
Standard Method of Test for

Density of Plastic and Hardened Portland Cement Concrete In-Place by Nuclear Methods

AASHTO Designation: T 271-83 (2004)



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1. SCOPE

1.1. These methods cover the determination of the density of plastic and hardened concrete in-place by gamma radiation.

1.2. Two methods are described as follows:

	Section
Method A—Direct Transmission	7
Method B—Backscatter	8

1.3. The values stated in SI units are to be regarded as the preferred standard.

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards:*

- T 19M/T 19, Bulk Density (“Unit Weight”) and Voids in Aggregate
- T 121M/T 121, Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete

3. SIGNIFICANCE AND USE

3.1. The methods described are useful as rapid, nondestructive techniques for the in-place determination of the density of plastic concrete. The backscatter method is also useful for the same purpose on hardened concrete. The fundamental assumptions inherent in the methods are that Compton scattering is the dominant interaction and that the material under test is homogeneous.

3.2. The methods are suitable for control and acceptance testing during construction, for evaluation subsequent to construction, and for research and development.

3.3. Test results may be affected by reinforcing steel, by chemical composition, and by sample heterogeneity. Results of tests by the backscatter method may also be affected by the density of underlying material. The backscatter method exhibits spatial bias in that the apparatus’s sensitivity to the material under it decreases with distance from the surface of the concrete.

4. APPARATUS

- 4.1. The system shall consist of the following items. The exact details of construction of the apparatus may vary, but the apparatus as a whole shall satisfy the requirements for system precision stated in Section 10.1.
- 4.1.1. *Gamma Source*—An encapsulated and sealed radioisotopic source such as cesium-137.
- 4.1.2. *Detector*—Any type of gamma detector such as a Geiger-Muller tube, scintillation crystal, or proportional counter.
- 4.1.3. *Probe*—For direct transmission measurements, either the gamma source or the detector shall be housed in a probe for inserting in a preformed hole in the material to be tested. The probe shall be marked in increments of 50 mm (2 in.) for tests with probe depths from 50 to 300 mm (2 to 12 in.). The probe shall be so made mechanically that when moved manually to the marked depth desired it would be held securely in position at that depth.
- 4.1.4. *Readout Instrument*—a suitable scaler or direct readout meter.
- 4.1.5. *Gauge Housing*—The source, detector, readout instrument and appropriate power supplies shall be in housings of rugged construction that are moisture and dust proof.
- 4.1.6. *Reference Standard*—A block of uniform, unchanging density provided for checking equipment operation, background count, and count rate reproducibility.
- 4.1.7. *Guide Plate and Hole-Forming-Device*—For direct transmission measurements, a guide plate and a device, such as a pin or drill rod, having a nominal diameter equal to slightly larger than the probe, for forming a hole normal to the concrete surface.
- 4.1.8. *Calibration Adjustment Container*—A rigid, water-tight container, whose minimum inside dimensions are large enough to allow the calibration curve adjustment procedure (Section 5.2) to be followed with no effect of the finite size of the container on the instrument's response. The volume of the container shall be established following the procedure outlined in T 19M /T 19.
- Note 1**—For backscatter measurements, a container 450 by 450 by 150 mm (18 by 18 by 6 in.) will meet this requirement for most equipment currently available commercially. For 50 mm (2 in.) depth direct transmission measurements, a container 600 by 600 by 100 mm (24 by 24 by 4 in.) will meet this requirement.
- 4.1.9. *Scale*—A scale accurate to within 0.2 kg (0.5 lb) of the test load at any point within the range of use. The range of use shall be considered to extend from the mass of the calibration adjustment container empty to the mass of the measure plus the contents at 2600 kg/m³ (160 lb/ft³).
- 4.1.10. *Strike-Off Bar*—A straight steel bar or angle 900 mm (36 in.) long.

5. CALIBRATION

- 5.1. Calibration curves are established by determining the nuclear count rate of each of several materials at different and known densities, plotting the count rate (or count ratio) versus each known density, and placing a curve through the resulting points. The method used in establishing the curve must be the same as will be used in determining the density. The materials used for calibration must be of uniform density.