

METHODS OF SAMPLING AND TESTING
MT 112-05
OBTAINING AND TESTING DRILLED CONCRETE CORES
(Modified AASHTO T24)

1 Scope:

- 1.1 This method covers obtaining, preparing, and testing cores drilled from concrete for length or compressive strength determination.

2 Referenced Documents:

2.1 AASHTO:

T 22 Compressive strength of Cylindrical Concrete Specimens
T 148 Measuring Length of Drilled Concrete Cores

MT Materials Manual:

MT 106 Measuring Length of Drilled Concrete Cores
MT 609 Field Numbering Concrete Cylinders

3 Significance and Use:

- 3.1 This test method provides standardized procedures to determine the length of drilled cores and the compressive strength of in-place concrete. Sampling and sample preparation requirements are given to ensure that the dimensional requirements are met and that the cores are made of intact, sound concrete, and are as free of flaws as the particular structure will allow.
- 3.2 Generally, test cores are obtained when doubt exists about the in-place concrete quality due to either too low strength test results during construction or signs of distress in the structure. Additionally, this method may be used to provide strength information on older structures.
- 3.3 Concrete strength is affected by the location of the concrete in the 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. 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 cores at the time of test. There is no standard procedure to condition a core 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 core 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 percent of the corresponding standard-cured cylinder strengths, but this is not applicable to all situations. The acceptance criteria for core strength is to be established by the specifying authority.

4 Apparatus:

4.1 *Core Drill* – For obtaining cylindrical core specimens, a diamond drill will be used.

5 Sampling:**5.1 General:**

5.1.1 Samples of hardened concrete shall not be taken until the concrete has become hard enough to permit sample removal without disturbing the bond between the mortar and the coarse aggregate. In general, the concrete shall be 14 days old before the cores are removed. When preparing strength test specimens from samples of hardened concrete, samples that show abnormal defects or samples that have been damaged in the process of removal shall not be tested.

5.1.2 Cores containing embedded reinforcement shall not be used for determining compressive strength.

5.2 *Core Drilling* – A core taken perpendicular to a horizontal surface shall be located, when possible, so that its axis is perpendicular to the bed of the concrete as originally placed and not near formed joints or obvious edges of a unit of deposit. A core taken 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 and not near formed joints or obvious edges of a unit of deposit.

6 Length of Drilled Cores:

6.1 *Minimum Diameter* – Cores shall have a diameter of at least 3.75 inches (95 mm) or as specified by the specifying authority.

6.2 *Procedure for Length Determination* – Measure the length of the cores according to MT-106.

7 Cores for Compressive Strength:

7.1 *Test Cores* – The nominal diameter of cores for compressive strength determination shall be at least 3.75 inches (95 mm). Core diameters less than 3.75 inches (95 mm) are permitted when it is possible to obtain cores with length to diameter (L/D) ratio ≥ 1 for compressive strength evaluations in cases other than load bearing situations. For concrete with nominal maximum aggregate size greater than 1½ inches (37.5 mm), the nominal diameter should preferably be at least three times the nominal maximum size of the coarse aggregate and must be at least twice the nominal maximum size of the coarse aggregate. The preferred length of the capped core is between 1.9 and 2.1 times the diameter. If the ratio of the length to the diameter of the core exceeds 2.1, reduce the length of the core so that the ratio is between 2.1 and 1.9. Cores with length-to-diameter ratios less than 1.75 require corrections to the measured compressive strength (see Section 7.7.2). A core having a maximum length of less than 95 percent of its diameter before capping or a length less than its diameter after capping shall not be tested.

Note 1 – The compressive strengths of nominal 2 inch (50 mm) diameter cores are known to be somewhat lower and more variable than those of nominal 4 inch (100 mm) diameter cores. In addition, small diameter cores appear to be more sensitive to the effect of length to diameter ratio.

7.2 *End Preparation* – The ends of the cores for compression testing, shall be essentially smooth, perpendicular to the longitudinal axis, and of the same diameter as the body of the core. If necessary, saw or tool the ends of the cores until the following requirements are met:

7.2.1 Projections, if any, shall not extend more than 0.2 inches (5 mm) above the end surfaces,

7.2.2 The end surfaces shall not depart from perpendicularity to the longitudinal axis by more than five degrees, and

7 Cores for Compressive Strength: (continued)

7.2.3 The diameter of the ends shall not depart more than 0.1 inch (2.5 mm) from the mean diameter of the core.

7.3 *Moisture Conditioning* – Test cores after moisture conditioning as specified in this test method or as directed by the specifying authority. 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 core preparation.

7.3.1 After cores have been drilled, wipe off the surface drill water and allow remaining surface moisture to evaporate. When surfaces appear dry, but not later than 1 hour 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 practicable. Keep cores in the sealed plastic bags or nonabsorbent containers at all times, except when the cores may be unsealed for a maximum of 2 hours, for end preparation and capping, before testing.

7.3.2 If water is used during sawing or grinding of core ends, complete these operations as soon as practicable, but no later than two days after drilling of cores unless stipulated. 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 five days after last being wetted before testing, unless otherwise stipulated.

Note 2 – The waiting period of at least five 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 Sections 7.3.1, 7.3.1, and 7.3.3, report the alternative procedure.

7.4 *Capping* – Before making the compression test, cap the ends of the cores in conformance with the procedure prescribed in the applicable section of T 231. The capped surfaces of the cores shall conform to the planeness requirements of T 231.

Note 3 – Prior to capping, the density of a core may be determined by weighing it and dividing it by the volume calculated from the average diameter and length, or by any other standard method for determining density.

7.5 *Measurement* – Prior to testing, measure the length of the capped core to the nearest 0.1 inch (2.5 mm) and use this length to compute the length-diameter ratio. Determine the average diameter by averaging two measurements taken at right angles to each other about mid-height of the core. Measure core diameters to the nearest 0.01 inch (0.25 mm) whenever possible, but at least to the nearest 0.1 inch (2.5 mm). Do not test cores if the differences between the largest and smallest diameter exceeds 5 percent of their average.

7.6 *Testing* – Test the cores within seven days after coring, unless otherwise specified.

8 Calculations:

8.1 Calculate the compressive strength of each core using the computed cross sectional area based on the average diameter of the core.

- 8.2 *Length* – The preferred length of the ground or capped core 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 is between 2.1 and 1.9. Cores with length-to-diameter ratios equal to or less than 1.75 require corrections to the measured compressive strength (see Section 7.7.2). A strength correction factor is not required for (L/D) greater than 1.75. A core having a maximum length of less than 95 percent of its diameter before capping or end grinding shall not be tested.
- 8.3 If the ration of the length to the diameter of the core is less than 1.75, apply correction factors shown in the table below:

Table 1

Ration of Length of Cylinder to Diameter <i>l/d</i>	Strength Correction Factor
1.75	0.98
1.50	0.96
1.25	0.93
1.00	0.87

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

Note 4 – Correction factors depend on various conditions, such as moisture condition, strength level, and elastic modulus. Average values are given in Table 1. These correction factors apply to lightweight concrete weighing between 100 and 120 lb/ft³ (1600 and 1920 kg/m³) and normal weight concrete. They are applicable to both dry and wet concrete for strengths between 2000 and 6000 PSI (13.8 and 41.4 MPa). For strengths above 10,000 PSI (70 MPa), test data on cores show that the correction factors may be higher than the values listed above. Thus, these factors should be applied to high-strength concrete with caution.

9 Report:

- 9.1 Report the results as follows:
- 9.2 Length of core as drilled to the nearest 0.2 in. (5 mm),
- 9.3 Length of core before and after capping or end grinding to the nearest 0.1 in. (2.5 mm), and the average diameter of the core to the nearest 0.01 in. (0.25 mm) or 0.1 in. (2.5 mm),
- 9.4 Compressive strength to the nearest 10 PSI (69 kPa) when the diameter is measured to the nearest 0.01 in. (0.25 mm), and to the nearest 50 PSI (345 kPa) when the diameter id measured to the nearest 0.1 in. (2.5 mm), after correction for length-diameter ratio when required,
- 9.5 Direction of application of the load on the core with respect to the horizontal plane of the concrete as placed,
- 9.6 The moisture condition history:
 - 9.6.1 The date and time the core was obtained and first placed in sealed bag or no-absorbent container,
 - 9.6.2 If water was used during end preparation, the date and time end preparation was completed and the core placed in the bag or no-absorbent container,

- 9.7 The date and time when tested,
- 9.8 The density, if determined,
- 9.9 The description of any defects in the core that could not be tested, and
- 9.10 If any deviation from this test was required, describe the deviation and explain why it was necessary.

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