



Standard Method of Test
for



Comparing Concrete on the Basis of the Bond Developed with Reinforcing Steel

AASHTO DESIGNATION: T 159-88 (1996)

(ASTM DESIGNATION: C 234-87)

1. SCOPE

1.1 This test method covers comparison of concretes on the basis of the bond developed with reinforcing steel.

1.2 *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.*

1.3 The values stated in inch-pound units are to be regarded as the standard. The SI equivalents of inch-pound units may be approximate.

2. REFERENCED DOCUMENTS

2.1 AASHTO Standards:

- M 31/M 31 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- M 201 Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
- T 22 Compressive Strength of Cylindrical Concrete Specimens
- T 119 Slump of Hydraulic Cement Concrete
- T 121 Mass per Cubic Meter (Cubic Foot), Yield, and Air Content (Gravimetric) of Concrete
- T 126 Making and Curing

Concrete Test Specimens in the Laboratory

- T 152 Air Content of Freshly Mixed Concrete by the Pressure Method
- T 177 Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading)
- T 196 Air Content of Freshly Mixed Concrete by the Volumetric Method
- T 231 Capping Cylindrical Concrete Specimens
- T 244 Mechanical Testing of Steel Products

3. SIGNIFICANCE AND USE

3.1 This test method is not intended either for use in tests in which the principal variable is the size or type of reinforcing bar or for establishing bond values for structural purposes. This test method is adaptable to use for research purposes by varying the conditions as desired, but no attempt to do so has been included in the method. This test method may also be used to determine the conformance of a product or a treatment with a requirement relating to its effect on the bond developed between concrete and reinforcing steel.

4. APPARATUS

4.1 Molds for Bond Test Specimens—Two types of molds will be required: for 6 in. (150 mm) concrete cubes each containing a vertically embedded bar, and for 6 by 6 by 12 in. (150 by 150 by 300 mm) prisms each containing

two horizontally embedded bars. The molds preferably shall be made of metal, not less than $\frac{1}{4}$ in. (6 mm) thick. If made of wood, they shall be lined with smooth sheet metal approximately $\frac{1}{8}$ in. (3 mm) thick. The molds shall be watertight. With all-metal molds, watertightness may be accomplished by using grooved joints, or a sealing compound may be applied along the exteriors of the end joints after assembly. Particular care shall be taken to seal the openings where reinforcing bars extend through the molds. The molds shall be designed to hold the bars rigidly in place, including the free ends of projecting bars. The molds shall be constructed for each removal without disturbance of embedded bars. Suitable molds are shown in Figure 1.

4.2 Measuring Apparatus—Apparatus shall be provided for measuring the movement of the reinforcing bar with respect to the concrete at the loaded end of the bar. Dial gages shall be graduated in 0.001 in. (0.025 mm) units; a range of at least 0.5 in. (13 mm) shall be provided, and a range of 1.0 in. (25 mm) is desirable.

NOTE 1—Type of apparatus that has been found satisfactory is shown in Figure 2. The dial gages are mounted on suitable yokes which are attached to the concrete specimens with setscrews. At the loaded end of the bar, adjustment is accomplished by changing the height of the cap screws on the ends of the split-ring cross bar on which the stems of the gages bear. The split-ring cross bar is attached to the reinforcing bar through four screws in the arms of the cross bar which bring the gasket rubber lining into firm contact with the reinforcing bar. The three set-screws as shown are used to ensure additional cross bar contact. The cross bar is located in a slot machined in the intermediate bearing plate, but is fastened to the reinforcing bar in such

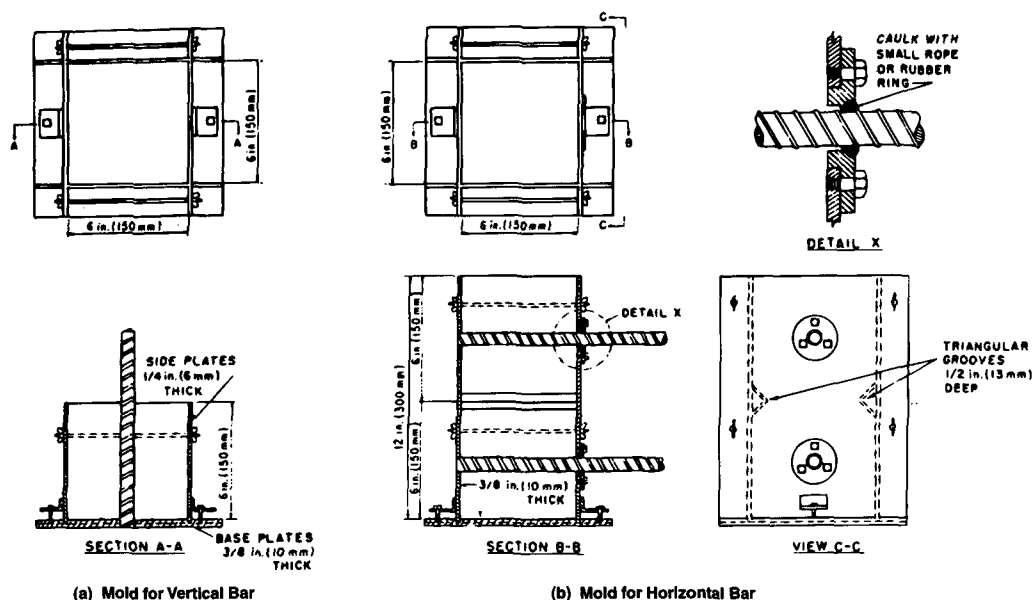


FIGURE 1 Molds for Bond Test Specimens

a way that no contact is made with the bearing plate during the test.

4.3 Testing Apparatus—The capped or bearing surface of the concrete cube shall be supported on a machined steel bearing plate at least 6 in. (150 mm) square and $\frac{3}{4}$ in. (19 mm) thick, with a hole drilled through its center of sufficient diameter to accommodate the reinforcing bar. If a cross bar measuring apparatus similar to that shown in Figure 2 is used, the bearing plate should be supported on a steel block at least 5 in. (125 mm) in diameter and 3 in. (75 mm) thick. This block should have a central hole to accommodate the reinforcing bar, and in addition, on its top side should have a diametrical slot and central hole of dimension sufficient to accommodate the cross bar. This slotted block shall rest in turn on a spherically seated bearing block at least 5 in. in diameter and having a central hole at least $1\frac{1}{2}$ in. (38 mm) in diameter (Figure 2).

5. TEST SPECIMENS

5.1 The test specimens shall be of two types: one containing one reinforcing bar embedded vertically, and the other containing two bars embedded horizontally. Three specimens of each type shall constitute a set of test specimens.

5.2 Specimens for Vertically Embedded Bar—These specimens shall consist

of concrete cubes, 6 in. (150 mm) on each edge with a single reinforcing bar embedded vertically along a central axis in each specimen. The bar shall project downward from the bottom face of the cube as cast a distance of about $\frac{3}{8}$ in. (10 mm), and shall project upward from the top face whatever distance is necessary to provide sufficient length of bar to extend through the bearing blocks and the support of the testing machine and to provide an adequate length to be gripped for application of load (Figure 1).

5.3 Specimens for Horizontally Embedded Bars—These specimens shall consist of concrete prisms 6 by 6 by 12 in. (150 by 150 by 300 mm) with the longer axes vertical. Two bars shall be embedded in each specimen, perpendicular to the long axis and parallel to and equidistant from the vertical sides of the prism (Figure 1). In the vertical direction, one bar shall be located with its axis 3 in. (75 mm) from the bottom of the prism, and the other 9 in. (225 mm) from the bottom. Both bars shall project from the two ends of the specimen distances corresponding to those specified in Section 3.2 for the specimens having a vertically embedded bar. A triangular groove or chamber shall be formed in each of the two opposite sides of the prism parallel to the axes of the bars and at midheight of the prism. These grooves shall be at least $\frac{1}{2}$ in. (13 mm) deep, measured perpendicularly from

the surface of the concrete. They are for the purpose of facilitating the breaking of the prism into two test specimens at this weakened plane prior to making the bond tests.

NOTE 2—To obtain the expected maximum effect on bond due to bleeding, settlement, and accumulation of air voids under the bars, the common plane of the two longitudinal ribs on each bar should be in a horizontal plane in the as-cast position.

5.4 Reinforcing Bars—The reinforcing bars shall be No. 6 deformed bars conforming to M 31. Care shall be taken that all bars used in a given series of tests are of the same type and have the same size, shape, and pattern of deformations. The lengths of the individual bars shall be such as to meet the requirements of the test specimens.

NOTE 3—In consideration of the size of the test specimens and the consequent limited clearances between the reinforcing bars and the sides of the molds, and for standardization, it is recommended that the size of the coarse aggregate used in the concrete be not greater than 1 in. (25 mm).

6. MIXING CONCRETE

6.1 The concrete shall be batched, machine mixed, molded, and cured in accordance with the applicable portions of T 126, except as may be otherwise directed herein. Immediately after mix-