

# ASTM C204

Standard Test Methods for Fineness of Hydraulic  
Cement by Air-Permeability – Staying Up To Standard

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

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May 9, 2016



## Related Procedures

- ▶ BS 4359 :1972 British Standard for the Determination of Specific Surface of Powders: Part 2: Air Permeability Methods



## Significance of ASTM C204 - Blaine

- ▶ Determine fineness of cement
- ▶ Very important physical property
  - Affects setting time, hydration rate, strength, shrinkage, heat of hydration, and permeability
- ▶ Increase in fineness
  - Increases rate of hydration, shortens setting time, increases early-age strength gain
  - Affects consistency of mixtures and admixture demand
- ▶ Required for ASTM C150 and C989

## Fineness

- ▶ Requirements for Type I, II, IV & V
  - (No requirements for Type III)

	<u>Air Permeability</u>
Minimum, m <sup>2</sup> /kg	280
Maximum, m <sup>2</sup> /kg	400
Typical Values, m <sup>2</sup> /kg	350-380 Type I 450-600 Type III

- ▶ No limits for blended cement (ASTM C 595), hydraulic cements (ASTM C 1157), or slag cement (ASTM C989) but values must be reported

## Fineness Standards

ASTM C204 – Blaine Surface Area



ASTM C115 – Turbidimeter



ASTM C430 – No. 325 Sieve



## Scope of Test Method

- ▶ Determination of fineness using Blaine air permeability apparatus
- ▶ Result is in surface area of  $\text{cm}^2/\text{g}$  or  $\text{m}^2/\text{kg}$
- ▶ Results are considered relative values, not absolute
- ▶ Known to work well for portland cement. Should be used with caution on other materials.

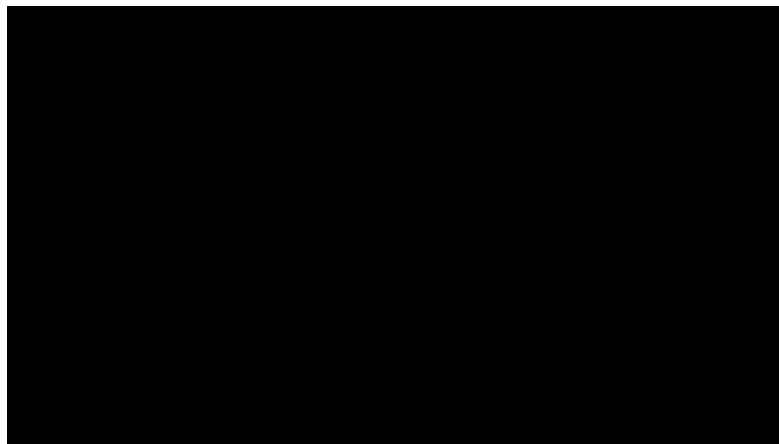
## Nature of Apparatus

- ▶ The Blaine air-permeability apparatus consists essentially of a means of drawing a definite quantity of air through a prepared bed of cement of definite porosity. The number and size of the pores in a prepared bed of definite porosity is a function of the size of the particles and determines the rate of air flow through the bed.

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## Nature of Apparatus



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## Apparatus: Perforated Disc

- ▶ Non-corroding
- ▶ 30-40 holes, 1 mm diameter
- ▶ Marked on one side to maintain orientation between tests
- ▶ 0.9 mm thick ( $\pm 0.1$  mm)



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## Apparatus: Plunger

- ▶ Stainless steel
- ▶ Air vent 3.0 mm wide
- ▶ Sized to leave 15.0 mm gap between the bottom of the plunger and the perforated disc (the space to be occupied by the cement sample)



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## Apparatus: Filter Paper

- ▶ Type I, Grade B (ASTM Specification E8232)
- ▶ Circular and same diameter as inside of permeability cell

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## Apparatus: Manometer

- ▶ U-tube
- ▶ Air shall be air tight with cell
- ▶ Midpoint line etched around the tube at 125 to 145 mm
- ▶ Liquid: Low density, nonvolatile liquid such as Dibutyl phthalate or light grade mineral oil



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## Calibration of Apparatus

- ▶ Calibration of the air permeability apparatus shall be made using the current lot of standard material:
  - NIST Standard Reference Material No. 114
- ▶ Determine Bulk Volume of compacted Bed of Powder by Physical Measurement:
  - Measure average diameter and average cell depth

$$Volume = \pi r^2 h$$

Note: Bulk volume can also be determined by mercury displacement method. Not covered in this presentation.

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## Calibration of Apparatus

- ▶ Prepare sample by shaking in a sample jar, let stand for 2 minutes, gently stir the sample.
- ▶ Use equation to determine the mass of sample required to have a porosity of 0.500

$$W = \rho V(1 - \varepsilon)$$

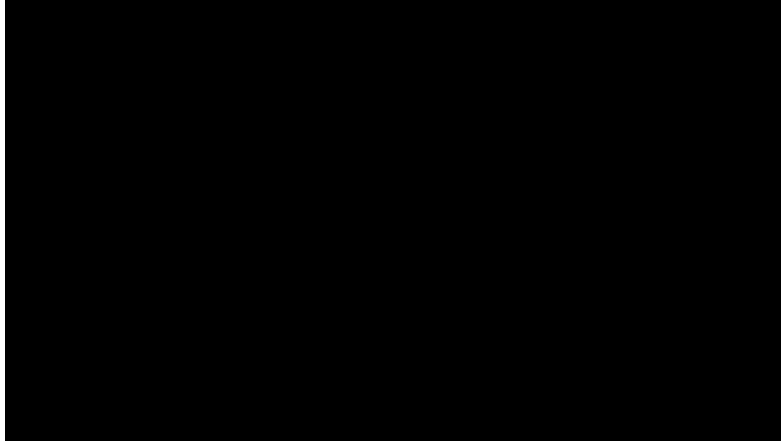
W = grams of sample required  
 ρ = density of sample for portland cement 3.15  
 V = bulk volume  
 ε = desired porosity of bed of cement 0.500 ± 0.005

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## Procedure: Preparation of Cement Bed



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## Procedure: Preparation of Cement Bed

- ▶ Seat the perforated disc
- ▶ Place filter paper on disc and press the edges down with a rod
- ▶ Measure cement mass to nearest 0.001 grams
- ▶ Place cement sample in the cell and tap the side to level the cement
- ▶ Place filter paper on top of cement
- ▶ Compress sample with plunger until plunger collar is in contact with top of cell
- ▶ Withdraw the plunger a short distance and rotate 90° and repress the sample and then withdraw plunger

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## Procedure: Preparation of Cement Bed (1/3)



**1. Seat Perforated Disc**



**2. Place Filter Paper on Metal Disc**



**3. Press Edges Down with Rod**

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## Procedure: Preparation of Cement Bed (2/3)



**4. Measure Cement Mass to Nearest 0.001g**



**5. Place Cement Sample in Cell**



**6. Tap Side to Level Cement**

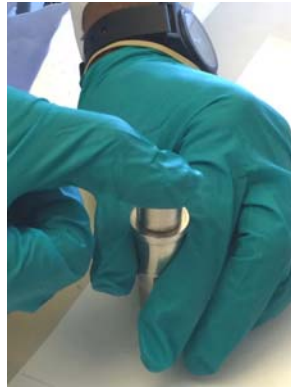
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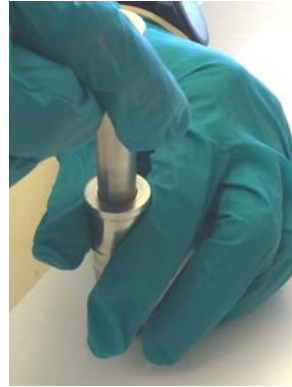
## Procedure: Preparation of Cement Bed (3/3)



**7. Place Filter Paper on Top of Cement**



**8. Compress Sample with Plunger Until Collar is in Contact with Top of Cell**

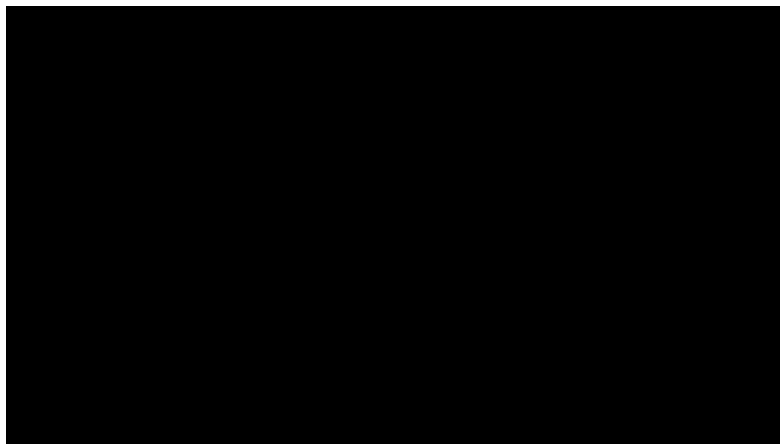


**9. Withdraw Short Distance, Rotate 90°, Recompress, and Withdraw**

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## Procedure: Permeability Test



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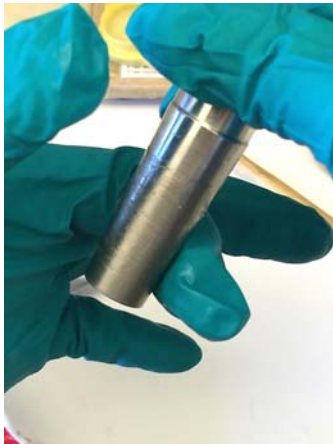
## Procedure: Permeability Test

- ▶ Apply stopcock grease to standard tapered connection
- ▶ Attach cell to manometer with secure air-tight connection
- ▶ Evacuate the air from one arm until the liquid reaches the top mark and close the air valve
- ▶ Start the timer when the liquid reaches the next mark down from the top (2<sup>nd</sup> mark)
- ▶ Stop the timer when the liquid reaches the next mark down from the top (3<sup>rd</sup> mark)
- ▶ Record time for test and the temperature at the time of testing
- ▶ Repeat 3 times and recalibrate no less than every 2.5 years

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## Procedure: Permeability Test (1/4)



**1. Apply Stopcock Grease to Tapered Connection**

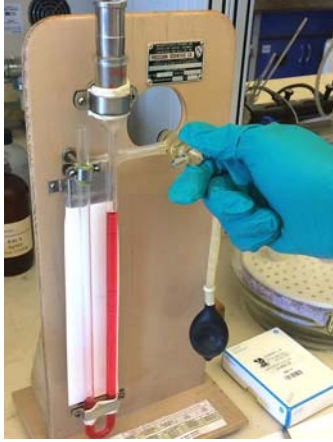


**2. Attach Cell to Manometer Tube**

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## Procedure: Permeability Test (2/4)



**3. Evacuate Air from One Arm Until Liquid Reaches Top Mark**

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**4. Close Air Valve**

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## Procedure: Permeability Test (3/4)



**5. Start Timer when Liquid Reaches Next Mark Down from Top (2<sup>nd</sup> Mark)**

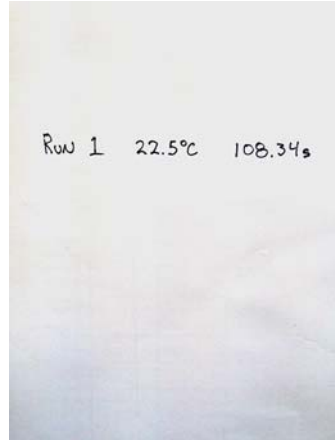
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**6. Stop Timer when Liquid Reaches Next Mark Down from Top (3<sup>rd</sup> mark)**

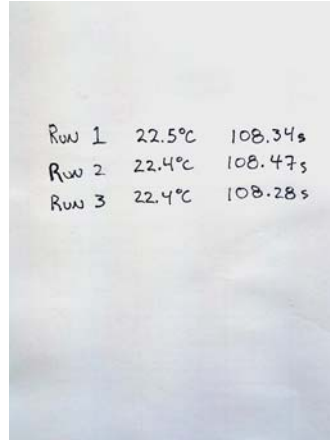
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## Procedure: Permeability Test (4/4)



**7. Record Time Interval for Test in Seconds and Temperature at Time of Testing in °C.**

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**8. Repeat 3 Times and Recalibrate No Less than Every 2.5 Years**

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## Procedure: About Cement and Other Materials

- ▶ Cement shall be at room temperature for test
- ▶ Same weight of sample as used with calibration sample:
  - For type III cement, or other fine ground cements, the bulk of material will be too great for thumb pressure on plunger to compress sample – use a porosity of 0.530 for sample mass calculation
  - For other materials, or cements where 0.500 and 0.530 won't work, adjust mass of sample such that a firm bed of material is produced with thumb pressure only. Plunger must not rebound once thumb is removed.

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## Calculation (section 6) and Report (section 7)

$$S = \frac{S_1 \sqrt{T}}{\sqrt{T_1}}$$

- ▶ Round values to nearest 10 cm<sup>2</sup>/g or nearest 1 m<sup>2</sup>/kg
- ▶ Report results of single trial
- ▶ For high fineness materials report the average of 2 trials (if trials are within 2% of each other). If trials are not within 2% discard values and repeat until 2 values are within 2%

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## Method B: Automated Apparatus (sections 9-13)

- ▶ Automated device based on
  - Blaine Air permeability method
  - Lea and Nurse Method
- ▶ Device specific calibration procedures
- ▶ Qualify device using 2 different cement samples tested in triplicate (with densities differing by no more than 0.06g/cm<sup>3</sup>)
- ▶ Standardization between samples using 5 reference samples

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## Limitations and Errors

- ▶ Specific surface area does NOT characterize the particle size distribution of a cement.
- ▶ Watch for air leaks, continuous loss of pressure in the manometer.
- ▶ Care should be taken when testing other materials than portland cement.
- ▶ Reporting temperature and comparing it to calibration temperature.

## Questions & Answers