Designation: C1768/C1768M – 12 (Reapproved 2017)

Standard Practice for Accelerated Curing of Concrete Cylinders[1]

This standard is issued under the fixed designation C1768/C1768M; 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 practice covers two procedures for making and curing cylindrical specimens of concrete under conditions that increase the rate of hydration at early ages. The procedures are: A—Warm Water Method and B—Autogenous Curing Method.

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 may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 *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 and health 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.*[2])

1.4 *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]

C31/C31M Practice for Making and Curing Concrete Test Specimens in the Field

C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens

C125 Terminology Relating to Concrete and Concrete Aggregates

C143/C143M Test Method for Slump of Hydraulic-Cement Concrete

C172/C172M Practice for Sampling Freshly Mixed Concrete

C173/C173M Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

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

C231/C231M Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

C470/C470M Specification for Molds for Forming Concrete Test Cylinders Vertically

C918/C918M Test Method for Measuring Early-Age Compressive Strength and Projecting Later-Age Strength

C1064/C1064M Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

C1231/C1231M Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Cylindrical Concrete Specimens

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this practice, refer to Terminology C125.

4. Summary of Practice

4.1 Molded concrete cylindrical specimens are cured under conditions that increase the early-age concrete temperature and the rate of hydration. This permits the specimens to develop a significant portion of their ultimate properties within a time period ranging from 24 to 49 h, depending upon the procedure used. In Procedure A, specimens are stored in a warm water bath for 24 h. In Procedure B, specimens are stored for 48 h in insulated curing containers in which the elevated curing temperature is obtained from heat of hydration of the cement. If specimens are to be used for estimating strength potential in accordance with Test Method C918/C918M, specimen temperature is monitored during the accelerated curing period.

4.2 Table 1 summarizes important characteristics of these curing procedures.

[1] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.61 on Testing for Strength.

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

[3] 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.

TABLE 1 Characteristics of Accelerated Curing Procedures

Procedure	Molds	Accelerated Curing Temperature °C [°F]	Duration of Accelerated Curing	Age at Testing
A. Warm Water	Reusable or single-use	35 [95]	23.5 h ± 30 min	24 h ± 15 min
B. Autogenous Curing	Single-use	Initial concrete temperature augmented by heat of hydration	48 h ± 15 min	49 h ± 15 min

5. Significance and Use

5.1 By increasing the concrete temperature, the rate of hydration increases and a larger portion of the later-age properties of the concrete can be attained during the short curing period compared with standard temperature curing as described in Practice C31/C31M and Practice C192/C192M.

5.2 Specimens subjected to accelerated curing can be used to estimate the later-age strength under standard-curing conditions by using this practice in conjunction with Test Method C918/C918M. The temperature history of the test specimens is recorded and the maturity index at the time of testing is calculated. Based on the measured maturity index and the early-age strength test results, the later age strength (such as at 28 days) under standard curing can be estimated from a previously established strength-maturity relationship for that concrete mixture. Thus accelerated curing procedures can provide, at the earliest practical time, an indication of the potential strength of the concrete sample. These early-age strength tests also provide information on the variability of the production process for use in quality control, so that necessary adjustments in mixture proportions can be made in a timely manner.

5.3 The user shall select the procedure to use on the basis of experience and local conditions. These procedures, in general, will be practical if a field laboratory is available to house the curing containers and the testing equipment to measure compressive strength within the specified time limits.

6. Apparatus

6.1 *Small Tools and Equipment*—For fabricating specimens shall conform to Practice C31/C31M or Practice C192/C192M, whichever is applicable.

6.2 *Cylinder Molds*—Shall conform to Specification C470/C470M. Paper molds are not permitted. Procedure B requires single-use molds.

6.3 *Curing Apparatus:*

6.3.1 *Accelerated Curing Tank for Procedure A-Warm Water Method:*

6.3.1.1 The tank is of any configuration suitable for the number of cylinders to be cured. Arrange the cylinders in a configuration that provides a clearance of at least 50 mm [2 in.] between the surface of each cylinder and the wall of the tank, and at least 100 mm [4 in.] between adjacent cylinders. Maintain the water level at least 100 mm [4 in.] above the tops of the cylinders.

NOTE 1—It may be convenient to have an overflow pipe for controlling the water depth in the tank. A number of different tanks have been used successfully. A schematic of a suitable curing tank is given in Appendix X1.

6.3.1.2 Equip the tank with environmental control element(s) capable of: *(1)* maintaining the water temperature at 35 ± 3°C [95 ± 5°F] at any point in the water; and *(2)* limiting the temperature drop, after immersion of specimens, to less than 3°C [5°F]; and *(3)* returning to the specified water temperature within 15 min after immersion of specimens. A temperature recording device, independent of the thermostat, is required to monitor the water temperature.

NOTE 2—Depending upon the design features of the tank, insulation or mechanical agitation, or both, might be necessary to meet the specified temperature requirements. Electrical immersion heaters controlled by a thermostat have been used successfully to meet the water temperature requirements. The size of the heating element(s) required will depend upon the size of the tank and the number and size of specimens to be cured at one time. A lid may be provided to reduce evaporation and heat loss.

6.3.1.3 The support for the specimens is designed to permit circulation of water within the tank.

6.3.2 *Curing Container for Procedure B-Autogenous Curing Method:*

6.3.2.1 The container consists of thermal insulation that surrounds closely the concrete specimen or specimens. Any configuration is acceptable provided the curing container meets the heat retention and other requirements of Annex A1.

6.3.2.2 The container is capable of holding one or more specimens.

6.3.2.3 The container is capable of being opened to permit insertion and withdrawal of the specimen(s) and has an outer casing and inner liner to protect the insulation from mechanical damage.

6.3.2.4 The container has a temperature sensor that is not insulated from the molded specimen. The temperature sensor is connected to a data logger or other device for a continuous record of the temperature history within the container. The maximum interval between temperature measurements is 30 min.

6.3.2.5 The container has a lid or other means to provide secure closure during the specified curing period. The lid includes a heat seal that satisfies the requirements of Annex A1.

NOTE 3—Schematics of suitable containers are included in Appendix X1.

7. Sampling

7.1 Sample the freshly mixed concrete in accordance with Practice C172/C172M unless another procedure is required by the purchaser of the testing services. If applicable, record the location where the sampled batch is placed in the structure.

8. Slump, Air Content, and Temperature

8.1 *Slump*—Measure and record the slump in accordance with Test Method C143/C143M of each sample of concrete from which specimens are made.

8.2 *Air Content*—Measure and record the air content in accordance with either Test Method C173/C173M or Test Method C231/C231M. The concrete used in performing the air content test shall not be used in fabricating test specimens.

8.3 *Temperature*—Measure and record the concrete temperature in accordance with Test Method C1064/C1064M.

9. Procedure

9.1 *Procedure A—Warm Water Method:*

9.1.1 *Preparation of Curing Tank*—Activate the heating control elements at least 1 h before the start of scheduled curing of concrete cylinders to allow the temperature of the water to stabilize.

9.1.2 *Preparation of Test Specimens:*

9.1.2.1 Mold the test specimens in accordance with the requirements of Practice C31/C31M or Practice C192/C192M, whichever is applicable.

9.1.2.2 If the specimens are to be tested in accordance with Test Method C918/C918M, embed a temperature sensor into the center of one of the specimens molded from each sample. Activate the temperature recording device. Maintain a record of the concrete temperature during the curing period and until time of testing. The maximum interval between temperature measurements is 30 min. If the specimens are not be tested in accordance with Test method C918/C918M, monitor water temperature in accordance with 9.1.3.4.

9.1.3 *Curing:*

9.1.3.1 If necessary, cover the top of the specimens with a rigid plate or tight fitting lid to prevent loss of paste to the water bath.

9.1.3.2 Immediately after molding, place the specimens into the curing tank (Note 4). Maintain the water at the time of immersion and throughout the curing period at 35 ± 3°C [95 ± 5°F].

NOTE 4—Loss of paste can be mitigated by placing the cylinders into the water slowly so as not to agitate the water.

9.1.3.3 Curing time and specimen age are measured from the time the specimens are submerged. Record to the nearest 15 min the time when specimens are submerged.

9.1.3.4 Record the temperature of the curing water continuously throughout the curing period. The maximum interval between temperature measurements is 30 min.

9.1.3.5 After curing for 23.5 h ± 30 min, remove the specimens from the tank and remove the molds.

9.1.4 *Testing:*

9.1.4.1 If compressive strength is to be measured, test the specimens in accordance with Test Method C39/C39M at age 24 h ± 15 min.

NOTE 5—The use of unbonded caps in accordance with Practice C1231/C1231M is a practicable approach for meeting the time limit requirements between end of curing and testing. The hardness of the pads is selected based on the anticipated strength at the time of testing.

9.2 *Procedure B—Autogenous Curing Method:*

9.2.1 *Preparation of Test Specimens:*

9.2.1.1 Mold the test specimens in accordance with the requirements of Practice C31/C31M or Practice C192/C192M, whichever is applicable. Use single-use molds.

9.2.1.2 If the specimens are to be tested in accordance with Test Method C918/C918M, embed a temperature sensor into the center of one of the molded specimens for each sample. Activate the temperature recording device. Maintain a record of the concrete temperature during the curing period and until time of testing. The maximum interval between temperature measurements is 30 min.

9.2.1.3 If the specimens are not to be tested in accordance with Test Method C918/C918M, maintain a record of the temperature measured by the sensor in the container. The maximum interval between temperature measurements is 30 min.

9.2.2 *Curing:*

9.2.2.1 Immediately after molding the specimen, cover the mold with a tight-fitting cap and place the specimen into the autogenous curing container.

NOTE 6—It may be helpful to use a heavy-duty plastic bag to serve as a lifting grip for placing and removing the specimen from the curing container.

9.2.2.2 Secure the container lid and turn on the temperature recording device.

9.2.2.3 Curing time and specimen age are measured from the time the specimens are placed in the container. Record to the nearest 15 min the time when specimens are placed in the container.

9.2.2.4 Store the curing container for at least 12 h in a location not subject to disturbance or direct sunlight. The ambient temperature shall be 21 ± 6°C [70 ± 10°F].

9.2.2.5 At an elapsed time of 48 h ± 15 min from when the specimen was placed in the curing container, remove the specimen from the container and remove the mold. Allow the specimens to stand at room temperature for at least 30 min.

9.2.3 *Testing:*

9.2.3.1 If compressive strength is to be measured, test the specimens in accordance with Test Method C39/C39M at 49 h ± 15 min (see Note 5).

10. Report

10.1 Report the following information for each cylinder to the agency that will test the specimens:

10.1.1 Identification number.

10.1.2 Location where concrete represented by the sample was placed, if applicable.

10.1.3 Slump, air content, concrete temperature, and results of any other tests on the fresh concrete sample and any deviations from referenced standard test methods.

10.1.4 Date and time of molding.

10.1.5 Name of technician who molded the cylinders.

10.1.6 Accelerated curing procedure (A or B) that was used.

10.1.7 Time when cylinder was submerged for Procedure A, or time when cylinder was placed in the curing container for Procedure B.

10.1.8 Recorded temperature history.

10.1.9 Any deviations from this practice.

11. Keywords

11.1 accelerated curing; compressive strength; concrete cylinders; early-age strength; potential strength

ANNEX

(Mandatory Information)

A1. REQUIREMENTS FOR AUTOGENOUS CURING CONTAINERS (PROCEDURE B)

A1.1 *Heat Retention*—Place a watertight cylinder mold into the autogenous curing container. Fill the mold to within 5 mm [¼ in.] of the brim with water at a temperature of 82 ± 1°C [180 ± 2°F]. Insert a thermocouple into the water and measure the initial temperature of the water with a suitable readout device. Seal the water-filled mold with a cap and close the autogenous curing container. Store the autogenous curing container in still air at 21 ± 1°C [70 ± 2°F]. The measured water temperature shall meet the following requirements:

Elapsed time, h	°C	°F
12	67 ± 3	152 ± 5
24	58 ± 3	136 ± 6
48	45 ± 4	114 ± 7
72	38 ± 4	100 ± 8

A1.2 *Tightness Test for Gasket Heat Seal*—Immerse the autogenous curing container in water to a depth of 150 mm [6 in.] above the joint between the separable parts. No air shall escape through the heat seal within a period of 5 min.

A1.3 *Temperature Stability*—The container, or any part thereof, shall not fracture or distort when maintained at an ambient temperature of –30°C [–20°F] for 72 h, nor soften or distort when maintained at an ambient temperature of 60°C [140°F] for 72 h. The gasket type heat seal shall recover fully its original thickness within 5 s after 50 % compression under these specified temperature conditions.

APPENDIX

(Nonmandatory Information)

X1. CURING APPARATUS

X1.1 Warm-Water Curing Tank (Procedure A)

X1.1.1 Curing tanks similar to that shown in Fig. X1.1 have been used successfully.

X1.1.2 Properly designed tanks will ensure an almost uniform temperature throughout the tank without the need for a mechanical stirrer. Locate the immersion heaters centrally in plan and as near to the bottom of the tank as possible. The water above the heater will be kept in circulation by convection currents.

X1.1.3 For a tank containing two or three specimens, two coupled elements (1500 and 5000 W) have been found suitable. While the smaller elements will maintain the specified

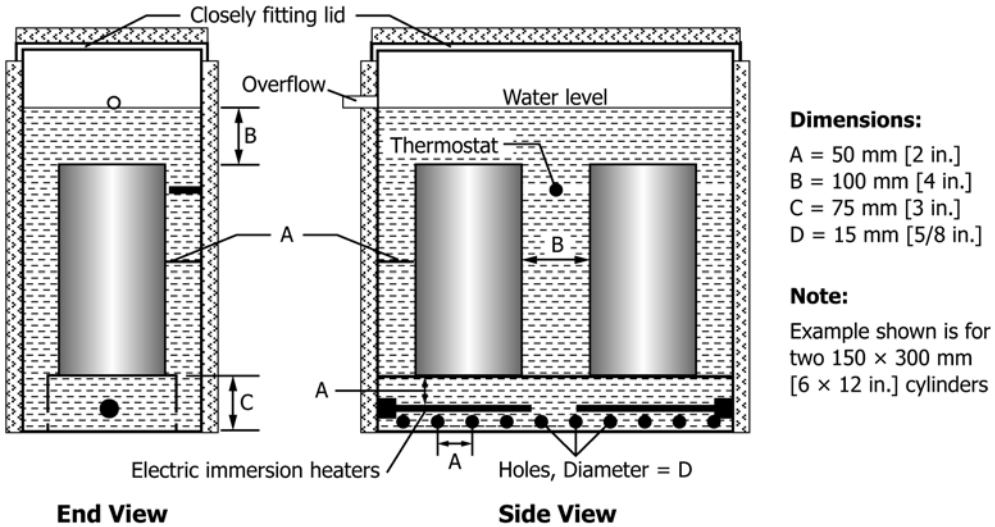
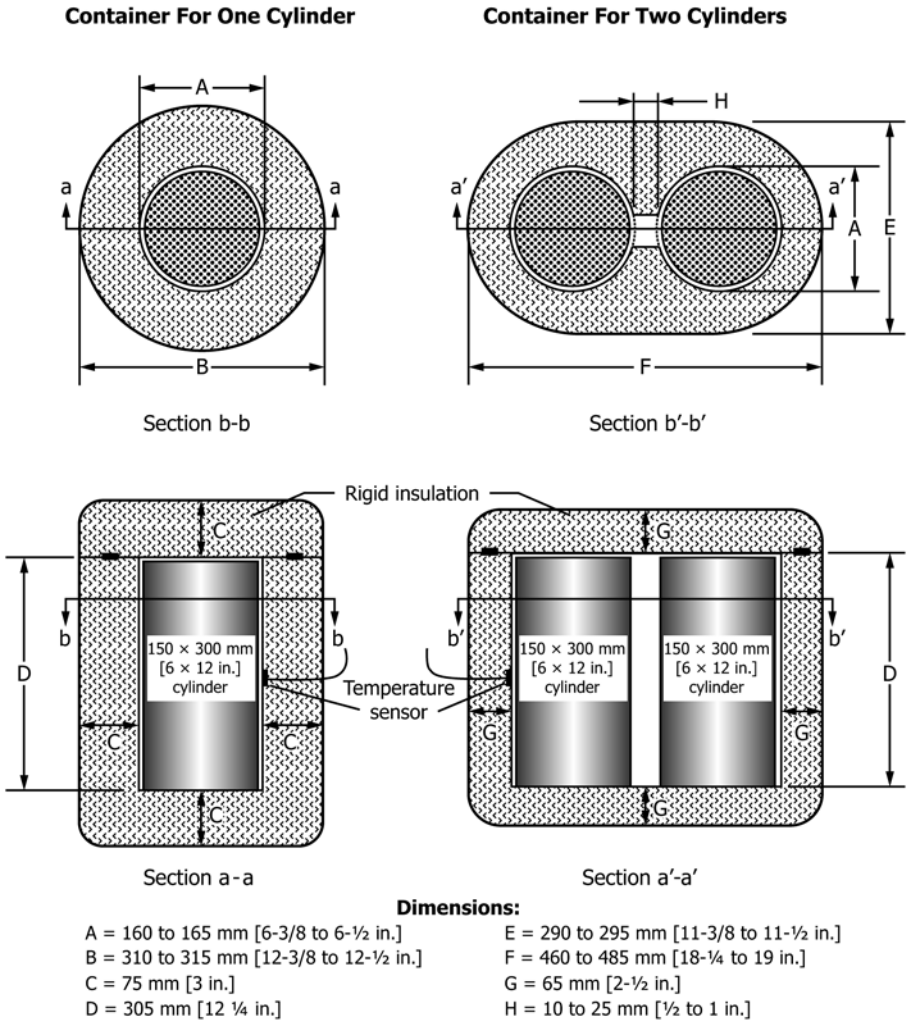


FIG. X1.1 Suggested Design for Warm-Water Curing Tank (Procedure A)



Note: Examples shown are for autogenous curing of 150 × 300 mm [6 × 12 in.] cylinders

FIG. X1.2 Autogenous Curing Container for One or Two Cylinders (Procedure B)

curing temperature, the larger element will reestablish water temperature within the specified time after the specimens have been immersed. Alternatively, a single 3000-W element has also been found suitable. With the 3000-W element, the tank may be of larger dimensions to hold more than two or three specimens when used for Procedure A.

X1.1.4 The overflow pipe, closely fitting lid, and exterior insulation are recommended but are not essential.

X1.2 Autogenous Curing Container (Procedure B)

X1.2.1 Satisfactory containers are shown in Fig. X1.2.

X1.2.2 The means of opening the container, securing when closed, and lifting are not shown.

X1.2.3 A heat seal is required at the joint face between the separable parts of the container. This may be a labyrinth or a gasket type seal provided the requirements of Annex A1 are met. A suitable gasket is flexible polyurethane foam with a density of about 30 kg/m^3 [2 lb/ft^3] maintained at 50 % compression when the container is closed.

X1.2.4 Foamed-in-place closed-cell polyurethane having a density of between 30 and 50 kg/m^3 [2 and 3 lb/ft^3] and thermal conductivity equal to or less than 0.02 W/m·K [0.15 Btu·in./h·ft$^{2\circ}$F] has been found to be a suitable insulating material at the thicknesses indicated in Fig. X1.2 to meet the heat retention requirements of Annex A1.