Designation: C 330 – 00

Standard Specification for Lightweight Aggregates for Structural Concrete[1]

This standard is issued under the fixed designation C 330; 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 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 SI units are to be regarded as the standard. The values shown in parentheses are for information purposes only.

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:*

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

C 31/C 31M Practice for Making and Curing Concrete Test Specimens in the Field[2]

C 33 Specification for Concrete Aggregates[2]

C 39/C 39M Test Method for Compressive Strength of Cylindrical Concrete Specimens[2]

C 40 Test Method for Organic Impurities in Fine Aggregates for Concrete[2]

C 114 Test Methods for Chemical Analysis of Hydraulic Cement[3]

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

C 142 Test Method for Clay Lumps and Friable Particles in Aggregates[2]

C 151 Test Method for Autoclave Expansion of Portland Cement[3]

C 157/C 157M Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete [2]

C 192/C 192M Practice for Making and Curing Concrete Test Specimens in the Laboratory[2]

C 496 Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens[2]

C 567 Test Method for Unit Weight of Structural Lightweight Concrete[2]

C 641 Test Method for Staining Materials in Lightweight Concrete Aggregates[2]

C 666 Test Method for Resistance of Concrete to Rapid Freezing and Thawing[2]

C 702 Practice for Reducing Samples of Aggregate to Testing Size [2]

D 75 Practice for Sampling Aggregates[4]

2.2 *ACI Standards:*

ACI 211.2 Standard Practices for Selecting Proportions for Structural Lightweight Concrete [5]

3. General Characteristics

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 C 40)*—Lightweight aggregates that, upon being subjected to test for organic

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

[3] *Annual Book of ASTM Standards,* Vol 04.01.

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

[5] Available from American Concrete Institute, PO Box 9094, Farmington Hills, MI 48333.

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 C 641)*—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 (Methods C 114)*—The loss on ignition of lightweight aggregates shall not exceed 5 %.

NOTE 2—Certain processed aggregates may be hydraulic in character, and may be partially hydrated during production; if so, the quality of the product is not usually reduced thereby. Therefore, consideration should be given to the type of material when evaluating the product in terms of ignition loss.

5. Physical Properties

5.1 Lightweight aggregate under test shall meet the following requirements:

5.1.1 *Clay Lumps*—The amount of clay lumps shall not exceed 2 % by dry weight.

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

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 *Bulk Density (Loose)*—The bulk density (loose) of the lightweight aggregates shall conform to the requirements shown in Table 2.

5.1.5 *Uniformity of Bulk Density (Loose)*—The reported bulk density (loose) of lightweight aggregate shipments, sampled and tested, shall not differ by more than 10 % from that of the sample submitted for acceptance tests, but the dry loose bulk density 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 C 39/C 39M), Density (Test Method C 567), and Splitting Tensile Strength (Test Method C 496)* —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 the following table will be satisfied without exceeding the corresponding maximum unit weight values.

Average Air Dry 28-day Density max, kg/m³ (lb/ft³)	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)
	Sand/Lightweight Aggregate	
1840 (115)	2.3 (330)	28 (4000)
1760 (110)	2.1 (310)	21 (3000)
1680 (105)	2.1 (300)	17 (2500)

NOTE 3—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 Sand*— Natural sand, when used to replace part, or all, of the lightweight-aggregate fines shall comply with the applicable requirements of Specification C 330. The test report shall record the proportion of all ingredients and the characteristics of the natural sand to ensure compliance with these minimum requirements.

5.2.3 *Drying Shrinkage*— The drying shrinkage of concrete specimens prepared and tested as described in the method for preparation of samples for shrinkage of concrete shall not exceed 0.07 %.

5.2.4 *Popouts*—Concrete specimens prepared as described in the method for preparation of sample for shrinkage of

TABLE 1 Grading Requirements for Lightweight Aggregates for Structural Concrete

Size Designation	Percentages (Mass) Passing Sieves Having Square Openings								
	25.0 mm (1 in.)	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)	300 µm (No. 50)	150 µm (No. 100)
Fine aggregate:									
4.75 mm to 0	...	...	...	100	85–100	...	40–80	10–35	5–25
Coarse aggregate:									
25.0 m to 4.75 mm	95–100	...	25–60	...	0–10	...	...	...	...
19.0 mm to 4.75 mm	100	90–100	...	10–50	0–15	...	...	...	...
12.5 mm to 4.75 mm	...	100	90–100	40–80	0–20	0–10	...	...	...
9.5 mm to 2.36 mm	...	...	100	80–100	5–40	0–20	0–10	...	...
Combined fine and coarse aggregate:									
12.5 mm to 0	...	100	95–100	...	50–80	...	...	5–20	2–15
9.5 mm to 0	...	...	100	90–100	65–90	35–65	...	10–25	5–15

TABLE 2 Bulk Density (Loose) Requirements of Lightweight Aggregates for Structural Concrete

Size Designation	Maximum Dry Loose Bulk Density kg/m³ (lb/ft³)
Fine aggregate	1120 (70)
Coarse aggregate	880 (55)
Combined fine and coarse aggregate	1040 (65)