

**Standard Test Method for
Flexural Strength of Concrete
(Using Simple Beam with Third-Point Loading)**

AASHTO Designation: T97-86 (1993)

(ASTM Designation: C78-84)

AASHTO Designation: TP19-93^{1,2}

1. Scope

1.1 This test method covers determination of the flexural strength of concrete by the use of simple beam with third-point loading.

1.2 The values stated in inch-pound units are to be regarded as the standard.

Note 1 -- For methods of molding concrete specimens, see T23 and T126.

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.*

2. Referenced Documents

2.1 AASHTO Standards:

- T23 Making and Curing Concrete Compressive and Flexural Strength Test Specimens in the Field
- T67 Verification of Testing Machines
- T126 Making and Curing Concrete Test Specimens in the Laboratory

3. Apparatus

3.1 The testing machine shall conform to the requirements of Sections 16, 17, and 18 of T67. Hand-operated testing machines having pumps that do not provide a continuous loading in one stroke shall not be permitted. Motorized pumps of hand-operated positive displacement pumps having sufficient volume in one continuous stroke to complete a test without requiring replenishment are permitted and shall be capable of

applying loads at a uniform rate without shock or interruption. The third-point loading method

shall be used in making flexure tests of concrete employing bearing blocks which will ensure that forces applied to the beam will be perpendicular to the face of the specimen and applied without eccentricity. A diagram of an apparatus that accomplishes this purpose is shown in Figure 1.

3.2 All apparatus for making flexure tests of concrete should be capable of maintaining the specified span length and distances between load-applying blocks and support blocks constant within ± 0.05 in. (± 1.3 mm).

3.3 Reactions should be parallel to the direction of the applied forces at all times during the test and the ratio of distance between the point of load application and nearest reaction to the depth of the beam should not be less than one.

Note 2 -- If an apparatus similar to that illustrated in Figure 1 is used:

(a) The load-applying and support blocks should not be more than 2 1/2 in. (64 mm) high, measured from the center or axis of pivot, and should extend entirely across or beyond the full width of the specimen. Each case-hardened bearing surface in contact with the specimen shall not depart from a plane by more than 0.002 in. (0.05 mm) and should be a portion of a cylinder, the axis of which is coincidental with either the axis of the rod or center of the ball, whichever the block is pivoted upon. The angle subtended by the curved surface of each block should be at least 45 deg (0.79 rad).

(b) The load-applying and support blocks should be maintained in a vertical position and in contact with the rod or ball by means of spring-loaded screws which hold them in contact with the pivot rod or ball.

¹ This standard is based on SHRP Product 2023.

² Approved in October 1993, this provisional standard was first published in January 1994. Reconfirmed January 2000.

(c) The uppermost bearing place and center-point ball in Figure 1 may be omitted when a spherically seated bearing block is used, provided one rod and one ball are used as pivots for the upper load-applying blocks.

4. Test Specimen

4.1 The test specimen shall conform to all applicable requirements of T23 and T126. The specimen shall have a test span within 2 percent of being three times its depth as tested. The sides of the specimen shall be at right angles with the top and bottom. All surfaces in contact with load-applying and support blocks shall be smooth and free of scars, indentations, holes, or inscribed identifications.

4.2 Where tensile strain and deflection measurements are to be taken, a No. 2 smooth reinforcing bar placed along the centroidal axis would prevent sudden collapse of the specimen.

5. Procedure

5.1 Turn the test specimen on its side with respect to its position as molded and center on the bearing blocks. Center the loading system in relation to the applied force. Bring the load-applying blocks in contact with the surface of the specimen at the third points between the supports. If full contact is not obtained at no load between the specimen and the load-applying blocks and the supports so that there is a 1 in. (25 mm) or longer gap in excess of 0.004 in. (0.1 mm), grind or cap the contact surfaces of the specimen, or shim with leather strips.

Note 3 -- It is recommended that grinding lateral surfaces of the specimens be minimized as it may change the physical characteristics of the specimens and thereby affect the test results.

5.2 Use leather shims only when the specimen surfaces in contact with the blocks or supports depart from a plane by not more than 0.015 in. (0.38 mm). Leather shims shall be of uniform 1/4 in. (6.4 mm) thickness, 1 to 2 in. (25 to 50 mm) in width, and shall extend across the full width of the specimens. The load may be applied rapidly, up to approximately 50 percent of the breaking load. Thereafter, apply the load continuously at a rate which constantly increases the extreme fiber stress between 125 and 175 psi (861 and 1,207 kPa)/min, when calculated in accordance with Section 7.1, until rupture occurs.

6. Measurement of Specimens After Test

6.1 Take three measurements across each dimension (one at each edge and at the center) to the nearest 0.05 in. (1.3 mm) to determine the average width, average depth, and line of fracture location of the specimen at the section of failure.

7. Calculations

7.1 If the fracture initiates in the tension surface within the middle third of the span length, calculate the modulus of rupture as follows:

$$R = Pl/bd^2$$

where:

- R = modulus of rupture, psi, (or kPa),
- P = maximum applied load indicated by the testing machine, lbf, (or N),
- l = span length, in., (or mm),
- b = average width of specimen, in., (or mm), and
- d = average depth of specimen, in., (or mm).

7.1.1 If fracture occurs at a capped section, include the cap thickness in the measurement.

Note 4 -- The weight of the beam is not included in the above calculation.

7.2 If the fracture occurs in the tension outside of the middle third of the span length by not more than 5 percent of the span length, calculate the modulus of rupture as follows:

$$R = 3Pa/bd^2$$

where:

- a = average distance between line of fracture and the nearest support measured on the tension surface of the beam, in., (or mm).

7.3 If the fracture occurs in the tension surface outside of the middle third of the span length by more than 5 percent of the span length, discard the results of the test.