



Designation: C1693-09<sup>ε1</sup> Designation: C1693 - 11

## Standard Specification for Autoclaved Aerated Concrete (AAC)<sup>1</sup>

This standard is issued under the fixed designation C1693; 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.

~~<sup>ε1</sup>Note—Subsection 3.1 was editorially corrected in December 2009.~~

### 1. Scope

1.1 This specification covers autoclaved aerated concrete (AAC), a cementitious product based on calcium silicate hydrates in which low density is attained by the inclusion of an agent resulting in macroscopic voids, and in which curing is carried out using high-pressure steam.

1.2 The raw materials used in the production of autoclaved aerated concrete are portland cement or blended cements, quartz sand, water, lime, gypsum or anhydrite, and an agent resulting in macroscopic voids. The quartz sand used as a raw material may be replaced by a siliceous fine aggregate other than sand, and usually is ground to a fine powder before use. Fly ash may be used as a sand replacement. The batched raw materials are mixed thoroughly together to form a slurry. The slurry is cast into steel molds. Due to the chemical reactions that take place within the slurry, the volume expands. After setting, and before hardening, the mass is machine cut into units of various sizes. The units then are steam-cured under pressure in autoclaves where the material is transformed into a hard calcium silicate.

1.3 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.

1.4 *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. See Section 6, 7, and 8.*

### 2. Referenced Documents

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

C22/C22M Specification for Gypsum

C33 Specification for Concrete Aggregates

C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens

C144 Specification for Aggregate for Masonry Mortar

C150 Specification for Portland Cement

C332 Specification for Lightweight Aggregates for Insulating Concrete

C595/C595M Specification for Blended Hydraulic Cements

C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

C1692 Practice for Construction and Testing of Autoclaved Aerated Concrete (AAC) Masonry

E4 Practices for Force Verification of Testing Machines

E575 Practice for Reporting Data from Structural Tests of Building Constructions, Elements, Connections, and Assemblies

### 3. Classification

3.1 AAC units manufactured in accordance with this specification are classified according to their strength class.

### 4. Materials and Manufacture

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

4.1.1 *Portland Cement*, Specification C150.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C27 on Precast Concrete Products and is the direct responsibility of Subcommittee C27.60 on Precast Autoclaved Aerated Concrete.

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

- 4.1.2 *Blended Cements*, Specification C595/C595M.
- 4.1.3 *Pozzolan*, Specification C618.
- 4.1.4 *Gypsum*, Specification C22/C22M.
- 4.1.5 *Aggregates*, Specifications C33, C144, or C332.

## 5. Physical Requirements

5.1 *Compressive Strength*—The compressive strength shall be determined according to Section 6 and shall conform to the requirements of Table 1.

5.2 *Dry Bulk Density*—The dry bulk density shall be determined according to Section 7 and shall conform to the requirements of Table 1.

5.3 *Drying Shrinkage*—The drying shrinkage shall be determined in accordance with Section 8, and shall conform to the requirements of Table 1.

5.4 *Modulus of Elasticity*—If required, the modulus of elasticity shall be determined in accordance with Section 9.

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## ASTM C1693-11

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**TABLE 1 Physical Requirements<sup>A</sup>**

Strength Class	Compressive Strength, psi (MPa)	Nominal Dry- Bulk Density, lb/ft <sup>3</sup> (kg/m <sup>3</sup> )	Density Limits, lb/ft <sup>3</sup> (kg/m <sup>3</sup> )Average Drying Shrinkage, %		Density Limits, lb/ft <sup>3</sup> (kg/m <sup>3</sup> )
			Strength Class		
			Compressive Strength, psi (MPa)	Nominal Dry Bulk Density, lb/ft <sup>3</sup> (kg/m <sup>3</sup> )	
min		Lower Limit >	Upper Limit ≤		
AAC-2	290 (2.0)	25 (400)	22-28 (350-450)	≤0.02	
AAC-2	290 (2.0)	25 (400)	22 (350)	28 (450)	
		31 (500)	28-34 (450-550)	≤0.02	
		31 (500)	28 (450)	34 (550)	
AAC-4	580 (4.0)	31 (500)	28-34 (450-550)	≤0.02	
AAC-3	435 (3.0)	31 (500)	28 (450)	34 (550)	
		37 (600)	34-41 (550-650)	≤0.02	
		37 (600)	34 (550)	41 (650)	
		44 (700)	41-47 (650-750)	≤0.02	
AAC-4	580 (4.0)	31 (500)	28 (450)	34 (550)	
		50 (800)	47-53 (750-850)	≤0.02	
		37 (600)	34 (550)	41 (650)	
AAC-6	870 (6.0)	37 (600)	35-41 (550-650)	≤0.02	
AAC-5	725 (5.0)	37 (600)	34 (550)	41 (650)	
		44 (700)	41-47 (650-750)	≤0.02	
		44 (700)	41 (650)	47 (750)	
		50 (800)	47-53 (750-850)	≤0.02	
AAC-6	870 (6.0)	37 (600)	35 (550)	41 (650)	
		44 (7020)	41 (650)	47 (750)	
		44 (700)	41 (650)	47 (750)	

<sup>A</sup> The average drying shrinkage requirement of all strength classes is ≤0.02 %.

## 6. Determination of Compressive Strength

### 6.1 Apparatus:

6.1.1 *Testing Machine*—The testing machine shall conform to the requirements prescribed in Practice E4. The machine shall be equipped with two steel bearing blocks one of which is a spherically seated block that will transmit load to the upper surface of the specimen, and the other a plane rigid block on which the specimen will rest.

### 6.2 Test Specimens:

6.2.1 Three cube specimens of 4 in. (100 mm) edge length shall be tested in an air dried condition (5 to 15 % by mass moisture content). If the samples have to be dried before testing to reach that moisture content, they shall be stored at a temperature not exceeding 158°F (70°C).

6.2.2 A minimum of three specimens shall be tested. Whenever possible, one specimen shall be obtained from the upper third of the product, one from the middle, and one from the lower third, determined in the direction of the rising of the mass during manufacture. Otherwise, the position of the cubes and information regarding the rise shall be reported. The direction of the rise shall be noted on all specimens. This is shown in Fig. 1.

6.2.3 Loadbearing surfaces of the specimen shall be plane within 0.0035 in. (0.09 mm) per 4 in. (100 mm). This can be achieved by grinding, milling, or capping. When capping, a gypsum plaster compound shall be used.

### 6.3 Procedure:

6.3.1 The specimen shall be placed in the testing machine and the load applied perpendicular to the direction of rise during manufacture.

6.3.2 *Speed of Testing*—Apply the load up to one half of the expected maximum load at a convenient rate, after which adjust the controls of the machine as required to give a uniform rate of travel of the moving head such that the remaining load is applied in not less than one nor more than two minutes.

6.3.3 Calculate the compressive strength of each specimen as follows:

$$\text{Compressive strength, } f = \frac{P}{A} \quad (1)$$

where:

$f$  = compressive strength of the specimen, psi (or Pa),

$P$  = maximum load, lbf (or N), indicated by the testing machine, and

$A$  = gross cross-sectional area of the specimen, in.<sup>2</sup> (mm<sup>2</sup>).

6.4 The compressive strength shall be reported to the nearest 10 psi (69 kPa) for each specimen and as the average for three specimens.

## 7. Determination of Moisture Content and Bulk Density

### 7.1 Apparatus:

7.1.1 *Balance*—shall be sensitive within 0.5 % of the mass of the specimen.

7.2 *Test Specimens*—Three test specimens, as described in 8.2, shall be used for calculating the bulk density.

### 7.3 Procedure:

7.3.1 Determine the mass of the specimens, and then dry them in a ventilated oven at 212 to 230°F (100 to 110°C) for not less than 24 h, and until two successive determinations of mass at intervals of 2 h show an increment of loss not greater than 0.2 % of the last previously determined mass of the specimen.

7.3.2 Calculate the moisture content of each specimen as follows:

$$\text{Moisture Content } \%, MC = (A-B)/B \times 100 \quad (2)$$

where:

$MC$  = moisture content, %,

$A$  = sampled mass of specimen, lb (kg), and

$B$  to = dry mass of specimen, lb (kg).

7.3.2.1 Report the average moisture content of all of the specimens as the moisture content of the lot.

7.3.3 Determine the dimensions of the test specimens with a caliper gauge. Measure the width and height at the ends and in the middle of the length of the specimen. Measure the length on two opposite sides. Determine the volume of the specimen by multiplying the average values of the dimensions.

7.3.4 Calculate the dry bulk density of each specimen as follows:

$$\gamma = B/V \quad (3)$$

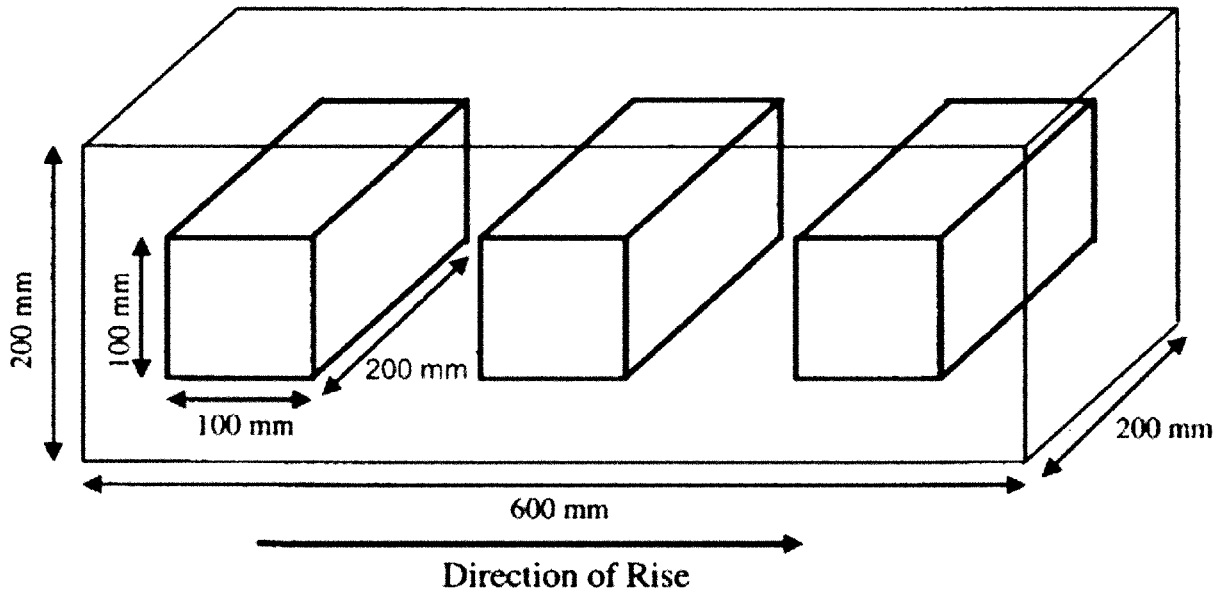
where:

$\gamma$  = dry bulk density, lb/ft<sup>3</sup> (kg/m<sup>3</sup>),

$B$  = dry mass of specimen, lb (kg), and

$V$  = volume of the specimen, ft<sup>3</sup> (m<sup>3</sup>).

7.3.4.1 Report the average dry bulk density of all of the specimens as the dry bulk density of the lot.



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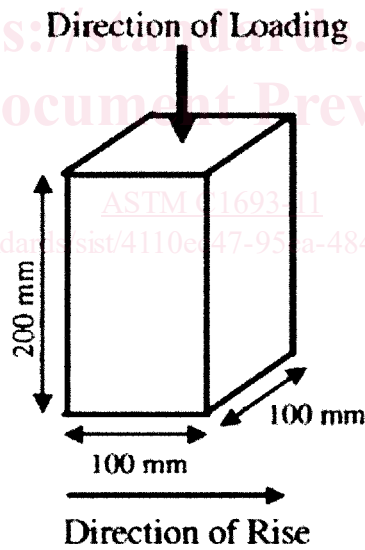


FIG. 1 Direction of Loading

## 8. Determination of Drying Shrinkage

### 8.1 Apparatus:

8.1.1 *Balance*, shall be sensitive to within 0.1 % of the mass of the specimen.

8.1.2 *Caliper Gage*, shall be accurate to 0.004 in. (0.1 mm).

8.1.3 *Temperature Regulated Environment*, capable of regulating the temperature to  $68 \pm 4^\circ\text{F}$  ( $20 \pm 2^\circ\text{C}$ ) and a minimum relative humidity of 45 % in which the samples are stored during drying and while the measurements in the change in length are performed.

8.1.4 *Measuring Instrument*, used to determine the change in length of the test samples. Any suitable device shall be permitted to be used provided it meets the following requirements:

8.1.4.1 The instrument shall measure change in length along the longitudinal axis of the sample.

8.1.4.2 The instrument shall be able to make contact with the measurement marks fastened to the face of the samples.

8.1.4.3 The measurements shall be made with an accuracy of  $\Delta L/L_{[ogr]} \leq 10^{-6}$ , where  $L_{[ogr]}$  is the original length of the sample