Designation: C 1452 – 00

Standard Specification for Reinforced Autoclaved Aerated Concrete Elements[1]

This standard is issued under the fixed designation C 1452; 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 load-bearing and nonload-bearing reinforced autoclaved aerated concrete (AAC) floor, roof, wall, and stair elements used as components for building construction. Autoclaved aerated concrete is a cementitous 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. 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 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 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 with high accuracy into elements of various sizes. The elements then are steam-cured under pressure in autoclaves where the matrix is transformed into a solid calcium silicate hydrate.

NOTE 1—LOI up to 12 % may be acceptable for production of AAC provided supporting test data is presented by the manufacturer.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are provided for information only.

2. Referenced Documents

2.1 *ASTM Standards:*

A 82 Specification for Steel Wire, Plain, for Concrete Reinforcement[2]

C 22/C 22M Specification for Gypsum[3]

C 33 Specification for Concrete Aggregates[4]

C 144 Specification for Aggregate for Masonry Mortar[5]

C 150 Specification for Portland Cement[3]

C 332 Specification for Lightweight Aggregates for Insulating Concrete[4]

C 595 Specifications for Blended Hydraulic Cements[3]

C 618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete[4]

C 1386 Specification for Precast Autoclaved Aerated Concrete (PAAC) Wall Construction Units[5]

3. Classification

3.1 Autoclaved aerated concrete elements manufactured in accordance with this specification are classified according to their strength class as shown in Table 1.

4. Materials and Manufacture

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

4.1.1 *Quicklime*, in accordance with manufacturer's specification.

4.1.2 *Aggregate*, in accordance with Specification C 33, C 144, or C 332.

4.1.3 *Portland Cement*, in accordance with Specification C 150.

4.1.4 *Blended Cements*, in accordance with Specification C 595.

4.1.5 *Gypsum*, in accordance with Specification C 22/C 22M.

4.1.6 *Pozzolan*, in accordance with Specification C 618.

4.1.7 Gas-producing agent conforming to the manufacturer's specification.

4.2 *Steel Reinforcing*—Steel reinforcing shall conform to the following specification and the requirements of Table 2.

4.2.1 *Steel Wire*, in accordance with Specification A 82.

5. Physical Requirements

5.1 *Compressive Strength*—The compressive strength of the AAC material shall be determined according to Specification C 1386 and shall conform to the requirements of Table 1.

5.2 *Bulk Density*—The dry bulk density shall be determined according to Specification C 1386 and shall conform to the requirements of Table 1.

[1] This specification is under the jurisdiction of ASTM Committee C-27 on Precast Concrete Products and is the direct responsibility of Subcommittee C27.60 on Precast Autoclaved Aerated Concrete.

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[2] *Annual Book of ASTM Standards*, Vol 01.04.

[3] *Annual Book of ASTM Standards*, Vol 04.01.

[4] *Annual Book of ASTM Standards*, Vol 04.02.

[5] *Annual Book of ASTM Standards*, Vol 04.05.

TABLE 1 Physical Requirements

Strength Class	Minimum Compressive Strength of AAC, psi (MPa)		Nominal Dry Bulk Density, lb/ft^3 (kg/m^3)	Density Limits, lb/ft^3 (kg/m^3)	Average Drying Shrinkage (%)	Maximum Area of Steel Corrosion[A] (%)
	Average	Min				
AAC-2	360 (2.5)	290 (2.0)	25 (400) 31 (500)	22 (350)—28 (450) 28 (450)—34 (550)		
AAC-4	725 (5.0)	580 (4.0)	31 (500) 37 (600) 44 (700)	28 (450)—34 (550) 34 (550)—41 (650) 41 (650)—47 (750)	≤ 0.02	≤ 5.0
AAC-6	1090 (7.5)	870 (6.0)	37 (600) 44 (700) 50 (800)	35 (550)—41 (650) 41 (650)—47 (750) 47 (750)—53 (850)		

[A] As determined according to Section 7, indicated by a slight trace of rust on the surface of the steel. No flaking or deep rust should be evident on the steel surface.

TABLE 2 Properties of Steel Reinforcement

Property	Minimum Characteristic Value
Yield strength, min, ksi (MPa)	70 (485)
Tensile strength, min, ksi, (MPa)	80 (550)
Reduction of area, min, %	30[A]

[A] For material testing over 100 ksi (690 MPa) tensile strength, the reduction of area shall be not less than 25 %.

5.3 *Shrinkage*—The drying shrinkage of the AAC material shall be determined according to Specification C 1386 and shall conform to the requirements of Table 1.

5.4 *Weld-Point Shear Strength*—The weld-point shear strength in the reinforcement shall be determined in accordance with Section 8 and shall conform to the requirements of Table 3.

5.5 *Concrete Cover of Steel Reinforcement*—The minimum concrete cover over the steel reinforcement shall be 0.375 in. (10 mm). The reinforcing steel shall receive a rust-resistant coating before casting.

5.6 *Effectiveness of Corrosion Protection of Steel Reinforcement*—The effectiveness of the corrosion protection for the steel reinforcement shall be determined according to Section 7 and shall conform to the requirements of Table 1.

5.7 *Steel Reinforcement*—The properties of the steel reinforcement shall be determined in accordance with Specification A 82 and shall conform to the requirements of Table 2.

5.8 The load-bearing capacity of the reinforced AAC elements shall be determined using the test method in Section 9, or by calculation provided adequate test data are available for verification of the calculation method.

6. Dimensions and Permissible Variations

6.1 The dimensions of the reinforced elements shall be as specified by the AAC manufacturer. The allowable deviations for the element dimensions shall be as specified in Table 4.

TABLE 3 Weld-Point Shear Strength

Diameter of the Longitudinal Reinforcement, in. (mm)	Minimum Shear Strength of the Joint, lbf (kN)
0.16 (4.0)	495 (2.20)
0.18 (4.5)	598 (2.66)
0.20 (5.0)	771 (3.43)
0.24 (6.0)	1113 (4.95)
0.28 (7.0)	1513 (6.73)
0.32 (8.0)	1987 (8.84)
0.35 (9.0)	2502 (11.13)
0.40 (10.0)	3091 (13.75)
0.43 (11.0)	3741 (16.64)
0.47 (12.0)	5339 (19.79)

7. Corrosion Protection of Steel Reinforcement in AAC

7.1 *Apparatus*:

7.1.1 *Storage Container*, with dimensions sufficient to completely immerse AAC specimens.

7.2 *Test Specimens*:

7.2.1 A test set shall consist of six test specimens having the dimensions 16 in. (400 mm) by width of the reinforced element by thickness of the reinforced element. The exposed surface areas of the steel reinforcement at each end of the test specimen shall be coated with the corrosion-protection compound and allowed to dry before testing. Three specimens are to be kept as reference specimens, and three specimens shall be tested.

7.3 *Procedure*:

7.3.1 *Reference Specimens*—The reference specimens are stored in a room having a temperature of 59–68°F (15–20°C) and a relative humidity of 50 to 70 %.

7.3.2 *Test Specimens*—The test specimens are immersed in an aqueous sodium chloride solution, 3 % NaCl by mass, for periods of 2 h at intervals of three days. This is repeated for a total of ten test cycles. When the specimens are not immersed in the sodium chloride solution, they are stored under the same conditions as the reference specimens. After completion of the ten testing cycles the specimens are allowed to air dry for 4 h.

7.3.3 *Inspection for Rust*—After completion of the testing procedure the autoclaved aerated concrete around the steel reinforcing is removed from both the reference and the test specimens. The area of rust covering the steel is determined by visual inspection and is expressed as a percentage of the total area of the specimen. This is determined as follows:

$$A_t = \pi n_1 d_1 I_1 + \pi n_2 d_2 l_2, \text{ (mm}^2\text{)}$$

$$Ar = \Sigma w_i l_i, \text{ (mm}^2\text{), and}$$

$$Pr = 100\ (A_r/A_t)$$

TABLE 4 Dimensional Tolerances for AAC Reinforced Elements

Dimension	Floor, Roof, and Wall Panels
Length	± 0.20 in. (± 5 mm)
Width	± 0.12 in. (± 3 mm)
Thickness	± 0.12 in. (± 3 mm)
Tongue/groove alignment	± 0.12 in. (± 3 mm)

where:

A_t = Total surface of reinforcement present in the specimen (mm^2),
n_1 = Number of longitudinal reinforcing rods,
d_1 = Diameter of the longitudinal reinforcing rods (mm),
l_1 = Length of the longitudinal reinforcing rods (mm),
n_2 = Number of transverse reinforcing rods,
d_2 = Diameter of transverse reinforcing rods (mm),
l_2 = Length of the transverse reinforcing rods (mm),
A_r = Area of rusted surface,
w_i = Unrolled width of the rusted surface,
l_i = Length of the rusted surface, and
P_r = Percentage of surface area which is rusted.

The total area of rusted surface shall be reported as the average total area for the three test and three reference specimens.

8. Weld-Point Shear Strength

8.1 *Apparatus*:

8.1.1 This test can be performed using the device shown in Fig. 1 or an equivalent device, which can be fitted into a normal tension testing machine.

8.2 *Specimen*—The shape of the specimen is shown in Fig. 2. These specimens should be taken at random from welded reinforcement mats that have not been coated with a corrosion-protection compound. The bar with the largest diameter shall be selected as the test specimen. Special test specimens shall not be fabricated for this test except for initial qualification of the welding device.

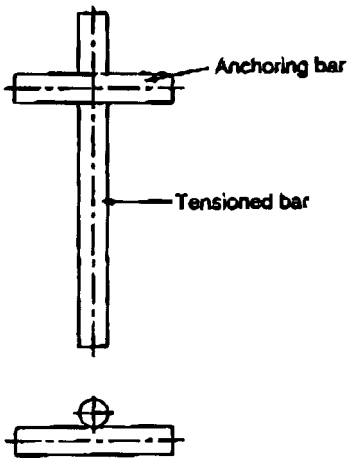


FIG. 2 Weld-Point Shear Strength Test Specimens

8.3 *Procedure*—The shear specimen shall be gripped in the test fixture such that the tension bar is centrally located and rotation of the anchoring bar is prevented. The loading rate shall not exceed 112 lbf/s (0.5 kN/s).

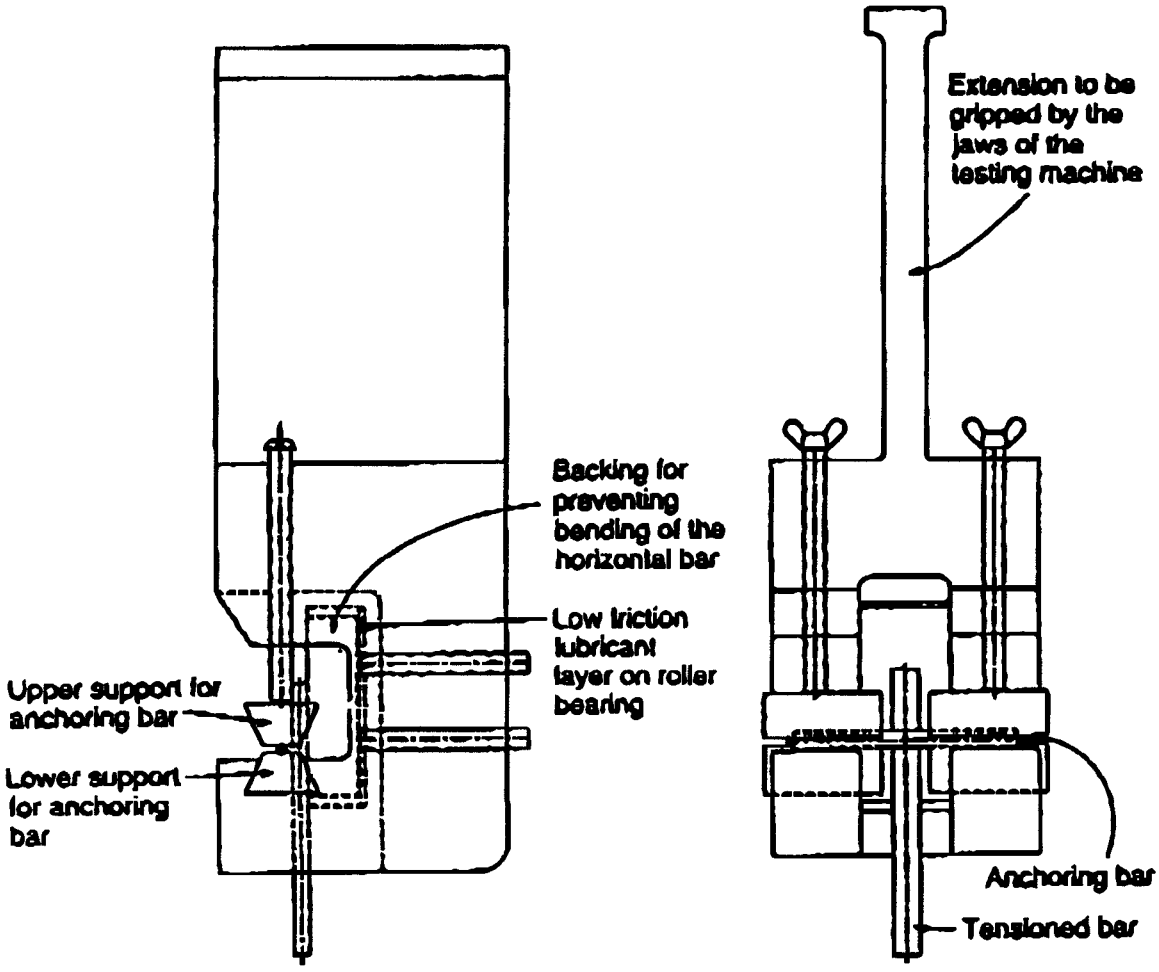


FIG. 1 Weld-Point Shear Strength Test Apparatus

8.4 *Test Results*—The test report shall include the following:

8.4.1 Nominal steel quality.

8.4.2 Diameter of the longitudinal bar (tensioned bar).

8.4.3 Diameter of the transverse bar (anchoring bar).

8.4.4 Ultimate shear force.

9. Determination of Transverse Loading (Flexural) Characteristics of AAC Reinforced Elements

9.1 *Scope*—The scope of this test method is to determine the deflection and the load bearing capacity (ultimate load) of these elements.

9.2 *Apparatus*:

9.2.1 The testing machine shall allow a service load to be imposed with an accuracy of 5 % and an ultimate load with an accuracy of 2 %.

9.2.2 The testing machine shall be such that the reinforced elements are simply supported on two supports, one fixed and one freely movable in the horizontal direction, which allows free rotation of the bearing surface, with the bearing surface constructed from steel. The bearing surface shall provide bearing to the entire width of the element. The bearing length shall be adjustable, such that the minimum bearing length shall be equivalent to the least bearing length supplied by the manufacturer or a minimum of 1.6 in. (40 mm).

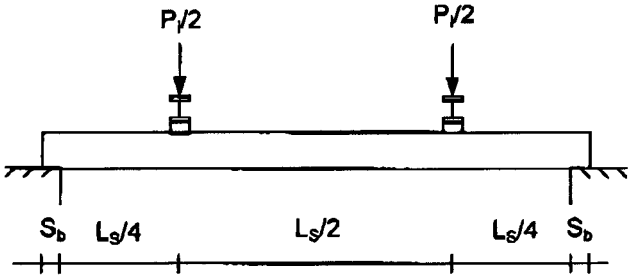
9.2.3 The deflection gauge shall allow the deflection to be determined with an accuracy of 0.02 in. (0.5 mm).

9.3 *Test Specimens*:

9.3.1 The test specimens shall consist of whole AAC reinforced elements as supplied by the AAC manufacturer. The elements shall not be tested until they have attained the same temperature as the testing environment. Moisture content of the specimens should be between 10 and 40 % by mass. If the dry density of the AAC material is known to an accuracy of 5 %, then the moisture content may be determined by calculation based on the mass and volume of the element and the mass of the reinforcement. The mass of the specimens shall be determined before testing to an accuracy of 10 lb (4.5 kg). Report the moisture content of the AAC at time of test.

9.4 *Procedure*:

9.4.1 The load shall be applied as two symmetrical and equal point loads at a distance of one fourth of the clear span from the midspan point as shown in Fig. 3. The two-point loads should be transmitted to the surface of the element by steel profiles placed on soft fiberboard with a thickness of 0.4–0.50 in. (10–12 mm). The steel profiles should have sufficient bearing area to produce an even bearing pressure not exceeding 50 % of the compressive strength of the AAC material. The bearing area shall cover the entire width of the element, and its extension along the length of the element shall not be less than 100 mm.



Position of Applied Loads:
L_s = clear span,
S_b = bearing length of support, and
P_l = imposed test load.

FIG. 3 Transverse Loading (Flexural) Test

9.4.2 Deflection should be measured at midspan, either on both sides of the element or in the center. The first deflection reading is taken when the element is resting on the supports without any imposed load. The loading apparatus is placed in position and load is applied, which corresponds to the imposed service load. The rate of loading shall be such that the service load is reached after two minutes. The service load shall be maintained for five minutes during which the element is inspected for cracking. Should cracks appear, the width shall be measured at a level corresponding to the bottom of the reinforcement. After the five-minute period of application of the service load is completed, the deflection of the element shall be measured and recorded as the deflection of the element under the service load. The element should be loaded to failure with a rate of loading such that the ultimate load is reached after two minutes. The ultimate load shall be recorded and observations made as to the mode of failure of the specimen. Before the element is removed from the testing apparatus the number, and size of all of the reinforcement bars shall be recorded as well as the coverage of the AAC over the steel.

10. Shipping and Handling of AAC Reinforced Element

10.1 Reinforced AAC elements shall be protected from damage during shipping by placement on pallets or other supports, banding of the elements, placement of material between the elements, or any other method deemed appropriate by the AAC manufacturer. Reinforced AAC elements should be handled using lifting devices or clamps recommended by the AAC manufacturer.

11. Repair of Reinforced Elements

11.1 Should damage occur during handling or shipping of the reinforced AAC elements, repairs should be made using special repair mortars designed for AAC element repairs. If the damages are severe, the AAC manufacturer should be consulted as to the structural integrity of the element. Damage that results in exposure of the reinforced element should be repaired only after the exposed steel is coated with a corrosion-resistant coating as recommended by the AAC manufacturer.

12. Field Cutting of Reinforced Elements

12.1 Field cutting of the reinforced elements is not allowed unless approved by the project engineer and performed in accordance with the AAC manufacturer's recommendations.

13. Rejection

13.1 If, upon delivery, an individual element fails to conform to this specification, the manufacturer may repair the element to satisfy the specification or replace the element.

14. Expense of Tests

14.1 Except as specified in Section 9, and unless otherwise

agreed, the expense of inspection and testing shall be the responsibility of the purchaser.

15. Precision and Bias

15.1 The precision and bias of the test procedures are being determined and will be provided when sufficient data are available to indicate acceptable tolerances in repeatability and reproducibility.

16. Keywords

16.1 autoclaved aerated concrete; concrete cover; corrosion protection; reinforced elements; service loading; shear strength; stairs; ultimate loading; weld point