



# Standard Specification for Architectural Cast Stone<sup>1</sup>

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## 1. Scope

1.1 This specification includes the physical properties, sampling, testing, tolerance, and appearance requirements for architectural cast stone.

1.2 Cast stone units covered under this specification include both wet cast and vibratory dry tamp products. Production methods of cast stone can vary among manufacturers; many production methods are acceptable provided the delivered cast stone meets the requirements of this specification.

1.3 Surface textures, finish, color, special applications, or other features shall be specified by the purchaser. Slump, manufacturing method, and apparatus shall be selected by the manufacturer and not specified by the purchaser.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered 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 and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

- A615/A615M Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- C33 Specification for Concrete Aggregates
- C150 Specification for Portland Cement
- C173/C173M Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
- C231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- C260 Specification for Air-Entraining Admixtures for Concrete
  - C426 Test Method for Linear Drying Shrinkage of Concrete Masonry Units
  - C494/C494M Specification for Chemical Admixtures for Concrete
  - C595 Specification for Blended Hydraulic Cements
  - C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
  - C666/C666M Test Method for Resistance of Concrete to Rapid Freezing and Thawing
  - C979 Specification for Pigments for Integrally Colored Concrete
  - C989 Specification for Slag Cement for Use in Concrete and Mortars
  - C1157 Performance Specification for Hydraulic Cement
  - C1194 Test Method for Compressive Strength of Architectural Cast Stone
  - C1195 Test Method for Absorption of Architectural Cast Stone
  - D1729 Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials
  - D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
- 2.2 ACI Standards:
- 318 Building Code Requirements for Reinforced Concrete<sup>3</sup>

## 3. Terminology

### 3.1 Definitions:

3.1.1 *cast stone, n*—an architectural precast concrete building unit intended to simulate natural cut stone.

3.1.2 *vibrant dry tamp (dry cast) products, n*—cast stone manufactured from zero slump concrete densely compacted by apparatus. (See Note 1.)

3.1.3 *wet cast products, n*—cast stone manufactured from measurable slump concrete consolidated by apparatus. (See Note 1.)

NOTE 1—Apparatus used in the production of cast stone may include automatic, semi-automatic, or manual devices that deploy internal or

<sup>3</sup> Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333.

external vibration, vibrant tamping, vibration under pressure, centrifugal casting, or combinations of these techniques to achieve the specified physical properties.

#### 4. Materials and Design

4.1 *Raw Materials*—Materials shall conform to the following specifications:

4.1.1 *Cement*:

4.1.1.1 *Portland Cement*—Specification **C150**.

4.1.1.2 *Blended Cement*—Specification **C595**.

4.1.1.3 *Hydraulic Cement*—Specification **C1157**.

4.1.2 *Aggregates*—Specification **C33**, except for grading requirements.

4.1.3 *Coloring Pigment*—Specification **C979**, except that carbon black pigment shall not be used.

4.1.4 *Reinforcement*—Specification **A615/A615M**.

4.1.5 *Chemical Admixtures*—Chemical admixtures shall conform to the following applicable specifications:

4.1.5.1 *Air Entraining Admixtures*—Specification **C260**, except for vibrant dry tamp products.

4.1.5.2 *Water Reducing and Accelerating Admixtures*—Specification **C494/C494M**.

4.1.5.3 *Other Constituents*—Integral water repellents and other chemicals for which no ASTM standard exists shall be previously established as suitable for use in concrete by proven field performance or through laboratory testing.

4.1.6 *Ground Slag*—Specification **C989**.

4.1.7 *Fly Ash or Natural Pozzolan*—Specification **C618**.

4.2 *Design*—Samples shall be submitted for approval of color and texture. The manufacturer shall prepare drawings for approval showing shapes, sizes, reinforcement, exposed faces, and anchorage provisions. The purchaser or his authorized representative shall approve the samples and drawings before manufacture.

4.3 *Reinforcement*:

4.3.1 Reinforcement shall be new billet steel reinforcing bars meeting the requirements of Specification **A615/A615M** unless specified otherwise by the purchaser.

4.3.2 Reinforce units when necessary for safe handling and structural stress.

4.3.3 Reinforcement shall be noncorrosive where faces exposed to weather are covered with less than 1.5 in. (38 mm) of concrete material. All reinforcement shall have minimum coverage of twice the diameter of the bars.

4.3.4 Area of reinforcement in panels greater than 24 in. (600 mm) in more than one direction shall be not less than 0.25 % of the cross section area [in that direction]. Units less than 24" (600 mm) in both their length and width dimension shall be non-reinforced unless otherwise specified.

#### 5. Physical Requirements

5.1 *Compressive Strength*—At 28 days after manufacture, not less than 6500 psi (45 MPa), when tested in accordance with Test Method **C1194**.

5.2 *Absorption, Cold Water*—At 28 days after manufacture, not greater than 6 %, when tested in accordance with Method A, Cold Water of Test Method **C1195**.

5.3 *Absorption, Boiling Water*—At 28 days after manufacture, not greater than 10 %, when tested in accordance with Method B, Boiling Water Test of Test Method **C1195**.

5.4 *Air Content*—Provide sufficient air content to meet the freeze-thaw requirements for wet cast products, when the air content is tested in accordance with Test Method **C173/C173M** or Test Method **C231**.

5.5 *Field Testing* of cast stone shall be in accordance with Test Methods **C1194** and **C1195**. Field tested specimens shall have a minimum compressive strength of 85 % with no single specimen testing less than 75 % of the design requirement as allowed by ACI 318.

5.6 *Resistance to Freezing and Thawing*:

5.6.1 The manufacturer shall satisfy the purchaser that the units have adequate resistance to freezing and thawing either through proven field performance of similar products made from the same materials or through laboratory testing.

5.6.2 If laboratory testing is required, the cast stone shall be tested using Test Method **C666/C666M**, Procedure A, except the method of evaluation is to be based on cumulative percent loss in mass and not relative dynamic modulus of elasticity and durability factor (that is, do not measure the fundamental transverse frequency during testing). Follow the procedure modifications to Test Method **C666/C666M** in 5.6.2.1 through 5.6.2.5.

5.6.2.1 After the cast stone is 14 days of age, wet-saw three 3 by 4 by 16 in. (76 by 102 by 406 mm) beams from a single sample of cast stone to represent three specimens for a single test. One surface of each beam shall be from the exposed, formed face of the sample and the remaining sides shall be saw cut. The allowable size tolerance of the specimens shall be  $\pm \frac{1}{8}$  in. (3 mm).

5.6.2.2 Do not oven dry the beam specimens until all testing for resistance to freezing and thawing has been completed.

5.6.2.3 Submerge each beam specimen in lime-saturated water at  $73.4 \pm 3^\circ\text{F}$  ( $23 \pm 1.7^\circ\text{C}$ ) at least 24 h prior to subjection to freezing and thawing. Subject each specimen to freezing and thawing as described in Test Method **C666/C666M**, Procedure A. Inspect each specimen every 30 to 36 cycles and collect the fragments caused by freeze-thaw cycling from each specimen individually to monitor loss in mass during testing. For each specimen, oven dry the spalled material and determine its mass until the loss in mass due to drying is not more than 0.2 % in 2 h of drying. Record the data individually and cumulatively for each specimen throughout the test until 300 cycles are completed or the mass lost is at least 10 %, whichever occurs first. Specimens shall then be oven dried at a temperature of 212 to 230°F (100 to 110°C) until the loss in mass due to drying is not more than 0.1 % in 48 h of drying. They shall be removed from the oven and allowed to cool at room temperature for approximately 30 min before measuring final dry mass. The initial dry mass of each specimen is considered to be the final dry mass of the specimen plus the total dry mass of fragments collected from the beam throughout the test.

5.6.2.4 Calculate the cumulative percent mass loss (CPWL) for each beam specimen as follows:

$$CPWL (Beam), \% = \frac{S}{S+B} \times 100 \quad (1)$$

where:

*CPWL (Beam)* = cumulative percent mass loss,  
*S* = total dry mass of spalled material, and  
*B* = oven dried beam mass at the end of the test.

5.6.2.5 Calculate the CPWL for the sample. The CPWL of the sample is the average CPWL (Beam) of the three specimens.

5.6.2.6 It is not possible to specify the precision of the procedure in this specification for freeze-thaw because data is not yet available. Since there is no accepted reference material suitable for determining the bias of results of this test, no statement on bias is being made.

5.6.3 The CPWL shall be less than 5 % after 300 cycles of freezing and thawing.

5.7 *Linear Drying Shrinkage*—Shall not exceed 0.065 % when tested in accordance with Test Method **C426**.

## 6. Dimensions and Permissible Variations

6.1 Cross section dimensions shall not deviate by more than  $\pm \frac{1}{8}$  in. (3 mm) from approved dimensions.

6.2 Length of units shall not deviate by more than length/360 or  $\pm \frac{1}{8}$  in. (3 mm), whichever is greater, not to exceed  $\pm \frac{1}{4}$  in. (6 mm).

## 7. Sampling and Testing

7.1 Sample and test units of cast stone in accordance with Test Methods **C1194** and **C1195**.

7.1.1 If laboratory testing is required for resistance to freezing and thawing, sample and test one unit from each cast stone mixture design in accordance with **5.6**.

7.2 Visually examine units in accordance with Section **8**.

7.3 Visually examine color differences between units and the approved sample under daylight illumination as defined under Spectral Power Distribution in paragraph 5.1.1.1 of Practice **D1729**.

7.4 Instrumentally examine color differences, if required, in accordance with Test Method **D2244**.

## 8. Visual Inspection

8.1 All surfaces intended to be exposed to view shall have a fine-grained texture similar to natural stone, with no air voids in excess of  $\frac{1}{32}$  in. (0.8 mm) and the density of such voids shall be less than three occurrences per any 1 in.<sup>2</sup> (25 mm<sup>2</sup>) and not obvious under direct daylight illumination from a 5-ft (1.5-m) distance, unless otherwise specified.

8.2 Minor chipping resulting from shipment and delivery shall not be grounds for rejection. Minor chipping shall not be obvious under direct daylight illumination from a 20-ft (6-m) distance.

8.3 Units shall exhibit a texture approximately equal to the approved sample when viewed under direct daylight illumination at a 10-ft (3-m) distance.

8.4 The occurrence of crazing or efflorescence shall not constitute a cause for rejection.

## 9. Permissible Variation in Color

9.1 *Total Color Difference*—Not greater than 6 units from the approved sample or between units of comparable age subjected to similar weathering when tested in accordance with the color difference equation in paragraph 6.2.1 of Test Method **D2244**.

9.2 *Hue Difference*—Not greater than 2 units from the approved sample or between units of comparable age subjected to similar weathering when tested in accordance with the color difference equation in paragraph 6.2.7 of Test Method **D2244**.

## 10. Rejection

10.1 If the shipment fails to conform to physical or visual requirements in Sections **5** and **7**, the manufacturer may recall the shipment, sort it, and new specimens shall be selected by the purchaser and tested at the expense of the manufacturer. If the second set of specimens fails to conform to the test requirements, the entire shipment shall be rejected.

10.2 Units shall be visually inspected and tested prior to installation.

## 11. Keywords

11.1 architectural cast stone; precast building unit; simulate natural stone

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