Designation: C33/C33M – 24

# Standard Specification for Concrete Aggregates[1]

This standard is issued under the fixed designation C33/C33M; 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 defines the requirements for grading and quality of fine and coarse aggregate (other than lightweight or heavyweight aggregate) for use in concrete.[2]

1.2 This specification is for use by a contractor, concrete supplier, or other purchaser as part of the purchase document describing the material to be furnished.

NOTE 1—This specification is regarded as adequate to ensure satisfactory materials for most concrete. It is recognized that, for certain work or in certain regions, it may be either more or less restrictive than needed. For example, where aesthetics are important, more restrictive limits may be considered regarding impurities that would stain the concrete surface. The specifier should ascertain that aggregates specified are or can be made available in the area of the work, with regard to grading, physical, or chemical properties, or combination thereof.

1.3 This specification is also for use in project specifications to define the quality of aggregate, the nominal maximum size of the aggregate, and other specific grading requirements. Those responsible for selecting the proportions for the concrete mixture shall have the responsibility of determining the proportions of fine and coarse aggregate and the addition of blending aggregate sizes if required or approved.

1.4 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.

NOTE 2—Sieve size is identified by its standard designation in Specification E11. The alternative designation given in parentheses is for information only and does not represent a different standard sieve size.

1.5 The text of this standard refers to notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of this standard.

1.6 *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:*[3]

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

C40/C40M Test Method for Organic Impurities in Fine Aggregates for Concrete

C87/C87M Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar

C88/C88M Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

C117 Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing

C123/C123M Test Method for Lightweight Particles in Aggregate

C125 Terminology Relating to Concrete and Concrete Aggregates

C131/C131M Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

C136/C136M Test Method for Sieve Analysis of Fine and Coarse Aggregates

C142/C142M Test Method for Clay Lumps and Friable Particles in Aggregates

C294 Descriptive Nomenclature for Constituents of Concrete Aggregates

C295/C295M Guide for Petrographic Examination of Aggregates for Concrete

C330/C330M Specification for Lightweight Aggregates for Structural Concrete

C331/C331M Specification for Lightweight Aggregates for Concrete Masonry Units

C332 Specification for Lightweight Aggregates for Insulating Concrete

[1] This specification is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.20 on Aggregates.

Current edition approved Aug. 1, 2024. Published September 2024. Originally approved in 1921. Last previous edition approved in 2023 as C33/C33M – 23. DOI: 10.1520/C0033_C0033M-24.

[2] For lightweight aggregates, see Specifications C330/C330M, C331/C331M, and C332; for heavyweight aggregates see Specification C637 and Descriptive Nomenclature C638.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. 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**

C535 Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C637 Specification for Aggregates for Radiation-Shielding Concrete
C638 Descriptive Nomenclature of Constituents of Aggregates for Radiation-Shielding Concrete
C666/C666M Test Method for Resistance of Concrete to Rapid Freezing and Thawing (Withdrawn 2024)[4]
C1777 Test Method for Rapid Determination of the Methylene Blue Value for Fine Aggregate or Mineral Filler Using a Colorimeter
C1778 Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete
D75/D75M Practice for Sampling Aggregates
D422 Test Method for Particle-Size Analysis of Soils (Withdrawn 2016)[4]
D2419 Test Method for Sand Equivalent Value of Soils and Fine Aggregate
D3665 Practice for Random Sampling of Construction Materials
E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

2.2 *Other Standards:*

AASHTO T 330 Method of Test for the Qualitative Detection of Harmful Clays of the Smectite Group in Aggregates Using Methylene Blue[5]
ACI CODE-318 Building Code Requirements for Structural Concrete[6]
ACI CODE-332 Residential Code Requirements for Structural Concrete[6]

## 3. Terminology

3.1 For definitions of terms used in this standard, refer to Terminology C125.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *aggregate, recycled, n*—granular material that has been diverted, separated, or removed from the solid waste stream, and processed for use in the form of raw materials or products.

## 4. Ordering and Specifying Information

4.1 The direct purchaser of aggregates shall include the information in 4.2 in the purchase order as applicable. A project specifier shall include in the project documents information to describe the aggregate to be used in the project from the applicable items in 4.3.

4.2 Include in the purchase order for aggregates the following information, as applicable:

4.2.1 Reference to this specification, as Specification C33/C33M—XX, where XX is the current version,

4.2.2 Whether the order is for fine aggregate or for coarse aggregate,

4.2.3 Quantity, in metric tons or tons,

4.2.4 If the order is for fine aggregate:

4.2.4.1 Requirements for alkali-aggregate reactivity (see 7.3),

4.2.4.2 In the case of the sulfate soundness test (see 8.1) which salt is to be used. If none is stated, either sodium sulfate or magnesium sulfate shall be used,

4.2.4.3 The appropriate limit for material finer than 75-µm (No. 200) sieve (see Table 1). If not stated, the 3.0 % limit shall apply,

4.2.4.4 The appropriate limit for coal and lignite (see Table 2). If not stated, the 1.0 % limit shall apply,

4.2.5 If the order is for coarse aggregate:

4.2.5.1 The grading (size number) (see 10.1 and Table 3), or alternate grading as agreed between the purchaser and aggregate supplier.

4.2.5.2 The appropriate limit for material finer than 75 µm (No. 200) sieve (see Table 3). If not stated, the 1.0 % limit shall apply,

4.2.5.3 The class designation for type of concrete construction (see 12.1 and Table 4),

4.2.5.4 Requirements for alkali-aggregate reactivity (see 12.2),

4.2.5.5 In the case of the sulfate soundness test, which salt is to be used. If none is stated, either sodium sulfate or magnesium sulfate shall be used, and

4.2.6 Any exceptions or additions to this specification (see Note 1).

4.3 Include in project specifications for aggregates the following information, as applicable:

4.3.1 Reference to this specification, as Specification C33/C33M–XX, where XX is the current version.

4.3.2 When the aggregate being described is fine aggregate include:

4.3.2.1 Requirements for alkali-aggregate reactivity (see 7.3),

4.3.2.2 In the case of the sulfate soundness test (see 8.1) which salt is to be used. If none is stated, either sodium sulfate or magnesium sulfate shall be used.

**TABLE 1 Grading Requirements for Fine Aggregate**

| Sieve (Specification E11) | Percent Passing |
|---|---|
| 9.5-mm (⅜-in.) | 100 |
| 4.75-mm (No. 4) | 95 to 100 |
| 2.36-mm (No. 8) | 80 to 100 |
| 1.18-mm (No. 16) | 50 to 85 |
| 600-µm (No. 30) | 25 to 60 |
| 300-µm (No. 50) | 5 to 30 |
| 150-µm (No. 100) | 0 to 10 |
| 75-µm (No. 200) | 0 to 3.0[A,B] |

[A] For concrete not subject to abrasion, the limit for material finer than the 75-µm (No. 200) sieve shall be 5.0 % maximum.
[B] For manufactured fine or other recycled aggregate, if the material finer than the 75-µm (No. 200) sieve consists of the dust of fracture, essentially free of clay or shale, this limit shall be 5.0% for concrete subject to abrasion, and 7% maximum for concrete not subject to abrasion.

[4] The last approved version of this historical standard is referenced on www.astm.org.
[5] *AASHTO Standard Specifications, Part 2B: Tests.* Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.
[6] Available from American Concrete Institute, Farmington Hills, MI, www.concrete.org

**TABLE 2 Limits for Deleterious Substances in Fine Aggregate for Concrete**

| Item | Mass Percent of Total Sample, max |
|---|---|
| Clay lumps and friable particles | 3.0 |
| Coal and lignite: | |
| Where surface appearance of concrete is of importance | 0.5 |
| All other concrete | 1.0 |

4.3.2.3 The appropriate limit for material finer than the 75 µm (No. 200) sieve (see Table 1). If not stated, the 3.0 % limit shall apply, and

4.3.2.4 The limit that applies with regard to coal and lignite (Table 2). If not stated, the 1.0 % limit shall apply.

4.3.3 If the aggregate being described is coarse aggregate, include:

4.3.3.1 The nominal maximum size or sizes permitted, based on thickness of section or spacing of reinforcing bars or other criteria. In lieu of stating the nominal maximum size, the specifier shall designate an appropriate size number or numbers (see 10.1 and Table 3). Designation of a size number to indicate a nominal size shall not restrict the person responsible for selecting proportions from combining two or more gradings of aggregate to obtain a desired grading, provided that the gradings are not otherwise restricted by the project specifier and the nominal maximum size indicated by the size number is not exceeded,

4.3.3.2 The class designation for type of concrete construction (see 12.1 and Table 4),

4.3.3.3 Requirements for alkali-aggregate reactivity (see 12.2),

4.3.3.4 In the case of the sulfate soundness test (see 11.2), which salt is to be used. If none is stated, either sodium sulfate or magnesium sulfate shall be used, and

4.3.4 The person responsible for selecting the concrete proportions if other than the concrete producer.

4.3.5 Any exceptions or additions to this specification (see Note 1).

## FINE AGGREGATE

### 5. General Characteristics

5.1 Fine aggregate shall consist of natural sand, manufactured sand, or other recycled aggregate, or a combination thereof.

NOTE 3—This standard only addresses properties of aggregates considered necessary for use in concrete and the associated test methods contained within this standard. Certain recycled aggregate sources may contain materials and properties not addressed as part of the document specifications, limits, or test methods. Recycled aggregates may require evaluation for environmental considerations (air quality, water quality, storage) using the appropriate local, state, and federal test methods in effect at the time of use.

### 6. Grading

6.1 *Sieve Analysis*—Fine aggregate, except as provided in 6.2 and 6.3 shall be graded within the limits in Table 1.

NOTE 4—Concrete with fine aggregate gradings near the minimums for percent passing the 300 µm (No.50) and 150 µm (No.100) sometimes have difficulties with workability, pumping or excessive bleeding. The addition of entrained air, additional cement, or the addition of an approved supplementary cementitious material to supply the deficient fines, are methods used to alleviate such difficulties.

6.2 The fine aggregate shall have not more than 45 % passing any sieve and retained on the next consecutive sieve of those shown in 6.1, and its fineness modulus shall be not less than 2.3 nor more than 3.1.

6.3 Fine aggregate failing to meet these grading requirements shall meet the requirements of this section provided that the supplier can demonstrate to the purchaser or specifier that concrete of the class specified, made with fine aggregate under consideration, will have relevant properties (see Note 7) at least equal to those of concrete made with the same ingredients, with the exception that the reference fine aggregate shall be selected from a source having an acceptable performance record in similar concrete construction.

NOTE 5—Manufactured fine aggregate having elevated proportions of material passing the 75-µm (No. 200) sieve may need further evaluation to ensure that material passing the 75 µm (No. 200) sieve is essentially composed of dust of fracture derived from the parent rock in the crushing operation, and does not contain an appreciable level of clay minerals or other deleterious constituents as described in Descriptive Nomenclature C294. Because some of the dust of fracture may occur in the clay size range, defined here as material finer than 2 µm, care must be taken to properly differentiate these clay-sized materials from clay minerals. Natural fine aggregate with elevated proportions of material passing the 75 µm (No. 200) sieve may have higher potential for clay mineral content.

Various means are available for characterizing these fines, such as petrographic analysis (Guide C295/C295M), sand equivalent determination (Test Method D2419), hydrometer analysis (Test Method D422), methylene blue adsorption determination (AASHTO T 330, or Test Method C1777) and X-ray diffraction analysis. While these techniques are useful for investigative purposes, no specific limits have been established for prediction of performance of these materials in concrete under various intended service conditions. Methylene blue adsorption and hydrometer analyses are believed to be two relatively quick and reliable tests for characterization of material passing the 75 µm (No. 200) sieve to determine suitability for use in concrete. Research[7,8] has indicated that manufactured fine aggregate with less than 4 % by mass finer than 2 µm, and with methylene blue adsorption values less than 5 mg/g generally is suitable for use in concrete. Fine aggregate that exceeds these values also may be suitable for use provided that fresh and hardened concrete properties are shown to be acceptable.

NOTE 6—Fine aggregate that conforms to the grading requirements of a specification, prepared by another organization such as a state transportation agency, which is in general use in the area, should be considered as having a satisfactory service record with regard to those concrete properties affected by grading.

NOTE 7—Relevant properties are those properties of the concrete that are important to the particular application being considered. STP 169D[9] provides a discussion of important concrete properties.

6.4 For continuing shipments of fine aggregate from a given source, the fineness modulus shall not vary more than 0.20

[7] Ahn, N. and Fowler, D. W., "An Experimental Study on the Guidelines for Using Higher Contents of Aggregate Microfines in Portland Cement Concrete," ICAR Research Report 102-1F, International Center for Aggregates Research, University of Texas, Austin, TX, 2001, 435 pp. (http://www.icar.utexas.edu/publications/101_2F/101_2Cvr.pdf)

[8] Norvell, J.K., Stewart, J.G., Juenger, M.C.G and Fowler, D.W., "Influence of Clay and Clay-Sized Particles on Concrete Performance, "*Journal of Materials in Civil Engineering*, ASCE, Vol 19, No. 12, December 2007, pp. 1053–1059.

[9] *Significance of Tests and Properties of Concrete and Concrete Making Materials, STP 169D*, ed. Joseph Lamond and James Pielert, ASTM, 2006.