

CRD-C 49-74

**SUPPLEMENTARY STANDARD METHODS OF MAKING AND CURING CONCRETE TEST SPECIMENS IN THE LABORATORY**

1. Scope

1.1 The procedures of CRD-C 10 cover most of the provisions applicable for use by Corps of Engineers' laboratories for making and curing concrete test specimens. However, some supplementary provisions are regarded as desirable. These are given here.

2. Variations in Procedures

2.1 A considerable number of references to alternative procedures, to modification of procedures under certain circumstances, and to a range of permissible circumstances are included in CRD-C 10. Such references are believed necessary in order to permit the method to be sufficiently flexible to be applied to all conditions under which it may be used and to prevent situations developing in which a deviation from the requirements becomes mandatory. Such references are also designed to permit limited variation in equipment design so that available equipment may be used whenever there are no data to indicate that rigid uniformity is required. Variation in procedures or equipment shall not be permitted in the making and curing of specimens that are to be compared with each other.

3. Beams for Laboratory Freezing-and-Thawing (CRD-C 114)

3.1 Size of Specimens.- The specimens shall be beams with dimensions 3-1/2 by 4-1/2 by 16 in. (89 by 114 by 406 mm).

3.2 Molds.- Means shall be provided for securing the base plate to the mold.

3.3 Molding Specimens.- The test specimen shall be formed with its 3-1/2 in. (89-mm) dimension and its long axis horizontal. The concrete shall be placed in the mold in a single layer and the mold shall be filled heaping full. The concrete shall then be consolidated in the mold by hand-rod-  
ding, using 30 strokes of a 5/8-in.

(16-mm) rod evenly distributed over the surface of the specimen. After rodding, the concrete shall be spaded along the sides and ends with a mason's trowel or other suitable tool. When the rodding and spading operations are completed, the sides of the molds may be tapped with a rubber mallet to the extent necessary to close the rod holes and achieve adequate consolidation. The top shall then be struck off with a wood float and finished with a steel trowel. The test specimen shall be made promptly and without interruption. The identifying labels shall be placed near one end of the specimen to facilitate differentiation of one end from the other. The placement of the labels shall be by procedures that do not cause a point of significant weakness in specimens to be tested for resistance to freezing-and-thawing.

3.4 Curing.- As soon as finishing has been completed, the top finished surface of the specimen shall be covered. The specimen shall then be stored at a temperature of  $73.4 \pm 2$  F ( $23 \pm 1.1$  C) until the time of stripping and in such a manner as to prevent loss of moisture from the specimen. Specimens shall be removed from the molds  $48 \pm 4$  hr after molding and stored in a moist condition at  $73.4 \pm 2$  F ( $23 \pm 1.1$  C) until time of test. Specimens intended for freezing-and-thawing (CRD-C 114) shall be stored in saturated limewater at  $73.4 \pm 2$  F ( $23 \pm 1.1$  C) for the final  $48 \pm 4$  hr before the time of test (Note).

Note.- It is the intent of the above to insure that the specimens: (1) receive uninterrupted water curing, and (2) be soaked in water (saturated with lime) for at least 44 hr before they are put in the freezer. It is not the intent that immersed storage be either mandatory or forbidden during the period between stripping and  $48 \pm 4$  hr before the time of test. Any curing condition that meets the requirements for temperature and "moist storage" may be used up to  $48 \pm 4$  hr before the time of test. This includes immersed storage (in lime solution). Immersed storage, if available, will presumably be chosen for curing between the time of stripping and the time of test since its use will remove the need for rehandling the specimens at 12 days age.

4. Thermal-Diffusivity Test Specimens (CRD-C 36)

4.1 Specimens.- Specimens for

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thermal-diffusivity test shall be made and cured in accordance with requirements for compression test specimens (CRD-C 10), except that each specimen shall be molded with a thermocouple embedded at the center of mass.

### 5. Cubes for Determination of Thermal Diffusivity of Mass Concrete (CRD-C 37) and for Subsequent Coring

5.1 Size of Specimens.- The specimens shall be cubes 8 cu ft (0.0227 m<sup>3</sup>) in volume.

5.2 Forms.- The assembled form shall be mortartight and shall be lightly oiled prior to use.

5.3 Molding Specimens.- Concrete shall be placed in the form in two layers which shall be consolidated separately. Vibration of the upper layer shall be carried through into the lower layer. In the event that the two layers comprise separate batches, the form shall be covered with wet burlap between batches, and vibration of the first layer shall be delayed until just before the second layer is ready to be placed. Vibration shall not be delayed more than 20 min after placement. Vibration shall be accomplished by use of an internal vibrator and shall be only of such duration as to insure adequate consolidation. The vibrator frequency shall be not less than 6500 vpm (108 Hz) and the vibrator head shall be approximately 2-3/8 in. (61 mm) in diameter by 18 in. (457 mm) long.

5.4 Curing.- Specimens shall be stripped not earlier than 40 hr after molding and coated with an approved concrete curing compound.

5.5 Embedded Items.- Specimens will be equipped with hoisting rings, thermocouples, and other items as prescribed in CRD-C 37.

### 6. Permeability Test Specimens (CRD-C 48)

6.1 Specimens for the determination of permeability of concrete containing aggregate, the maximum size of which is in excess of 1 in. (25 mm) but not greater than 3 in. (75 mm) in nominal size, shall be cylinders 14-1/2 in. (368 mm) in diameter by 15 in. (381 mm) in length. These are

referred to below as "large" specimens. Specimens for the determination of permeability of concrete paste, mortars, or concrete having a maximum size of aggregate of 1 in. (25 mm) or less shall be cylinders 6 in. (152 mm) in diameter by 6 in. (152 mm) in length. These are referred to below as "small" specimens.

6.2 Forms for "Large" Specimens.- The forms for "large" specimens shall be of 24- or 26-gage (0.64- or 0.48-mm) galvanized sheet steel with crimped and soldered seams. A 1/4-in. (6.4-mm) flange shall be turned out around the top, and a cover provided having a radius 1/8 in. (3.2 mm) less than the outside radius of the flange so that a firm soldered joint may be made when the cover is sealed. The flange and the contacting edge of the cover shall be tinned to assist in soldering the cover in place.

6.3 Molding and Curing of "Large" Specimens.- To mold specimens of 14-1/2-in. (368-mm) diameter by 15-in. (381-mm) length, the concrete shall be placed in the form in two layers which shall be consolidated separately. Vibration shall be accomplished by means of an internal vibrator. The top shall be screeded and a small depression made around the top edge of the specimen to prevent water from interfering with the soldering operation. After the cover is soldered the specimen shall be turned on its side so that bleeding water will rise normal to the axis of the specimen. This position shall be marked and retained without rotation during and curing period. The specimen shall be stored in the sealed container at 73.4 ± 2 F (23 ± 1.1 C) until time of testing.

6.4 Molding and Curing of "Small" Specimens.- The "small" specimens shall be prepared as 6- by 12-in. (152- by 305-mm) cylinders in conformity with CRD-C 10, except as follows: The permeability specimens shall be cast in standard 6- by 12-in. (152 - by 305-mm) cylinder molds equipped with both a top and bottom made of steel plates, plywood, or other suitable material. The top and bottom of the molds shall be held firmly in place by bolts, clamps, or other suitable devices. The molds shall be made

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as nearly watertight as practicable. After the specimens have been cast, and the tops and bottoms of the molds securely fixed in position, they shall be kept in a horizontal position until they are stripped. They shall be removed from the molds at an age of not less than 40 hr. They shall be sawed into two 6- by 6-in. (152- by 152-mm) cylinders prior to time of test.

#### 7. Temperature-Rise Test Specimens (CRD-C 38)

7.1 Precooling Materials.- Unless otherwise specified the specimens shall be molded so that the initial temperature of the concrete in the specimen immediately after consolidation of the final layer shall be  $50 \pm 5$  F ( $10 \pm 2.3$  C). All materials shall be pre-cooled, as may be necessary, to a temperature sufficiently low to insure that the specified initial temperature will be achieved.

7.2 Size of Specimens.- The specimens shall be cylinders, 30 in. (760 mm) in diameter and 29 in. (737 mm) in height. All of a single batch of concrete, intended to yield 11.86 cu ft ( $0.336$  m<sup>3</sup>) with the intended air content, shall be used to mold one specimen.

7.3 Supplementary Tests.- Slump (CRD-C 5) and air content (gravimetric) (CRD-C 71) shall be determined. The concrete used for these tests shall be returned to the batch prior to molding the temperature-rise test specimen. These tests shall be accomplished as expeditiously as possible so that placement of the concrete will not be delayed.

#### 8. Specimens for Outdoor Exposure

8.1 Size of Specimens.- The speci-

mens shall be beams 18 in. (457 mm) in height and width, and 36 in. (914 mm) in length.

8.2 Forms.- Forms for these test specimens shall be made of 3/8-in. (9.5-mm) metal plate and shall be provided with base plates. Means shall be provided for securing the base plates to the forms. The assembled forms shall be mortartight and shall be lightly oiled prior to use.

8.3 Molding Specimens.- Concrete shall be placed in the form in two layers and each layer shall be consolidated separately. Vibration shall be carried through the upper layer into the lower layer. Consolidation shall be accomplished by making a series of diagonal insertions along the longitudinal axis of the prism, spaced at equal intervals, for each layer with an internal vibrator. The diagonal insertion at approximately 45 deg shall be made in such a manner that the axis of the vibrator tube shall be in a plane parallel to the side of the beam. Vibration shall be only of such duration as to insure adequate consolidation.

8.4 Curing.- When the finishing has been completed, the specimens shall be stored at a temperature of  $73.4 \pm 2$  F ( $23 \pm 1.1$  C) until the time of stripping and in such a manner as to prevent loss of moisture. The specimens shall be removed from the forms (not earlier than 40 hr after molding) and stored in a moist condition at  $73.4 \pm 2$  F ( $23 \pm 1.1$  C). The specimens shall be removed from the moist condition at an age of 28 days and stored indoors in air until the time of removal to outdoor exposure.

8.5 Labels.- The identifying labels shall be placed near one end of the specimen and affixed permanently thereto by slight embedment to facilitate identification.