



# Standard Test Method for Determining Bond Strength Between Hardened Roller Compacted Concrete and Other Hardened Cementitious Mixtures (Point Load Test)<sup>1</sup>

This standard is issued under the fixed designation C 1245/C 1245M; 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 reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope\*

1.1 This test method is intended for testing roller-compacted concrete specimens and covers determination of the relative bond between layers of roller-compacted concrete or other hardened concrete in multiple-lift forms of construction. It is applicable to all types of layered concrete where the total depth is sufficient to meet the minimum specimen length and diameter requirements of this test method. This test method is not intended to provide tensile strength results of the material tested.

1.2 The values stated in SI units, shown in brackets, or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other, without combining values in any way. Combining values from the two systems may result in non-conformance 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.*

## 2. Referenced Documents

### 2.1 ASTM Standards:

- C 39/C 39M Test Method for Compressive Strength of Cylindrical Concrete Specimens<sup>2</sup>
- C 42/C 42M Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete<sup>2</sup>
- C 125 Terminology Relating to Concrete and Concrete Aggregates<sup>2</sup>
- C 192/C 192M Practice for Making and Curing Concrete Test Specimens in the Laboratory<sup>2</sup>
- C 670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials<sup>2</sup>

- C 1176 Practice for Making Roller-Compacted Concrete in Cylinder Molds Using a Vibrating Table<sup>2</sup>
- C 1435 Practice for Making Roller-Compacted Concrete in Cylinder Molds Using a Vibrating Hammer<sup>2</sup>
- D 1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56 000 ft-lbf/ft<sup>3</sup>(2700 kN-m/m<sup>3</sup>))<sup>3</sup>

## 3. Terminology

3.1 Refer to Terminology C 125 for definitions of terms used in this test method.

## 4. Significance and Use

4.1 This test method is used to measure the effectiveness of bonding roller-compacted concrete to other roller-compacted concrete or other hardened cementitious mixtures by using a point load test at the joint. Bond strength is determined using drilled cores or cast cylindrical specimens in which the bond surface is essentially normal to the longitudinal axis at approximately the mid-length of the specimen. A splitting tensile stress normal to the bond surface is produced by applying a point load at the joint.

4.2 This test method may be used either for laboratory investigation by casting individual composite cylinders or by coring prototype structures or assemblies (Test Method C 42/C 42M).

## 5. Apparatus

5.1 *Testing Machine*—The testing machine shall conform to the requirements of Test Method C 39/C 39M.

5.2 *Testing Apparatus*—The testing apparatus shall be constructed of steel and allow the testing of both 4 and 6-in. [100 and 150-mm] diameter specimens. The test schematic is given in Fig. 1. The testing apparatus shall permit the positioning of a specimen such that the joint of the bonded surfaces is oriented as closely as possible parallel to the direction of loading. A photograph of the test configuration is given in Fig. 2. Figs. 3-10 provide the information necessary to construct the apparatus for 4 and 6-in. [100 and 150-mm] diameter specimens. Anvil rods (Fig. 4 and Fig. 6) shall have a hardness of

<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 C09.45 on Roller Compacted Concrete.

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

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 04.08.

\*A Summary of Changes section appears at the end of this standard.

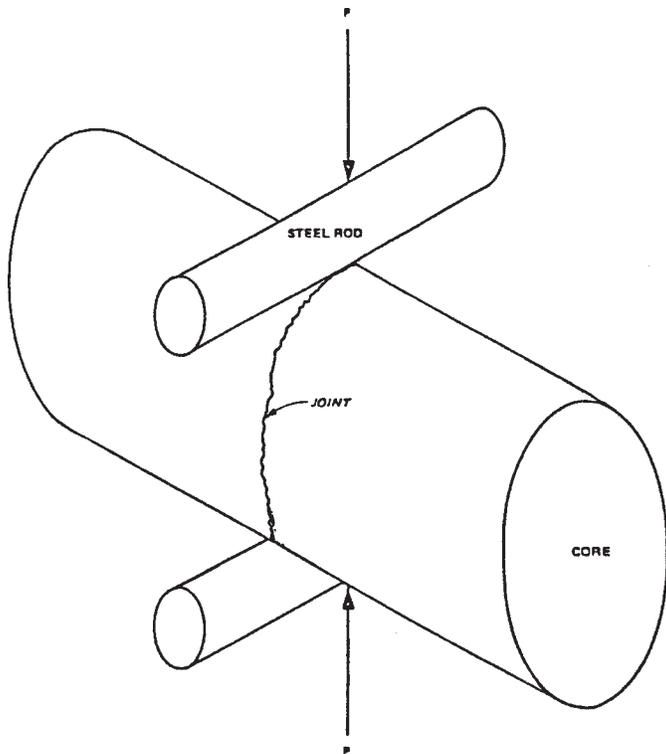


FIG. 1 Schematic of Loading Method

not less than 55 HRC (Rockwell hardness number of 55 on the C scale) and shall be plane on the bearing surfaces to within  $\pm 0.001$  in. [0.025 mm]. The alignment post shall ensure that the anvil rods are kept parallel to each other in the vertical plane. The system is easily adaptable to most testing machines.

## 6. Test Specimens

6.1 Test specimens shall be cores or cast cylinders 4 or 6  $\pm$  0.25 in. [100 or 150  $\pm$  5 mm] in diameter. Cast cylinders in accordance with Practice C 1176, Practice C 1435, or Test Method D 1557. Cut each core and cast each cylinder to ensure that the plane best describing the bond surface is oriented at  $90 \pm 15^\circ$  to the long axes of the specimens.

6.2 Cure molded test specimens in accordance with Practice C 192/C 192M (laboratory specimens). Drilled cores shall be moisture conditioned in accordance with Test Method C 42/C 42M.

NOTE 1—Test results are not affected significantly by specimen surfaces obtained with normal coring operations. The ends of cores need not be trimmed.

NOTE 2—Where the bond surface undulates grossly, that is, the surface has a local texture exceeding 0.5 in. [13 mm] in amplitude, 6-in. [150-mm] diameter cores are preferable. No information is available on the relative results of 6-in. [150-mm] versus 4-in. [100-mm] diameter specimens.

## 7. Procedure

7.1 *Measurements*—Determine the diameter of the test specimens by averaging three diameters measured on the bond surface. Visually identify the bond surface by color, texture, or material contrasts. Measure diameters to the nearest 0.01 in. [0.25 mm] with calipers, whenever possible, but at least to the nearest 0.1 in. [2.5 mm]. Determine the length of each section

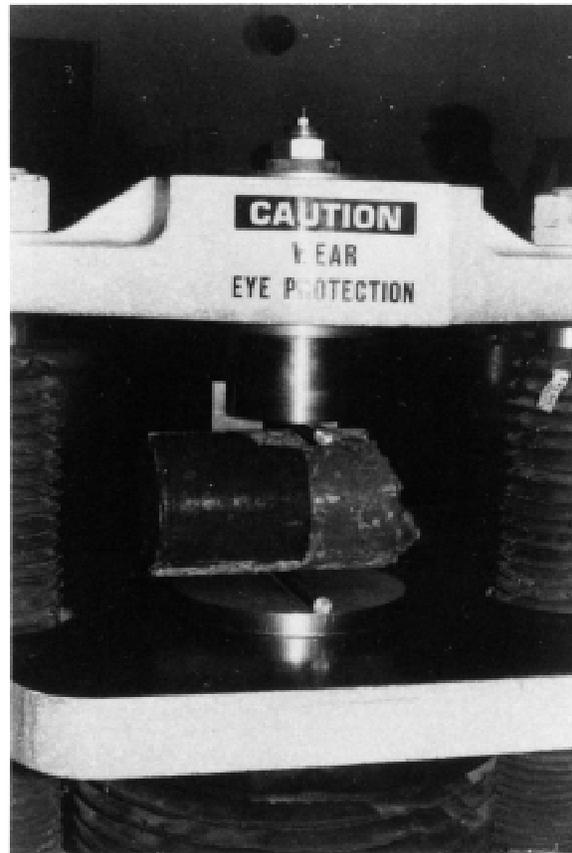


FIG. 2 Test Specimen in Testing Machine

of the bonded specimens to the nearest 0.1 in. [2.5 mm], and use these lengths to determine the section length-to-diameter ratios. Specimens must have a minimum length-to-diameter ratio of 1.2 if the bond plane is at mid-length (within  $\pm 0.25$  in. [6 mm]) of the specimen. If the bond plane is not at mid-length of the specimen, the section on each side of the bond plane shall be of a length at least 0.6 the diameter. Where the bond surface is irregular or undulating, mark on the specimen a line representing a plane extending through and along the approximate average bearing of the bond surface, and measure the length from this line.

NOTE 3—Many drilled cores will not be smooth enough to justify the measurement of diameters closer than to the nearest 0.1 in. [2.5 mm].

7.2 *Positioning*—Assemble and position the apparatus in the testing machine. Place the specimen on the bottom platen with the joint in contact with the anvil rods (see Fig. 2). The longer anvil rods (Fig. 4a and Fig. 6a) and the longer alignment post (Fig. 10) are used to test 6-in. [150-mm] diameter specimens. The shorter anvil rods (Fig. 4b and Fig. 6b) and the shorter alignment post (Fig. 9) are used to test 4-in. [100-mm] diameter specimens.

7.2.1 Zero the load-indicating mechanism. Position the specimen so that the bond surface is parallel to the upper and lower anvil rods (see Fig. 2). This is best accomplished by positioning the specimen by hand while gently bringing the top anvil into contact with the specimen. Alternatively, the specimen may be supported with modeling clay or pieces of

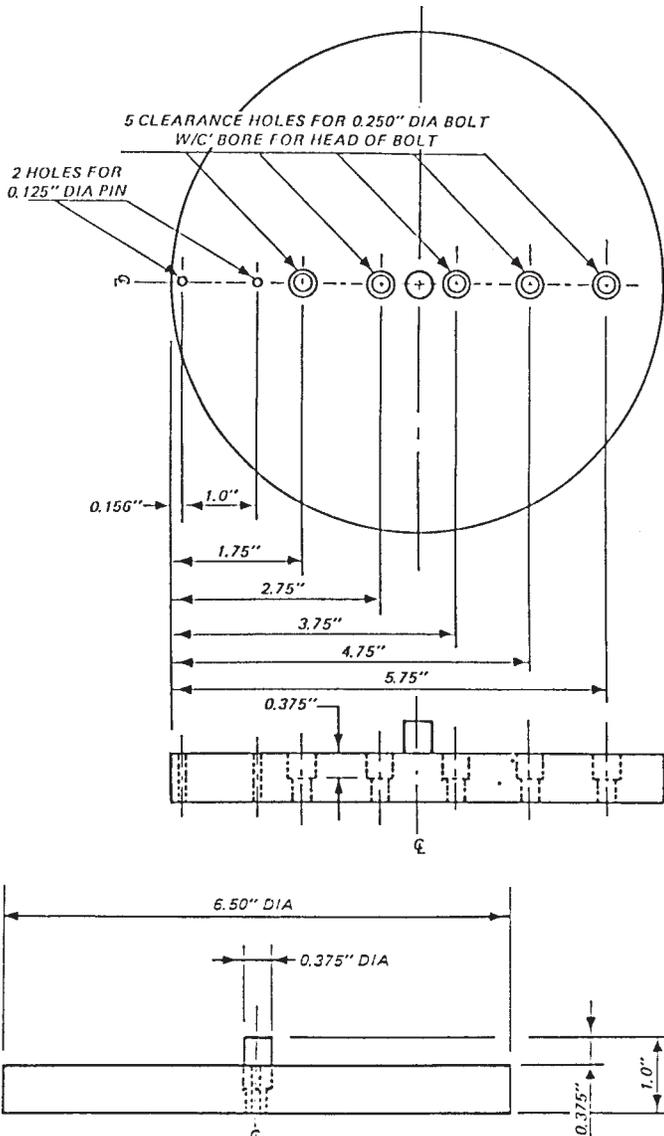


FIG. 3 Base Plate

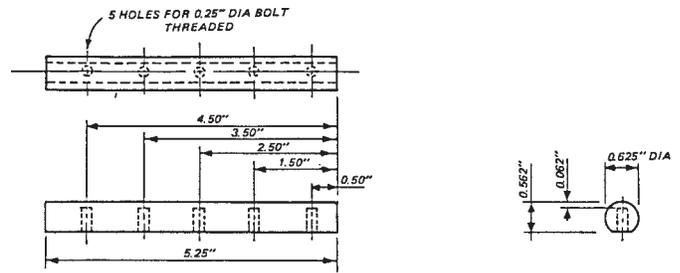
polystyrene. Where the bond surface is irregular or undulating, align the anvil rods along the approximate average bearing of the bond surface. Bring the anvil rods in contact with the bond surface at the contact point on the circumference of the specimen.

7.3 Loading—Do not preload the specimen. Apply the load at a uniform rate within the range of 150 to 200 psi/min [1 to 1.4 MPa/min] until the specimen fails. Record the maximum load applied.

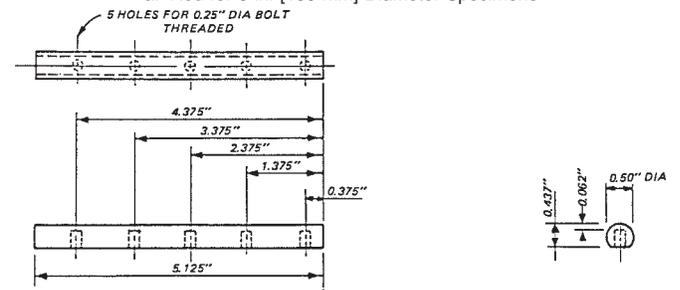
### 8. Calculation

8.1 Calculate the strength of the bond as follows:

$$f_{ib} = \frac{P}{D^2}$$



a. Rod for 6-in. [150-mm] Diameter Specimens



b. Rod for 4-in. [100-mm] Diameter Specimens

FIG. 4 Bottom Anvil Rods

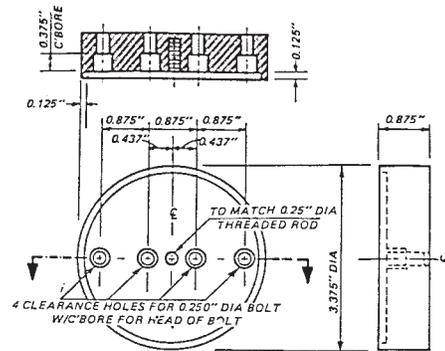


FIG. 5 Top Plate

where:

$f_{ib}$  = bond strength, psi [MPa],

$P$  = maximum applied load, lbf [N], and

$D$  = average specimen diameter at bond surface, in. [mm].

### 9. Report

9.1 Report the following information:

9.1.1 Date of testing.

9.1.2 Specimen identification and if cored, the location of the core.

9.1.3 Details of the materials comprising the specimens, such as the following:

9.1.3.1 Mixture proportions of the concretes and mortars;

9.1.3.2 Details of fabrication including the practice or test method used to cast or mold cylinders;

9.1.3.3 Details of bonding techniques;

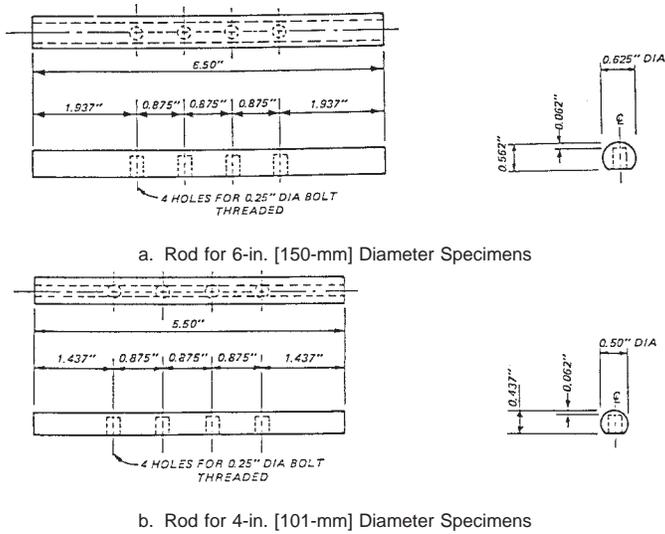


FIG. 6 Top Anvil Rods

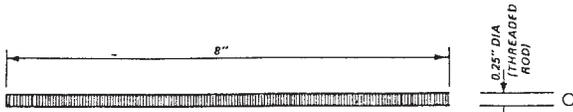


FIG. 7 Threaded Rod for Attachment of Top Plate

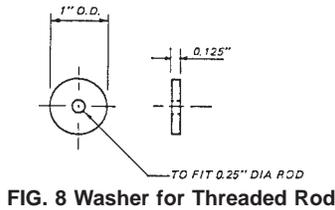


FIG. 8 Washer for Threaded Rod

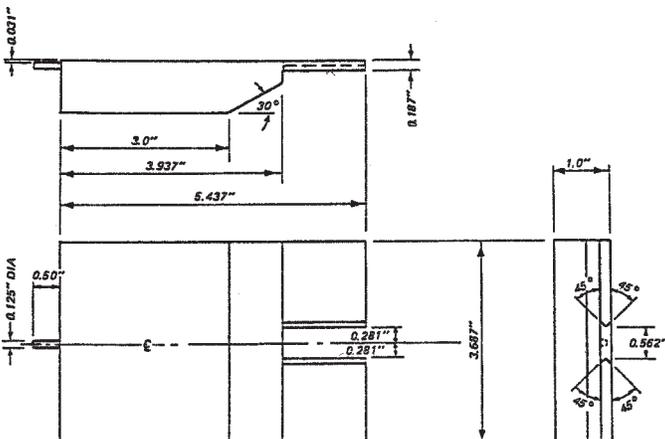


FIG. 9 Alignment Post for 4-in. [100-mm] Diameter Specimens

9.1.3.4 Age, when tested;

9.1.3.5 Specimen size including diameter and length of each layer material and whether a cast cylinder or drilled core was used; and

9.1.3.6 Any other information necessary to describe the production or features of the specimens.

9.1.4 Record of curing and moisture condition of the specimens at the time of test.

9.1.5 Any special treatment or prior testing performed on the specimens.

9.1.6 Strength of the bond to the nearest 10 psi [0.1 MPa].

9.1.7 Mode of failure:

9.1.7.1 Whether bond failure or aggregate failure, or both, were observed in the plane of failure;

9.1.7.2 Should the fracture occur along the original bond surface, the nature of the surface such as texture (smooth or rough), appearance (glossy or dull, undulating or flat), and detailed descriptions of discoloration, foreign objects or materials, loose or dusty material in voids, and the suspected presence and condition, or absence, of any bonding improvement agent;

9.1.7.3 Alternatively, should the plane of fracture occur partially or totally within the concrete layers adjacent to the bond surface, the percentage of the total area subjected to this type of failure versus the percentage area where failure occurred at the bond surface; and

9.1.7.4 Any unexpected features.

## 10. Precision and Bias

10.1 *Precision*—Precision of this test method was calculated from results published in Saucier,<sup>4</sup> which compared tensile strength of bonds and unbonded concrete for five mixtures of varying proportions. These data only represent within laboratory data for a single laboratory. A report of this analysis is on file at ASTM International Headquarters, as Research Report RR: C09-1025.<sup>5</sup>

10.1.1 The single-laboratory single-batch standard deviation for splitting tensile strength of unbonded concrete cores has been found to be 23 psi [0.16 MPa]<sup>6</sup> in 95 % of the cases. Therefore, results of tests on two cores taken from the same batch of concrete should differ by no more than 106 psi [0.73 MPa]<sup>6</sup> in 95 % of cases.

10.1.2 The single-laboratory single-batch standard deviation for splitting tensile bond strength of cores obtained from a layered specimen has been found to be 38 psi [0.26 MPa]<sup>6</sup> in 95 % of the cases. Therefore, results of tests on two cores taken from the same batch of concrete should differ by no more than 106 psi [07.3 MPa] in 95 % of cases.

10.2 *Bias*—This test method has no bias because there is no standard material on which to estimate this property.

<sup>4</sup> Saucier, K. L. "No-Slump Roller Compacted Concrete (RCC) for Use in Mass Concrete Construction," Technical Report SL-84-17, U.S. Army Research and Development Center, 3909 Halls Ferry Rd., Vicksburg, MS 39180, 1984.

<sup>5</sup> Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: C09-1025.

<sup>6</sup> These numbers represent, respectively, the (1s) and (d2s) limits as described in Practice C 670.



**TABLE 1 Metric Equivalent for Figs. 3-10**

in.	mm
0.031	0.8
0.062	1.6
0.125	3.2
0.156	4.0
0.187	4.7
0.25	6.4
0.281	7.1
0.343	8.7
0.375	9.5
0.437	11
0.50	13
0.562	14
0.625	16
0.687	17
0.75	19
0.875	22
1.0	25
1.25	32
1.375	35
1.437	36
1.50	38
1.75	44
1.937	49
2.25	57
2.375	60
2.50	65
2.75	70
3.0	75
3.375	85
3.43	87
3.50	90
3.687	94
3.75	95
3.937	100
4.375	110
4.50	115
4.75	120
5.437	138
5.50	140
5.75	145
6.50	165
8.0	200
8.25	205

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