Designation: C796/C796M – 19

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

This standard is issued under the fixed designation C796/C796M; 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 U.S. 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 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, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.4 If the required results obtained from another standard are not reported in the same system of units as used by this standard, it is permitted to convert those results using the conversion factors found in the SI Quick Reference Guide.

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.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

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:*[2]

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

C88/C88M Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

C150/C150M Specification for Portland Cement

C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory

C495/C495M Test Method for Compressive Strength of Lightweight Insulating Concrete

C496/C496M Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens

C511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes

C802 Practice for Conducting an Interlaboratory Test Program to Determine the Precision of Test Methods for Construction Materials

C869/C869M Specification for Foaming Agents Used in Making Preformed Foam for Cellular Concrete

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

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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.

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

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, kg/m^3 [lb/ft^3]
D_{ex2} = experimental density of the concrete after pumping, kg/m^3 [lb/ft^3]
D_{th} = theoretical density of the plastic mix based on absolute volume, kg/m^3 [lb/ft^3]
D_d = design density of the text mixture, kg/m^3 [lb/ft^3]
SGC = specific gravity of cement = 3.15
T = time required to overfill the container, min
T_1 = time required to generate 1 m^3 [1 ft^3] of foam, min
V = volume of foam container, m^3 [ft^3]
V_a = volume of air required in the test batch, m^3 [ft^3]
V_c = volume of test specimen (cylinder), m^3 [ft^3]
V_f = volume of foam in the test batch, m^3 [ft^3]
V_w = volume of water absorbed by test specimen in 24 h, m^3 [ft^3]
W_1 = net mass of foam in overfilled container before striking off, kg [lb]
W_2 = net mass of foam in container after striking off, kg [lb]
W_c = mass of cement in the test batch, kg [lb]
W_f = mass of foam in the test batch, kg [lb]
W_{TW} = total mass of water in the test batch, including weight of foam, kg [lb]
W_{uf} = density of foam, kg/m^3 [lb/ft^3]
W_w = mass of water added to test batch at mixer, kg [lb]

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 C869/C869M.

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

6. Apparatus

6.1 *Mixer*—The mixer shall be a power-driven paddle-type mixer with a capacity of at least 0.10 m^3 [4 ft^3], an operating speed of 4 to 5 rad/s [40 to 50 r/min], 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 and shall be run at 27 to 66 rad/s [260 to 630 r/min]. The pump shall be equipped with a 0.15-m^3 [4.5-ft^3] "feed" reservoir and 15 m [50 ft] of open-end 25-mm [1-in.] 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 C511.

6.5 *Molds*—The cylindrical molds for compression test specimens shall be as described in the Apparatus section of Test Method C495/C495M. The molds for all other test specimens shall conform to the cylinder molds in the Apparatus section of Practice C192/C192M.

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

6.7 *Scales*—Scales and mass 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 Method C39/C39M.

6.9 *Drying Oven*—The drying oven shall be as described in Test Method C88/C88M.

6.10 *Compressed Air*—A source of compressed air capable of maintaining pressures at a selected pressure in the range of 400 to 700 kPa [60 to 100 psi]. The pressure selected shall be held in a tolerance of ±35 kPa [±5 psi].

6.11 *Weighing Container for Concrete*— A machined-steel container of 0.015 m^3 [0.5 ft^3] volume with a flat smooth rim.

6.12 *Strike-Off Plate for Weighing Container*—A 6-mm [¼-in.] thick, flat steel plate, at least 200 mm [8 in.] longer and 50 mm [2 in.] 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 75, 150, and 300 mm [3, 6, and 12 in.].

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

6.16 *Strike-Off Plate for Foam Weighing Container*—A 6-mm [¼-in.] thick, flat steel plate at least 200 mm [8 in.] longer and 50 mm [2 in.] 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 C150/C150M.

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 a different water-cement ratio.

7.3 *Batch Quantities*—The cement quantity shall be sufficient to allow molding all the test specimens from one test batch. The mixture water-cement ratio determined from 7.2 shall be used to make the test batch.

7.3.1 The foaming solution in the foam shall be considered as part of the total mixing water. Foam volume shall be adjusted for the batch to produce a density after pumping of 640 ± 50 kg/m^3 [40 ± 3 lb/ft^3].

8. Procedure

8.1 Make an aqueous solution of the foaming agent in the dilution specified by the manufacturer. If the dilution is not specified, preliminary tests are necessary to determine the required dilution. A suggested starting point for such tests is 40 parts water to 1 part foaming agent, by volume.

8.2 Charge the foam generator with the amount of foaming solution suggested by the manufacturer of the generator.

8.3 Connect the generator with the source of compressed air, adjusting the pressure to that recommended by the manufacturer of the foaming agent being tested.

8.4 Using the stop watch, calibrate the generator as follows. Weigh the empty foam container and determine its volume. Overfill the container with foam, measuring the time required using a stop watch then weigh. Strike off the excess foam, holding the strike-off plate in a horizontal position (plane of the plate horizontal) and moving it across the top of the container with a sawing action. Again weigh. Calculate the time required per cubic metre [or cubic foot] of foam using the following equation:

$$T_1 = \frac{T\,W_2}{W_1\,V} \tag{1}$$

8.4.1 Calculate also the density of the foam as follows:

$$W_{uf} = \frac{W_2}{V} \tag{2}$$

8.4.2 Calculate the length of time required to generate the required volume of foam, $V_f\,T_1$, as follows:
SI Units:

$$V_fT_1 = \frac{1000\,V_aT_1}{1000 - W_{uf}} \tag{3}$$

Inch-Pound Units:

$$V_fT_1 = \frac{62.4\,V_aT_1}{62.4 - W_{uf}} \tag{4}$$

8.4.3 Calculate the mass, W_f, of the required volume of foam, $V_f\,W_{uf}$.

NOTE 1—The density of the foam will usually range from 30 to 65 kg/m^3 [2 to 4 lb/ft^3] depending on the foam chemical used. Adjust the density of foam, W_{uf}, to the manufacturer's recommendation if the foam generator is adjustable.

8.4.3.1 If Type I cement is used, weigh out 26.0 – W_f kg [58.0 – W_f lb] of water, W_w, and 45.0 kg [100.0 lb] of Type I cement.

8.4.3.2 If Type III cement is used, weigh out 29.0 – W_f kg [64.0 – W_f lb] of water, W_w, and 45.0 kg [100.0 lb] of Type III cement.

8.5 Wet the mixer with water and drain. Add the water, W_w, and start the mixer. Gradually add the cement (over a period of ½ min). With a trowel, break up any lumps of undispersed cement. Mix for 5 min.

8.6 While still mixing, add V_f m^3 [ft^3] of foam. The required foam time is V_fT_1. Mix for 2 min after all the foam has been added. Discharge the mixer into the pump feed reservoir. Immediately, proceed to 8.7.

8.7 *Weighing*—Fill a tared weighing container with a representative sample of the concrete in the reservoir. Before taking the sample, carefully mix the concrete in the reservoir to assure better uniformity without entrapping large air bubbles in the mix. Use a paddle of proper size to reach the bottom of the reservoir. Use a scoop to transfer the concrete to the container and tap the sides of the container briskly with the rubber hammer during the filling operation. Overfill the container and strike off the excess concrete, holding the strike-off plate in a horizontal position (plane of plate horizontal) and moving it across the top of the container with a sawing motion. Wipe the surface of the container free of spilled concrete with a cloth. Weigh the full container. Calculate the density of the concrete and record as the density before pumping (D_{ex1}).

8.7.1 Pump the batch of concrete through the 15-m [50-ft] hose, discharging it into a sampling basin. From the sampling basin, take a second density sample as in 8.7, weigh, and record as the density after pumping (D_{ex2}).

8.8 *Molding*—Immediately, fill the cylinder molds with concrete from the sampling basin. Tap the sides of the mold with the rubber hammer while the mold is being filled. The minimum number of specimens required is four cylinders, 75 by 150 mm [3 by 6 in.] and ten cylinders 150 by 300 mm [6 by 12 in.].

8.8.1 As soon as possible after casting, strike off the top surface of each specimen and cover the specimen with a plastic bag to prevent evaporation, without marring the surface.

8.9 *Removal from Molds and Curing*— Follow the applicable requirements of the Test Specimen section of Test Method C495/C495M with the following exception: continue air drying from day 25 to day 28 in place of oven drying the specimens. Do not oven dry specimens that are to be load-tested.