



Designation: C332 – 23

Standard Specification for Lightweight Aggregates for Insulating Concrete¹

This standard is issued under the fixed designation C332; 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 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 E11.

1.3.1 With regard to other units of measure, the values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 The following precautionary caveat pertains only to the test method portion, Section 7, 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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.*

¹ This specification is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.21 on Lightweight Aggregates and Concrete.

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2. Referenced Documents

2.1 ASTM Standards:²

- C29/C29M Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate
- C125 Terminology Relating to Concrete and Concrete Aggregates
- C136/C136M Test Method for Sieve Analysis of Fine and Coarse Aggregates
- C177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
- D75/D75M Practice for Sampling Aggregates
- E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

3. Terminology

3.1 Definitions:

- 3.1.1 For definitions of terms used in this specification, refer to Terminology C125.

4. Classification

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

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

NOTE 1—These aggregates generally produce concrete having a density from 15 lb/ft³ to 50 lb/ft³ (240 kg/m³ to 800 kg/m³), the thermal conductivity of which may be expected to range from 0.45 Btu·in/h·ft² to 1.50 Btu·in/h·ft² · °F (0.065 W/m·K to 0.22 W/m·K).

4.1.2 *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 having a density from 45 lb/ft³ to 90 lb/ft³ (720 kg/m³ to 1440 kg/m³), the thermal conductivity of which may be expected to range from 1.05 BTU·in/h·ft² · °F to 3.00 BTU·in/h·ft² · °F (0.15 W/m·K to 0.43 W/m·K).

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

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

5. Physical Properties

5.1 *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 Bulk Density, 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)

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

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

5.3 *Loose Bulk Density (Test Method C29/C29M)*—The dry loose bulk density of lightweight aggregates shall conform to the requirements shown in Table 2.

5.3.1 *Uniformity of Loose Bulk Density*—The dry loose bulk density of successive shipments of lightweight aggregates shall not differ by more than 10 % from that of the sample submitted for acceptance.

6. Sampling and Testing for Aggregate Properties

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

6.1.1 *Sampling*—Practice D75/D75M, except sample bagged materials by riffing and then quartering.

TABLE 2 Bulk Density Requirement for Lightweight Aggregates of Insulating Concrete

Size Designation	Dry Loose Bulk Density lb/ft ³ (kg/m ³)	
	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)

6.1.2 *Grading*—Method C136/C136M, except that when a mechanical sieving device is used, the sieving time shall be 5 min ± 0.1 min and the following modification shall apply:

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

Nominal Density lb/ft ³ (kg/m ³)	Mass 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

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

6.1.3 *Loose Bulk Density*—Test Method C29/C29M utilizing the shoveling procedure described in Test Method C29/C29M, except test the aggregate in an oven-dry condition.

6.1.4 *Fineness Modulus*—Calculate as described in Test Method C136/C136M.

TABLE 1 Grading Requirements for Lightweight Aggregates for Insulating Concrete

Nominal Size Designation	Percentages (Mass) Passing Sieves Having Square Openings								
	19.0-mm (¾-in.)	12.5-mm (½-in.)	9.5-mm (¾-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:	...	...	100	85 to 100	...	40 to 80	...	10 to 35	5 to 25
4.75-mm (No. 4) to 0									
Coarse Aggregate:	100	90 to 100	40 to 80	0 to 20	0 to 10	...	...	...	...
12.5 to 4.75-mm (½-in. to No. 4)									
9.5 to 2.36-mm (¾-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 (¾-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.

7. Test Methods for Insulating Concrete Properties

7.1 Determine the density and thermal conductivity of the concrete in accordance with the following methods:

7.1.1 *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 $73.4\text{ }^{\circ}\text{F} \pm 3\text{ }^{\circ}\text{F}$ ($23\text{ }^{\circ}\text{C} \pm 1.7\text{ }^{\circ}\text{C}$) and at a relative humidity of $50\% \pm 5\%$ until the time of test. Dry the specimens at the age of 28 days in an oven at $230\text{ }^{\circ}\text{F} \pm 18\text{ }^{\circ}\text{F}$ ($110\text{ }^{\circ}\text{C} \pm 10\text{ }^{\circ}\text{C}$) and weigh them at 24-h intervals until the loss in mass does not exceed 1 % in a 24-h period.

7.1.2 *Concrete Density*—Determine the density from specimens each of which has a volume of not less than 0.1 ft^3 (2 L). Determine the mass and dimensions of the oven-dry specimens and compute the volume and the density from the average data obtained.

7.1.3 *Thermal Conductivity*—Determine the thermal conductivity in accordance with Test Method **C177**, except prepare and cure the specimens in accordance with 7.1.1. 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.

8. Rejection and Rehearing

8.1 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.

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

8.3 Individual packages are subject to rejection when:

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

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

8.4 The entire shipment is subject to rejection.

8.4.1 On a mass 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.

8.4.2 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.

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

8.6 The bulk volume of the contents in a package shall be calculated by determining the mass of the contents of the package and dividing by the bulk density of the aggregate. The bulk density of the aggregate shall be determined in accordance with the shoveling procedure given in Test Method **C29/C29M** using material from one or more of the packages selected in 8.4.2.

9. Certification

9.1 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.

10. Packaging and Package Marking

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

11. Keywords

11.1 insulating concrete; lightweight aggregate; thermal properties

SUMMARY OF CHANGES

Committee C09 has identified the location of selected changes to this specification since the last issue, C332 – 17, that may impact the use of this specification. (Approved June 1, 2023.)

(1) Added time tolerance to 6.1.2.