Designation: C 796 – 97

Standard Test Method for Foaming Agents for Use in Producing Cellular Concrete Using Preformed Foam[1]

This standard is issued under the fixed designation C 796; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method furnishes a way of measuring, in the laboratory, the performance of a foaming chemical to be used in producing foam (air cells) for making cellular concrete.

1.2 This test method includes the following:

1.2.1 Manufacture of laboratory quantities of cellular concrete.

1.2.2 Determination of the air content of the freshly prepared cellular concrete and of the hardened concrete after handling in conventional machinery.

1.2.3 Determination of the following properties of the hardened concrete: compressive strength, tensile splitting strength, density, and water absorption. It may not be necessary to study all of the above properties in all cases, depending on the proposed use of the material.

1.3 The values stated in inch-pound units are to be regarded as the 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.*

1.5 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

C 88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate[2]

C 150 Specification for Portland Cement[2]

C 192 Practice for Making and Curing Concrete Test Specimens in the Laboratory[2]

C 495 Test Method for Compressive Strength of Lightweight Insulating Concrete[2]

C 496 Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens[2]

C 511 Specification for Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes[2]

C 869 Specification for Foaming Agents Used in Making Preformed Foam for Cellular Concrete[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *cellular concrete*—a lightweight product consisting of portland cement, cement-silica, cement-pozzolan, lime-pozzolan, or lime-silica pastes, or pastes containing blends of these ingredients and having a homogeneous void or cell structure, attained with gas-forming chemicals or foaming agents (for cellular concretes containing binder ingredients other than, or in addition to portland cement, autoclave curing is usually employed).[3] In cellular concrete the density control is achieved by substituting macroscopic air cells for all or part of the fine aggregate. Normal-weight coarse aggregate is usually not used but lightweight aggregates, both fine and coarse, are often utilized in cellular concrete.

3.2 *Symbols:*

D_{ex1} = experimental density of the concrete before pumping, lb/ft^3(kg/m^3)

D_{ex2} = experimental density of the concrete after pumping, lb/ft^3(kg/m^3)

D_{th} = theoretical density of the plastic mix based on absolute volume, lb/ft^3(kg/m ^{3})

D_d = design density of the text mixture, lb/ft^3(kg/m^3)

SGC = specific gravity of cement = 3.15

T = time required to overfill the container, min

T_1 = time required to generate 1 ft^3(1 m^3) of foam, min

V = volume of foam container, ft^3(m^3)

V_a = volume of air required in the test batch, ft^3(m^3)

V_c = volume of test specimen (cylinder), ft^3(m^3)

[1] This test method is under the jurisdiction of ASTM Committee C-9 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.23 on Chemical Admixtures.

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

[3] ACI Committee 116, "Cement and Concrete Terminology," American Concrete Institute, Publication SP-19, 1967, p. 144.

V_f = volume of foam in the test batch, $ft^3(m^3)$
V_w = volume of water absorbed by test specimen in 24 h, $ft^3(m^3)$
W_1 = net weight of foam in overfilled container before striking off, lb (kg)
W_2 = net weight of foam in container after striking off, lb (kg)
W_c = weight of cement in the test batch, lb (kg)
W_f = weight of foam in the test batch, lb (kg)
W_{TW} = total weight of water in the test batch, including weight of foam, lb (kg)
W_{uf} = density of foam, $lb/ft^3(kg/m^3)$
W_w = weight of water added to test batch at mixer, lb (kg)

4. Summary of Test Method

4.1 This test method includes the following:

4.1.1 Manufacture of laboratory quantities of cellular concrete.

4.1.2 Determination of the air content of freshly prepared cellular concrete and of hardened concrete after handling in conventional machinery.

4.1.3 Determination of the following properties of hardened concrete: compressive strength, tensile splitting strength, density, and water absorption. It may not be necessary to study all of the above properties in all cases, depending on the proposed use of the material.

5. Significance and Use

5.1 This test method is used to develop data for comparison or compliance with the requirements of Specification C 869.

6. Apparatus

6.1 *Mixer*—The mixer shall be a power-driven paddle-type mixer with a capacity of at least 4 $ft^3(0.12\ m^3)$, an operating speed of 40 to 45 r/min (0.24 to 0.27 kHz), and equipped with rubber wiper blades.

6.2 *Foam Generator*—The foam generator shall be a laboratory-sized generator approved by the manufacturer of the foam being used and shall be similar to the type used in the field.

6.3 *Pump*—The pump shall be an open or closed throat-type pump[4] and shall be run at 450 r/min (2.7 kHz). The pump shall be equipped with a 4.5-$ft^3(0.13\text{-}m^3)$" feed" reservoir and 50 ft (15 m) of open-end 1-in. (25-mm) inside diameter rubber hose on the pump discharge, the exit end of the hose being at the same height as the pump.

6.4 *Curing Cabinet*—The curing cabinet shall be as described in Specification C 511.

6.5 *Molds*—The cylindrical molds for compression test specimens shall be as described in the Apparatus section of Test Method C 495. The molds for all other test specimens shall conform to the cylinder molds in the Apparatus section of Method C 192.

6.6 *Strike-Off Plate for Molds*—A ¼-in. (6-mm) thick, flat steel plate at least 8 in. (200 mm) longer and 2 in. (50 mm) wider than the diameter of the mold.

6.7 *Scales*—Scales and weights shall be accurate to within 0.1 % of the weight of the material being measured.

6.8 *Compression Machines*—Compression testing machines used for compressive strength tests and tensile-splitting strength tests shall conform to the requirements of Test Methods C 495 and C 496, respectively.

6.9 *Drying Oven*—The drying oven shall be as described in Test Method C 88.

6.10 *Compressed Air*—A source of compressed air capable of maintaining pressures in the range of 60 to 100 psi (0.4 to 0.7 MPa) to ±1 psi (±0.007 MPa).

6.11 *Weighing Container for Concrete*— A machined-steel container of 0.5 $ft^3(0.014\ m^3)$ volume with a flat smooth rim.

6.12 *Strike-Off Plate for Weighing Container*—A ¼-in. (6-mm) thick, flat steel plate, at least 8 in. (200 mm) longer and 2 in. (50 mm) wider than the diameter of the rim of the weighing container.

6.13 *Stop Watch*—A stop watch graduated in seconds and minutes.

6.14 *Calipers*—Calipers to span 3, 6, and 12 in. (76, 152, and 305 mm).

6.15 *Foam Weighing Container*—A lightweight vessel of approximately 2 $ft^3(0.06\ m^3)$ capacity, with a smooth rim for striking off.

6.16 *Strike-Off Plate for Foam Weighing Container*—A ¼-in. (6-mm) thick, flat steel plate at least 8 in. (200 mm) longer and 2 in. (50 mm) wider than the diameter of the rim of the container.

6.17 *Small Tools*—Small tools such as a rubber-headed hammer and a trowel shall be provided.

7. Materials and Proportions

7.1 *Cement*—The cement used shall be Type I or Type III portland cement meeting the requirements of Specification C 150.

7.2 *Water-Cement Ratio*—The water requirement will vary with the type and source of cement. For the purpose of these tests, $w/c = 0.58$ for Type I cement and $w/c = 0.64$ for Type III cement shall be used. However, if a particular cement or foaming agent used with these values of w/c does not produce a satisfactory mix, a trial mix or mixes may be made using the cement and foaming agent in question. Pump the trial mix (see 8.7.1) and revise the w/c if D_{ex2}, the unit weight of the concrete after pumping, is more than 10 % different from the design unit weight of 40 $lb/ft^3(641\ kg/m^3)$.

7.3 *Batch Quantities*—The quantities of materials described in Table 1 shall be used in the test batch.

7.3.1 The foaming solution in the foam will be considered as part of the total mixing water. The quantities listed in Table

TABLE 1 Materials for the Test Batch

Type of Cement	Cement, lb (kg)	Total Water, lb (kg)	Foam, $ft^3(m^3)$
I	100.0 (45.36)	58.0 (26.31)	$156.62/(62.4 - W_{uf})\ (71.0/(1000 - W_{uf}))$
III	100.0 (45.36)	64.0 (29.03)	$160.37/(62.4 - W_{uf})\ (73.0/(1000 - W_{uf}))$

[4] The Moyno Type CDR, Frame 2JC4 or 2L4 pump, or equivalent, has been found satisfactory for this purpose.