Designation: C 1386 – 07

# Standard Specification for Precast Autoclaved Aerated Concrete (AAC) Wall Construction Units[1]

This standard is issued under the fixed designation C 1386; 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 (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers solid nonload-bearing and load-bearing precast concrete wall units made from autoclaved aerated concrete. Precast autoclaved aerated concrete (AAC) is 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 is subjected to high-pressure steam curing. The precast autoclaved aerated concrete wall units are large-size solid rectangular prisms, which are to be laid using thin-bed mortar. Installed units covered by this specification shall be protected against direct exposure to moisture using a coating material accepted by the AAC manufacturer.

1.2 The raw materials used in the production of precast autoclaved aerated concrete are portland cement, 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 the standard. The values given in parentheses are for information only.

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 8, Section 9, and Section 10.

## 2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 22/C 22M Specification for Gypsum
C 33 Specification for Concrete Aggregates
C 144 Specification for Aggregate for Masonry Mortar
C 150 Specification for Portland Cement
C 332 Specification for Lightweight Aggregates for Insulating Concrete
C 595 Specification for Blended Hydraulic Cements
C 618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
E 4 Practices for Force Verification of Testing Machines

## 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 C 150.
4.1.2 *Blended Cements*, Specification C 595.
4.1.3 *Pozzolan*, Specification C 618.
4.1.4 *Gypsum*, Specification C 22/C 22M.
4.1.5 *Aggregates*, Specifications C 33, C 144, or C 332.

## 5. Physical Requirements

5.1 *Compressive Strength*—The compressive strength of the units shall be determined according to Section 8 and shall conform to the requirements of Table 1.

5.2 *Dry Bulk Density*—The dry bulk density shall be determined according to Section 9 and shall conform to the requirements of Table 1.

5.3 *Drying Shrinkage*—The drying shrinkage shall be determined in accordance with Section 10, and the average drying shrinkage shall conform to the requirements of Table 1.

[1] This specification is under the jurisdiction of ASTM Committee C27 on Precast Concrete Products and is the direct responsibility of C27.60 on Precast Autoclaved Aerated Concrete.

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[2] 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.

**TABLE 1 Physical Requirements**

| Strength Class | Compressive Strength, psi (MPa), min | Nominal Dry Bulk Density lb/ft$^3$(kg/m$^3$) | Density Limits, lb/ft$^3$(kg/m$^3$) | Average Drying Shrinkage, % |
|---|---|---|---|---|
| AAC-2 | 290 (2.0) | 25 (400) | 22 (350)–28 (450) | |
| | | 31 (500) | 28 (450)–34 (550) | |
| AAC-4 | 580 (4.0) | 31 (500) | 28 (450)–34 (550) | ≤ 0.02 |
| | | 37 (600) | 34 (550)–41 (650) | |
| | | 44 (700) | 41 (650)–47 (750) | |
| AAC-6 | 870 (6.0) | 37 (600) | 35 (550)–41 (650) | |
| | | 44 (700) | 41 (650)–47 (750) | |
| | | 50 (800) | 47 (750)–53 (850) | |

## 6. Dimensions and Permissible Variations

6.1 The dimensions of the units shall be as specified by the AAC manufacturer.

6.2 No overall unit dimension (width, height, and length) shall differ by more than ⅛ in. (3 mm) from the specified standard dimensions.

## 7. Visual Inspection

7.1 All units shall be sound and free of defects that would interfere with the proper placing of the unit or impair the strength or permanence of the construction. Minor imperfections incidental to the usual methods of manufacture, or resulting from customary methods of handling in shipment and delivery, shall not be deemed grounds for rejection.

## 8. Compressive Strength Test

8.1 *Apparatus*:

8.1.1 *Testing Machine*—The testing machine shall conform to the requirements prescribed in Practice E 4. 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.

8.2 *Test Specimens*:

8.2.1 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).

8.2.2 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.

8.2.3 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.

8.3 *Procedure*:

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

8.3.2 *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.

8.3.3 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.$^2$ (mm$^2$).

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

## 9. Moisture Content and Bulk Density Test

9.1 *Apparatus*:

9.1.1 *Balance*, shall be sensitive within 0.5 % of the mass of the specimen.

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

9.3 *Procedure*:

9.3.1 The mass of the specimens shall be determined and then dried 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.

9.3.2 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
$B$ = dry mass of specimen, lb (kg).

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

9.3.3 The dimensions of the test specimens are determined with a caliper gauge. The width and height are to be measured at the ends and in the middle of the length of the specimen. The length is measured on two opposite sides. The volume of the specimen is determined by multiplying the average values of the dimensions.

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

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

where:

$\gamma$ = dry bulk density, lb/ft$^3$(kg/m$^3$),
$B$ = dry mass of specimen, lb (kg), and
$V$ = volume of the specimen, ft$^3$ (m$^3$).

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

## 10. Shrinkage Test

10.1 *Apparatus*:

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

10.1.2 *Caliper Gauge*, shall be accurate to 0.004 in. (0.1 mm).

10.1.3 *Temperature Regulated Environment*, which shall be capable of regulating the temperature to 68 ± 4°F (20 ± 2°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.

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

10.1.4.1 The change in length is measured along the longitudinal axis of the sample.

10.1.4.2 Contact must be able to be made with the measurement marks fastened to the face of the samples.

10.1.4.3 The measurements are made with an accuracy of $\Delta L/L_o \leq 10^{-6}$, where $L_o$ is the original length of the sample.

10.1.4.4 The device must have a measurement scale capable of detecting minute changes in length.

10.1.4.5 The device must be able to be checked with a measurement standard prior to each measurement.

10.1.5 *Measurement Marks*, which are fastened to the faces of the samples, must be made of a corrosion proof material and shaped in such a way that reliable contact with the measuring instrument is assured.

10.1.6 *Ventilated Drying Oven*, which is capable of maintaining a temperature of 220 ± 8°F (105 ± 5°C).

10.2 *Test Specimens*:

10.2.1 The specimens to be used are prisms having the dimensions of 1.5 by 1.5 by 6.3 in. (40 by 40 by 160 mm), and each test shall consist of a minimum of three specimens. 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 by the direction of the rising of the mass during manufacture. Otherwise, the position of the sample and information regarding the rising direction shall be reported. The direction of rise shall be noted on all specimens.

10.2.2 The longitudinal axis of the specimen shall be normal to the direction of rising and preferably parallel with the longitudinal direction of the product. The measurement marks are cemented, or otherwise securely fastened to the faces.

10.3 *Measurement and Conditioning of Test Specimens*:

10.3.1 The dimensions of the test specimens are determined with a caliper gauge. The width and height are to be measured at the ends and in the middle of the length of the specimen. The length is measured on two opposite sides. The volume of the specimen is determined by multiplying the average values of the dimensions.

10.3.2 The samples shall be packaged in plastic and stored for a minimum of 24 h at 68 ± 4°F (20 ± 2°C) to obtain a uniform moisture distribution. The moisture content shall be determined as follows:

$$MC = (\gamma m - \gamma db)/\gamma db \times 100 \quad (4)$$

where:

$\gamma m$ = $m_m/V$, wet bulk density as determined by the mass in the damp condition divided by the volume, and

$\gamma db$ = dry bulk density of a comparative sample as determined in Section 9.

10.4 *Determination of Drying Shrinkage*:

10.4.1 The measurement marks are to be cleaned before each reading. After removal from the plastic enclosure, the first determination of length and mass is made. The specimen then shall be stored on a grid to allow sufficient movement of air around the specimens in an atmosphere of 68 ± 4°F (20 ± 2°C) and a relative humidity of 45 %. The specimen's mass and length shall be determined at regular intervals until the moisture content has decreased to below 4 %. At least five determinations shall be made.

10.4.2 The test specimens shall be stored in a drying cabinet at 220 ± 8°F (105 ± 5°C) until the mass at two determinations does not change by more than 0.2 %. After a constant mass is reached, the measurement marks shall be removed, and the mass determined.

10.5 *Calculation of Test Results*:

10.5.1 The relative change in length between readings is calculated as follows:

$$\epsilon_{si} = (L_o - L_f/L_o) \times 100 \quad (5)$$

$$\epsilon_{si} = (\Delta L/L_o) \times 100$$

where:

$\Delta L$ = change in measured length according to 10.4.1 in. (mm),

$L_o$ = the initial length of the specimen, and

$L_f$ = the final length of the specimen.

10.5.1.1 The relative change in length shall be reported with an accuracy of 0.00001 in./in. (0.00001 mm/mm).

10.5.2 The moisture content at each reading time shall be calculated as follows:

$$MC = (m_i - m_d)/(m_d - m_{plug}) \times 100 \quad (6)$$

where:

$MC$ = moisture content,

$m_i$ = mass of the damp sample at the reading time in lb (kg),

$m_d$ = mass of the sample unit after drying out in lb (kg), and

$m_{plug}$ = mass of the measurement plug in lb (kg).

10.5.2.1 The moisture content shall be reported with an accuracy of 0.1 %.

10.5.3 The average values for the relative change in length and the moisture content for each reading shall be shown graphically and connected by a curve (Fig. 1). The amount of drying shrinkage, $\epsilon_{cs}$, is the difference in the relative change in length between the moisture contents of 30 % and 6 %.

## 11. Sampling and Testing

11.1 The purchaser or his authorized representative shall be accorded proper facilities to inspect and sample the units at the place of manufacture from the lots ready for delivery.

11.2 The units shall be sampled and tested in accordance with test methods of this specification.

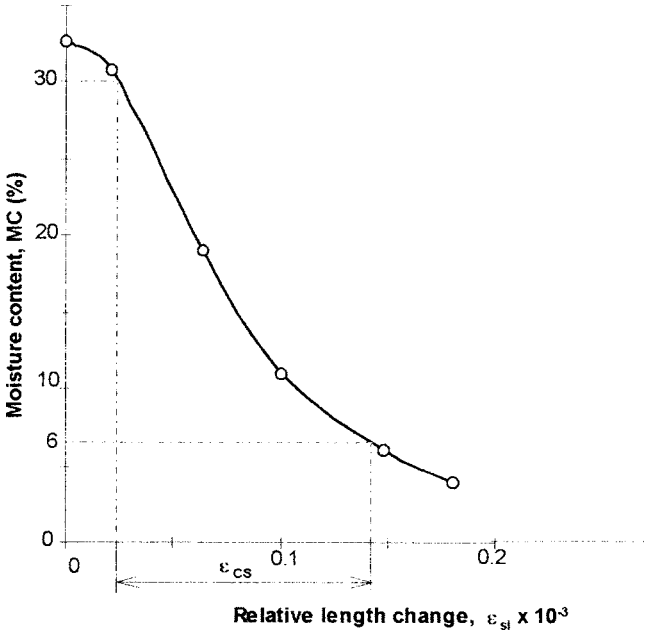


FIG. 1 Determination of Drying Shrinkage, $\epsilon_{cs}$

## 12. Rejection

12.1 If the shipment fails to conform to the specific requirements, the manufacture may sort it, and new specimens shall be selected by the purchaser from the retained lot and tested at the expense of the manufacture. If the second set of specimens fails to conform to the test requirements, the entire lot shall be rejected.

## 13. Expense of Tests

13.1 Except as specified in Section 12, and unless otherwise agreed, the expense of inspection and testing shall be borne by the purchaser.

## 14. Precision and Bias

14.1 The precision and bias of the test procedures described in Section 8, Section 9, and Section 10 are being determined and will be provided when sufficient data are available to indicate acceptable tolerances in repeatability and reproducibility.

## 15. Keywords

15.1 AAC; compressive strength; density; moisture content; precast autoclaved aerated concrete; shrinkage