

WSDOT FOP for AASHTO T 22¹

Compressive Strength of Cylindrical Concrete Specimens

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/ft³ (800 kg/m³).
- 1.2 The values stated in English units are the standard.
- 1.3 This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and 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 Volume 04.02 of the Annual Book of ASTM Standards, are recommended.

- 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 AASHTO Standards

R 39 – Making and Curing Concrete Test Specimens in the Laboratory

T 23 – Making and Curing Concrete Test Specimens in the Field

T 24 – Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

T 231 – Capping Cylindrical Concrete Specimens

2.2 ASTM Standards

C 873 – Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds

C 1231 – Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders

E 74 – Practice for Calibration of Force-Measuring Instruments for Verifying the Load Indication of Testing Machines

¹This FOP is based on AASHTO T 22-11 and has been modified per WSDOT standards. To view the redline modifications, contact the WSDOT Quality Systems Manager at 360-709-5412.

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 Methods T 23, T 24, T 231, and ASTM C873.
- 4.3 The results of this test method are used as a basis for quality control of concrete proportioning, mixing, and placing operations; determination of compliance with specifications; control for evaluating effectiveness of admixtures and similar uses.

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 [Section 7.5](#). As a minimum, the machine should be capable of achieving 170 percent of the design strength.
- 5.1.1 Verify calibration of the testing machines in accordance with Method T 67 except that the verified loading range shall be as required in [Section 5.3.2](#). Verification is required under the following conditions:
- 5.1.1.1 At least annually, but not to exceed 13 months.
- 5.1.1.2 On original installation or immediately after relocation.
- 5.1.1.3 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.
- 5.1.1.4 Whenever there is reason to suspect the accuracy of the indicated loads.
- 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 [Section 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 ± 1.0 percent 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:

$$E = A - B$$

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

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 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.
- 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 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 0.001 in (0.025 mm) in any 6 in (150 mm) of blocks 6 in (150 mm) in diameter or larger, or by more than 0.001 in (0.025 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 0.031 in (0.8 mm) deep and not more than 0.047 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. Its least horizontal dimension shall be at least 3 percent greater than the diameter of the specimen to be tested. Concentric circles as described in [Section 5.2](#) are optional on the bottom block.

Note 4: The block may be fastened to the platen of the testing machine.

- 5.2.1.2 Final centering must be made with reference to the upper spherical block when the lower bearing block is used to assist in centering the specimen. The center of the concentric rings, when provided, or the center of the block itself must be directly below the center of the spherical head. Provision shall be made on the platen of the machine to assure such a position.
- 5.2.1.3 The bottom bearing block shall be at least 1 in (25 mm) thick when new, and at least 0.9 in (22.5 mm) thick after any resurfacing operations, except when the block is in full and intimate contact with the lower platen of the testing machine, the thickness may be reduced to 0.38 in (10 mm).

Note 5: If the testing machine is so designed that the platen itself can be readily maintained in the specified surface condition, a bottom block is not required.

5.2.2 The spherically seated bearing block shall conform to the following requirements:

5.2.2.1 The maximum diameter of the bearing face of the suspended spherically seated block shall not exceed the values given below:

Diameter of Test Specimens in (mm)	Maximum Diameter of Bearing Face in (mm)
2 (50)	4 (105)
3 (75)	5 (130)
4 (100)	6.5 (165)
6 (150)	10 (255)
8 (200)	11 (280)

Note 6: Square bearing faces are permissible, provided the diameter of the largest possible inscribed circle does not exceed the above diameter.

5.2.2.2 The center of the sphere shall coincide with the surface of the bearing face within a tolerance of ± 5 percent of the radius of the sphere. The diameter of the sphere shall be at least 75 percent of the diameter of the specimen to be tested.

5.2.2.3 The ball and the socket shall be designed so that the steel in the contact area does not permanently deform when loaded to the capacity of the test machine. (Note 7).

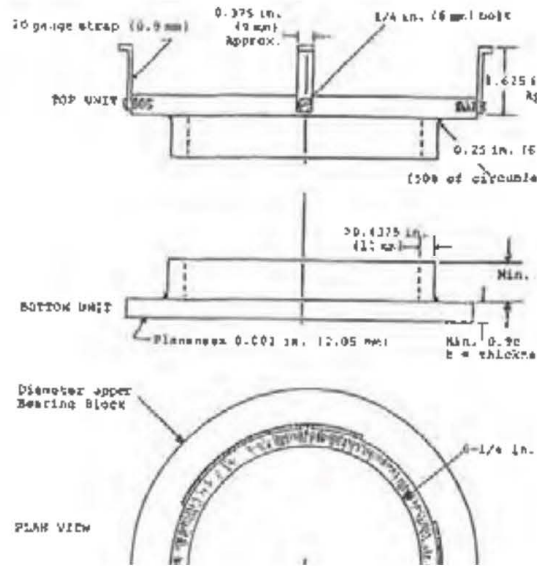
Note 7: The preferred contact area is in the form of a ring (described as preferred “bearing” area) as shown on [Figure 1](#).

5.2.2.4 The curved surfaces of the socket and of the spherical portion shall be kept clean and shall be lubricated with a petroleum-type oil such as conventional motor oil, not with a pressure type grease. After contacting the specimen and application of small initial load, further tilting of the spherically seated block is not intended and is undesirable.

5.2.2.5 If the radius of the sphere is smaller than the radius of the largest specimen to be tested, the portion of the bearing face extending beyond the sphere shall have a thickness not less than the difference between the radius of the sphere and radius of the specimen. The least dimension of the bearing face shall be at least as great as the diameter of the sphere (see [Figure 1](#)).

5.2.2.6 The movable portion of the bearing block shall be held closely in the spherical seat, but the design shall be such that the bearing face can be rotated freely and tilted at least 4 degrees in any direction.

5.2.2.7 If the ball portion of the upper bearing block is a two-piece design composed of a spherical portion and a bearing plate, a mechanical means shall be provided to ensure that the spherical portion is fixed and centered on the bearing plate.



Note: Provision shall be made for holding the ball in the socket and for holding the entire unit in the testing machine

Schematic Sketch of a Typical Spherical Bearing Block
Figure 1

5.3 Load Indication

- 5.3.1 If the load of a compression machine used in concrete testing is registered on a dial, the dial shall be provided with a graduated scale that is readable to at least the nearest 0.1 percent of the full scale load (Note 8). The dial shall be readable within 1 percent of the indicated load at any given load level within the loading range. In no case shall the loading range of a dial be considered to include loads below the value that is 100 times the smallest change of load that can be read on the scale. The scale shall be provided with a graduation line equal to zero and so numbered. The dial pointer shall be of sufficient length to reach the graduation marks; the width of the end of the pointer shall not exceed the clear distance between the smallest graduations. Each dial shall be equipped with a zero adjustment which is easily accessible from the outside of the dial case, while observing the zero mark and dial pointer, and with a *suitable device that at all times until reset will indicate to within one percent accuracy the maximum load applied to the specimen.*

Note 8: As close as can reasonably be read is considered to be 0.02 in (0.5 mm) along the arc described by the end of the pointer. Also, one half of a scale interval is close as can reasonably be read when the spacing on the load indicating mechanism is between 0.04 in (1 mm) and 0.06 in (2 mm). When the spacing is between 0.06 and 0.12 in (2 and 3 mm), one third of a scale interval can be read with reasonable certainty. When the spacing is 0.12 in (3 mm) or more, one fourth of a scale interval can be read with reasonable certainty.