



Designation: C 39/C 39M – 03

## Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens<sup>1</sup>

This standard is issued under the fixed designation C 39/C 39M; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

*This standard has been approved for use by agencies of the Department of Defense.*

### 1. Scope

1.1 This test method covers determination of compressive strength of cylindrical concrete specimens such as molded cylinders and drilled cores. It is limited to concrete having a unit weight in excess of 50 lb/ft<sup>3</sup> [800 kg/m<sup>3</sup>].

1.2 The values stated in either inch-pound or SI units are to be regarded separately as standard. The SI units are shown in brackets. 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 nonconformance 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.*

1.4 The text of this standard references notes which provide explanatory material. These notes shall not be considered as requirements of the standard.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

- C 31/C 31M Practice for Making and Curing Concrete Test Specimens in the Field<sup>2</sup>
- C 42/C 42M Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete<sup>2</sup>
- C 192/C 192M Practice for Making and Curing Concrete Test Specimens in the Laboratory<sup>2</sup>
- C 617 Practice for Capping Cylindrical Concrete Specimens<sup>2</sup>
- C 670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials<sup>2</sup>
- C 873 Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds<sup>2</sup>

<sup>1</sup> 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 Concrete for Strength.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 04.02.

C 1077 Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation<sup>2</sup>

C 1231/C 1231M Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders<sup>2</sup>

E 4 Practices for Force Verification of Testing Machines<sup>3</sup>

E 74 Practice for Calibration of Force-Measuring Instruments for Verifying the Load Indication of Testing Machines<sup>3</sup>

Manual of Aggregate and Concrete Testing<sup>2</sup>

2.2 *American Concrete Institute:*

CP-16 Concrete Laboratory Testing Technician, Grade I<sup>4</sup>

### 3. Summary of Test Method

3.1 This test method consists of applying a compressive axial load to molded cylinders or cores at a rate which is within a prescribed range until failure occurs. The compressive strength of the specimen is calculated by dividing the maximum load attained during the test by the cross-sectional area of the specimen.

### 4. Significance and Use

4.1 Care must be exercised in the interpretation of the significance of compressive strength determinations by this test method since strength is not a fundamental or intrinsic property of concrete made from given materials. Values obtained will depend on the size and shape of the specimen, batching, mixing procedures, the methods of sampling, molding, and fabrication and the age, temperature, and moisture conditions during curing.

4.2 This test method is used to determine compressive strength of cylindrical specimens prepared and cured in accordance with Practices C 31/C 31M, C 192/C 192M, C 617, and C 1231/C 1231M and Test Methods C 42/C 42M and C 873.

4.3 The results of this test method are used as a basis for quality control of concrete proportioning, mixing, and placing

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 03.01.

<sup>4</sup> Available from American Concrete Institute, P.O. Box 9094, Farmington Hills, MI 48333-9094.

operations; determination of compliance with specifications; control for evaluating effectiveness of admixtures; and similar uses.

4.4 The individual who tests concrete cylinders for acceptance testing shall have demonstrated a knowledge and ability to perform the test procedure equivalent to the minimum guidelines for certification of Concrete Laboratory Technician, Level I, in accordance with ACI CP-16.

NOTE 1—The testing laboratory performing this test method should be evaluated in accordance with Practice C 1077.

## 5. Apparatus

5.1 *Testing Machine*—The testing machine shall be of a type having sufficient capacity and capable of providing the rates of loading prescribed in 7.5.

5.1.1 Verify calibration of the testing machines in accordance with Practices E 4, except that the verified loading range shall be as required in 5.3.2. Verification is required under the following conditions:

5.1.1.1 After an elapsed interval since the previous verification of 18 months maximum, but preferably after an interval of 12 months,

5.1.1.2 On original installation or relocation of the machine,

5.1.1.3 Immediately after making repairs or adjustments that affect the operation of the force applying system of the machine or the values displayed on the load indicating system, except for zero adjustments that compensate for the mass of bearing blocks or specimen, or both, or

5.1.1.4 Whenever there is reason to doubt the accuracy of the results, without regard to the time interval since the last verification.

5.1.2 *Design*—The design of the machine must include the following features:

5.1.2.1 The machine must be power operated and must apply the load continuously rather than intermittently, and without shock. If it has only one loading rate (meeting the requirements of 7.5), it must be provided with a supplemental means for loading at a rate suitable for verification. This supplemental means of loading may be power or hand operated.

5.1.2.2 The space provided for test specimens shall be large enough to accommodate, in a readable position, an elastic calibration device which is of sufficient capacity to cover the potential loading range of the testing machine and which complies with the requirements of Practice E 74.

NOTE 2—The types of elastic calibration devices most generally available and most commonly used for this purpose are the circular proving ring or load cell.

5.1.3 *Accuracy*—The accuracy of the testing machine shall be in accordance with the following provisions:

5.1.3.1 The percentage of error for the loads within the proposed range of use of the testing machine shall not exceed  $\pm 1.0$  % of the indicated load.

5.1.3.2 The accuracy of the testing machine shall be verified by applying five test loads in four approximately equal increments in ascending order. The difference between any two successive test loads shall not exceed one third of the difference between the maximum and minimum test loads.

5.1.3.3 The test load as indicated by the testing machine and the applied load computed from the readings of the verification device shall be recorded at each test point. Calculate the error,  $E$ , and the percentage of error,  $E_p$ , for each point from these data as follows:

$$E = A - B \quad (1)$$

$$E_p = 100(A - B)/B$$

where:

$A$  = load, lbf [kN] indicated by the machine being verified, and

$B$  = applied load, lbf [kN] as determined by the calibrating device.

5.1.3.4 The report on the verification of a testing machine shall state within what loading range it was found to conform to specification requirements rather than reporting a blanket acceptance or rejection. In no case shall the loading range be stated as including loads below the value which is 100 times the smallest change of load estimable on the load-indicating mechanism of the testing machine or loads within that portion of the range below 10 % of the maximum range capacity.

5.1.3.5 In no case shall the loading range be stated as including loads outside the range of loads applied during the verification test.

5.1.3.6 The indicated load of a testing machine shall not be corrected either by calculation or by the use of a calibration diagram to obtain values within the required permissible variation.

5.2 The testing machine shall be equipped with two steel bearing blocks with hardened faces (Note 3), one of which is a spherically seated block that will bear on the upper surface of the specimen, and the other a solid block on which the specimen shall rest. Bearing faces of the blocks shall have a minimum dimension at least 3 % greater than the diameter of the specimen to be tested. Except for the concentric circles described below, the bearing faces shall not depart from a plane by more than 0.001 in. [0.02 mm] in any 6 in. [150 mm] of blocks 6 in. [150 mm] in diameter or larger, or by more than 0.001 in. [0.02 mm] in the diameter of any smaller block; and new blocks shall be manufactured within one half of this tolerance. When the diameter of the bearing face of the spherically seated block exceeds the diameter of the specimen by more than 0.5 in. [13 mm], concentric circles not more than 0.03 in. [0.8 mm] deep and not more than 0.04 in. [1 mm] wide shall be inscribed to facilitate proper centering.

NOTE 3—It is desirable that the bearing faces of blocks used for compression testing of concrete have a Rockwell hardness of not less than 55 HRC.

5.2.1 Bottom bearing blocks shall conform to the following requirements:

5.2.1.1 The bottom bearing block is specified for the purpose of providing a readily machinable surface for maintenance of the specified surface conditions (Note 4). The top and bottom surfaces shall be parallel to each other. If the testing machine is so designed that the platen itself is readily maintained in the specified surface condition, a bottom block is not required. Its least horizontal dimension shall be at least 3 %