ASTM C185

Standard Test Method for Air Content of Hydraulic Cement Mortar

Understanding ASTM International Test Procedures for Cement and Concrete - Staying Up to Standard

Anthony F. Bentivegna, Ph.D., P.E.

May 9, 2016

CTLGROUP

Outline

- Objectives
- Related Procedures
- Scope/Significance and Use
- Summary of Test Method
- Apparatus
- Standard Sand
- Procedure
- Understand Limitations of Procedure
- Calculation

CTLGROUP

Objectives

- Define Key Terminology
- Identify Necessary Equipment
- Understand Sources of Errors
- Understand Limitations of Procedure

Related Procedures (1/3)

- ASTM C91 – Specification for Masonry Cement
- ASTM C109 – Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50-mm Cube Specimens)
- ASTM C150 – Specification for Portland Cement
- ASTM C183 – Practice for Sampling and the Amount of Testing of Hydraulic Cement
- ASTM C230 – Specification for Flow Table for Use in Tests of Hydraulic Cement
- ASTM C305 – Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency

Related Procedures (2/3)

- ASTM C511 – Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
- ASTM C595 – Specification for Blended Hydraulic Cements
- ASTM C778 – Specification for Sand
- ASTM C1005 – Specification for Reference Masses and Devices for Determining Mass and Volume for Use in the Physical Testing of Hydraulic Cements
- ASTM C1157 – Performance Specification for Hydraulic Cement

Related Procedures (3/3)

- ASTM C1328 – Specification for Plastic (Stucco) Cement
- ASTM C1329 – Specification for Mortar Cement
- ASTM E438 – Specification for Glasses in Laboratory Aparatus
- ASTM E694 – Specification for Laboratory Glass Volumetric Apparatus
- IEEE/ASTM SI 10 – Standard for Use of the International System of Units (SI): The Modern Metric System

Scope/Significance and Use

- ***Scope:*** This test method covers the determination of the air content of hydraulic cement mortar.
- ***Significance and Use:*** The purpose of this test method is to determine whether or not the hydraulic cement under test meets the air-entraining or non-air-entraining requirements of the applicable hydraulic cement specification for which the test is being made. The air content of concrete is influenced by many factors other than the potential of the cement for air entrainment.

Summary of Test Method

- Prepare a mortar with standard sand and the cement to be tested, using a water content sufficient to give a required flow.
- Compact the mortar into a measure of known volume and determine mass.
- Calculate the air content from the measured density of the mortar, the known densities of the constituents, and the mixture proportions.

Key Terminology

- Air Content - of freshly mixed mortar the volume of air (and other gases) in mortar, expressed as a percentage of total volume of mortar.

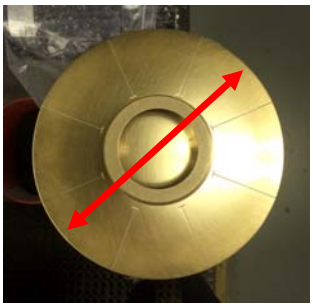
Source: ASTM C219

Apparatus

- Flow Table, Flow Mold, and Caliper
- Measure
- Mixer, Bowl, and Paddle
- Straightedge
- Weights and Weighing Devices
- Glass Graduates
- Tamper
- Tapping Stick
- Spoon

Apparatus: Flow Table, Flow Mold, and Caliper (1/2)

- Flow Table



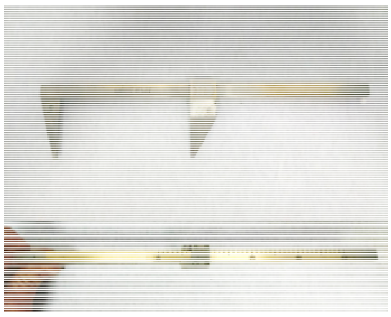
Diameter: 255 ± 2.5 mm

Raised Height: 12.7 ± 0.13 mm

Apparatus: Flow Table, Flow Mold, and Caliper (2/2)

- Conical Mold and Caliper

Diameter Top: 70 ± 0.5 mm
Diameter Bottom: 100 ± 0.5 mm
Height: 50 ± 0.5 mm



Distance to Zero: 100 ± 0.25 mm

Apparatus: Measure

- A cylindrical measure having an inside diameter of 76 ± 2 mm and a depth (approximately 88 mm) adjusted by standardization with water to contain 400 ± 1 mL at 23.0 ± 2.0 °C.

Apparatus: Measure Calibration

Apparatus: Straightedge

- A steel straightedge not less than 200 mm long and not less than 1.5 mm nor more than 3.5 mm in thickness.

Apparatus: Tamper and Tapping Stick

- **Tapping Stick :** A piece of hard wood having a diameter of approximately 16 mm and a length of approximately 152 mm.
- **Tamper:** Conforming to the requirements of Test Method C109. The tamping face of the tamper shall be flat and at right angles to the length of the tamper.

Apparatus: Other

- Mixer, Paddle and Bowl Shall Conform to Practice C305
- Weights and Weighing Devices Shall Conform to C1005
- Glass graduates of 250-mL capacity, conforming to the requirements of Specifications E438 and E694.

Temperature and Humidity Requirements

- The temperature of the air and mixing water shall conform to the requirements of Specification C511.
  - Air – Temp. 23.0 ± 4.0°C
  - Mixing Water - shall be 23.0 ± 2.0 °C
- The relative humidity of the laboratory shall conform to the requirements of Specification C511.
  - Relative Humidity - not less than 50 %

Procedure: Mixing

- Proportion the standard mortar using
  - 350 g Cement
  - 1400 g 20-30 Standard Sand
  - Sufficient water to give a flow of 87 ½ ± 7 ½ %.
- Mixing Mortar per Practice C305

Procedure: Flow Determination

Procedure: Flow Determination

- Determine flow per ASTM C1437 and Drop 10 times
- Achieve Flow of 87½ ± 7½%



Procedure: Mass per 400 mL of Mortar

Procedure: Mass per 400 mL of Mortar

1. Place Mortar in Three Equal Layers

2. Tamp each Layer 20 Times.

3. Tap the Sides of the Measure at Five Different Points.

Procedure: Mass per 400 mL of Mortar

4. Cut off Mortar Plane with Sawing Motion with Straightedge or Trowel.

5. Wipe off Adhered Mortar and Water to Outside of Mold.

6. Determine Mass of Measure and Constituents.

Calculation: Air Content

- Calculate the air content of the mortar, expressed as
- When,
  - Portland Cement SG = 3.15
  - 20-30 Standard Sand SG = 2.65

$$\textbf{\textit{Air Content, volume}}\ \% = \ \mathbf{100}\ - \mathbf{W}\left[\frac{(\mathbf{182.7} + \boldsymbol{P})}{(\mathbf{2000} + \mathbf{4}\boldsymbol{P})}\right]$$

W= Mass of 400 mL of Mortar, g
P = Percentage of Water(%)

Calculation: Note 5

- When the hydraulic cement is other than portland, the appropriate value for its specific gravity shall be substituted for the value of 3.15 and the formula rederived accordingly:

$$\text{Air content, volume } \% = 100[1 - (W_a/W_c)] \qquad (2)$$

where:

W_a = actual mass per unit of volume as determined by this test method.
= W/400 g/mL, where W is the mass in grams of the specified 400 mL of mortar (9.4),

W_c = theoretical mass per unit of volume, calculated on an air-free basis as follows and using the values for quantities of materials and specific gravities as given in 9.1 and 10.1,

$$= \frac{350 + 1400 + 350 \times P \times 0.01}{\frac{350}{3.15} + \frac{1400}{2.65} + \frac{350 \times P \times 0.01}{1}}$$

Calculation: Note 5

$$= \frac{(5+0.01P)}{(1.827+0.01P)}, \text{ and}$$

P = percentage of mixing water, based on mass of cement.

Substituting for W_a and W_c we have:

$$\text{Air content, volume \%} = 100\left(1 - \frac{W}{400} \times \frac{1.827+0.01P}{5+0.01P}\right)$$

$$\text{Air content, volume \%} = 100 - \frac{W}{4} \times \frac{(1.827+0.01P)}{(5+0.01P)}$$

$$\text{Air content, volume \%} = 100 - 2.5W\frac{(182.7+P)}{(5000+10P)}$$

$$\text{Air content, volume \%} = 100 - W\frac{(182.7+P)}{(2000+4P)}$$

Limitations and Errors

- Room temperature should be well maintained as per test requirement.
- All apparatus used should be clean.
- Flow test drop 10 times.
- Don’t use mortar from flow test.
- Don’t forget to tap the sides.
- Do not over compress mortar.

Questions & Answers