



Designation: C33/C33M-11 ~~Designation: C33/C33M - 11a~~

Standard Specification for Concrete Aggregates¹

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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

This standard has been approved for use by agencies of the Department of Defense.

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.

1.5 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 this standard.

2. Referenced Documents

2.1 ASTM Standards:³

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

C40 Test Method for Organic Impurities in Fine Aggregates for Concrete

C87 Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar [74ed/astm-c33-c33m-11a](#)

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

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

C123 Test Method for Lightweight Particles in Aggregate

C125 Terminology Relating to Concrete and Concrete Aggregates

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

C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates

C142 Test Method for Clay Lumps and Friable Particles in Aggregates

C150 Specification for Portland Cement

C227 Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)

C289 Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)

C294 Descriptive Nomenclature for Constituents of Concrete Aggregates

C295 Guide for Petrographic Examination of Aggregates for 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 Normal Weight Aggregates.

Current edition approved Jan-Aug. 1, 2011. Published February-September 2011. Originally approved in 1921. Last previous edition approved in 20082011 as C33/C33M-08, C33/C33M-11. DOI: 10.1520/C0033_C0033M-11a.

² For lightweight aggregates, see Specifications C330, C331, 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 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.

- C311 Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
 - C330 Specification for Lightweight Aggregates for Structural Concrete
 - C331 Specification for Lightweight Aggregates for Concrete Masonry Units
 - C332 Specification for Lightweight Aggregates for Insulating Concrete
 - C342 Test Method for Potential Volume Change of Cement-Aggregate Combinations
 - C441 Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
 - C535 Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
 - C586 Test Method for Potential Alkali Reactivity of Carbonate Rocks as Concrete Aggregates (Rock-Cylinder Method)
 - C595 Specification for Blended Hydraulic Cements
 - C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
 - 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
 - C989 Specification for Slag Cement for Use in Concrete and Mortars
 - C1105 Test Method for Length Change of Concrete Due to Alkali-Carbonate Rock Reaction
 - C1157 Performance Specification for Hydraulic Cement
 - C1240 Specification for Silica Fume Used in Cementitious Mixtures
 - C1260 Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
 - C1293 Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
 - C1567 Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
 - D75 Practice for Sampling Aggregates
 - D422 Test Method for Particle-Size Analysis of Soils
 - 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 Blue⁴

3. Terminology

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

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 C33____,
 - 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 When the order is for fine aggregate:
 - 4.2.4.1 Whether the restriction on reactive materials in 7.3 applies,
 - 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- μ m (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 1~~Table 2). If not stated, the 1.0 % limit shall apply,
 - 4.2.5 When the order is for coarse aggregate:
 - 4.2.5.1 The grading (size number) (see 10.1 and ~~Table 2~~Table 3), or alternate grading as agreed between the purchaser and aggregate supplier.
 - 4.2.5.2 The class designation (see 11.1 and ~~Table 3~~Table 4),

⁴ *Significance of Tests and Properties of Concrete and Concrete Making Materials, STP 169D*, ASTM, 2006; 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>.

**TABLE 1 Grading Requirements for Fine Aggregate**

Sieve (Specification E11)	Percent Passing
9.5-mm (3/8-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- μ m (No. 30)	25 to 60
300- μ m (No. 50)	5 to 30
150- μ m (No. 100)	0 to 10
75- μ m (No. 200)	0 to 3.0 ^{A,B}

^AFor concrete not subject to abrasion, the limit for material finer than the 75- μ m (No. 200) sieve shall be 5.0 % maximum.

^BFor manufactured fine aggregate, if the material finer than the 75- μ m (No. 200) sieve consists of dust of fracture, essentially free of clay or shale, this limit shall be 5.0 % maximum for concrete subject to abrasion, and 7.0 % maximum for concrete not subject to abrasion.

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
Material finer than 75-μm (No. 200) sieve:	
— Concrete subject to abrasion	3.0 ^A
— All other concrete	5.0 ^A
Coal and lignite:	
Where surface appearance of concrete is of importance	0.5
All other concrete	1.0

^AIn the case of manufactured sand, if the material finer than the 75- μ m (No. 200) sieve consists of the dust of fracture, essentially free of clay or shale, these limits are permitted to be increased to 5 and 7%, respectively.

4.2.5.3 Whether the restriction on reactive materials in 11.2 applies,

4.2.5.4 In the case of the sulfate soundness test (see Table 3 Table 4), 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 C33 <https://standards.iteh.ai/>

4.3.2 When the aggregate being described is fine aggregate:

4.3.2.1 Whether the restriction on reactive materials in 7.3 applies,

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.

4.3.2.3 The appropriate limit for material finer than the 75- μ m (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 1 Table 2). If not stated, the 1.0 % limit shall apply.

4.3.3 When 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 2 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 (see 11.1 and Table 3 Table 4),

4.3.3.3 Whether the restriction on reactive materials in 11.2 applies,

4.3.3.4 In the case of the sulfate soundness test (see Table 3 Table 4), 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 a combination thereof.

TABLE-2.3 Grading Requirements for Coarse Aggregates

Size Number	Nominal Size (Sieves with Square Openings)	Amounts Finer than Each Laboratory Sieve (Square-Openings), Mass Percent													
		100 mm (4 in.)	90 mm (3½ in.)	75 mm (3 in.)	63 mm (2½ in.)	50 mm (2 in.)	37.5 mm (1½ in.)	25.0 mm (1 in.)	19.0 mm (¾ in.)	12.5 mm (½ in.)	9.5 mm (¾ in.)	4.75 mm (No. 4)	2.36 mm (No. 8)	1.18 mm (No. 16)	300 µm (No. 50)
1	90 to 37.5 mm (3½ to 1½ in.)	100	90 to 100	...	25 to 60	...	0 to 15	...	0 to 5	...	...	...	...	...	...
2	63 to 37.5 mm (2½ to 1½ in.)	...	...	100	90 to 100	...	0 to 15	...	0 to 5	...	...	...	...	...	...
3	50 to 25.0 mm (2 to 1 in.)	...	...	...	100	90 to 100	35 to 70	0 to 15	...	0 to 5	...	...	...	...	...
357	50 to 4.75 mm (2 in. to No. 4)	...	...	...	100	95 to 100	35 to 70	...	...	...	0 to 5	...	...	...	...
4	37.5 to 19.0 mm (1½ to ¾ in.)	...	...	...	...	90 to 100	20 to 55	0 to 15	...	0 to 5	...	...	...	...	...
467	37.5 to 4.75 mm (1½ in. to No. 4)	...	...	...	...	100	...	35 to 70	...	10 to 30	0 to 5	...	...	...	...
5	25.0 to 12.5 mm (1 to ½ in.)	...	...	...	...	...	90 to 100	20 to 55	0 to 10	0 to 5	...	...	...	...	...
56	25.0 to 9.5 mm (1 to ¾ in.)	...	...	...	...	...	100	40 to 85	10 to 40	0 to 15	0 to 5	...	...	...	...
57	25.0 to 4.75 mm (1 in. to No. 4)	...	...	...	...	...	100	95 to 100	25 to 60	...	0 to 10	0 to 5	...	...	...
6	19.0 to 9.5 mm (¾ to ¾ in.)	...	...	...	...	...	...	90 to 100	20 to 55	0 to 15	0 to 5	...	...	...	...
67	19.0 to 4.75 mm (¾ in. to No. 4)	...	...	...	...	...	...	100	20 to 55	20 to 55	0 to 10	0 to 5	...	...	...
7	12.5 to 4.75 mm (½ in. to No. 4)	...	...	...	...	...	...	100	90 to 100	40 to 70	0 to 15	0 to 5	...	...	...
8	9.5 to 2.36 mm (¾ in. to No. 8)	...	...	...	...	...	...	...	100	85 to 100	10 to 30	0 to 10	0 to 5	...	...
89	9.5 to 1.18 mm (¾ in. to No. 16)	...	...	...	...	...	...	...	100	90 to 100	20 to 55	5 to 30	0 to 10	0 to 5	0 to 5
9 ^A	4.75 to 1.18 mm (No. 4 to No. 16)	...	...	...	...	...	...	...	...	100	85 to 100	10 to 40	0 to 10	0 to 5	0 to 5

^A Size number 9 aggregate is defined in Terminology C125 as a fine aggregate. It is included as a coarse aggregate when it is combined with a size number 8 material to create a size number 89, which is a coarse aggregate as defined by Terminology C125.



TABLE-3.4 Limits for Deleterious Substances and Physical Property Requirements of Coarse Aggregate for Concrete

NOTE 1—See Fig. 1 for the location of the weathering regions and Note-9-10 for guidance in using the map. The weathering regions are defined as follows:

- (S) Severe Weathering Region—A cold climate where concrete is exposed to deicing chemicals or other aggressive agents, or where concrete may become saturated by continued contact with moisture or free water prior to repeated freezing and thawing.
- (M) Moderate Weathering Region—A climate where occasional freezing is expected, but where concrete in outdoor service will not be continually exposed to freezing and thawing in the presence of moisture or to deicing chemicals.
- (N) Negligible Weathering Region—A climate where concrete is rarely exposed to freezing in the presence of moisture.

Class Designation	Type or Location of Concrete Construction	Clay Lumps and Friable Particles	Chert (Less Than 2.40 sp gr SSD)	Sum of Clay Lumps, Friable Particles, and Chert (Less Than 2.40 sp gr SSD)	Material Finer Than 75-µm (No. 200) Sieve	Coal and Lignite	Abrasion ^A	Magnesium Sulfate Soundness (5 cycles) ^B	Maximum Allowable, %
1S	Footings, foundations, columns and beams not exposed to the weather, interior floor slabs to be given coverings	10.0	...	...	1.0 ^C	1.0	50	...	
2S	Interior floors without coverings	5.0	...	...	1.0 ^C	0.5	50	...	
3S	Foundation walls above grade, retaining walls, abutments, piers, girders, and beams exposed to the weather	5.0	5.0	7.0	1.0 ^C	0.5	50	18	
4S	Pavements, bridge decks, driveways and curbs, walks, patios, garage floors, exposed floors and porches, or water-front structures, subject to frequent wetting	3.0	5.0	5.0	1.0 ^C	0.5	50	18	
5S	Exposed architectural concrete	2.0	3.0	3.0	1.0 ^C	0.5	50	18	
1M	Footings, foundations, columns, and beams not exposed to the weather, interior floor slabs to be given coverings	10.0	...	...	1.0 ^C	1.0	50	...	
2M	Interior floors without coverings	5.0	...	...	1.0 ^C	0.5	50	...	
3M	Foundation walls above grade, retaining walls, abutments, piers, girders, and beams exposed to the weather	5.0	8.0	10.0	1.0 ^C	0.5	50	18	
4M	Pavements, bridge decks, driveways and curbs, walks, patios, garage floors, exposed floors and porches, or water-front structures subject to frequent wetting	5.0	5.0	7.0	1.0 ^C	0.5	50	18	
5M	Exposed architectural concrete	3.0	3.0	5.0	1.0 ^C	0.5	50	18	
1N	Slabs subject to traffic abrasion, bridge decks, floors, sidewalks, pavements	5.0	...	...	1.0 ^C	0.5	50	...	
2N	All other classes of concrete	10.0	...	...	1.0 ^C	1.0	50	...	

^A Crushed air-cooled blast-furnace slag is excluded from the abrasion requirements. The rodDED or jiggED bulk density (unit weight) of crushed air-cooled blast-furnace slag shall be not less than 1120 kg/m³ [70 lb/ft³]. The grading of slag used in the bulk density (unit weight) test shall conform to the grading to be used in the concrete. Abrasion loss of gravel, crushed gravel, or crushed stone shall be determined on the test size or sizes most nearly corresponding to the grading or gradings to be used in the concrete. When more than one grading is to be used, the limit on abrasion loss shall apply to each.

^B The allowable limits for soundness shall be 12 % if sodium sulfate is used.

^C This percentage under either of the following conditions: (1) is permitted to be increased to 1.5 if the material is essentially free of clay or shale; or (2) if the source of the fine aggregate to be used in the concrete is known to contain less than the specified maximum amount passing the 75-µm (No. 200) sieve—(Table 1) the percentage limit (L) on the amount in the coarse aggregate is permitted to be increased to $L = 1 + [(P)/(100 - P)] (T - A)$, where P = percentage of sand in the concrete as a percent of total aggregate, T = the Table 1 limit for the amount permitted in the fine aggregate, and A = the actual amount in the fine aggregate. (This provides a weighted calculation designed to limit the maximum mass of material passing the 75-µm (No. 200) sieve in the concrete to that which would be obtained if both the fine and coarse aggregate were supplied at the maximum tabulated percentage for each of these ingredients.)

6. Grading

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

Sieve (Specification E11)	Percent Passing
9.5 mm (¾ 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

shall be graded within the limits in Table 1.

NOTE 2—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 mineral admixture 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 4⁵) 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 3—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. 3—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), sand equivalent determination (Test Method D2419), hydrometer analysis (Test Method D422), methylene blue adsorption determination (AASHTO T 330) 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 (6,7) 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 4—Relevant properties are those properties of the concrete that are important to the particular application being considered. STP 169D⁵ 4—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 5—Relevant properties are those properties of the concrete that are important to the particular application being considered. STP 169D⁵ 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 from the base fineness modulus. The base fineness modulus shall be that value that is typical of the source. The purchaser or specifier has the authority to approve a change in the base fineness modulus.

NOTE 5—The 6—The base fineness modulus should be determined from previous tests, or if no previous tests exist, from the average of the fineness modulus values for the first ten samples (or all preceding samples if less than ten) on the order. The proportioning of a concrete mixture may be dependent on the base fineness modulus of the fine aggregate to be used. Therefore, when it appears that the base fineness modulus is considerably different from the value used in the concrete mixture, a suitable adjustment in the mixture may be necessary.

7. Deleterious Substances

7.1 The amount of deleterious substances in fine aggregate shall not exceed the limits prescribed in Table 1²Table 2.

7.2 Organic Impurities:

7.2.1 Fine aggregate shall be free of injurious amounts of organic impurities. Except as herein provided, aggregates subjected to the test for organic impurities and producing a color darker than the standard shall be rejected.

7.2.2 Use of a fine aggregate failing in the test is not prohibited, provided that the discoloration is due principally to the presence of small quantities of coal, lignite, or similar discrete particles.

²The boldface numbers in parentheses refer to the list of references at the end of this standard.

⁵Significance of Tests and Properties of Concrete and Concrete Making Materials, STP 169D, ASTM, 2006.