Designation: C666/C666M – 26

Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing[1]

This standard is issued under the fixed designation C666/C666M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This test method covers the determination of the resistance of concrete specimens to rapidly repeated cycles of freezing and thawing in the laboratory by two different procedures: Procedure A, Rapid Freezing and Thawing in Water, and Procedure B, Rapid Freezing in Air and Thawing in Water. Both procedures are intended for use in determining the effects of variations in the properties of concrete on the resistance of the concrete to the cyclical freezing and thawing cycles specified in the particular procedure. Neither procedure is intended to provide a quantitative measure of the length of service that may be expected from a specific type of concrete.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.3 All requirements in this test method not specifically designated as belonging to Procedure A or Procedure B apply to both procedures.

1.4 The text of this standard refers to 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.

1.5 *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 the skin and tissue upon prolonged exposure.[2]

1.6 *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:*[3]

C125 Terminology Relating to Concrete and Concrete Aggregates

C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory

C215 Test Method for Fundamental Transverse, Longitudinal, and Torsional Resonant Frequencies of Concrete Specimens

C233/C233M Test Method for Air-Entraining Admixtures for Concrete

C341/C341M Practice for Preparation and Conditioning of Cast, Drilled, or Sawed Specimens of Hydraulic-Cement Mortar and Concrete Used for Length Change Measurements

C490/C490M Practice for Use of Apparatus for the Determination of Length Change of Hardened Cement Paste, Mortar, and Concrete

C494/C494M Specification for Chemical Admixtures for Concrete

C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

C823/C823M Practice for Examination and Sampling of Hardened Concrete in Constructions

C856/C856M Practice for Petrographic Examination of Hardened Concrete

[1] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregatesand is the direct responsibility of Subcommittee C09.67 on Resistance to the Environment.

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[2] Section on Safety Precautions, Manual of Aggregate and Concrete Testing, Annual Book of ASTM Standards, Vol 4.02.

[3] For referenced ASTM standards and Special Technical Publications (STPs), 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.

***A Summary of Changes section appears at the end of this standard**

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions used in this test method, refer to Terminology C125.

4. Significance and Use

4.1 This test method provides two separate procedures, each providing different exposure conditions, to determine the resistance of concrete to cyclical freezing and thawing. This test method is used in Specification C494/C494M and Test Method C233/C233M, and it is also used to evaluate the effect of a coarse aggregate on a concrete mixture's resistance to cyclic freezing and thawing.

4.2 These procedures are assumed to have no significant damaging effect on concrete that is resistant to cyclical freezing and thawing. Concrete resistant to cyclical freezing and thawing is defined as concrete that has one or more of the following properties *(1)* not sufficiently saturated with water to be damaged by freezing, *(2)* made with aggregates resistant to cyclical freezing and thawing, *(3)* adequately air entrained, and *(4)* cured to achieve the appropriate maturity necessary to resist the actions of cyclical freezing and thawing.

4.3 No relationship has been established between the resistance to cyclical of freezing and thawing of specimens cut from hardened concrete and specimens prepared in the laboratory.

4.4 There is no specific guidance on choosing between Procedure A and Procedure B for a given application, except when contained in a specification. Test Method C233/C233M and Specification C494/C494M both stipulate Procedure A. In many instances the choice is based on the user's determination of suitability to a specific application. Procedure A is generally considered to be the more aggressive of the two and to better reveal defective materials, although some consider the constant saturation of the test specimens to be unrealistic. Some users prefer Procedure B as being more representative of the saturation patterns in some field applications. The history of this standard and a more complete discussion of significance and use can be found in ASTM STP 169D.[4]

5. Apparatus

5.1 *Cyclical Freezing and Thawing Apparatus:*

5.1.1 The cyclical freezing and thawing apparatus shall consist of a suitable chamber or chambers in which the specimens are subjected to the specified cyclical freezing and thawing exposure, together with the necessary refrigeration and heating equipment and controls to produce continuously, and automatically, reproducible cycles within the specified temperature requirements. In the event that the equipment does not operate automatically, provision shall be made for either its continuous manual operation on a 24 hour a day basis or for the storage of all specimens in a frozen condition when the equipment is not in operation.

5.1.2 The apparatus shall be arranged so that, except for necessary supports, each specimen is: (*1*) for Procedure A, completely surrounded by not less than 1 mm [1⁄32 in.] nor more than 3 mm [1⁄8 in.] of water at all times while it is being subjected to cyclical freezing and thawing, or (*2*) for Procedure B, completely surrounded by air during the freezing phase of the cycle and by water during the thawing phase. Rigid containers used with Procedure A, which have the potential to damage specimens, are not permitted. Do not use containers that change dimensions during cycling such that the specimens are not maintained within the above referenced water clearances. Length change specimens in vertical containers shall be supported in a manner to avoid damage to the gage studs.

5.1.3 The temperature of the heat-exchanging medium shall be uniform within 3 °C [6 °F] throughout the specimen cabinet when measured at any given time, at any point on the surface of any specimen container for Procedure A or on the surface of any specimen for Procedure B, except during the transition from the freezing conditions to the thawing conditions, or from the thawing conditions to the freezing conditions.

5.1.3.1 Support each specimen at the bottom of its container in such a way that the temperature of the heat-exchanging medium will not be transmitted directly through the bottom of the container to the full area of the bottom of the specimen, thereby subjecting it to conditions substantially different from the remainder of the specimen.

NOTE 1—A flat spiral of 3 mm [1⁄8 in.] wire placed in the bottom of the container has been found adequate for supporting specimens.

5.1.4 For Procedure B, specimens are not be kept in containers. The supports on which the specimens rest shall be such that they are not in contact with the full area of the supported side or end of the specimen, thereby subjecting this area to conditions substantially different from those imposed on the remainder of the specimen.

NOTE 2—The use of relatively open gratings, metal rods, or the edges of metal angles has been found adequate for supporting specimens, provided the heat-exchanging medium can circulate in the direction of the long axis of the rods or angles.

5.2 *Temperature-Measuring Equipment,* consisting of thermometers, resistance thermometers, or thermocouples, capable of measuring the temperature at various points within the specimen chamber and at the centers of control specimens to within 1 °C [2 °F].

5.3 *Dynamic Testing Apparatus,* conforming to the requirements of Test Method C215.

5.4 *Optional Length Change Test Length Change Comparator,* conforming to the requirements of Specification C490/C490M. When specimens longer than the nominal 285 mm [11¼ in.] length provided for in Specification C490/C490M are used for freeze-thaw tests, use an appropriate length reference bar, which otherwise meets the Specification C490/C490M requirements. Dial gage micrometers for use on these longer length change comparators shall meet the gradation interval and accuracy requirements for Specification C490/C490M for either the SI or inch-pound units calibration requirements. Prior to the start of measurements on any specimens, fix the comparator at an appropriate length to accommodate all of the specimens to be monitored for length change.

[4] ASTM STP 169D Significance of Tests and Properties of Concrete and Concrete-Making Materials.