Designation: C330/C330M – 17a

Standard Specification for Lightweight Aggregates for Structural Concrete[1]

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 (ε) 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.

1.4 *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.*

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/C33M Specification for Concrete Aggregates
C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens
C40/C40M Test Method for Organic Impurities in Fine Aggregates for Concrete
C114 Test Methods for Chemical Analysis of Hydraulic Cement
C125 Terminology Relating to Concrete and Concrete Aggregates
C127 Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
C128 Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate
C136/C136M Test Method for Sieve Analysis of Fine and Coarse Aggregates
C142/C142M Test Method for Clay Lumps and Friable Particles in Aggregates
C151/C151M 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/C567M 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/C702M Practice for Reducing Samples of Aggregate to Testing Size
D75/D75M Practice for Sampling Aggregates

3. Terminology

3.1 *Definitions:*

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

[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.

Current edition approved June 15, 2017. Published July 2017. Originally approved in 1953. Last previous edition approved in 2017 as C330/C330M–17. DOI: 10.1520/C0330_C0330M-17A.

[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. Aggregate Types

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

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

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

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

5. Chemical Composition

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

5.1.1 *Organic Impurities (Test Method C40/C40M)*—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.

5.1.2 *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.

5.1.3 *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.

6. Physical Properties

6.1 Lightweight aggregate under test shall meet the following requirements:

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

6.1.2 *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.

6.1.3 *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.

6.1.4 *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 [½ cubic foot] measure.

6.1.5 *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.

6.1.6 *Relative Density*—When specified, the relative density shall be determined in accordance with 9.10.

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

6.2.1 *Compressive Strength (Test Method C39/C39M), Density (Test Method C567/C567M), 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.

6.2.2 *Natural Aggregates*— Natural aggregates, when used to replace part, or all, of the lightweight-aggregates shall comply with the applicable requirements of Specification C33/C33M. The test report shall record the proportion of all ingredients and the characteristics of the natural aggregates to ensure compliance with these minimum requirements.

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 (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)	75 µm (No. 200)
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	...	...	...	...	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]

6.2.3 *Drying Shrinkage*— The drying shrinkage of concrete specimens prepared, cured, and tested in accordance with 9.4 shall not exceed 0.07 %.

6.2.4 *Popouts*—Concrete specimens prepared in accordance with 9.4 and 9.5, and tested in accordance with Test Method C151/C151M shall show no surface popouts.

6.2.5 *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.

7. Sampling

7.1 Sample lightweight aggregates in accordance with Practice D75/D75M.

7.2 Reduce sample to test sizes in accordance with Practice C702/C702M.

8. Number of Tests

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

8.2 *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.

9. Test Methods

9.1 *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.

9.2 *Splitting Tensile Strength*—Make 150 by 300 mm [6 by 12 in.] cylindrical test specimens in accordance with Practice C192/C192M, cure, and test in accordance with Test Method C496/C496M.

9.3 *Density of Concrete (Test Method C567/C567M)*—Follow the procedures in Test Method C567/C567M.

9.4 *Shrinkage of Concrete (Test Method C157/C157M)*—Follow the procedures of Test Method C157/C157M with the following exceptions:

9.4.1 Prepare the concrete mixture using 335 kg of cement/m^3 [564 lb/yd^3], admixture (if any), and with an air content of 6 ± 1 %. Adjust the water content so as to produce a slump of 50 to 100 mm [2 to 4 in.]. Thoroughly consolidate the concrete in steel molds not smaller than 50 by 50 mm [2 by 2 in.] nor larger than 100 by 100 mm [4 by 4 in.] in cross section, and long enough to provide a 250 mm [10 in.] gauge length. The surface of the concrete shall be steel troweled.

9.4.2 *Curing*—To prevent evaporation of water from the unhardened concrete, cover the specimen with a nonabsorptive, nonreactive plate or sheet of tough, durable, impervious plastic or wet burlap. When wet burlap is used for covering, the burlap must be kept wet until the specimens are removed from the molds (see Note 5). Remove specimens from the molds not less than 20 nor more than 48 h after casting and store in a moist room maintained at 23 ± 2 °C [73.5 ± 3.5 °F] with a relative humidity of not less than 95 %. At the age of 7 days, remove the specimens from the moist room, measure for length, and store in a curing cabinet maintained at 37.8 ± 1.1 °C [100 ± 2 °F] with a relative humidity of 32 ± 2 %.

NOTE 5—Placing a sheet of plastic over the burlap will facilitate keeping it wet.

NOTE 6—The air immediately above a saturated solution of magnesium chloride ($MgCl_2$) at 37.8 °C [100 °F] is approximately 32 % relative humidity.

9.4.3 *Report*—After storage in the cabinet for 28 days, remove each specimen and within 15 s, determine its change in length to the nearest 0.01 % of the effective gauge length. Report the change in length as the drying shrinkage of the specimen; report the average drying shrinkage of the specimens as the drying shrinkage of the concrete.

9.5 *Test for Popout Materials*—Prepare concrete specimens for the test for popout materials as described in method for preparation of samples for shrinkage of concrete. Cure and autoclave the specimens in accordance with Test Method C151/C151M. Visually inspect the autoclaved specimens for the number of popouts that have developed on the surface. Report the number of popouts per specimen.

9.6 *Test for Freezing and Thawing*— Make freezing and thawing tests of concrete, when required, in accordance with

Test Method C666/C666M, with the following modification to the section on Test Specimens and on Procedure. Unless otherwise specified, remove the lightweight aggregate concrete specimens from moist curing at an age of 14 days and allow to dry in air for another 14 days exposed to a relative humidity of 50 ± 5 % and a temperature of 23 ± 2 °C [73.5 ± 3.5 °F]. Then submerge the specimens in water for 24 hours, prior to the freezing and thawing test.

9.7 *Grading (Test Method C136/C136M)*—Follow the procedures of Test Method C136/C136M, except that the mass of the test sample for fine aggregate shall be in accordance with Table 4. The test sample for coarse aggregate shall consist of 2830 cm^3 [0.1 ft^3] or more of the material used for the determination of bulk density. Mechanical sieving of aggregate shall be for 5 minutes.

TABLE 4 Mass of Sieve Test Sample for Fine Lightweight Aggregates

Nominal Bulk Density (Loose) of Aggregate		Mass of Test Sample, g
kg/m^3	lb/ft^3	
80–240	5–15	50
240–400	15–25	100
400–560	25–35	150
560–720	35–45	200
720–880	45–55	250
880– 1040	55–65	300
1040–1120	65–70	350

9.8 *Bulk Density (Loose) (Test Method C29/C29M)*—The aggregate shall be tested in an oven dry condition utilizing the shoveling procedure.

9.9 *Clay Lumps and Friable Particles in Aggregate,* shall be in accordance with Test Method C142/C142M.

9.10 *Relative Density*—Determine the Relative Density ("Specific Gravity") in accordance with Test Methods C127 and C128.

10. Rejection

10.1 Material that fails to conform to the requirements of this specification shall be subject to rejection. The reason for rejection shall be reported to the producer or supplier promptly and in writing.

11. Certification

11.1 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 sampled and tested 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.

SUMMARY OF CHANGES

Committee C09 has identified the location of selected changes to this specification since the last issue, C330/C330M–17, that may impact the use of this specification. (Approved June 15, 2017.)

(1) Added terminology section.