



Designation: C330/C330M – 13

# Standard Specification for Lightweight Aggregates for Structural Concrete<sup>1</sup>

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 reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 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:*<sup>2</sup>

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

## 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.

<sup>1</sup> 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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<sup>2</sup> 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. 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  $Fe_2O_3$  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  $\mu m$  (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.

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

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

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.

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 %.

**TABLE 1 Grading Requirements for Lightweight Aggregate for Structural Concrete**

| Nominal Size Designation                            | Percentages (Mass) Passing Sieves Having Square Openings |                                 |                                 |                                |                    |                    |                     |                         |                          |                         |
|---|--|---------------------------------|---------------------------------|--------------------------------|--------------------|--------------------|---------------------|-------------------------|--------------------------|-------------------------|
|   | 25.0 mm<br>(1 in.)                                       | 19.0 mm<br>( $\frac{3}{4}$ in.) | 12.5 mm<br>( $\frac{1}{2}$ in.) | 9.5 mm<br>( $\frac{3}{8}$ in.) | 4.75 mm<br>(No. 4) | 2.36 mm<br>(No. 8) | 1.18 mm<br>(No. 16) | 300 $\mu m$<br>(No. 50) | 150 $\mu m$<br>(No. 100) | 75 $\mu m$<br>(No. 200) |
| Fine aggregate:<br>4.75 mm to 0                     | ...  | ...                             | ...                             | 100                            | 85–100             | ...                | 40–80               | 10–35                   | 5–25                     | ...                     |
| Coarse aggregate:<br>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:<br>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                    |