
Standard Method of Test for

Compressive Strength of Cylindrical Concrete Specimens

AASHTO Designation: T 22M/T 22-22¹



Technically Revised: 2022

Technical Subcommittee: 3c, Hardened Concrete

ASTM Designation: C39/C39M-21

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 800 kg/m³ (50 lb/ft³).
- 1.2. The values stated in either SI units or inch-pound units are to be regarded separately as standard. The inch-pound units are shown in parentheses. 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 may involve hazardous materials, operations, or equipment. 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.*
Warning—Means should be provided to contain concrete fragments during sudden rupture of specimens. Tendency for sudden rupture increases with increasing concrete strength (Note 1).
Note 1—The safety precautions given in the *Manual of Aggregate and Concrete Testing*, located in the Related Materials section of Vol. 04.02 of the *Annual Book of ASTM Standards*, are recommended.
- 1.4. The text of this standard references notes that provide explanatory material. These notes shall not be considered as requirements of the standard.
- 1.5. *The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of R 18 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with R 18 alone does not completely assure reliable results. Reliable results depend on many factors; following the suggestions of R 18 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.*

2. REFERENCED DOCUMENTS

- 2.1. AASHTO Standards:
■ M 339M/M 339, Thermometers Used in the Testing of Construction Materials

- < R 18, Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
- < R 39, Making and Curing Concrete Test Specimens in the Laboratory
- < R 100, Making and Curing Concrete Test Specimens in the Field
- < T 24M/T 24, Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- < T 231, Capping Cylindrical Concrete Specimens

2.2. *ASTM Standards:*

- < C670, Standard Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
- < C873/C873M, Standard Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds
- < C1231/C1231M, Standard Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Cylindrical Concrete Specimens
- < E1, Standard Specification for ASTM Liquid-in-Glass Thermometers
- < E4, Standard Practices for Force Verification of Testing Machines
- < E74, Standard Practices for Calibration and Verification for Force-Measuring Instruments
- < E230/E230M, Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
- < E2877, Standard Guide for Digital Contact Thermometers
- < R0030, *Manual of Aggregate and Concrete Testing* (not an ASTM standard; available as PDF only)

2.3. *International Electrotechnical Commission Standard:*

- < IEC 60584-1:2013 Thermocouples - Part 1: EMF Specifications and Tolerances

3. TERMINOLOGY

3.1. *Definitions of Terms Specific to This Standard;*

3.1.1. *bearing block*—steel piece to distribute the load from the testing machine to the specimen.

3.1.2. *lower bearing block*—steel piece placed under the specimen to distribute the load from the testing machine to the specimen.

3.1.2.1. *Discussion*—The lower bearing block provides a readily machinable surface for maintaining the specified bearing surface. The lower bearing block may also be used to adapt the testing machine to various specimen heights. The lower bearing block is also referred to as *bottom block*, *plain block*, and *false platen*.

3.1.3. *platen*—primary bearing surface of the testing machine.

3.1.3.1. *Discussion*—The platen is also referred to as the testing machine *table*.

3.1.4. *spacer*—steel piece used to elevate the lower bearing block to accommodate test specimens of various heights.

3.1.4.1. *Discussion*—Spacers are not required to have hardened bearing faces because spacers are not in direct contact with the specimen or the retainers of unbonded caps.

- 3.1.5. *upper bearing block*—steel assembly suspended above the specimen that is capable of tilting to bear uniformly on the top of the specimen.
- 3.1.5.1. *Discussion*—The upper bearing block is also referred to as the *spherically seated block* and the *suspended block*.

4. SUMMARY OF TEST METHOD

- 4.1. This test method consists of applying a compressive axial load to molded cylinders or cores at a rate that 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.

5. SIGNIFICANCE AND USE

- 5.1. Care must be exercised in the interpretation of the significance of compressive strength determinations by this test method because 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.
- 5.2. This test method may be used to determine compressive strength of cylindrical specimens prepared and cured in accordance with R 39, R 100, T 24M/T 24, T 231, and ASTM C873/C873M.
- 5.3. The results of this test method may be used as a basis for quality control of concrete proportioning, mixing, and placing operations; determination of compliance with specification; and control for evaluating effectiveness of admixtures and similar uses (R 18).

6. APPARATUS

- 6.1. *Testing Machine*—The testing machine shall be of a type having sufficient capacity and capable of providing the rates of loading prescribed in Section 8.5.
- 6.1.1. Verify calibration of the testing machines in accordance with ASTM E4, except that the verified loading range shall be as required in Section 6.3. Verification is required under the following conditions:
- 6.1.1.1. Within 13 months of the last calibration;
- 6.1.1.2. On original installation or immediately after relocation;
- 6.1.1.3. Immediately after making repairs or adjustments that affect the operation of the force applying system or the values displayed on the load indicating system, except for zero adjustments that compensate for the mass (weight) of tooling or specimen, or both; or
- 6.1.1.4. Whenever there is reason to suspect the accuracy of the indicated loads.
- 6.1.2. *Design*—The design of the machine must include the following features:
- 6.1.2.1. 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

Section 8.5), 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.

- 6.1.2.2. The space provided for test specimens shall be large enough to accommodate, in a readable position, an elastic calibration device that is of sufficient capacity to cover the potential loading range of the testing machine and that complies with the requirement of ASTM E74.

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

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

- 6.1.3.1. The percentage of error for the loads within the proposed range of use of the testing machine shall not exceed ± 1.0 percent of the indicated load.

- 6.1.3.2. 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.

- 6.1.3.3. 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:

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

$$E_p = 100 (A - B)/B \quad (2)$$

where:

A = load, kN (lbf) indicated by the machine being verified; and

B = applied load, kN (lbf) as determined by the calibrating device.

- 6.1.3.4. 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 that is 100 times the smallest change of load that can be estimated on the load-indicating mechanism of the testing machine or loads within that portion of the range below 10 percent of the maximum range capacity.

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

- 6.1.3.6. 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.

- 6.2. 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 percent 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 0.02 mm (0.001 in.) in any 150 mm (6 in.) of blocks 150 mm (6 in.) in diameter or larger or by more than 0.02 mm (0.001 in.) 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 13 mm (0.5 in.), concentric circles not more than 0.8 mm (0.03 in.) deep and not more than 1 mm (0.04 in.) wide shall be inscribed to facilitate proper centering.