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## **Standard Method of Test for**

# **Air Content of Freshly Mixed Concrete by the Pressure Method**

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**AASHTO Designation: T 152-24**

Technically Revised: 2024

Editorially Revised: 2024

**Technical Subcommittee: 3b, Fresh Concrete**

**ASTM Designation: C231/C231M-22**



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1. SCOPE

- 1.1. This method covers determination of the air content of freshly mixed concrete from observation of the change in volume of concrete with a change in pressure.
- 1.2. This method is intended for use with concretes and mortars made with relatively dense aggregates for which the aggregate correction factor can be satisfactorily determined by the technique described in Section 7. It is not applicable to concretes made with lightweight aggregates, air-cooled blast-furnace slag, or aggregates of high porosity. In these cases, T 196M/T 196 should be used. This test method is also not applicable to nonplastic concrete such as is commonly used in the manufacture of pipe and concrete masonry units.
- 1.3. The text of this standard references notes and footnotes that provide explanatory information. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements for this standard.
- 1.4. The values stated in inch-pound units are to be regarded as the standard.
- 1.5. *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*  
**Warning**—Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.
- 1.6. *The quality of the results produced by this standard is dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of R 18 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with R 18 alone does not completely assure reliable results. Reliable results depend on many factors; following the suggestions of R 18 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.*

2. REFERENCED DOCUMENTS

- 2.1. AASHTO Standards:

- R 18, Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
- R 60M/R 60, Sampling Freshly Mixed Concrete
- R 61, Establishing Requirements for Equipment Calibrations, Standardizations, and Checks
- R 100M/R 100, Making and Curing Concrete Test Specimens in the Field
- T 119M/T 119, Slump of Hydraulic Cement Concrete
- T 121M/T 121, Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
- T 196M/T 196, Air Content of Freshly Mixed Concrete by the Volumetric Method

2.2. *ASTM Standards:*

- C670, Standard Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
- E177, Standard Practice for Use of the Terms Precision and Bias in ASTM Test Methods

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### 3. SIGNIFICANCE AND USE

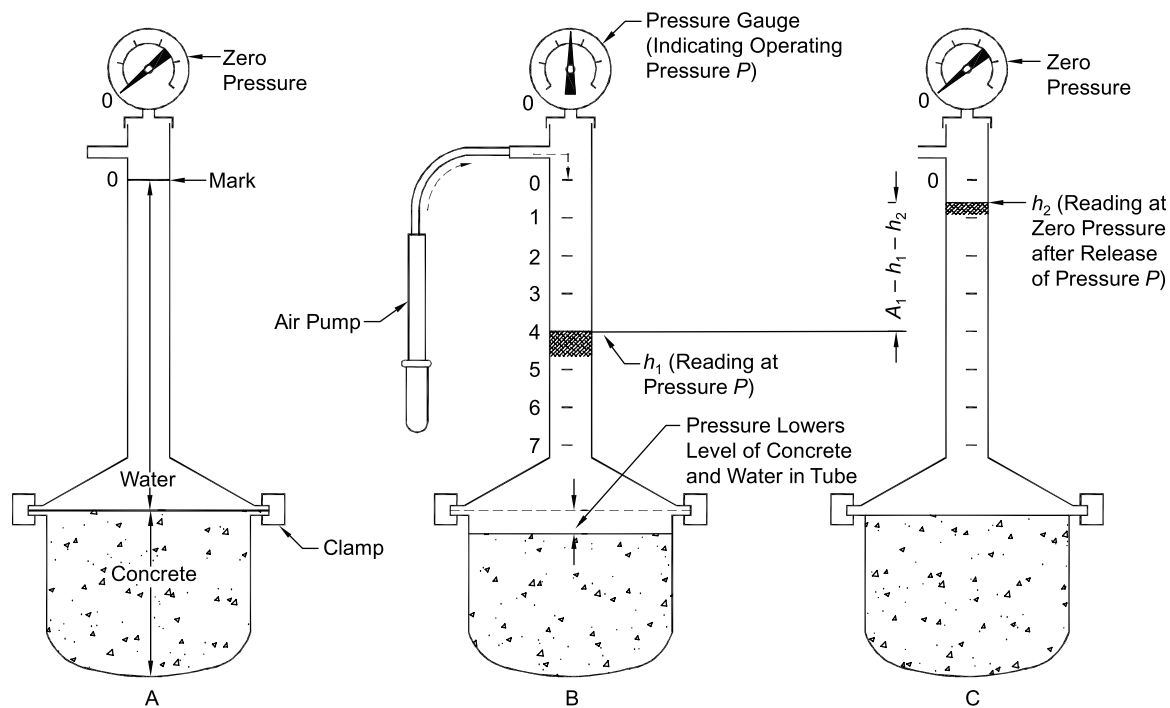
- 3.1. This test method covers the determination of the air content of freshly mixed concrete. The test determines the air content of freshly mixed concrete exclusive of any air that exists inside voids within aggregate particles. For this reason, it is applicable to concrete made with relatively dense aggregate particles and requires determination of the aggregate correction factor. (See Sections 7.1 and 10.1.)
- 3.2. This test method and T 121M/T 121 and T 196M/T 196 provide pressure, gravimetric, and volumetric procedures, respectively, for determining the air content of freshly mixed concrete. The pressure procedure of this test method gives substantially the same air content as the other two test methods for concrete made with dense aggregates.
- 3.3. The air content of hardened concrete may be either higher or lower than that determined by this test method. This depends on the methods and amount of consolidation effort applied to the concrete from which the hardened concrete specimen is taken; uniformity and stability of the air bubbles in the fresh and hardened concrete; accuracy of the microscopic examination, if used; time of comparison; environmental exposure; stage in the delivery, placement, and consolidation processes at which the air is determined, that is, before or after the concrete goes through a pump; and other factors.

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### 4. APPARATUS

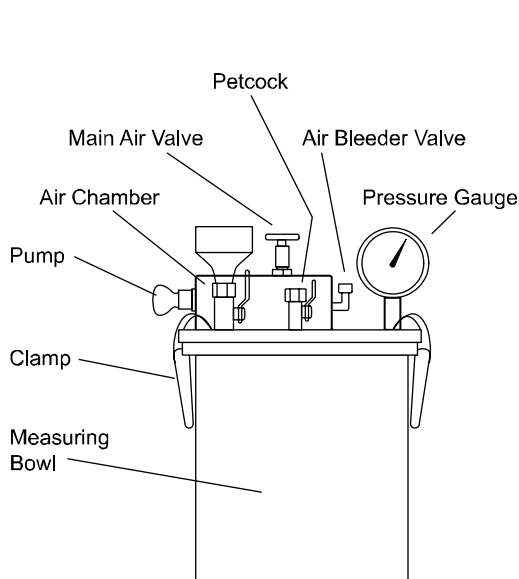
- 4.1. *Air Meters*—There are available satisfactory apparatus of two basic operational designs employing the principle of Boyle's Law. For purposes of reference herein these are designated Meter Type A and Meter Type B.
- 4.1.1. *Meter Type A*—An air meter consisting of a measuring bowl and cover assembly (Figure 1) conforming to the requirements of Sections 4.2 and 4.3. The operational principle of this meter consists of introducing water to a predetermined height above a sample of concrete of known volume and the application of a predetermined air pressure over the water. The determination consists of the reduction in volume of the air in the concrete sample by observing the amount the water level is lowered under the applied pressure, the latter amount being standardized in terms of percent of air in the concrete sample.
- Note 1**—Standardization is a critical step to ensure accurate test results when using this apparatus. Failure to perform the standardization procedures as described herein will produce inaccurate or unreliable test results.

- 4.1.2. *Meter Type B*—An air meter consisting of a measuring bowl and cover assembly (see Figure 2) conforming to the requirements of Sections 4.2 and 4.3. The operational principle of this meter consists of equalizing a known volume of air at a known pressure in a sealed air chamber with the unknown volume of air in the concrete sample, the dial on the pressure gauge being standardized in terms of percent air for the observed pressure at which equalization takes place. Working pressures of 7.5 to 30.0 psi (50 to 205 kPa) have been used satisfactorily.
- 4.2. *Measuring Bowl*—The measuring bowl shall be essentially cylindrical in shape, made of steel, hard metal, or other hard material not readily attacked by the cement paste, having a minimum diameter equal to 0.75 to 1.25 times the height, and a capacity of at least 0.20 ft<sup>3</sup> (5.7 L). It shall be flanged or otherwise constructed to provide for a pressure-tight fit between the measuring bowl and cover assembly. The interior surfaces of the measuring bowl and surfaces of rims, flanges, and other component fitted parts shall be machined smooth. The measuring bowl and cover assembly shall be sufficiently rigid to limit the expansion factor,  $D$ , of the apparatus assembly (see Annex A1.5) to not more than 0.1 percent of air content on the indicator scale when under normal operating pressure.

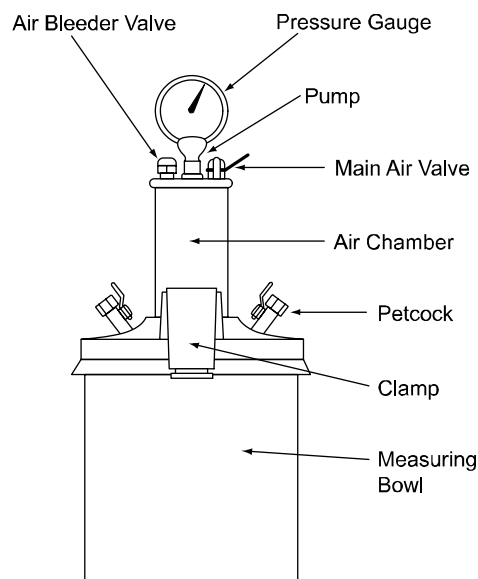


Note:  $A_1 = h_1 - h_2$  when measuring bowl contains concrete as shown in this figure; when measuring bowl contains only aggregate and water,  $h_1 - h_2 = G$  (aggregate correction factor).  
 $A_1 - G = A$  (entrained air content of concrete).

**Figure 1**—Illustration of the Pressure Method for Air Content: Type A Meter



2a. Horizontal Air Chamber



2b. Vertical Air Chamber

**Figure 2**—Schematic Diagram: Type B Meter

#### 4.3. *Cover Assembly:*

4.3.1. The cover assembly shall be made of steel, hard metal, or other hard material not readily attacked by the cement paste. It shall be flanged or otherwise constructed to provide for a pressure-tight fit between measuring bowl and cover assembly and shall have machined-smooth interior surfaces contoured to provide an air space above the level of the top of the measuring bowl. The cover shall be sufficiently rigid to limit the expansion factor of the apparatus assembly as prescribed in Section 4.2.

4.3.2. The cover assembly shall be fitted with a means of direct reading of the air content. The cover for the Type A meter shall be fitted with a standpipe, which may be a transparent graduated tube or may be a metal tube of uniform bore with a glass water gauge attached. In the Type B meter, the dial of the pressure gauge shall be standardized to indicate the percent of air. Graduations shall be provided for a range in air content of at least 8 percent, easily readable to 0.1 percent, as determined by the proper air pressure standardization test.

4.3.3. The cover assembly shall be fitted with air valves, air bleeder valves, and petcocks for bleeding off or through which water may be introduced as necessary for the particular meter design. Suitable means for clamping the cover to the measuring bowl shall be provided to make a pressure-tight seal without entrapping air at the joint between the flanges of the cover and measuring bowl. A suitable hand pump shall be provided with the cover, either as an attachment or as an accessory.

4.4. *Standardization Vessel*—A measure having an internal volume equal to a percent of the volume of the measuring bowl corresponding to the approximate percent of air in the concrete to be tested; or, if smaller, it shall be possible to check standardization of the meter indicator at the approximate percent of air in the concrete to be tested by repeated filling of the measure. When the design of the meter requires placing the standardization vessel within the measuring bowl to check standardization, the measure shall be cylindrical in shape and of an inside depth  $\frac{1}{2}$  in. (13 mm) less than that of the measuring bowl.

**Note 2**—A satisfactory standardization vessel to place within the measuring bowl may be machined for No. 16 gauge brass tubing, of a diameter to provide the volume desired, to which a brass disk  $\frac{1}{2}$  in. thick is soldered to form an end. When design of the meter requires withdrawing of water from the water-filled measuring bowl and cover assembly to check standardization, the measure may be an integral part of the cover assembly or may be a separate cylindrical measure similar to the above described cylinder.

- 4.5. The designs of various available types of air meters are such that they differ in operating techniques and, therefore, all of the items described in Sections 4.6 through 4.16 may not be required. The items required shall be those necessary for use with the particular design of apparatus used to satisfactorily determine air content in accordance with the procedures prescribed herein.
- 4.6. *Coil Spring or Other Device*—For holding standardization cylinder in place.
- 4.7. *Spray Tube*—A brass tube of appropriate diameter, which may be an integral part of the cover assembly or which may be provided separately. It shall be so constructed that when water is added to the container, it is sprayed to the walls of the cover in such a manner as to flow down the side causing a minimum of disturbance to the concrete.
- 4.8. *Trowel*—A standard brick mason's trowel.
- 4.9. *Tamping Rod*—A round, straight steel rod, with a  $\frac{5}{8}$  in.  $\pm \frac{1}{16}$ -in. (16 mm  $\pm$  2-mm) diameter. The length of the tamping rod shall be at least 4 in. (100 mm) greater than the depth of the measure in which rodding is being performed but not greater than 24 in. (600 mm) in overall length (see Note 3). The length tolerance for the tamping rod shall be  $\pm \frac{1}{8}$  in. ( $\pm$  4 mm). The rod shall have the tamping end or both ends rounded to a hemispherical tip of the same diameter as the rod.
- Note 3**—A rod length of 16 in. (400 mm) to 24 in. (600 mm) meets the requirements of the following AASHTO Test Methods: R 100M/R 100, T 119M/T 119, T 121M/T 121, T 152, and T 196M/T 196.
- 4.10. *Mallet*—A mallet (with a rubber or rawhide head) weighing approximately  $1.25 \pm 0.50$  lb ( $0.60 \pm 0.25$  kg) for use with measures of  $0.5 \text{ ft}^3$  (14 L) or smaller and a mallet weighing approximately  $2.25 \pm 0.50$  lb ( $1.0 \pm 0.25$  kg) for use with measures larger than  $0.5 \text{ ft}^3$  (14 L).
- 4.11. *Strike-Off Bar*—A flat straight bar of steel or other suitable metal at least  $\frac{1}{8}$  in. (3 mm) thick and  $\frac{3}{4}$  in. (20 mm) wide by 12 in. (300 mm) long.
- 4.12. *Strike-Off Plate*—A flat rectangular metal plate at least  $\frac{1}{4}$  in. (6 mm) thick or a glass or acrylic plate at least  $\frac{1}{2}$  in. (12 mm) thick with a length and width at least 2 in. (50 mm) greater than the diameter of the measure with which it is to be used. The edges of the plate shall be straight and smooth within a tolerance of  $\frac{1}{16}$  in. (1.5 mm).
- 4.13. *Funnel*—With the spout fitting into a spray tube.
- 4.14. *Measure for Water*—Having the necessary capacity to fill the indicator with water from the top of the concrete to the zero mark.
- 4.15. *Internal Vibrator*—The vibrator frequency shall be at least 9000 vibrations per minute (150 Hz) while the vibrator is operating in the concrete. The outside diameter of a round vibrator shall be at least 19 mm [0.75 in.] and not greater than 38 mm [1.50 in.]. Other shaped vibrators shall have a perimeter equivalent to the circumference of an appropriate round vibrator. The combined length of the vibrator shaft and vibrating element shall exceed the depth of the section being vibrated by at least 75 mm (3 in.). The vibrator frequency shall be checked periodically.