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American Association State Highway and Transportation Officials Standard AASHTO No.: T24

Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete[1]

This standard is issued under the fixed designation C42/C42M; 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 (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This test method covers obtaining, preparing, and testing cores drilled from concrete for length or compressive strength or splitting tensile strength determinations.

NOTE 1—Appendix X1 provides recommendations for obtaining and testing sawed beams for flexural performance.

1.2 The values stated in either SI units 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. Combining values from the two systems may result in non-conformance with the standard.

1.3 The text of this standard references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.4 *This standard does not purport to address 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:*[2]

C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens

C78 Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)

C174/C174M Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores

C496/C496M Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens

C617 Practice for Capping Cylindrical Concrete Specimens

C642 Test Method for Density, Absorption, and Voids in Hardened Concrete

C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

C823 Practice for Examination and Sampling of Hardened Concrete in Constructions

C1231/C1231M ~~Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders~~ Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders

C1542/C1542M Test Method for Measuring Length of Concrete Cores

2.2 *ACI Standards:*[3]

318 Building Code Requirements for Structural Concrete

3. Significance and Use

3.1 This test method provides standardized procedures for obtaining and testing specimens to determine the compressive, splitting tensile, and flexural strength of in-place concrete.

3.2 Generally, test specimens are obtained when doubt exists about the in-place concrete quality due either to low strength test results during construction or signs of distress in the structure. Another use of this method is to provide strength information on older structures.

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[1] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.61 on Testing for Strength.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.concrete.org.

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

3.3 Concrete strength is affected by the location of the concrete in a structural element, with the concrete at the bottom tending to be stronger than the concrete at the top. Core strength is also affected by core orientation relative to the horizontal plane of the concrete as placed, with strength tending to be lower when measured parallel to the horizontal plane.[4] These factors shall be considered in planning the locations for obtaining concrete samples and in comparing strength test results.

3.4 The strength of concrete measured by tests of cores is affected by the amount and distribution of moisture in the specimen at the time of test. There is no standard procedure to condition a specimen that will ensure that, at the time of test, it will be in the identical moisture condition as concrete in the structure. The moisture conditioning procedures in this test method are intended to provide reproducible moisture conditions that minimize within-laboratory and between-laboratory variations and to reduce the effects of moisture introduced during specimen preparation.

3.5 There is no universal relationship between the compressive strength of a core and the corresponding compressive strength of standard-cured molded cylinders. The relationship is affected by many factors such as the strength level of the concrete, the in-place temperature and moisture history, and the strength gain characteristics of the concrete. Historically, it has been assumed that core strengths are generally 85 % of the corresponding standard-cured cylinder strengths, but this is not applicable to all situations. The acceptance criteria for core strength are to be established by the specifier of the tests. ACI 318 provides core strength acceptance criteria for new construction.

3.6 The apparent compressive strength of concrete as measured by a core is affected by the length-diameter ratio (L/D) of the core as tested and this must be considered in preparing core specimens and evaluating test results.

4. Apparatus

4.1 *Core Drill*, for obtaining cylindrical core specimens with diamond impregnated bits attached to a core barrel.

4.2 *Saw*, for trimming ends of cores. The saw shall have a diamond or silicon-carbide cutting edge and shall be capable of cutting cores without introducing cracks or dislodging aggregate particles.

4.3 Balance, accurate to at least 5 g [0.01 lb].

5. Sampling

5.1 *General*:

5.1.1 Samples of hardened concrete for use in the preparation of strength test specimens shall not be taken until the concrete is strong enough to permit sample removal without disturbing the bond between the mortar and the coarse aggregate (see Note 2 and Note 3). When preparing strength test specimens from samples of hardened concrete, samples that have been damaged during removal shall not be used unless the damaged portion(s) are removed and the lengths of resulting test specimens satisfy the minimum length-diameter ratio requirement in 7.2. Samples of defective or damaged concrete that cannot be tested shall be reported along with the reason that prohibits use of the sample for preparing strength test specimens.

NOTE 2—Practice C823 provides guidance on the development of a sampling plan for concrete in constructions.

NOTE 3—It is not possible to specify a minimum age when concrete is strong enough to withstand damage during removal, because the strength at any age depends on the curing history and strength grade of the concrete. If time permits, the concrete should not be removed before it is 14 days old. If this is not practical, removal of concrete can proceed if the cut surfaces do not display erosion of the mortar and the exposed coarse aggregate particles are embedded firmly in the mortar. In-place test methods may be used to estimate the level of strength development prior to attempting removal of concrete samples.

~~5.1.2Specimens containing embedded reinforcement shall not be used for determining compressive, splitting tensile, or flexural strength.~~

5.1.2 Except as provided in 5.1.3, cores containing embedded reinforcement, excluding fibers, or other embedded objects shall not be used for determining strength of concrete.

5.1.3 If it is not possible to prepare a test specimen that meets the requirements of 7.1 and 7.2 and that is free of embedded reinforcement or other metal, the specifier of the tests is permitted to allow testing of cores with embedded metal (see Note 4). If a core tested for strength contains embedded metal, the size, shape, and location of the metal within the core shall be documented in the test report.

NOTE 4—The presence of steel reinforcement, other than fibers, or other embedded metal in a core can affect the measured strength.[5,6] There are insufficient data to derive reliable correction factors that can be applied to the measured strength to account for embedded reinforcement perpendicular to the core axis. If testing of cores containing embedded reinforcement is permitted, engineering judgment is required to assess the significance of the results. The specifier of the tests should not permit a core to be tested for strength if bar reinforcement, or other elongated embedded metal object, is oriented close to parallel to the core axis.

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[4] Neville, A., "Core Tests: Easy to Perform, Not Easy to Interpret," *Concrete International*, Vol. 23, No. 11, November 2001, pp. 59-68.

~~[5] Bartlett, F.M. and MacGregor, J.G., "Effect of Core Diameter on Concrete Core Strengths," *ACI Materials Journal*, Vol. 91, No. 5, September-October 1994, pp. 460-470.~~

[5] Gaynor, R.D., "Effect of Horizontal Reinforcing Steel on the Strength of Molded Cylinders," Problems and Practices in *Journal of the American Concrete Institute, Proceedings*, Vol. 62, No. 7, July 1965, pp. 837-840

~~[6] Bartlett, F.M. and MacGregor, J.G, "Effect of Core Length-to-Diameter Ratio on Concrete Core Strengths," *ACI Materials Journal*, Vol. 91, No. 4, July-August 1994, pp. 339-348.~~

[6] Concrete Society Working Party, "Concrete Core Testing for Strength," Concrete Society Technical Report No. 11, The Concrete Society, England, May 1976.

5.2 *Core Drilling*—When a core will be tested to measure concrete strength, the core specimen shall be drilled perpendicular to the surface and not near formed joints or obvious edges of a unit of deposit. Record and report the approximate angle between the longitudinal axis of the drilled core and the horizontal plane of the concrete as placed. A specimen drilled perpendicular to a vertical surface, or perpendicular to a surface with a batter, shall be taken from near the middle of a unit of deposit when possible. When obtained for purposes other than determination of strength, drill cores in accordance with the instructions provided by the specifier. —When a core will be tested to measure concrete strength, the core shall be drilled perpendicular to the surface and at least 150 mm [6 in.] away from formed joints or obvious edges of a unit of deposit (see Note 5). This minimum distance does not apply to the formed boundaries of structural members. Record the approximate angle between the longitudinal axis of the drilled core and the horizontal plane of the concrete as placed. A specimen drilled perpendicular to a vertical surface, or perpendicular to a sloping surface, shall be taken from near the middle of a unit of deposit when possible. If cores are obtained for purposes other than determination of strength, drill cores in accordance with the instructions provided by the specifier of the tests. Record the date core was drilled. If known, record the date when concrete was placed.

NOTE 5—The intent is to avoid drilling cores in non-representative concrete that may exist near formed joints or the boundary of a unit of placement.

5.3 *Slab Removal*—Remove a slab sufficiently large to secure the desired test specimens without the inclusion of any concrete that has been cracked, spalled, undercut, or otherwise damaged.

DRILLED CORES

6. Measuring the Length of Drilled Cores

6.1 Cores for determining the thickness of pavements, slabs, walls or other structural elements shall have a diameter of at least 94 mm [3.70 in.] when the lengths of such cores are stipulated to be measured in accordance with Test Method C174/C174M. When core length for determining the thickness of a member is not required to be measured in accordance with Test Method C174/C174M, core diameter shall be as directed by specifier of tests.

6.2 For cores that are not intended for determining structural dimensions, measure the longest and shortest lengths on the cut surface along lines parallel to the core axis. Record the average length to the nearest 5 mm [¼ in.].

7. Cores for Compressive Strength

7.1 *Diameter* —The diameter of core specimens for the determination of compressive strength in load bearing structural members shall be at least 94 mm [3.70 in.]. For non-load bearing structural members or when it is impossible to obtain cores with length-diameter ratio (L/D) greater than or equal to 1, core diameters less than 94 mm [3.70 in.] are not prohibited (see Note 4). For concrete with nominal maximum aggregate size greater than or equal to 37.5 mm [1½ in.], the core diameters shall be as directed by the specifier of the tests (see Note 5).

7.1.1 Except as provided in 7.1.2, the diameter of core specimens for the determination of compressive strength shall be at least 94 mm [3.70 in.] or at least two times the nominal maximum size of the coarse aggregate, whichever is larger.

7.1.2 If limited member thickness makes it impossible to obtain cores with length-diameter ratio (L/D) of at least 1.0 or if clear distance between reinforcement is limited, core diameters less than 94 mm [3.70 in.] are not prohibited. If a core diameter less than 94 mm [3.70 in.] is used, report the reason.

NOTE4—The compressive strengths of nominal 50-mm [2-in.] diameter cores are known to be somewhat lower and more variable than those of nominal 100-mm [4-in.] diameter cores. In addition, smaller diameter cores appear to be more sensitive to the effect of the length-diameter ratio.

NOTE5—The preferred minimum core diameter is three times the nominal maximum size of the coarse aggregate, but it should be at least two times the nominal maximum size of the coarse aggregate. 6—The compressive strengths of nominal 50-mm [2-in.] diameter cores are known to be somewhat lower and more variable than those of nominal 100-mm [4-in.] diameter cores. In addition, smaller diameter cores appear to be more sensitive to the effect of the length-diameter ratio.[7]

7.2 *Length* —The

7.2.1 Except as provided in 7.2.2, the preferred length of the capped or ground specimen is between 1.9 and 2.1 times the diameter. If the ratio of the length to the diameter (L/D) of the core exceeds 2.1, reduce the length of the core so that the ratio of the capped or ground specimen is between 1.9 and 2.1. Core specimens with length-diameter ratios equal to or less than 1.75 require corrections to the measured compressive strength (see 7.9.1). A strength correction factor is not required for L/D greater than 1.75. A core having a maximum length of less than 95% of its diameter before capping or a length less than its diameter after capping or end grinding shall not be tested.). A strength correction factor is not required for L/D greater than 1.75. A core having a maximum length of less than 95 % of its diameter before capping or a length less than its diameter after capping, trimming, or end grinding shall not be tested.

7.2.2 If the compressive strengths of cores are to be compared with specified strengths based on standard concrete cubes, cores shall be tested with L/D, after end preparation, in the range of 1.00 to 1.05 unless otherwise directed by the specifier of the tests.

[7] Bollin, G. E., "Development of Precision and Bias Statements for Testing Drilled Cores in Accordance with ASTM C42," *ASTM Journal of Cement, Concrete, and Aggregates*, Vol 15, No. 1, 1993.

[7] Bartlett, F.M. and MacGregor, J.G., "Effect of Core Diameter on Concrete Core Strengths," *ACI Materials Journal*, Vol. 91, No. 5, September-October 1994, pp. 460-470.

If the strengths of cores with L/D =1 are to be compared with specified concrete cube strength, do not apply the correction factor in 7.9.1.

7.3 *Moisture Conditioning*—Test cores after moisture conditioning as specified in this test method or as directed by the specifier of the tests. The moisture conditioning procedures specified in this test method are intended to preserve the moisture of the drilled core and to provide a reproducible moisture condition that minimizes the effects of moisture gradients introduced by wetting during drilling and specimen preparation.

7.3.1 After cores have been drilled, wipe off surface drill water and allow remaining surface moisture to evaporate. When surfaces appear dry, but not later than 1 h after drilling, place cores in separate plastic bags or nonabsorbent containers and seal to prevent moisture loss. Maintain cores at ambient temperature, and protect cores from exposure to direct sunlight. Transport the cores to the testing laboratory as soon as possible. Keep cores in the sealed plastic bags or nonabsorbent containers at all times except during end preparation and for a maximum time of 2 h to permit capping before testing.

7.3.2 If water is used during sawing or grinding of core ends, complete these operations as soon as possible, but no later than 2 days after drilling of cores unless stipulated otherwise by the specifier of tests. After completing end preparation, wipe off surface moisture, allow the surfaces to dry, and place the cores in sealed plastic bags or nonabsorbent containers. Minimize the duration of exposure to water during end preparation.

7.3.3 Allow the cores to remain in the sealed plastic bags or nonabsorbent containers for at least 5 days after last being wetted and before testing, unless stipulated otherwise by the specifier of tests.

NOTE~~6—The~~ 7—The waiting period of at least 5 days is intended to reduce moisture gradients introduced when the core is drilled or wetted during sawing or grinding.

7.3.4 When direction is given to test cores in a moisture condition other than achieved by conditioning according to 7.3.1, 7.3.2, and 7.3.3, report the alternative procedure.

7.4 *Sawing of Ends*—The ends of core specimens to be tested in compression shall be flat, and perpendicular to the longitudinal axis in accordance with Test Method C39/C39M. If necessary, saw the ends of cores that will be capped so that prior to capping, the following requirements are met:

7.4.1 Projections, if any, shall not extend more than 5 mm [0.2 in.] above the end surfaces.

7.4.2 The end surfaces shall not depart from perpendicularity to the longitudinal axis by a slope of more than 1:8*d* or [1:0.3*d*] where *d* is the average core diameter in mm [or inches].

~~7.5*Density*—When required by the specifier of the tests, determine the density by weighing the core before capping and dividing the mass by the volume of the core calculated from the average diameter and length. Alternatively, determine the density from the mass in air and submerged mass in accordance with Test Method~~

7.5 *Calculated Density*—Measure the mass of the core just before capping or just before testing if bonded caps are not used. Divide the mass by the volume of the core calculated from the average diameter and length determined in 7.7. Record the calculated density to the nearest 20 kg/m^3 [1 lb/ft^3].

NOTE 8—The intent of 7.5 is to obtain an approximate density of the specimen, which can provide additional insight on measured strength. Because the moisture content of the core is not known and because the calculated volume is approximate, the calculated density is not intended for evaluating compliance with specified density requirements. Separate cores should be taken for this purpose, and the specifier of the tests should indicate the procedure for measuring density; for example, Test Method C642 ~~. After submerged weighing, dry cores in accordance with 7.3.2 and store in sealed plastic bags or nonabsorbent containers for at least 5 days before testing.~~

~~7.6~~*could be specified for normalweight concrete.*

7.6 *Capping*—If the ends of the cores do not conform to the perpendicularity ~~and planeness~~ requirements of Test Method C39/C39M, they shall be sawed or ground to meet those requirements or capped with bonded caps in accordance with Practice C617~~. If cores are capped in accordance with Practice~~ . If the ends of the cores do not conform to the planeness requirements of Test Method C39/C39M, they shall be sawed or ground to meet those requirements or capped with bonded caps in accordance with Practice C617 ~~, the capping device shall accommodate actual core diameters and produce caps that are concentric with the core ends. Measure core lengths to the nearest 2 mm [0.1 in.] before capping. Unbonded caps in accordance with Practice~~ or tested with unbonded caps in accordance with Practice C1231/C1231M~~are not permitted.~~

~~7.7~~*. If cores are capped in accordance with Practice C617, the capping device shall accommodate actual core diameters and produce caps that are concentric with the core ends. Measure core lengths to the nearest 1 mm [0.1 in.] before capping. If unbonded caps are used, the gap between the core and retaining rings shall conform to the requirements of Practice C1231/C1231M.*

NOTE 9—To satisfy the maximum gap limit in Practice C1231/C1231M the inner diameter of the retaining rings cannot exceed 107 % of the average core diameter. Smaller diameter retaining rings may be needed for testing cores with diameters smaller than standard cylinders. For example if the core diameter is 95 mm [3.75 in.], the inside diameter of the retaining rings cannot exceed 102 mm [4.01 in.].

7.7 *Measurement*~~—Before testing, measure the length of the capped or ground specimen to the nearest 2 mm [0.1 in.] and use this length to compute the length-diameter (L/D) ratio. Determine the average diameter by averaging two measurements taken at right angles to each other at the mid-height of the specimen. Measure core diameters to the nearest 0.2 mm [0.01 in.] when the difference in core diameters does not exceed 2% of their average, otherwise measure to the nearest 2 mm [0.1 in.]. Do not test cores if the difference between the largest and smallest diameter exceeds 5% of their average.~~ —Before testing, measure the length of

the core to the nearest 1 mm [0.1 in.] in accordance with Test Method C1542/C1542M or Test Method C174/C174M, and use this length to compute the length-diameter (L/D) ratio. For cores to be tested with bonded caps, measure the lengths of the capped cores. For cores to be tested with unbonded caps or with ground ends, measure the lengths of the prepared cores. Determine the average diameter by averaging two measurements taken at right angles to each other at the mid-height of the core. Measure core diameters to the nearest 0.2 mm [0.01 in.] if the difference in core diameters does not exceed 2 % of their average, otherwise measure to the nearest 1 mm [0.1 in.]. Do not test cores if the difference between the largest and smallest diameter exceeds 5 % of their average.

7.8 *Testing*—Test the specimens in accordance with Test Method C39/C39M. Test the specimens within 7 days after coring, unless specified otherwise.

7.9 *Calculation*—Calculate the compressive strength of each specimen using the computed cross-sectional area based on the average diameter of the specimen.

7.9.1 If the ratio of length to diameter (L/D) of the specimen is 1.75 or less, correct the result obtained in 7.9 by multiplying by the appropriate correction factor shown in the following table (see ~~Note 7~~Note 10):

Ratio of Length to Diameter (L/D)	Strength Correction Factor
1.75	0.98
1.50	0.96
1.25	0.93
1.00	0.87

Use interpolation to determine correction factors for L/D values not given in the table.

NOTE ~~7~~10—Correction factors depend on various conditions such as moisture condition, strength level, and elastic modulus. Average values for corrections due to length-diameter ratio are given in the table. These correction factors apply to low-density concrete having a density between 1600 and 1920 kg/m^3 [100 and 120 lb/ft^3] and to normal density concrete. They are applicable to both dry and wet concrete for strengths between 14 MPa and 42 MPa [2000 psi and 6000 psi]. For strengths above 70 MPa [10 000 psi], test data on cores show that the correction factors may be larger than the values listed above.[8]

7.10 *Report*—Report the results as required by Test Method C39/C39Mwith the addition of the following information:

7.10.1 Length of core as drilled to the nearest 5 mm [¼ in.],

7.10.2 If the core diameter is less than 94 mm [3.70 in.], provide reason for using the smaller diameter.

7.10.3 Length of test specimen before and after capping or end ~~grinding~~preparation to the nearest ~~2~~1 mm [0.1 in.], and average diameter of core to the nearest 0.2 mm [0.01 in.] or 2 mm [0.1 in.],

7.10.~~3~~4 Compressive strength to the nearest 0.1 MPa [10 psi] when the diameter is measured to the nearest 0.2 mm [0.01 in.] and to the nearest 0.5 MPa [50 psi] when the diameter is measured to the nearest 2 mm [0.1 in.], after correction for length-diameter ratio when required,

7.10.~~4~~5 Direction of application of the load on the specimen with respect to the horizontal plane of the concrete as placed,

~~7.10.5~~7.10.6 The moisture conditioning history:

~~7.10.5.1The date and time core was obtained and first placed in sealed bag or nonabsorbent container,~~

~~7.10.5.2If water was used during end preparation, the date and time end preparation was completed and core placed in sealed bag or nonabsorbent container,~~

~~7.10.6The date and time when tested,~~

~~7.10.7Nominal maximum size of concrete aggregate.~~

~~7.10.8If determined, the density,~~

~~7.10.9If applicable, description of defects in cores that could not be tested, and~~

~~7.10.10If any deviation from this test method was required, describe the deviation and explain why it was necessary.~~

7.10.6.1 The date and time core was obtained and first placed in sealed bag or nonabsorbent container,

7.10.6.2 If water was used during end preparation, the date and time end preparation was completed and core placed in sealed bag or nonabsorbent container,

7.10.7 Date concrete was placed, if known,

7.10.8 The date and time when tested,

7.10.9 Nominal maximum size of concrete aggregate.

7.10.10 The calculated density to the nearest 20 kg/m^3 [1 lb/ft^3].

7.10.11 The location, shape, and size of embedded metal, if the specifier of the tests permits testing cores with embedded metal.

7.10.12 If applicable, description of defects in cores that could not be tested, and

7.10.13 If any deviation from this test method was required, describe the deviation and explain why it was necessary.

~~[8] These numbers represent, respectively, the (1s%) and (d2s%) limits as described in Practice C670.~~

[8] Bartlett, F.M. and MacGregor, J.G, "Effect of Core Length-to-Diameter Ratio on Concrete Core Strengths," *ACI Materials Journal*, Vol. 91 , No. 4, July-August 1994, pp. 339-348.

7.11 *Precision:*[9]

7.11.1 The single-operator coefficient of variation on cores has been found to be 3.2 %[10] for a range of compressive strength between 32.0 MPa [4500 psi] and 48.3 MPa [7000 psi]. Therefore, results of two properly conducted tests of single cores by the same operator on the same sample of material should not differ from each other by more than 9 %[10]of their average.

7.11.2 The multi-laboratory coefficient of variation on cores has been found to be 4.7 %[10] for a range of compressive strength between 32.0 MPa [4500 psi] and 48.3 MPa [7000 psi]. Therefore, results of two properly conducted tests on cores sampled from the same hardened concrete (where a single test is defined as the average of two observations (cores), each made on separate adjacent drilled 100 mm [4 in.] diameter cores), and tested by two different laboratories should not differ from each other by more than 13 %[10]of their average.

7.12 *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedure in this test method, no statement on bias is being made.

8. Cores for Splitting Tensile Strength

8.1 *Test Specimens*—The specimens shall conform to the dimensional requirements in 7.1, 7.2, 7.4.1, and 7.4.2. Ends are not to be capped.

8.2 *Moisture Conditioning*—Condition the specimens as described in 7.3, or as directed by the specifier of tests.

8.3 *Bearing Surfaces*—The line of contact between the specimen and each bearing strip shall be straight and free of any projections or depressions higher or deeper than 0.2 mm [0.01 in.]. When the line of contact is not straight or contains projections or depressions having heights or depths greater than 0.2 mm [0.01 in.], grind or cap the specimen so as to produce bearing lines meeting these requirements. Do not test specimens with projections or depressions greater than 2.0 mm [0.1 in.]. When capping is employed, the caps shall be as thin as practicable and shall be formed of high-strength gypsum paste.

NOTE 8—Fig. 1 illustrates a device suitable for applying caps to the bearing surfaces of core specimens.

8.4 *Testing*—Test the specimens in accordance with Test Method C496/C496M.

8.5 *Calculation and Report*—Calculate the splitting tensile strength and report the results as required in Test Method C496/C496M. When grinding or capping of the bearing surfaces is required, measure the diameter between the finished surfaces. Indicate that the specimen was a core and provide the moisture conditioning history as in 7.10.5.

8.6 *Precision:*[11]

8.6.1 The within laboratory single operator coefficient of variation for splitting tensile strength between 3.6 MPa [520 psi] and 4.1 MPa [590 psi] of cores has been found to be 5.3 %.[10] Therefore, results of two properly conducted tests by the same operator in the same laboratory on the same sample of material should not differ by more than 14.9 %[10]of their average.

8.6.2 The multi-laboratory coefficient of variation for splitting tensile strength between 3.6 MPa [520 psi] and 4.1 MPa [590 psi] of cores has been found to be 15.0 %.[10] Therefore, results of two properly conducted tests on the same sample of material of hardened concrete and tested by two different laboratories should not differ from each other by more than 42.3 %[10]of their average.

8.7 *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedure in this test method, no statement on bias is being made.

9. Keywords

9.1 compressive strength; concrete coring; concrete sawing; concrete strength; flexural strength; splitting tensile strength

[9] Steele, G.W., "Portland Cement Concrete Core Proficiency Sample Program," Strategic Highway Research Program, SHRP-P-636, National Research Council, Washington, D.C., 1993.

[9] Bollin, G. E., "Development of Precision and Bias Statements for Testing Drilled Cores in Accordance with ASTM C42," *ASTM Journal of Cement, Concrete, and Aggregates*, Vol 15, No. 1, 1993.

[10] See for example Raphael, J., "Tensile Strength of Concrete," *J. of the American Concrete Institute*, V. 81, No. 2, March-April 1984, pp 158-165 and "Referee Testing of Hardened Portland Cement Concrete Pavement—Percent Within Limits Revision," Engineering Brief No. 34A, Federal Aviation Administration, http://www.faa.gov/airports/engineering/engineering_briefs/media/EB_34a.pdf

[10] These numbers represent, respectively, the (1s %) and (d2s %) limits as described in Practice C670.

[11] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.61 on Testing for Strength.

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