Designation: C873/C873M – 15

# Standard Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds[1]

This standard is issued under the fixed designation C873/C873M; 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 strength of cylindrical concrete specimens that have been molded in place using special molds attached to formwork. This test method is limited to use in slabs where the depth of concrete is from 125 to 300 mm [5 to 12 in.].

1.2 *Units*—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 consult and 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])

## 2. Referenced Documents

2.1 *ASTM Standards:*[3]

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

C42/C42M Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

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

C617 Practice for Capping Cylindrical Concrete Specimens

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

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

## 3. Summary of Test Method

3.1 A concrete cylinder mold assembly consisting of a mold and a tubular support member is fastened within the concrete formwork prior to placement of the concrete as shown in Fig. 1. The elevation of the mold upper edge is adjusted to correspond to the level of the finished slab surface. The mold support prevents direct contact of the slab concrete with the outside of the mold and permits easy removal of the mold from the slab. The mold is filled at the time its location is reached in the normal course of concrete placement. The specimen in the "cured-in-place" condition is removed from its in-place location immediately prior to de-molding, capping, and testing. The reported compressive strength is corrected on the basis of specimen length-diameter ratio using correction factors provided in the section on calculation of Test Method C42/C42M.

## 4. Significance and Use

4.1 Cast-in-place cylinder strength relates to the strength of concrete in the structure due to the similarity of curing conditions because the cylinder is cured within the slab. However, due to differences in moisture condition, degree of consolidation, specimen size, and length-diameter ratio, there is not a unique relationship between the strength of cast-in-place cylinders and cores of the same age. When cores can be drilled undamaged and tested in the same moisture condition as the cast-in-place cylinders, the strength of the cylinders can be expected to be on average 10 % higher than the cores at ages up to 91 days for specimens of the same size and length-diameter ratio.[4]

4.2 Strength of cast-in-place cylinders may be used for various purposes, such as estimating the load-bearing capacity

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

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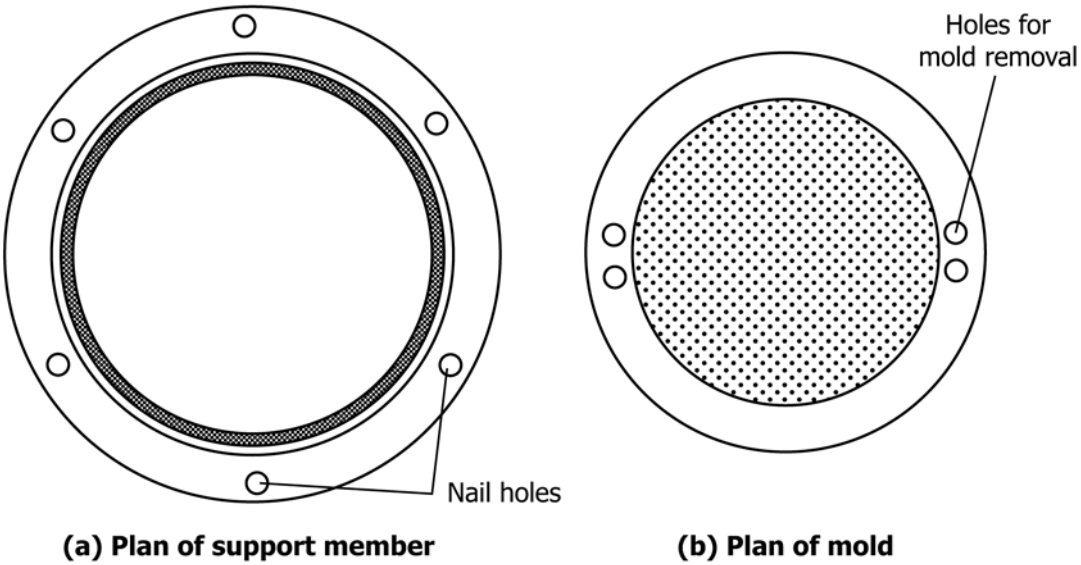
[2] Section on Safety Precautions, Manual of Aggregate and Concrete Testing, *Annual Book of ASTM Standards*, Vol 04.02.

[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.

[4] Bloem, D. L., "Concrete Strength in Structures," *Journal of the American Concrete Institute,* JACIA, March 1968, or *ACI Proceedings,* PACIA, Vol. 65, No. 3, pp. 169–248.

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



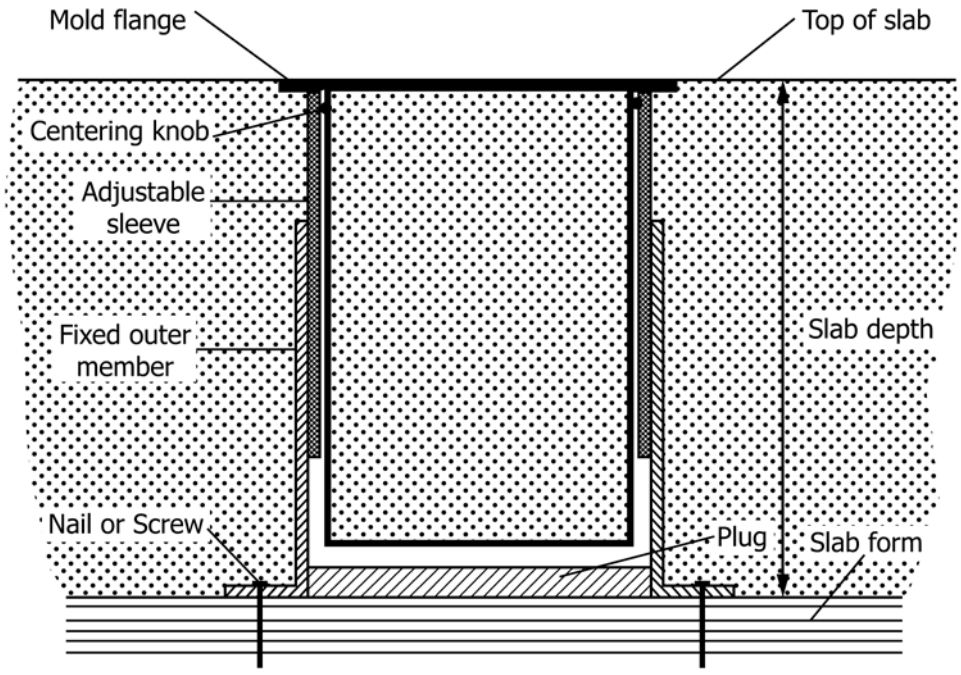




**FIG. 1 Schematic of Cast-in-Place Cylinder Mold Assembly**

of slabs, determining the time of form and shore removal, and determining the effectiveness of curing and protection.

## 5. Apparatus

5.1 Cast-in-place molds shall have a diameter at least three times the nominal maximum aggregate size. The length-diameter ratio (*L/D*) of the specimen after capping shall not be less than 1.0 (see Note 1). Molds (inner member) shall be constructed in one piece in the form of right circular cylinders at least 100 mm [4 in.] in inside diameter with the average diameter not differing from the nominal diameter by more than 1 % and no individual diameter differing from any other diameter by more than 2 %. The plane of the rim of the mold and the bottom shall be perpendicular to the axis of the mold within 0.5° (approximately equivalent to 1 mm in 300 mm [⅛ in. in 12 in.]).

NOTE 1—The length-diameter ratio should preferably be between 1.5 and 2.0.

5.2 Molds shall be watertight and meet the criteria of the section on water leakage of Specification C470/C470M. Molds and auxiliary apparatus shall be made of nonabsorbent material

that does not react with concrete containing portland or other hydraulic cements. Molds shall be sufficiently strong and tough to permit use under normal construction conditions without tearing, crushing, or otherwise deforming permanently when filled with fresh concrete. Molds shall resist permanent deformation to the extent that they produce hardened concrete cylinders such that two diameters measured at right angles to each other in any horizontal plane do not differ by more than 2.0 mm [1⁄16 in.].

5.3 The exterior top of the mold shall have outwardly extending centering knobs and an annular flange to rest on top of the support member (5.4) and to seal the annular ring space between the mold and that support member. Means for twisting and vertical withdrawal of molds from the support member shall be provided in the annular flange (see Fig. 1).

5.4 Support members shall be right circular cylinders and shall be rigid tubes of diameter required to accommodate molds stipulated in 5.1 and to concentrically contact and support the annular flange of the mold. Support members shall be provided with a means for height adjustment and shall be fitted with exterior means to permit nailing or other firm attachment to slab forms in a manner preventing entry of concrete or mortar into the annular ring space between the support member and the mold.

## 6. Installation of Apparatus

6.1 After completion of reinforcing steel placement and other formwork preparation, fasten the support member to slab forms using nails or screws. Adjust the support member so that the top of the mold is aligned with the elevation of screed guides used in striking off the concrete.

NOTE 2—The location of mold assemblies should be noted on project drawings for easy location after concrete placement and for identification.

6.2 Place the mold in the support member so that the flange of the mold is uniformly supported by the sleeve to prevent concrete or mortar from penetrating into the space between the mold and support member.

NOTE 3—Insertion of compressible material between the support member and the mold is permitted to prevent mortar seepage into the annular space.

## 7. Procedure

7.1 Inspect the molds to ensure they are clean and free of any debris or foreign matter. Fill the molds when the concrete placement progresses to the vicinity of mold location.

7.2 *Consolidation*—Consolidate concrete in the mold to simulate the conditions of placement. In normal field construction practice, if the surrounding concrete is consolidated by internal vibration, use the vibrator externally, briefly touching the exterior of the mold support member. Internal vibration of concrete in the mold is prohibited except under special circumstances that shall be explained in the report of test results. Subject the specimen surface to the same finishing as the surrounding concrete.

7.3 *Curing of Specimens*—Subject the specimens to the same curing and treatment as provided to the surrounding concrete. Record maximum and minimum slab surface temperatures during the curing period for inclusion in the report. Specimen molds shall remain fully seated in place until time of removal for transportation to the testing location.

7.4 *Mold Removal*—Remove molds from support members, exercising care so as not to physically damage specimens. From the time of removal from the structure until time of test, maintain test specimens at a temperature within ±5 °C [±10 °F] of the slab surface temperature at the time of removal. Transport specimens to the laboratory within 4 h after removal. During transportation protect the specimens with suitable material to prevent damage from jarring, to insulate them from extreme ambient temperatures, and to prevent moisture loss.

7.5 *Testing of Specimens*—Remove specimens from molds. Determine the average diameter of each specimen to the nearest 0.2 mm [0.01 in.] by averaging two diameters measured at right angles to each other at about the midheight of the specimen. Cap specimens in accordance with Practice C617 and measure the length of the capped specimens to the nearest 2 mm [0.1 in.]. Alternatively, measure the length of the specimens to the nearest 2 mm [0.1 in.] and use unbonded caps in accordance with Practice C1231/C1231M. Test the specimens in accordance with Test Method C39/C39M. Test the specimens for compressive strength in the "as-received" moisture condition unless required otherwise by project specifications.

## 8. Calculation

8.1 Calculate the compressive strength of each specimen using the computed cross-sectional area based on the average diameter of the specimen. If the length-diameter ratio of the specimen is 1.75 or less, correct the calculated strength by multiplying by the applicable strength correction factor given in Test Method C42/C42M.

## 9. Report

9.1 Report the following information:

9.1.1 Identification of structure in which specimens were cast, identification of specimen, and location of the mold in the structure,

9.1.2 Diameter and length, mm [in.],

9.1.3 Maximum load, N [lbf],

9.1.4 The *L/D* strength correction factor used,

9.1.5 Compressive strength calculated to the nearest 10 psi [0.1 MPa] after multiplying by the applicable *L/D* strength correction factor, if required,

9.1.6 Type of fracture (see Test Method C39/C39M),

9.1.7 Defects in specimen, or caps, if observed,

9.1.8 Age of specimen,

9.1.9 Curing methods used,

9.1.10 Initial concrete temperature,

9.1.11 Maximum and minimum temperature information obtained at job site to define curing conditions of specimens in place,

9.1.12 Detailed descriptions of any internal vibration or other internal manipulations of the fresh concrete in the mold (7.2), and

9.1.13 Other information pertaining to job conditions that could affect the results.

## 10. Precision and Bias

10.1 *Precision*—The single-operator coefficient of variation has been found to be 3.5 %[5] for a range of compressive strength between 10 and 41 MPa [1500 and 6000 psi].[6] Therefore, results of two properly conducted tests by the same operator on the same sample of concrete should not differ from each other by more than 10.0 %[5] of their average. Larger differences may be due to improperly prepared specimens or actual strength differences because of different batches of concrete or different curing conditions.

10.2 *Bias*—The bias of this test method cannot be determined because the strength of a cast-in-place cylindrical specimen can only be obtained by using this test method.

## 11. Keywords

11.1 compressive strength; concrete; cylinder molds ; in-place strength

[5] These numbers represent, respectively, the (1s %) and (d2s %) limits as described in Practice C670.

[6] This statement was derived from research data reported by Nicholas J. Carino, H. S. Lew, and Charles K. Volz in "Early Age Temperature Effects on Concrete Strength Prediction by the Maturity Method," *ACI Journal*, Vol 80, No. 2, March–April 1983.

## SUMMARY OF CHANGES

Committee C09 has identified the location of selected changes to this test method since the last issue, C873/C873M–10a, that may impact the use of this test method. (Approved Dec. 1, 2015.)

*(1)* Section 5.2 was revised.