index is calculated from the ratio of the bulk resistivity of the mixture containing the supplementary cementitious material to that of the control cement mixture.

5. Significance and Use

5.1 The electrical resistivity of a mortar specimen represents the opposition to the transport of ions in the pore solution of the mortar under an applied electric field. A higher resistivity is indicative of a lower rate of transport such as permeability. The measured electrical resistivity depends upon the pore volume, the pore structure (that is, pore size distribution and connectivity), the pore solution composition, the degree of saturation of the mortar specimen, and the specimen's temperature. Mortar mixture characteristics that are known to affect electrical resistivity, as well as resistance to fluid penetration, include water-cementitious materials ratio, supplementary cementitious material content, the presence of polymeric admixtures, air-entrainment, aggregate type, aggregate volume fraction, degree of consolidation, curing method, and age.

NOTE 1—The bulk resistivity values of mortar cubes should not be considered to be indicative of the potential bulk resistivity of concrete.

5.2 The bulk resistivity index is a relative indicator of the change in porosity, pore size distribution, pore connectivity, and pore solution composition for a mixture containing supplementary cementitious materials, compared to that of a control cement mixture.

NOTE 2—The bulk resistivity index provides an indicator of the reduction in the rate of fluid ingress provided by a supplementary cementitious material.

5.3 This test method is performed on mortar mixtures prepared in accordance with the procedure given in Practice C305, then cast and cured according in accordance with Test Method C109/C109M, immediately prior to testing for compressive strength.

5.4 This test method can also be used to assess the changes in pore structure after different times and temperatures of curing.

6. Interferences

6.1 Electrical resistivity is temperature dependent requiring all tests be performed on mortar specimens conditioned for at least 2 hours at 23 °C ± 2 °C and then tested at that temperature (**1**,**2**).[5]

6.2 The level of saturation of the mortar has a major impact on resistivity because the electric current is conducted through the pore solution. The conditioning procedure of immersion in lime-saturated water used in this test method provides a methodology for achieving a reproducible high level of saturation. Saturation will vary if different conditioning methodologies are used.

6.3 The resistivity of the mortar is a function of the microstructure and the resistivity of the pore solution. The resistivity of the pore solution varies with age and the type of cementitious materials used and the storage solution. The resistivity of the pore solution shall not be considered the same as the lime-saturated water.

6.4 Because mortar has a capacitive component, its electrical response is characterized by a magnitude and a phase difference that is a function of the applied voltage frequency. This may have an effect on the measured test result. The desired quantity is the magnitude of the resistance measured at a frequency that yields the minimum phase difference between the applied voltage and the measured current; that is, the system is behaving most like a resistor. A number of commercial devices operate at a single fixed frequency, typically between 10 Hz and 1 kHz. The degree to which a limited frequency range impacts the result has been found to be no more than 5 % (**1**).

6.5 The thin sponges, saturated with conductive fluid, that connect the test specimen to the plate electrodes, can provide a small amount of resistance (**3**). However, if both electrodes are clamped tightly to the test specimen or compressed with a weight of approximately 2 kg, the resistance is minimal and can be neglected.

7. Apparatus

7.1 *Bulk Resistivity or Conductivity Test Device,* capable of supplying an AC voltage across the entire cross-section of the specimen, measuring the current passing through the specimen to three significant digits, and measuring the voltage drop across the ends of the specimen to three significant digits, as described in Test Method C1876.

7.2 *Stainless Steel Electrically Conductive Plate Electrodes,* made with at least the same dimensions (Note 3) as the ends of

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