



Standard Specification for Concrete Aggregates¹

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

^{ε1} NOTE—The title of Specification E 11 was editorially corrected December 1999.

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 SI units are to be regarded as the standard. The values given in parentheses are for information only.

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:

C 29/C 29M Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate³

¹ This specification is under the jurisdiction of ASTM Committee C-9 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.20 on Normal Weight Aggregates.

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² For lightweight aggregates, see Specifications C 331, C 332, and C 330; for heavyweight aggregates see Specification C 637 and Descriptive Nomenclature C 638.

³ *Annual Book of ASTM Standards*, Vol 04.02.

- C 40 Test Method for Organic Impurities in Fine Aggregates for Concrete³
- C 87 Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar³
- C 88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate³
- C 117 Test Method for Material Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing³
- C 123 Test Method for Lightweight Particles in Aggregate³
- C 125 Terminology Relating to Concrete and Concrete Aggregates³
- C 131 Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine³
- C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregates³
- C 142 Test Method for Clay Lumps and Friable Particles in Aggregates³
- C 227 Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)³
- C 289 Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)³
- C 295 Guide for Petrographic Examination of Aggregates for Concrete³
- C 330 Specification for Lightweight Aggregates for Structural Concrete³
- C 331 Specification for Lightweight Aggregates for Concrete Masonry Units³
- C 332 Specification for Lightweight Aggregates for Insulating Concrete³
- C 342 Test Method for Potential Volume Change of Cement-Aggregate Combinations³
- C 535 Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine³
- C 586 Test Method for Potential Alkali Reactivity of Carbonate Rocks for Concrete Aggregates (Rock Cylinder Method)³
- C 637 Specification for Aggregates for Radiation-Shielding Concrete³
- C 638 Descriptive Nomenclature of Constituents of Aggregates for Radiation-Shielding Concrete³

- C 666 Test Method for Resistance of Concrete to Rapid Freezing and Thawing³
- D 75 Practice for Sampling Aggregates⁴
- D 3665 Practice for Random Sampling of Construction Materials⁴
- E 11 Specification for Wire Cloth and Sieves for Testing Purposes⁵

TABLE 1 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

^A In the case of manufactured sand, if the material finer than the 75-µm (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.

3. Terminology

3.1 For definitions of terms used in this standard, refer to Terminology C 125.

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 C 33____,
- 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 (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 (Table 1). If not stated, the 3.0 % limit shall apply,
 - 4.2.4.4 The appropriate limit for coal and lignite (Table 1). 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) (11.1 and Table 2), or alternate grading as agreed between the purchaser and aggregate supplier.
 - 4.2.5.2 The class designation (11.1 and Table 3),

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 (Table 3), 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 C 33____.
- 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 (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-µm (No. 200) sieve (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). If not stated, the 1.0 % limit shall apply.

4.3.3 When the aggregate being described is coarse aggregate:

- 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 (10.1 and Table 2). 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 (11.1 and Table 3),
 - 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 (Table 3), which salt is to be used. If none is stated, either sodium sulfate or magnesium sulfate shall be used, and
 - 4.3.3.5 The person responsible for selecting the concrete proportions if other than the concrete producer.
- 4.3.4 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.

6. Grading

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

⁴ Annual Book of ASTM Standards, Vol 04.03.
⁵ Annual Book of ASTM Standards, Vol 14.02.

TABLE 2 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 (⅜ 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	...	...	...	...	...	...	...
357	50 to 4.75 mm (2 in. to No. 4)	...	...	...	100	95 to 100	...	35 to 70	0 to 5	...	0 to 5	...	...	...	...
4	37.5 to 19.0 mm (1½ to ¾ in.)	...	...	...	...	100	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	95 to 100	...	35 to 70	10 to 30	0 to 5	...	...	...	...
5	25.0 to 12.5 mm (1 to ½ in.)	...	...	...	...	...	100	90 to 100	0 to 10	0 to 5	...	...	...	...	...
56	25.0 to 9.5 mm (1 to ⅜ in.)	...	...	...	...	...	100	90 to 100	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 ⅜ in.)	...	...	...	...	...	...	100	20 to 55	0 to 15	0 to 5	...	...	...	...
67	19.0 to 4.75 mm (¾ in. to No. 4)	...	...	...	...	...	...	100	90 to 100	20 to 55	0 to 10	0 to 5	...	...	...
7	12.5 to 4.75 mm (½ in. to No. 4)	...	...	...	...	...	...	...	90 to 100	40 to 70	0 to 15	0 to 5	...	...	...
8	9.5 to 2.36 mm (⅜ in. to No. 8)	...	...	...	...	...	...	...	100	85 to 100	10 to 30	0 to 10	0 to 5	...	...
89	9.5 to 1.18 mm (⅜ 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 Although size 9 aggregate is defined in Terminology C 125 as a fine aggregate, it is included as a coarse aggregate when it is combined with a size 8 material to create a size 89, which is a coarse aggregate as defined by Terminology C 125.

TABLE 3 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 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	Maximum Allowable, %						
		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
Severe Weathering Regions								
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 waterfront 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
Moderate Weathering Regions								
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 waterfront 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
Negligible Weathering Regions								
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 rodged or jigged 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 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.)

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