Designation: C 192/C 192M – 05

Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory[1]

This standard is issued under the fixed designation C 192/C 192M; 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 Department of Defense.

1. Scope

1.1 This practice covers procedures for making and curing test specimens of concrete in the laboratory under accurate control of materials and test conditions using concrete that can be consolidated by rodding or vibration as described herein.

1.2 The values stated in either inch-pound units or SI units shall be regarded separately as standard. The SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of each other. Combining values from the two systems may result in nonconformance.

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.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 70 Test Method for Surface Moisture in Fine Aggregate
C 125 Terminology Relating to Concrete and Concrete Aggregates
C 127 Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
C 128 Test Method for Density, Relative Density (Specific Gravity) and Absorption of Fine Aggregate
C 138 Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
C 143/C 143M Test Method for Slump of Hydraulic Cement Concrete
C 172 Practice for Sampling Freshly Mixed Concrete
C 173 Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
C 231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C 330 Specification for Lightweight Aggregates for Structural Concrete
C 403/C 403M Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
C 470/C 470M Specification for Molds for Forming Concrete Test Cylinders Vertically
C 494/C 494M Specification for Chemical Admixtures for Concrete
C 511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
C 566 Test Method for Total Moisture Content of Aggregate by Drying
C 617 Practice for Capping Cylindrical Concrete Specimens
C 1064 Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
C 1077 Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

2.2 *American Concrete Institute Publications:* [3]

211.3 Practice for Selecting Proportions for No-Slump Concrete
309 Guide for Concrete Consolidation

3. Significance and Use

3.1 This practice provides standardized requirements for preparation of materials, mixing concrete, and making and curing concrete test specimens under laboratory conditions.

3.2 If specimen preparation is controlled as stipulated herein, the specimens may be used to develop information for the following purposes:

3.2.1 Mixture proportioning for project concrete,
3.2.2 Evaluation of different mixtures and materials,
3.2.3 Correlation with nondestructive tests, and
3.2.4 Providing specimens for research purposes.

[1] This practice 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] 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.

[3] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333.

NOTE 1—The concrete test results for concrete specimens made and cured using this practice are widely used. They may be the basis for acceptance testing for project concrete, research evaluations, and other studies. Careful and knowledgeable handling of materials, mixing concrete, molding test specimens, and curing test specimens is necessary. Many laboratories performing this important work are independently inspected or accredited. Practice C 1077 identifies and defines duties, responsibilities, including minimum responsibilities of the laboratory personnel and minimum technical requirements for laboratory equipment used. Many laboratories ensure qualified technicians by participating in national certification programs such as the American Concrete Institute Laboratory Technician Program or an equivalent program.

4. Apparatus

4.1 *Molds, General*—Molds for specimens or fastenings thereto in contact with the concrete shall be made of steel, cast iron, or other nonabsorbent material, nonreactive with concrete containing portland or other hydraulic cements. Molds shall conform to the dimensions and tolerances specified in the method for which the specimens are required. Molds shall hold their dimensions and shape under all conditions of use. Watertightness of molds during use shall be judged by their ability to hold water poured into them. Test procedures for watertightness are given in the section on Test Methods for Elongation, Absorption, and Watertightness of Specification C 470/C 470M. A suitable sealant, such as heavy grease, modeling clay, or microcrystalline wax, shall be used where necessary to prevent leakage through the joints. Positive means shall be provided to hold base plates firmly to the molds. Reusable molds shall be lightly coated with mineral oil or a suitable nonreactive release material before use.

4.2 *Cylinder Molds:*

4.2.1 *Molds for Casting Specimens Vertically* shall conform to the requirements of 4.1 and Specification C 470/C 470M.

4.2.2 *Horizontal Molds for Creep Test Cylinders* shall conform to the requirements of 4.1 and to the requirements for symmetry and dimensional tolerance in the section on General Requirements except for verticality requirements of Specification C 470/C 470M. The use of horizontal molds is intended only for creep specimens that contain axially embedded strain gages. Molds for creep cylinders to be filled while supported in a horizontal position shall have a filling slot parallel to the axis of the mold which extends the full length to receive the concrete. The width of the slot shall be one half the diameter of the specimen. If necessary the edges of the slot shall be reinforced to maintain dimensional stability. Unless specimens are to be capped or ground to produce plane ends, the molds shall be provided with two machined metal end plates at least 1 in. [25 mm] thick and the working surfaces shall comply with the requirements for planeness and surface roughness given in the section on Capping Plates of Practice C 617. Provision shall be made for fixing both end plates firmly to the mold. The inside surface of each end plate shall be provided with at least three lugs or studs approximately 1 in. [25 mm] long, firmly fastened to the plate for embedment in the concrete. One base plate shall be drilled from the inside at an angle to permit the lead wire from the strain gage to exit the specimen through the edge of the plate. Provision shall be made for accurately positioning the strain gage. All necessary holes shall be as small as possible to minimize disturbance to subsequent strain measurements and shall be sealed to prevent leakage.

4.3 *Beam and Prism Molds* shall be rectangular in shape (unless otherwise specified) and of the dimensions required to produce the desired specimen size. The inside surfaces of the molds shall be smooth and free from indentations. The sides, bottom, and ends shall be at right angles to each other and shall be straight and true and free of warpage. Maximum variation from the nominal cross section shall not exceed 1⁄8 in. [3 mm] for molds with depth or breadth of 6 in. [150 mm] or more, or 1⁄16 in. [2 mm] for molds of smaller depth or breadth. Except for flexure specimens, molds shall not vary from the nominal length by more than 1⁄16 in. [2 mm]. Flexure molds shall not be shorter than 1⁄16 in. [2 mm] of the required length, but may exceed it by more than that amount.

4.4 *Tamping Rods*—Two sizes are specified in ASTM methods. Each shall be a round, straight steel rod with at least the tamping end rounded to a hemispherical tip of the same diameter as the rod. Both ends may be rounded, if preferred.

4.4.1 *Larger Rod*, 5⁄8 in. [16 mm] in diameter and approximately 24 in. [600 mm] long.

4.4.2 *Smaller Rod*, 3⁄8 in. [10 mm] in diameter and approximately 12 in. [300 mm] long.

4.5 *Mallets*—A mallet with a rubber or rawhide head weighing 1.25 ± 0.50 lb [0.6 ± 0.20 kg] shall be used.

4.6 *Vibrators*:

4.6.1 *Internal Vibrators*—The vibrator frequency shall be at least 7000 vibrations per minute [115 Hz] while the vibrator is operating in the concrete. The diameter of a round vibrator shall be no more than one fourth the diameter of the cylinder mold or one fourth the width of the beam or prism mold. Other shaped vibrators shall have a perimeter equivalent to the circumference of an appropriate round vibrator. The combined length of the vibrator shaft and vibrating element shall exceed the depth of the section being vibrated by at least 3 in. [75 mm].

NOTE 2—For information on size and frequency of various vibrators and method to periodically check vibrator frequency, see ACI 309.

4.6.2 *External Vibrators*—The two types of external vibrators permitted are either table or plank. The external vibrator frequency shall be 3600 vibrations per minute [60 Hz] or higher.

4.6.3 Provisions shall be made for clamping the mold securely to the apparatus for both types of vibrators.

NOTE 3—Vibratory impulses are frequently imparted to a table or plank vibrator through electromagnetic means, or by use of an eccentric weight on the shaft of an electric motor or on a separate shaft driven by a motor.

4.7 *Small Tools*—Tools and items such as shovels, pails, trowels, wood float, blunted trowels, straightedge, feeler gage, scoops, rulers, rubber gloves, and metal mixing bowls shall be provided.

4.8 *Slump Apparatus*—The apparatus for measurement of slump shall conform to the requirements of Test Method C 143/C 143M.

4.9 *Sampling and Mixing Pan*—The pan shall be flat-bottom and of heavy-gage metal, watertight, of convenient depth, and of sufficient capacity to allow easy mixing by shovel or trowel of the entire batch; or, if mixing is by machine, to receive the entire batch on discharge of the mixer and allow remixing in the pan by trowel or shovel.

4.10 *Wet-Sieving Equipment*—If wet-sieving is required, the equipment shall conform to the requirements of Practice C 172.

4.11 *Air Content Apparatus*—The apparatus for measuring air content shall conform to the requirements of either Test Methods C 231 or C 173.

4.12 *Scales*—Scales for determining the mass of batches of materials and concrete shall be accurate within 0.3 % of the test load at any point within the range of use.

NOTE 4—In general the mass of small quantities should not be determined on large capacity scales. In many applications the smallest mass determined on a scale should be greater than about 10 % of the maximum capacity of the scale; however, this will vary with the performance characteristics of the scale and the required accuracy of the determination. Acceptable scales used for determining the mass for concrete materials preferably should determine mass accurately to about 0.1 % of total capacity and the foregoing precaution is applicable. However, certain analytical and precision balances are exceptions to this rule and should weigh accurately to 0.001 %. Particular care must be exercised in measuring small quantities of material by determining the difference between two much larger masses.

4.13 *Temperature Measuring Device*—The temperature measuring device shall conform to the requirements of Test Method C 1064.

4.14 *Concrete Mixer*—A power-driven concrete mixer shall be a revolving drum, tilting mixer, or suitable revolving pan or revolving-paddle mixer capable of thoroughly mixing batches of the prescribed sizes at the required slump.

NOTE 5—A pan mixer is usually more suitable for mixing concrete with less than 1-in. [25 mm] slump than a revolving drum mixer. The rate of rotation, degree of tilt, and rated capacity of tilting mixers are not always suitable for laboratory mixed concrete. It may be found desirable to reduce the rate of rotation, decrease the angle of tilt from the horizontal, and use the mixer at somewhat less than the manufacturer's rated capacity.

5. Specimens

5.1 *Cylindrical Specimens*—Cylinder dimensions shall be as stipulated in the specification, test method or practice for the laboratory studies being performed and shall meet the requirements of 5.4. If dimensions are not stipulated in a specification, test method, or practice, the specimen selected shall have a length that is twice the diameter and meet the requirements of 5.4.

NOTE 6—The same cylinder size should be used for the reference (control) concrete mixture and test concrete mixtures when conducting comparative studies such as those required in Specification C 494/C 494M. For mixture proportioning of project concrete, it is preferable for the cylinder size in the laboratory to be the same as that specified for acceptance testing.

NOTE 7—When molds in SI units are required and not available, equivalent inch-pound unit size mold should be permitted.

5.1.1 Cylindrical specimens for tests other than creep shall be molded and allowed to harden with the axis of the cylinder vertical.

5.1.2 Cylindrical creep specimens may be cast with the cylindrical axis either vertical or horizontal and allowed to harden in the position in which cast.

5.2 *Prismatic Specimens*—Beams for flexural strength, prisms for freezing and thawing, bond, length change, volume change, etc., shall be formed with their long axes horizontal, unless otherwise required by the method of test in question, and shall conform in dimension to the requirements of the specific test method.

5.3 *Other Specimens*—Other shapes and sizes of specimens for particular tests may be molded as desired following the general procedures set forth in this practice.

5.4 *Specimen Size versus Aggregate Size*—The diameter of a cylindrical specimen or minimum cross-sectional dimension of a rectangular section shall be at least three times the nominal maximum size of the coarse aggregate in the concrete as defined in Terminology C 125. Occasional over-size aggregate particles (of a size not normally found in the average aggregate grading) shall be removed by hand picking during the molding of the specimens. When the concrete contains aggregate larger than that appropriate for the size of the molds or equipment to be used, wet-sieve the sample as described in Practice C 172.

5.5 *Number of Specimens*—The number of specimens and the number of test batches are dependent on established practice and the nature of the test program. Guidance is usually given in the test method or specification for which the specimens are made. Usually three or more specimens are molded for each test age and test condition unless otherwise specified (Note 8). Specimens involving a given variable should be made from three separate batches mixed on different days. An equal number of specimens for each variable should be made on any given day. When it is impossible to make at least one specimen for each variable on a given day, the mixing of the entire series of specimens should be completed in as few days as possible, and one of the mixtures should be repeated each day as a standard of comparison.

NOTE 8—Test ages often used are 7 and 28 days for compressive strength tests, or 14 and 28 days for flexural strength tests. Specimens containing Type III cement are often tested at 1, 3, 7, and 28 days. For later test ages, 3 months, 6 months, and 1 year are often used for both compressive and flexural strength tests. Other test ages may be required for other types of specimens.

6. Preparation of Materials

6.1 *Temperature*—Before mixing the concrete, bring the concrete materials to room temperature in the range from 68 to 86 °F [20 to 30 °C], except when the temperature of the concrete is stipulated. When a concrete temperature is stipulated, the method proposed to obtain the concrete temperature needs approval of the stipulator.

6.2 *Cement*—Store the cement in a dry place, in moisture-proof containers, preferably made of metal. The cement shall be thoroughly mixed to provide a uniform supply throughout the tests. It shall be passed through a 850-µm [No. 20] or finer sieve to remove all lumps, remixed on a plastic sheet, and returned to sample containers.

6.3 *Aggregates*—In order to preclude segregation of a coarse aggregate, separate into individual size fractions and for each batch recombine in the proper proportions to produce the desired grading.

NOTE 9—Only rarely is a coarse aggregate batched as a single size fraction. The number of size fractions will generally be between 2 and 5 for aggregate smaller than 2½ in. [60 mm]. When a size fraction to be batched is present in amounts in excess of 10 %, the ratio of the opening of the larger to the smaller sieve should not exceed 2.0. More closely sized groups are sometimes advisable.

6.3.1 Unless fine aggregate is separated into individual size fractions, maintain it in a damp condition or restore to a damp condition until use, to prevent segregation, unless material uniformly graded is subdivided into batch size lots using a sample splitter with proper size openings. If unusual gradings are being studied, the fine aggregate may need to be dried and separated into individual sizes. In this instance, if the total quantity of fine aggregate required is larger than can be efficiently blended in a single unit, then the individual size fractions should be determined in a mass required for each individual batch. When the total quantity of fine aggregate needed for the complete investigation is such that it can be thoroughly mixed, blended, and maintained in a damp condition, then it should be handled in that manner. Determine the specific gravity and absorption of aggregates in accordance with either Test Methods C 127 or C 128.

6.3.2 Before incorporating in concrete, prepare the aggregate to ensure a definite and uniform condition of moisture. Determine the weight of aggregate to be used in the batch by one of the following procedures:

6.3.2.1 Determine the mass of low-absorption aggregates (absorption less than 1.0 %) in the room-dry condition with allowance made for the amount of water that will be absorbed from the unset concrete (Note 10). This procedure is particularly useful for coarse aggregate which must be batched as individual sizes; because of the danger of segregation it can be used for fine aggregate only when the fine aggregate is separated into individual size fractions.

NOTE 10—When using aggregates with low absorption in room-dry condition the amount of water that will be absorbed by the aggregates before the concrete sets may be assumed to be 80 % of the difference between the 24-h absorption of the aggregates determined by Test Methods C 127 or C 128, and the amount of water in the pores of the aggregates in their room-dry state, as determined by Test Method C 566.

6.3.2.2 Individual size fractions of aggregate may be weighed separately, recombined into a tared container in the amounts required for the batch, and immersed in water for 24 h prior to use. After immersion the excess water is decanted and the combined weight of aggregate and mixing water determined. Allowance shall be made for the amount of water absorbed by the aggregate. The moisture content of the aggregates may be determined in accordance with Test Methods C 70 and C 566.

6.3.2.3 The aggregate may be brought to and maintained in a saturated condition, with surface moisture contained in sufficiently small amounts to preclude loss by draining, at least 24 h prior to use. When this method is used, the moisture content of the aggregate must be determined to permit calculation of proper quantities of the damp aggregate. The quantity of surface moisture present must be counted as a part of the required amount of mixing water. Surface moisture in fine aggregate may be determined in accordance with Test Methods C 70 and C 566, making due allowance for the amount of water absorbed. The method outlined here (moisture content slightly exceeding absorption) is particularly useful for fine aggregate. It is used less frequently for coarse aggregate because of the difficulty of accurately determining the moisture content, but if used, each size fraction must be handled separately to ensure that the proper grading is obtained.

6.3.2.4 Aggregates, fine or coarse, may be brought to and maintained in a saturated surface-dry condition until batched for use. This method is used primarily to prepare material for batches not exceeding ¼ ft^3 [0.007 m^3] in volume. Care must be taken to prevent drying during weighing and use.

6.4 *Lightweight Aggregates*—The procedures for specific gravity, absorption, and preparation of aggregates mentioned in this practice pertain to materials with normal absorption values. Lightweight aggregates, air-cooled slag, and certain highly porous or vesicular natural aggregate may be so absorptive as to be difficult to treat as described. The moisture content of lightweight aggregate at the time of mixing may have important effects on properties of freshly mixed and hardened concretes such as slump loss, compressive strength, and resistance to freezing and thawing.

6.5 *Admixtures*—Powdered admixtures that are entirely or largely insoluble, that do not contain hygroscopic salts and are to be added in small quantities, should be mixed with a portion of the cement before introduction into the batch in the mixer so as to ensure thorough distribution throughout the concrete. Essentially insoluble materials which are used in amounts exceeding 10 % by mass of cement, such as pozzolans, should be handled and added to the batch in the same manner as cement. Powdered admixtures which are largely insoluble but contain hygroscopic salts may cause balling of cement and should be mixed with the sand. Water-soluble and liquid admixtures should be added to the mixer in solution in the mixing water. The quantity of such solution used shall be included in the calculation of the water content of the concrete. Admixtures, incompatible in concentrated form, such as solutions of calcium chloride and certain air-entraining and set-retarding admixtures, should not be intermixed prior to their addition to concrete. The time, sequence, and method of adding some admixtures to a batch of concrete can have important effects on concrete properties such as time of set and air content. The method selected must remain unchanged from batch to batch.

NOTE 11—The mixing apparatus and accessories shall be thoroughly cleaned to ensure that chemical additions or admixtures used in dissimilar batches of concrete do not affect subsequent batches.

7. Procedure

7.1 *Mixing Concrete:*

7.1.1 *General*—Mix concrete in a suitable mixer or by hand in batches of such size as to leave about 10 % excess after molding the test specimens. Hand-mixing procedures are not applicable to air-entrained concrete or concrete with no measurable slump. Hand mixing should be limited to batches of ¼ ft^3 [0.007 m^3] volume or less. Mixing procedures are given in 7.1.2 and 7.1.3. However, other procedures may be used when it is desired to simulate special conditions or practices, or when the procedures specified are impracticable. A machine-mixing procedure suitable for drum-type mixers is described. It is important not to vary the mixing sequence and procedure from batch to batch unless the effect of such variation is under study.