Standard Test Method for

Air-Void Characteristics of Freshly Mixed Concrete by Buoyancy Change

AASHTO Designation: T 348-13 (2018)[1]

Technical Subcommittee: 3b, Fresh Concrete

Release: Group 1 (April)

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1. SCOPE

1.1. This test method covers the determination of characteristics of the air-void system of fresh concrete using a sample of mortar. Spacing factor, specific surface, and entrained air content are determined by capturing air bubbles released from a mortar sample.

1.2. The sample will only be representative of the depth of the concrete within approximately 60 mm (2.5 in.) below the level at which the sampling is begun. This method is applicable to fresh concrete with a minimum slump of 10 mm (0.4 in.) and air content between 3.5 and 10 percent by volume. Only air voids less than 3 mm (0.1 in.) in diameter are measured by this method.[2] The test must be performed in sheltered, stable conditions.

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

1.4. *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. *AASHTO Standards*:
- M 231, Weighing Devices Used in the Testing of Materials
- T 119M/T 119, Slump of Hydraulic Cement Concrete
- T 121M/T 121, Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
- T 152, Air Content of Freshly Mixed Concrete by the Pressure Method
- T 196M/T 196, Air Content of Freshly Mixed Concrete by the Volumetric Method

2.2. *ASTM Standard*:
- C457/C457M, Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete

3. SUMMARY OF TEST METHOD[3]

3.1. This method determines the air-void characteristics of fresh concrete by expelling all air bubbles present in a given mortar sample, collecting the air bubbles and recording their quantities, and calculating their size distribution. According to Stokes' Law, larger bubbles rise faster than smaller ones. Thus, for bubbles rising a known distance, the size of the bubbles can be determined from the time of their arrival at the surface of the liquid. The air voids of a sample of fresh concrete mortar are released as bubbles by mixing the mortar with a viscous liquid. The bubbles then emerge from the viscous liquid, rise through an overlying column of water, and collect under a submerged dish. As the bubbles accumulate under the dish, the buoyancy of the dish changes. The change in buoyancy of the dish, as measured by a change in weight and recorded as a function of time, can be related to the number of bubbles of different sizes by an empirical correlation. Specific surface, spacing factor, and air content as specified by ASTM C457/C457M may be calculated from this data with the use of an algorithm.

4. SIGNIFICANCE AND USE

4.1. An adequate air-void system in hardened concrete protects the cement paste from damage during freezing and thawing cycles under moist conditions. This air-void system can be characterized by the volume of entrained air, spacing between air voids, specific surface, and void-size distribution.

4.2. This buoyancy change test method is capable of testing the air-void system of concrete *in situ*, reflecting the history of the concrete as it is in place, not as it is prepared in a sample for testing.

4.3. The primary function of the buoyancy change method is to provide air-void size and distribution information for concrete mixture designs. This test method could be used by the mix designer to evaluate various mix proportion options during prequalification. The effect of admixture combinations and admixture dosages on the air-void system can be evaluated. It can also be used by the approving agency as a quick laboratory check on mixes offered to them for approval.

4.4. During production, the adequacy of the air-void system can be verified for acceptance and feedback can be provided for manufacturing control. This method also allows rapid assessment of the effect of production changes in the mixture or equipment or variations in placement conditions such as temperature, slump, and pumping on the air-void system. Characterization of the air-void system of the concrete shortly after production provides an assessment of the durability of the cement paste. Results are usually obtained within 2 h, allowing adjustments in the subsequent production.

4.5. This method yields results that generally correlate well with the results of a linear traverse measurement on hardened concrete, as prescribed in ASTM C457/C457M for characteristics of the air-void system. Discrepancies between the results of this method and the results of ASTM C457/C457M may be due to coalescence of bubbles in the analysis liquid or due to errors in the ASTM C457/C457M test. The buoyancy change method does not give a total air content result that can be directly correlated with the results of T 152 and T 196M/T 196.

4.6. For further discussion of the significance of characteristics of the air-void system, see ASTM C457/C457M, Section 5, Significance and Use.

5. APPARATUS[4]

5.1. *Analysis and Data Collection Apparatus*—This assembly, the sampling equipment, and materials are designed and built to function as an integrated system that has been demonstrated by the manufacturer to accurately measure and calculate air-void distribution in fresh air-entrained concrete.

5.1.1. *Riser Cylinder*—A clear plastic cylinder with a base and a collar approximately as shown in Figure 1. The base shall have an integral heating element capable of maintaining the analysis liquid at 23 ± 2°C (73 ± 4°F) and entry holes for the plastic rod and the sample syringe with gaskets to make a watertight seal.