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

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1. Scope

1.1 This test method covers the determination of strength of cylindrical concrete specimens derived by means of a cast-in-place mold technique using specimens molded in place in the concrete structural slab at the time the structural slab is cast. This test method is limited to use in slabs where the depth of concrete is from 5 to 12 in. [125 to 300 mm].

1.2 The values stated in either inch-pounds or SI units shall be regarded separately as standard. SI units are shown in brackets. The values stated may not be exact equivalents, therefore each system must be used independently of the other. Combining values of the two units 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 consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 39 Test Method for Compressive Strength of Cylindrical Concrete Specimens[2]

C 42 Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete[2]

C 470 Specification for Molds for Forming Concrete Test Cylinders Vertically[2]

C 617 Practice for Capping Cylindrical Concrete Specimens[2]

C 670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials[2]

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 plane of the finished slab surface. The mold support prevents direct contact of the slab concrete with the outside of the mold and permits its easy removal after the concrete has hardened. The mold is filled at the time its location is reached in the normal course of concrete placement. The specimen in the "as-cured" 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 to diameter ratio using correction factors provided in the section on calculation of Test Method C 42.

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 since the cylinder is actually cured within the slab. However, due to differences in moisture condition, degree of consolidation, specimen size, and length to diameter ratio, there is not a constant relationship between the strength of cast-in-place cylinders and cores. 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 an average 10 % higher than the cores at ages up to 91 days for specimens of the same size and length to diameter ratio.[3]

4.2 Strength of cast-in-place cylinders may be used for various purposes, such as estimating the load-bearing capacity 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 ratio of the length-to-diameter (*L/D*) of the specimen after capping shall not be less than 1.0 and should preferably be between 1.5 and 2.0. Molds (inner member) shall be constructed in one piece in the form of right circular cylinders at least 4 in. [100 mm] 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

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[2] *Annual Book of ASTM Standards*, Vol 04.02.

[3] 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.

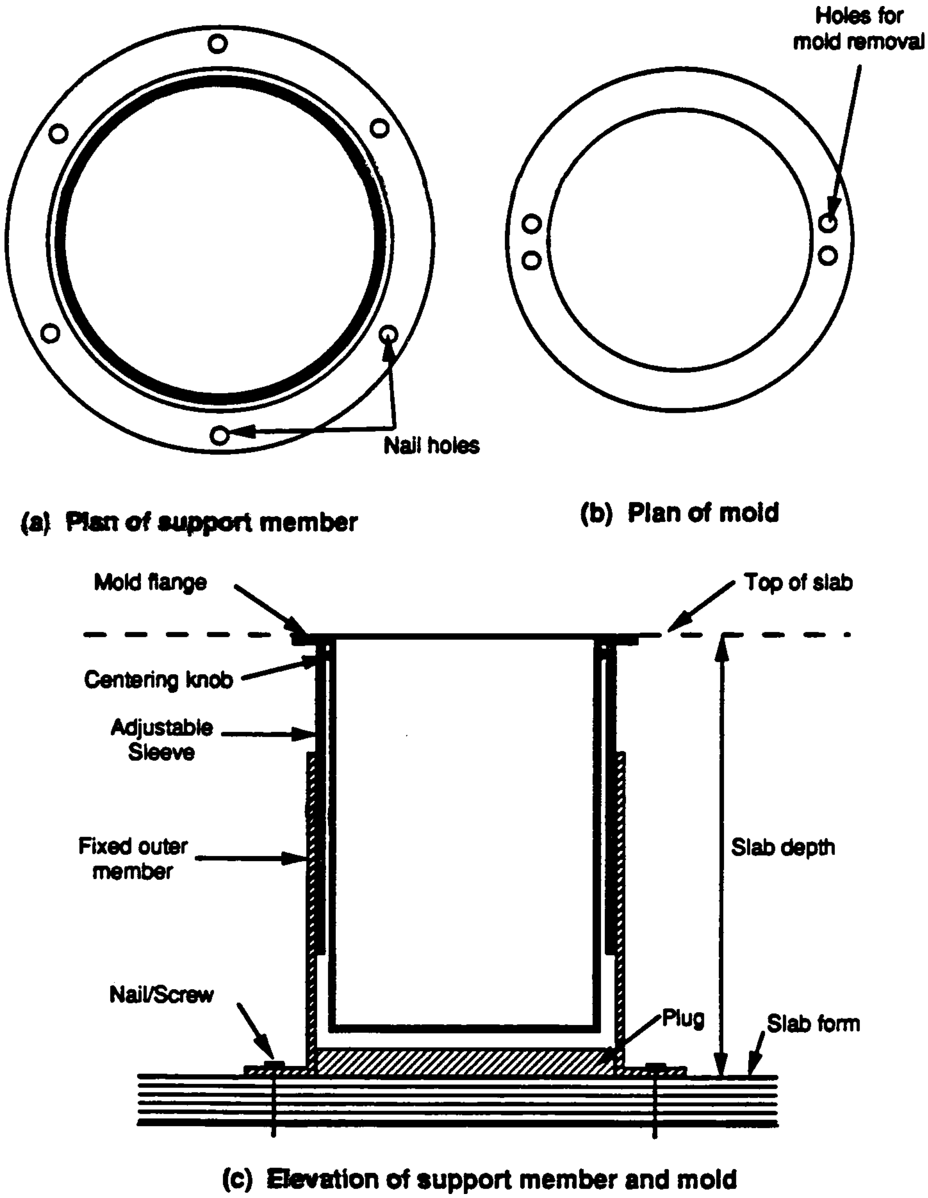

FIG. 1 Schematic of Cast-in-Place Cylinder Mold Assembly

perpendicular to the axis of the mold within 0.5° (approximately equivalent to ⅛ in. in 12 in. [3 mm in 300 mm]).

5.2 Molds shall be watertight and meet the criteria of the section on water leakage of Specification C 470. Molds and auxiliary apparatus shall be made of nonabsorbent material, nonreactive with concrete containing portland or other hydraulic cements. They shall be sufficiently strong and tough to permit use under normal construction conditions without tearing, crushing, or otherwise deforming when filled with fresh concrete. They shall resist 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 1⁄16 in. [2.0 mm].

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 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 or reinforcing steel 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 suport member to slab forms using nails or screws. Adjust the support member so that the tops of the molds are aligned with the elevation of other screeds. The location of mold assemblies should be noted on the project plans 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 (see Note 1).

NOTE 1—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 of concrete in the mold may be varied 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 not permissible except under special circumstances, which 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 Specimen*—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 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 of ± 10°F [±6°C] of the slab surface temperature at the time of removal. Transportation to the laboratory shall occur within 4 h after removal. During transportation protect the specimens with suitable material to prevent damage from jarring, freezing temperatures or moisture loss, or combination thereof.

7.5 *Testing of Specimens*—Remove specimens from molds. Cap specimens in accordance with Practice C 617 and test in accordance with Test Method C 39. 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 ratio of length-to-diameter of the specimen is appreciably less than 2.0, make allowance for the *L/D* effect by multiplying the uncorrected strength by the nearest applicable correction factor in the section on calculation of Test Method C 42.

9. Report

9.1 Report the following information:

9.1.1 Identification of source, identification of specimen, and location of the mold in the structure,

9.1.2 Diameter and length, in. [mm],

9.1.3 Maximum load, lbf [N],

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 correction by *L/D* factor,

9.1.6 Type of fracture,

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 %[4] for a range of compressive strength between 1500 and 6000 psi [10 and 41 MPa].[5] 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 %[4] 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

[4] These numbers represent, respectively, the (1s %) and (d2s %) limits as described in Practice C 670.

[5] 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.

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