



Designation: ~~C330/C330M—09~~ C330/C330M – 13

Standard Specification for Lightweight Aggregates for Structural Concrete¹

This standard is issued under the fixed designation C330/C330M; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope*

1.1 This specification covers lightweight aggregates intended for use in structural concrete in which prime considerations are reducing the density while maintaining the compressive strength of the concrete. Procedures covered in this specification are not intended for job control of concrete.

1.2 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, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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

1.3 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.

NOTE 1—This specification is regarded as adequate to ensure satisfactory lightweight aggregates for most concrete. It is recognized that it may be either more or less restrictive than needed for some conditions and for special purposes, such as fire resistance, fill, and concrete constructions, the use of which is based on load tests rather than conventional design procedures.

2. Referenced Documents

2.1 ASTM Standards:²

~~C29/C29M~~ Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate

~~C31/C31M~~ Practice for Making and Curing Concrete Test Specimens in the Field

~~C33~~ Specification for Concrete Aggregates

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

~~C40~~ Test Method for Organic Impurities in Fine Aggregates for Concrete

~~C114~~ Test Methods for Chemical Analysis of Hydraulic Cement

~~C127~~ Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate

~~C128~~ Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate

~~C136~~ Test Method for Sieve Analysis of Fine and Coarse Aggregates

~~C142~~ Test Method for Clay Lumps and Friable Particles in Aggregates

~~C151~~ Test Method for Autoclave Expansion of Hydraulic Cement

~~C157/C157M~~ Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete

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

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

~~C567~~ Test Method for Determining Density of Structural Lightweight Concrete

~~C641~~ Test Method for Iron Staining Materials in Lightweight Concrete Aggregates

~~C666/C666M~~ Test Method for Resistance of Concrete to Rapid Freezing and Thawing

~~C702~~ Practice for Reducing Samples of Aggregate to Testing Size

~~D75~~ Practice for Sampling Aggregates

2.2 ACI Standards:

~~ACI 211.2~~ Standard Practices for Selecting Proportions for Structural Lightweight Concrete³

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 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

3. Aggregate Types

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

3.1.1 Aggregates prepared by expanding, pelletizing, or sintering products such as blast-furnace slag, clay, diatomite, fly ash, shale, or slate, and

3.1.2 Aggregates prepared by processing natural materials, such as pumice, scoria, or tuff.

3.2 The aggregates shall be composed predominately of lightweight-cellular and granular inorganic material.

4. Chemical Composition

4.1 Lightweight aggregates shall not contain excessive amounts of deleterious substances, as determined by the following limits:

4.1.1 *Organic Impurities (Test Method C40)*—Lightweight aggregates that, upon being subjected to test for organic impurities, produce a color darker than the standard shall be rejected, unless it is demonstrated that the discoloration is due to small quantities of materials not harmful to the concrete.

4.1.2 *Staining (Test Method C641)*—An aggregate producing a stain index of 60 or higher shall be rejected when the deposited stain is found upon chemical analysis to contain an iron content, expressed as Fe₂O₃ equal to or greater than 1.5 mg/200 g of sample.

4.1.3 *Loss on Ignition (Test Methods C114)*—The loss on ignition of lightweight aggregates shall not exceed 5 %.

NOTE 2—Some aggregates may contain carbonates or water of hydration that contribute to loss on ignition but may not affect the quality of the product. Therefore, when evaluating an aggregate, consideration should be given to the material characteristics that cause the ignition loss.

5. Physical Properties

5.1 Lightweight aggregate under test shall meet the following requirements:

5.1.1 *Clay Lumps and Friable Particles*—The total amount of clay lumps and friable particles shall not exceed 2 % by dry mass.

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

NOTE 3—The surfaces of pyro-processed lightweight aggregate particles finer than 75 μm (No. 200) sieves are not deleterious and may be moderately pozzolanic.

5.1.3 *Uniformity of Grading*—To ensure reasonable uniformity in the grading of successive shipments of lightweight aggregate, fineness modulus shall be determined on samples taken from shipments at intervals stipulated by the purchaser. If the fineness modulus of the aggregate in any shipment differs by more than 7 % from that of the sample submitted for acceptance tests, the aggregate in the shipment shall be rejected, unless the supplier demonstrates that it will produce concrete of the required characteristics.

5.1.4 *Loose Bulk Density (Test Method C29/C29M)*—The dry loose bulk density of lightweight aggregates shall conform to the requirements shown in **Table 2** using a 14 L [$\frac{1}{2}$ cubic foot] measure.

5.1.5 *Uniformity of Loose Bulk Density*—The dry loose bulk density of lightweight aggregate shipments sampled and tested, shall not differ by more than 10 % from that of the sample submitted for acceptance tests, and shall not exceed the limits in **Table 2**.

5.1.6 *Density Factor*—When specified, the density factor shall be determined in accordance with **8.10**.

5.2 Concrete specimens containing lightweight aggregate under test shall meet the following requirements:

5.2.1 *Compressive Strength (Test Method C39/C39M), Density (Test Method C567), and Splitting Tensile Strength (Test Method C496/C496M)*—Compressive strength and density shall be an average of three specimens and the splitting tensile strength shall be the average of eight specimens. It shall be possible to produce structural concrete using the lightweight aggregates under test, so that from the same batch of concrete one or more of the compressive strength requirements and splitting tensile strength requirements in **Table 3** will be satisfied without exceeding the corresponding maximum density values.

TABLE 1 Grading Requirements for Lightweight Aggregate for Structural Concrete

Nominal Size Designation	Percentages (Mass) Passing Sieves Having Square Openings									
	25.0 mm (1 in.)	19.0 mm ($\frac{3}{4}$ in.)	12.5 mm ($\frac{1}{2}$ in.)	9.5 mm ($\frac{3}{8}$ in.)	4.75 mm (No. 4)	2.36 mm (No. 8)	1.18 mm (No. 16)	300 μm (No. 50)	150 μm (No. 100)	75 μm (No. 200)
Fine aggregate:										
4.75 mm to 0	...	...	...	100	85–100	...	40–80	10–35	5–25	...
Coarse aggregate:										
25.0 mm to 4.75 mm	95–100	...	25–60	...	0–10	...	...	...	...	0–10
19.0 mm to 4.75 mm	100	90–100	...	10–50	0–15	...	...	...	...	0–10
12.5 mm to 4.75 mm	...	100	90–100	40–80	0–20	0–10	...	...	...	0–10
9.5 mm to 2.36 mm	...	...	100	80–100	5–40	0–20	0–10	...	...	0–10
Combined fine and coarse aggregate:										
12.5 mm to 0	...	100	95–100	...	50–80	...	...	5–20	2–15	0–10
9.5 mm to 0	...	...	100	90–100	65–90	35–65	...	10–25	5–15	0–10

**TABLE 2 Maximum Dry Loose Bulk Density Requirements of Lightweight Aggregates for Structural Concrete**

Size Designation	Maximum Dry Loose Bulk Density kg/m ³ [lb/ft ³]
Fine aggregate	1120 [70]
Coarse aggregate	880 [55]
Combined fine and coarse aggregate	1040 [65]

TABLE 3 Compressive Strength and Splitting Tensile Strength Requirements

Calculated Equilibrium Density max, kg/m ³ [lb/ft ³]	Average 28-day Splitting Tensile Strength, min, MPa [psi]	Average 28-day Compressive Strength, min, MPa [psi]
All Lightweight Aggregate		
1760 [110]	2.2 [320]	28 [4000]
1680 [105]	2.1 [300]	21 [3000]
1600 [100]	2.0 [290]	17 [2500]
Combination of Normal Weight and Lightweight Aggregates		
1840 [115]	2.3 [330]	28 [4000]
1760 [110]	2.1 [310]	21 [3000]
1680 [105]	2.1 [300]	17 [2500]

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NOTE 4—Intermediate values for strength and corresponding density values shall be established by interpolation. Materials that do not meet the minimum average splitting tensile strength requirement may be used provided the design is modified to compensate for the lower value.

5.2.2 *Natural Aggregates*—Natural aggregates, when used to replace part, or all, of the lightweight-aggregates shall comply with the applicable requirements of Specification C33. The test report shall record the proportion of all ingredients and the characteristics of the natural aggregates to ensure compliance with these minimum requirements.

5.2.3 *Drying Shrinkage*—The drying shrinkage of concrete specimens prepared, cured, and tested in accordance with 8.4 shall not exceed 0.07 %.

5.2.4 *Popouts*—Concrete specimens prepared in accordance with 8.4 and 8.5, and tested in accordance with Test Method C151 shall show no surface popouts.

5.2.5 *Resistance to Freezing and Thawing*—When required, the aggregate supplier shall demonstrate by test or proven field performance that the lightweight aggregate when used in concrete, had the necessary resistance to freezing and thawing to perform satisfactorily in its intended use.

6. Sampling

6.1 Sample lightweight aggregates in accordance with Practice D75.

6.2 Reduce sample to test sizes in accordance with Practice C702.

7. Number of Tests

7.1 *Tests on Aggregates*—One representative sample is required for each test for organic impurities, staining, loss on ignition, grading, bulk density, and clay lumps.

7.2 *Tests on Concrete*—At least three specimens are required for each of the following tests of concrete: compressive strength, shrinkage, density, resistance to freezing and thawing, and presence of popout materials. At least eight concrete specimens are required for splitting tensile strength tests.

8. Test Methods

8.1 *Compressive Strength (Test Method C39/C39M)*—Make test specimens in accordance with Practice C192/C192M and Practice C31/C31M. Unless otherwise specified, cure specimens in accordance with Practice C192/C192M or Practice C31/C31M, until the time of test. When specified, an alternative curing method is allowed. The alternative method shall be in accordance with Practice C192/C192M or the standard curing procedure in Practice C31/C31M for the first 7 days, after which the specimens shall be removed from moist curing and stored at 23 ± 2 °C [73.5 ± 3.5 °F] with a relative humidity of 50 ± 5 % until the time of test.