



Designation: C1670/C1670M – 17

## Standard Specification for Adhered Manufactured Stone Masonry Veneer Units<sup>1</sup>

This standard is issued under the fixed designation C1670/C1670M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### INTRODUCTION

The purpose of this standard is to establish the minimum product specifications for adhered manufactured stone masonry veneer units. These units are manufactured using a wet cast concrete mixture and finished to simulate stone, rocks found in nature, and other textures.

### 1. Scope\*

1.1 This specification covers the minimum product requirements for adhered manufactured stone masonry veneer units applied as an adhered veneer to exterior and interior walls and structures suitable to receive units.

1.2 The property requirements of this specification apply at the time of delivery. This standard does not address the physical evaluation of installed units removed from service.

1.3 The units described by this specification are manufactured from a mixture of cement, normal or lightweight aggregates (or a combination of both), water, admixtures, other cementitious materials and other components which are wet-cast into shapes simulating the appearance of natural stone and other textures.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 The text of this specification references notes and footnotes which provide explanatory material. These notes and footnotes shall not be considered as requirements of the standard.

1.6 *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 of units.*

NOTE 1—When particular features are desired such as surface textures

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee C15 on Manufactured Masonry Units and is the direct responsibility of Subcommittee C15.03 on Concrete Masonry Units and Related Units.

Current edition approved July 1, 2017. Published August 2017. Originally approved in 2013. Last previous edition approved in 2016 as C1670/C1670M – 16. DOI: 10.1520/C1670\_C1670M-17.

or color these features should be specified separately. Suppliers should be consulted as to the availability of units having the desired features.

*1.7 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:

- C31/C31M Practice for Making and Curing Concrete Test Specimens in the Field
- C33/C33M Specification for Concrete Aggregates
- C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens
- C140/C140M Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
- C150/C150M Specification for Portland Cement
- C157/C157M Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
- C207 Specification for Hydrated Lime for Masonry Purposes
- C260/C260M Specification for Air-Entraining Admixtures for Concrete
- C330/C330M Specification for Lightweight Aggregates for Structural Concrete
- C331/C331M Specification for Lightweight Aggregates for Concrete Masonry Units
- C482 Test Method for Bond Strength of Ceramic Tile to Portland Cement Paste
- C494/C494M Specification for Chemical Admixtures for Concrete
- C511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
- C595/C595M Specification for Blended Hydraulic Cements
- C618 Specification for Coal Fly Ash and Raw or Calcined

\*A Summary of Changes section appears at the end of this standard



Natural Pozzolan for Use in Concrete  
 C666/C666M Test Method for Resistance of Concrete to  
 Rapid Freezing and Thawing  
 C979/C979M Specification for Pigments for Integrally Col-  
 ored Concrete  
 C989/C989M Specification for Slag Cement for Use in  
 Concrete and Mortars  
 C1116/C1116M Specification for Fiber-Reinforced Concrete  
 C1157/C1157M Performance Specification for Hydraulic  
 Cement  
 C1232 Terminology for Masonry  
 C1240 Specification for Silica Fume Used in Cementitious  
 Mixtures

### 3. Terminology

3.1 Terminology defined in Terminology C1232 shall apply for this specification.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *adhered manufactured stone masonry veneer unit, n*—a non-load bearing masonry unit that is produced by wet-cast blending of cementitious material, lightweight and other aggregates, pigments and admixtures, designed to be applied with a cementitious mortar to a backing surface.

3.2.2 *unit profile, n*—the combination of units that represent the range of shapes and sizes provided in the specified veneer.

3.2.3 *average thickness, n*—the mean of the depth measurement of the unit as measured from the back side to the face side.

3.2.4 *designated area, n*—the area of a completed wall section that is used to verify compliance.

3.2.5 *saturated density, n*—the water saturated weight of the cured specimen divided by the volume of the specimen.

3.2.6 *wet cast, adj*—manufactured from a measurable slump concrete.

### 4. Materials

4.1 Cementitious materials shall conform to the following applicable specifications:

- 4.1.1 *Portland Cement*—Specification C150/C150M.
- 4.1.2 *Blended Hydraulic Cements*—Specification C595/C595M.
- 4.1.3 *Pozzolans*—Specification C618.
- 4.1.4 *Slag Cement*—Specification C989/C989M.
- 4.1.5 *Hydraulic Cement*—Specification C1157/C1157M.
- 4.1.6 *Silica Fume*—Specification C1240.
- 4.1.7 *Hydrated Lime*—Specification C207.

4.2 *Aggregates*—Aggregates shall conform to the following specifications, except for grading requirements:

- 4.2.1 *Normal Weight Aggregates*—Specification C33/C33M.
- 4.2.2 *Lightweight Aggregates*—Specification C330/C330M or C331/C331M.

4.3 *Air-Entraining Admixtures*—Specification C260/C260M.

4.4 *Concrete Admixtures*—Specification C494/C494M.

4.5 *Coloring Pigments*—Specification C979/C979M.

4.6 *Reinforcement Fibers*—Specification C1116/C1116M.

4.7 *Other Constituents:*

4.7.1 Other constituent materials shall be shown by test of experience or history of performance under equivalent conditions not to be detrimental to the durability of the adhered manufactured stone masonry veneer unit, or adhered manufactured stone masonry veneer construction, or both.

### 5. Compressive Strength

5.1 From each manufacturing location, obtain representative samples from standard production of each concrete mix used for units in accordance with 5.2.

5.1.1 Sample and test the concrete mixes used for units no more than twelve months prior to production of units. More frequent testing shall be required if there is any change in the manufacturing process including changes in cementitious materials or their sources, aggregates or their sources, water-cementitious materials ratio, mix design, manufacturing process or curing. This does not include producing units of varying shapes, configurations or sizes of units.

NOTE 2—It is common practice to use the same mix design to produce a wide variety of adhered manufactured stone masonry veneer unit shapes, sizes, and configurations. This standard only requires the evaluation of the compressive strength of each mix design, not each unit configuration produced by a common mix design.

5.2 Sample the concrete mix at the manufacturing facility from standard production mix. Form compressive strength and absorption specimens in accordance with Practice C31/C31M; except that the time requirements for transportation do not apply when specimens are shipped to the testing laboratory.

5.2.1 For compressive strength testing, prepare five 4-in. diameter by 8 in. [100 mm by 200 mm] cylinders and test in accordance with 5.3. Do not disturb the curing cylinders for a minimum of 48 hours after casting. De-mold them at an age of seven days.

5.3 Test specimens at an age of 28 days in accordance with Test Method C39/C39M.

5.4 The average compressive strength of five specimens shall be a minimum of 2100 psi [15 MPa] with no individual specimen having a measured compressive strength less than 1800 psi [12 MPa].

### 6. Freeze-Thaw Durability

6.1 From each manufacturing location, obtain representative samples from standard production of each concrete mix used for units in accordance with 6.2.

6.1.1 Sample and test the concrete mixes used for units no more than twelve months prior to production of units. More frequent testing shall be required if there is any change in the manufacturing process including changes in cementitious materials or their sources, aggregates or their sources, water-cementitious materials ratio, mix design, manufacturing process or curing. This does not include producing units of varying shapes, configurations or sizes of units.

6.2 Sample the concrete mix at the manufacturing facility from standard production mix in accordance with Practice

**C31/C31M** except that the time requirements for transportation do not apply when specimens are shipped to the testing laboratory.

6.2.1 For freeze/thaw durability testing, prepare five beams complying with the dimensional requirements of Test Method **C666/C666M**. The molded beams shall be de-molded 24-32 hours after casting and shall be air cured for 28 days.

### 6.3 Testing Requirements:

6.3.1 No single specimen in a group of five specimens shall exhibit a mass loss greater than 1.5 % or show any fracture completely through the cross section when tested in accordance with Test Method **C666/C666M**, Procedure A, with the following modifications:

6.3.1.1 The molded beams are subjected to 50 consecutive cycles of freezing and thawing.

6.3.2 Determine mass loss in accordance with the following procedure:

6.3.2.1 Following immersion in water for a period of 48 hours, the initial specimen mass shall be measured. Excess surface water shall be immediately removed by blotting with damp cloth or fabric towel prior to mass measurement;

6.3.2.2 Following the completion of 50 freeze thaw cycles in accordance with Test Method **C666/C666M**, Procedure A, the specimens shall be removed from the containers and excess surface water shall be removed by blotting with damp cloth or fabric towel;

6.3.2.3 The Percent Mass Loss (PWL) for each specimen shall be determined at 50 cycles and be calculated as follows:

$$\text{PWL (beam), \%} = [(M_0 - M_1)/M_0] \times 100$$

where:

$\text{PWL (beam)}$  = percent mass loss of beam  
 $M_0$  = initial mass of beam following 48-hour saturation  
 $M_1$  = final mass of beam following 50 freeze/thaw cycles

6.3.2.4 Any test specimen which fractures completely through the cross section into two or more discrete sections shall be recorded as a failure.

6.3.3 In the case of specimen failure under 6.3.2.4, the failure mode must be reported in detail.

NOTE 3—Freeze-thaw testing is conducted on prism samples cast from representative concrete mix designs. While each manufacturer takes precautions to ensure that the surface color is durable, this freeze-thaw testing does not include a colored prism sample.

## 7. Shear Bond

7.1 From each manufacturing location, obtain a minimum of five (5) samples of units that are representative of the unit profile from which they are selected, using the same cementitious materials, aggregates, mix design, manufacturing process and curing.

7.1.1 Sampling and testing shall be performed at least annually to meet the requirements of this standard.

7.2 Each unit tested shall develop a shear bond strength with the mortar substrate of not less than 50 psi [350 kPa] when tested in accordance with Test Method **C482** with the following modifications (listed in 7.2.1 through 7.2.5):

7.2.1 Test a minimum of five (5) units at a minimum age of 28 days after manufacture.

NOTE 4—Test Method **C482** requires curing for seven (7) days following fabrication of test specimens. It is acceptable to begin fabrication of shear bond specimens 21 days following manufacture of the units.

7.2.2 The mortar substrate used shall be that specified for non-vitreous tile (water absorption greater than 7 %) in Test Method **C482**.

7.2.3 Use a unit that can be cut into a sample with minimum dimensions of 2 ¼ in. by 2 ¼ in. [60 mm by 60 mm] and maximum dimensions of 4 in. by 4 in. [100 mm by 100 mm], with a thickness no greater than 2 ⅝ in. [70 mm]. This sample is to be cut containing the back pattern of the unit throughout the entire back face.

7.2.4 Use a ½ in. [13 mm] by ½ in. [13 mm] steel bar (in place of the key) whose length shall be sufficient to reach the outer edges of the sample unit across its length. The steel bar shall be placed adjacent and parallel to the sample mortar interface.

7.2.5 Evaluate shear bond results of actual bonding surface of unit as manufactured. If the back surface of the unit used for testing has a directional back pattern, this back pattern shall be parallel to the direction of loading.

## 8. Water Absorption and Density

8.1 From each manufacturing location, obtain a minimum of three (3) samples of units that are representative of the unit profile from which they are selected, using the same cementitious materials, aggregates, mix design, manufacturing process and curing.

8.1.1 Sampling and testing shall be performed at least annually to meet the requirements of this standard.

### 8.2 Absorption:

8.2.1 At a minimum age of 28 days after manufacture, average absorption of three units shall be tested in accordance with Test Methods **C140/C140M**. Units shall be permitted to be cut with a saw if the testing facility cannot accommodate a full-sized unit.

### 8.3 Density:

8.3.1 The saturated density of the units shall be determined from the weights obtained during absorption testing (in accordance with Test Methods **C140/C140M** and 8.2.1) using the following calculation:

$$\text{Saturated Density, lb/ft}^3, ((W_s)/(W_s - W_i))$$

$$\times 62.4 \text{ for inch-pound units}$$

$$\text{Saturated Density, kg/m}^3, ((W_s)/(W_s - W_i)) \times 1000 \text{ for SI units}$$

where:

$W_s$  = saturated weight of specimen, lb [kg]  
 $W_i$  = immersed weight of specimen lb [kg]

8.3.2 The weight per square foot of the unit shall be determined by multiplying the saturated density of the unit by the average thickness, and shall not exceed 15 lb/ft<sup>2</sup> [73 kg/m<sup>2</sup>].

## 9. Dimensional Tolerances

9.1 From each manufacturing location, obtain a minimum of six (6) samples of units that are representative of the unit

profile from which they are selected, using the same cementitious materials, aggregates, mix design, manufacturing process and curing.

9.1.1 Sampling and testing shall be performed at least annually to meet the requirements of this standard.

### 9.2 Dimensions:

9.2.1 Units shall have a minimum thickness of  $\frac{1}{4}$  in. [6 mm] except those parts of a unit within 0.5 in. [13 mm] of the unit perimeter.

9.2.2 The average thickness<sup>2</sup> of each unit shall be less than or equal to  $2\frac{5}{8}$  in. [67 mm].

9.2.3 Units shall not exceed 36 in. [915 mm] in any face dimension and shall not exceed more than 5 ft<sup>2</sup> [0.5 m<sup>2</sup>] in total face area.

### 9.3 Linear Drying Shrinkage:

9.3.1 Length change for each concrete mix used in production of units shall be determined in accordance with Test Method **C157/C157M** with the following exceptions:

9.3.1.1 Sample and test the concrete mixes used for units no more than 24 months prior to production of units. More frequent testing shall be required if there is any change in the manufacturing process including changes in cementitious materials or their sources, aggregates or their sources, water-cementitious materials ratio, mix design, manufacturing process or curing. Retesting is not necessary when only producing units of varying shapes, configurations or sizes of units.

9.3.1.2 Following removal from the molds, measure specimens in accordance with Test Method **C157/C157M**, then store specimens in a moist storage facility conforming to Specification **C511** for seven days. Following this seven day period, remove specimens from moist storage and take a length reading in accordance with ASTM **C157/C157M**. Following this measurement, store specimens in accordance with the air storage requirements of Test Method **C157/C157M**.

9.3.1.3 Make subsequent length readings after specimens have been air cured for 28 days (total age of 35 days). Additional readings are permitted to determine the trend of length change.

9.3.2 The length change between the seven day reading (immediately following moist storage) and the 28 day air curing reading (total age of 35 days) shall not exceed 0.10 %.

## 10. Finish and Appearance

10.1 The finish and appearance requirements shall apply to units at the time of delivery to the jobsite and acceptance by the purchaser.

10.2 Units shall not show defects, deficiencies or protrusions on any surface that interfere with installation or significantly impair the performance of the construction.

10.3 Unit profile names, color range and textures of the units shall be specified by the purchaser. The finished faces

shall conform to approved samples representing the range of textures and colors selected.

NOTE 5—An approved sample typically consists of manufacturer's samples, individual units, or field mock-ups when specified.

10.4 Finished faces shall not have any chips with a dimension exceeding 0.75 in. [20 mm] or an aggregate length of chips that exceed 10 % of the perimeter of the finished face of the unit.

10.5 Finished faces of the unit shall not contain cracks, crazing, scuffing, or other imperfections that detract from the appearance of the designated area when viewed from a distance of 20 ft [6 m] under diffused lighting.

10.6 A shipment shall not contain more than 5 % of units, including broken units, that do not meet the requirements of **10.2**, **10.3**, **10.4**, and **10.5**.

NOTE 6—Many broken units are usable during installation. Units are commonly broken or saw-cut by the installer to fit into particular areas of the construction.

## 11. Product Identification and Packaging

11.1 Each package shall identify the manufacturer's name, profile name, location of manufacture, minimum quantity contained, and statement of product conformity to this specification.

## 12. Reporting

12.1 A complete report with testing completed within twelve (12) months of manufacture of units, consisting of the following shall be made available upon request:

12.1.1 Sampling information.

12.1.2 Date, time, and name of individual molding or selecting specimens for test or both.

12.1.3 Density as determined in **8.3**.

12.1.4 The weight per ft<sup>2</sup> [m<sup>2</sup>] of unit as determined in **8.3**.

12.1.5 The maximum compressive load imposed on each sample along with the compressive strength in pounds per square inch as determined in **5.3**.

12.1.6 The maximum load and shear bond strength as determined in Section **7**.

12.1.6.1 Dimensions (maximum and minimum values), including average thickness of the test sample.

12.1.6.2 The location of failure of each specimen; indicate whether it is in the unit itself, between specimen and bond coat, between bond coat and mortar setting bed, or in the setting bed itself.

12.1.7 Absorption to the nearest 0.1 lb/ft<sup>3</sup> [1 kg/m<sup>3</sup>] as determined in **8.2**.

12.1.8 Freeze-thaw results as determined in **6.3**.

## 13. Keywords

13.1 adhered; cementitious; concrete; manufactured; manufactured stone; masonry; veneer

<sup>2</sup> Annex A1 contains one method for determining average thickness.





## ANNEX

## (Mandatory Information)

## A1. PROCEDURE FOR DETERMINING AVERAGE THICKNESS

## A1.1 Scope

A1.1.1 This annex provides information on determining the average unit thickness on adhered manufactured stone masonry veneer units.

NOTE A1.1—Other methods than the one presented here for determining average thickness may exist. These other methods should be verified by comparing results to the method provided here.

## A1.2 Sample Size

A1.2.1 From each manufacturing location, obtain a minimum of three (3) samples of units that are representative of the materials, concrete mix design, manufacturing process and curing method.

## A1.3 Volume Measurement

A1.3.1 The net volume of each unit shall be determined by dividing the saturated weight ( $W_s$ ) by the saturated density determined in accordance with 8.3.

## A1.4 Area Measurement

A1.4.1 Determine the area of the unit using A1.4.2, A1.4.3, or A1.4.4.

A1.4.2 *Rectangular Units*—For rectangular units, measure the minimum and maximum length and width of each unit to the nearest 0.1 in. [2.5 mm]. Average the measured lengths and widths of each unit and calculate the average area of each unit by multiplying the average length and average width

A1.4.3 *Circular or Oval Units*—For circular or oval units, measure the length (defined as the largest diameter of each

unit) and the width (defined as the smallest diameter of each unit) to the nearest 0.1 in. [2.5 mm]. Calculate the average area of each unit as follows:

$$\text{Area, in.}^2 [\text{mm}^2] = \Pi \times \left( \frac{\text{length}}{2} \right) \times \left( \frac{\text{width}}{2} \right)$$

A1.4.4 *Non-Rectangular Units*—For non-rectangular units the area of a unit shall be determined using A1.4.4.1 or A1.4.4.2.

A1.4.4.1 Trace the outline of each unit onto graph paper. Count the number of squares inside the outline. Estimate the number of partial squares that are contained inside the outline. Add the total number of squares and determine the area of each unit by multiplying the number of squares counted by the area of each square on the graph paper.

A1.4.4.2 Cut a large, rectangular piece of graph paper to serve as control paper. Measure and record its area and mass. Divide the mass by area to compute the mass per unit area. Trace the outline of each unit onto graph paper. Cut out traced area and take weight of the paper cut out. Divide by weight by the mass per unit area of the control paper to calculate unit area.

## A1.5 Average Thickness Calculation

A1.5.1 Determine the average thickness of each unit by dividing the unit volume determined in accordance with A1.3 by the unit area determined in accordance with A1.4. The average of the three ACMV unit thicknesses shall be reported as the average unit thickness for the lot.

## SUMMARY OF CHANGES

Committee C15 has identified the location of selected changes to this standard since the last issue (C1670/C1670M – 16) that may impact the use of this standard. (July 1, 2017)

(1) Revised 7.1.1, 8.1.1, and 9.1.1 to remove permissive language.

Committee C15 has identified the location of selected changes to this standard since the last issue (C1670/C1670M – 15) that may impact the use of this standard. (August 1, 2016)

(1) Revised 7.2.2 to clarify requirements for shear bond substrate.

(2) Revised Section 4 by adding a clause that grading requirements for aggregates do not necessarily apply (4.2).

(3) Revised 6.2.1 to reference Test Method C666/C666M for specimen dimensions.

(4) Revised drying shrinkage requirements to modify the reference standard for testing to ASTM C157/C157M, and other changes were made to 9.3 to provide clarity in this testing.

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