Designation: C 332 – 99

Standard Specification for Lightweight Aggregates for Insulating Concrete[1]

This standard is issued under the fixed designation C 332; 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 specification covers lightweight aggregates intended for use in concrete not exposed to the weather, in which the prime consideration is the thermal insulating property of the resulting concrete.

1.2 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.

1.3 With regard to sieve size and the size of aggregate as determined by the use of testing sieves, the values in inch-pound units are shown for the convenience of the user; however, the standard sieve designation shown in parentheses is the standard value as stated in Specification E 11.

1.3.1 With regard to other units of measure, the values stated in inch-pound units are to be regarded as standard.

1.4 The following precautionary caveat pertains only to the test method portion, Section 6, of the specification: *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.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 29/C 29M Test Method for Unit Weight and Voids in Aggregate[2]

C 136 Method for Sieve Analysis of Fine and Coarse Aggregates[2]

C 177 Test Method for Steady-State Heat-Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus[3]

D 75 Practice for Sampling Aggregates[4]

E 11 Specification for Wire-Cloth and Sieves for Testing Purposes[5]

3. Classification

3.1 Two general types of lightweight aggregate are covered by this specification as follows:

3.1.1 *Group I*—Aggregates prepared by expanding products such as perlite or vermiculite.

NOTE 1—These aggregates generally produce concrete weighing from 15 to 50 lb/ft^3 (240 to 800 kg/m^3), the thermal conductivity of which may be expected to range from 0.45 to 1.50 Btu·in/h·ft^2·°F (0.065 to 0.22 W/m·K).

3.1.2 *Group II*—Aggregates prepared by expanding, calcining, or sintering products such as blast-furnace slag, clay, diatomite, fly ash, shale, or slate; and aggregates prepared by processing natural materials, such as pumice, scoria, or tuff.

NOTE 2—These aggregates generally produce concrete weighing from 45 to 90 lb/ft^3 (720 to 1440 kg/m^3), the thermal conductivity of which may be expected to range from 1.05 to 3.00 BTU·in/h·ft^2· °F (0.15 to 0.43 W/m·K).

3.2 The aggregate shall be composed predominantly of lightweight cellular and granular inorganic material.

4. Physical Properties

4.1 *Insulating Properties*—The thermal insulating properties of concrete made from the lightweight aggregate under test shall conform to the following limits:

Maximum Average 28-Day Oven-Dry Unit Weight, lb/ft^3 (kg/m^3)	Maximum Average Thermal Conductivity, Btu·in/h·ft^2·°F (W/m·K)
50 (800)	1.50 (0.22)
90 (1440)	3.00 (0.43)

4.2 *Grading*—The grading shall conform to the requirements shown in Table 1.

4.2.1 *Uniformity of Grading*—To ensure reasonable uniformity in the gradation of successive shipments of lightweight aggregates, fineness modulus determination shall be made

[1] This specification is under the jurisdiction of ASTM Committee C-9 on Concrete and Concrete Aggregatesand is the direct responsibility of Subcommittee C09.21on Lightweight Aggregates.

Current edition approved Nov. 10, 1999. Published February 2000. Originally published as C 332 – 54 T. Last previous edition C 332 – 87 (1998).

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

[3] *Annual Book of ASTM Standards*, Vol 04.06.

[4] *Annual Book of ASTM Standards*, Vol 04.03.

[5] *Annual Book of ASTM Standards*, Vol 14.02.

TABLE 1 Grading Requirements for Lightweight Aggregates for Insulating Concrete

Size Designation	Weight Percent Passing Sieves								
	19.0-mm (¾-in.)	12.5-mm (½-in.)	9.5-mm (⅜-in.)	4.75-mm (No. 4)	2.36-mm (No. 8)	1.18-mm (No. 16)	600-µm (No. 30)	300-µm (No. 50)	150-µm (No. 100)
Group I									
Perlite	...	...	...	100	85 to 100	40 to 85	20 to 60	5 to 25	0 to 10
Vermiculite[A] (Coarse)	...	...	100	98 to 100	60 to 100	30 to 85	2 to 45	1 to 20	0 to 10
Vermiculite (Fine)	...	...	...	...	100	85 to 100	35 to 85	2 to 40	0 to 10
Group II									
Fine aggregate: 4.75-mm (No. 4) to 0	...	...	100	85 to 100	...	40 to 80	...	10 to 35	5 to 25
Coarse Aggregate: 12.5 to 4.75-mm (½-in. to No. 4)	100	90 to 100	40 to 80	0 to 20	0 to 10	...	...	...	...
9.5 to 2.36-mm (⅜-in. to No. 8)	...	100	80 to 100	5 to 40	0 to 20	...	...	...	...
4.75 to 2.36-mm (No. 4 to No. 8)	...	...	100	90 to 100	0 to 20	...	...	...	...
Combined Fine and Coarse Aggregate:									
12.5-mm (½-in.) to 0	100	95 to 100	...	50 to 80	...	...	...	5 to 20	2 to 15
9.5-mm (⅜-in.) to 0	...	90 to 100	65 to 90	35 to 65	...	...	10 to 25	5 to 15	
	100								

[A] Attention is directed to the need for adjustment in water content and air entrainment to achieve comparable oven-dry unit weights for the two gradings.

periodically. If the fineness modulus of the aggregate differs by more than 7 % from that of the sample submitted for acceptance, the aggregate is subject to rejection, unless the supplier demonstrates that it will produce concrete of the required characteristics.

4.3 *Unit Weight*—The unit weight of lightweight aggregates shall conform to the requirements shown in Table 2.

4.3.1 *Uniformity of Unit Weight*—The weight of successive shipments of lightweight aggregates shall not differ by more than 10 % from that of the sample submitted for acceptance.

5. Sampling and Testing for Aggregate Properties

5.1 Sample lightweight aggregates and determine the properties enumerated in this specification in accordance with the following methods:

5.1.1 *Sampling*—Practice D 75, except sample bagged materials by riffling and then quartering.

5.1.2 *Grading*—Method C 136, except that when a mechanical sieving device is used, the sieving time shall be 5 min and the following modification shall apply:

5.1.2.1 *Fine aggregate*—The weight of the test sample shall be in accordance with the following table:

TABLE 2 Unit Weight Requirement for Lightweight Aggregates of Insulating Concrete

Size Designation	Dry Loose Weight lb/ft³ (kg/m³)	
	Min	Max
Group I:		
Perlite	7.5 (120)	12 (196)
Vermiculite	5.5 (88)	10 (160)
Group II:		
Fine aggregate	...	70 (1120)
Coarse aggregate	...	55 (880)
Combined fine and coarse aggregate	...	65 (1040)

Nominal Weight lb/ft³ (kg/m³)	Weight of Test Sample, g
5 to 15 (80 to 240)	50
15 to 25 (240 to 400)	100
25 to 35 (400 to 560)	150
35 to 45 (560 to 720)	200
45 to 55 (720 to 880)	250
55 to 65 (880 to 1040)	300
65 to 70 (1040 to 1120)	350

5.1.2.2 *Coarse Aggregate*—The sample shall be not less than 0.1 ft³ (2830 cm³) of the material obtained in making the unit weight determination.

5.1.3 *Unit Weight (Loose)*—Test Method C 29/C 29M utilizing the shoveling procedure described in Test Method C 29/C 29M, except test the aggregate in an oven-dry condition.

5.1.4 *Fineness Modulus*—Calculate as described in Test Method C 136.

6. Test Methods for Insulating Concrete Properties

6.1 Determine the unit weight and thermal conductivity of the concrete in accordance with the following methods:

6.1.1 *Specimen Preparation*—Prepare three specimens for each type of test, applying the same composition and fabrication procedure as is proposed for use. Moist-cure the specimens for 7 days and then remove them from the moist room and store at a temperature of 73.4 ± 3°F (23 ± 1.7°C) and at a relative humidity of 50 ± 5 % until the time of test. Dry the specimens at the age of 28 days in an oven at 230 ± 18°F (110 ± 10°C) and weigh them at 24-h intervals until the loss in weight does not exceed 1 % in a 24-h period.

6.1.2 *Unit Weight*—Determine the unit weight from specimens each of which has a volume of not less than 0.1 ft³ (2 L). Determine the weight and dimensions of the oven-dry specimens and compute the volume and the weight per cubic foot (or cubic metre) from the average data obtained.

6.1.3 *Thermal Conductivity*—Determine the thermal conductivity in accordance with Test Method C 177, except prepare and cure the specimens in accordance with 6.1.1. The dimensions of the specimens shall be as required for the testing equipment available. Report the details of the composition and fabrication procedure used in preparing the specimens.

7. Rejection and Rehearing

7.1 Material that fails to conform to the requirements of this specification is subject to rejection. Rejection shall be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the result of the test, the producer or supplier shall make claim for a rehearing.

7.2 The purchaser of materials covered by this specification shall have the option of evaluating these materials for rejection by either minimum weight or approximate volume as stated.

7.3 Individual packages are subject to rejection when:

7.3.1 The contents, on a weight basis, are 5 % less than that indicated on the package, or

7.3.2 The contents, on a volume basis, are 10 % less than that indicated on the package.

7.4 The entire shipment is subject to rejection.

7.4.1 On a weight basis when the average contents of two packages for each 100, but not less than 6 packages selected at random, in any one shipment, are less than that indicated on the package.

7.4.2 On a volume basis when the average contents of two packages for each 100, but not less than 6 packages selected at random, in any one shipment differ by more than 5 % from that indicated on the package.

7.5 The net weight of the contents shall be determined by weighing the package or packages and deducting the weight of the container.

7.6 The volume of the contents in the package shall be calculated by determining the weight of the contents of the package and then obtaining the weight per cubic foot (or cubic metre) of the aggregate, from an average weight package of the samples selected in 7.4.2, by the procedure given in Test Method C 29/C 29M and then dividing the weight of the contents of the bag by the weight per cubic foot (or cubic metre) of aggregate.

8. Certification

8.1 When specified in the purchase order or contract, a producer's or supplier's certification shall be furnished to the purchaser that the material was manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

9. Packaging and Package Marking

9.1 When lightweight aggregates covered by this specification are delivered in packages, the name of the manufacturer, type of aggregate, and minimum weight and approximate volume of the contents shall be plainly indicated thereon.

10. Keywords

10.1 insulating concrete; lightweight aggregate; thermal properties