



Designation: C 1157 – 03

Standard Performance Specification for Hydraulic Cement¹

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1. Scope

1.1 This specification covers hydraulic cements for both general and special applications. This is a specification giving performance requirements. There are no restrictions on the composition of the cement or its constituents.

1.2 The specification classifies cements by type based on specific requirements for general use, high early strength, resistance to attack by sulfates, and heat of hydration. Optional requirements are provided for the property of low reactivity with alkali-reactive aggregates.

1.3 For properties where values are given in both SI and inch-pound units, the values in SI units are to be regarded as the standard. Values in SI units shall be obtained by measurement in SI units or by appropriate conversion, using the Rules for Conversion and Rounding given in IEEE/ASTM SI 10, of measurements made in other units.

1.4 The text of this standard refers to notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) are not requirements of the standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—Specification C 150 is a prescription specification for portland cement and Specifications C 595 is a specification for blended hydraulic cement where the products that may be furnished are of restricted nature and proportions and where the products must meet prescriptive requirements as to chemical and physical properties.

2. Referenced Documents

2.1 ASTM Standards:²

C 109/C 109M Test Method for Compressive Strength of

Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
C 114 Test Methods for Chemical Analysis of Hydraulic Cement
C 150 Specification for Portland Cement
C 151 Test Method for Autoclave Expansion of Portland Cement
C 183 Practice for Sampling and the Amount of Testing of Hydraulic Cement
C 185 Test Method for Air Content of Hydraulic Cement Mortar
C 186 Test Method for Heat of Hydration of Hydraulic Cement
C 188 Test Method for Density of Hydraulic Cement
C 191 Test Method for Time of Setting of Hydraulic Cement by Vicat Needle
C 204 Test Method for Fineness of Hydraulic Cement by Air Permeability Apparatus
C 219 Terminology Relating to Hydraulic Cement
C 226 Specification for Air-Entraining Additions for Use in the Manufacture of Air-Entraining Hydraulic Cement
C 227 Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
C 311 Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete
C 430 Test Method for Fineness of Hydraulic Cement by the 45- μ m (No. 325) Sieve
C 441 Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
C 451 Test Method for Early Stiffening of Hydraulic Cement (Paste Method)
C 465 Specification for Processing Additions for Use in the Manufacture of Hydraulic Cements
C 595 Specifications for Blended Hydraulic Cements
C 688 Specification for Functional Additions for Use in Hydraulic Cements
C 1012 Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution
C 1038 Test Method for Expansion of Portland Cement Mortar Bars Stored in Water

¹ This specification is under the jurisdiction of ASTM Committee C01 on Cement and is the direct responsibility of Subcommittee C01.10 on Hydraulic Cements for General Concrete Construction.

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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.

IEEE/ASTM SI 10 Standard for Use of the International System of Units (SI): the Modern Metric System

3. Terminology

3.1 Definitions:

3.1.1 Terms used in this specification are defined in Terminology C 219, except for the following terms.

3.1.2 *blended hydraulic cement*—a hydraulic cement consisting of two or more inorganic ingredients which contribute to the strength-gaining properties of the cement, with or without other ingredients, processing additions, and functional additions.

3.1.2.1 Blended hydraulic cements are made by intergrinding or other blending processes.

4. Nomenclature

4.1 As selected by the producer, designate cements under this specification in accordance with the following names. The nomenclature does not establish or require any limits on the composition or properties of a cement. Its only purpose is to provide a uniform means for designating the cement after its ingredients and proportions have been selected by the manufacturer, thereby providing general information about the cement when the manufacturer so chooses.

4.2 *Hydraulic Cement*—Any cement meeting the requirements of this specification is a hydraulic cement. At the option of the producer, use this designation in addition to, or in lieu of, any other proper designation.

4.3 *Portland Cement*, consisting of portland-cement clinker to which, at the option of the manufacturer, one or more of the following additions, and no others, shall have been made during manufacture.

4.3.1 Calcium sulfate set-control addition.

4.3.2 Water, including that present in clinker and other additions, in amounts such that loss-on-ignition does not exceed 3.0 % by mass of the cement.

4.3.3 Processing additions up to the maximum amount demonstrating conformance to the applicable specification.

4.3.4 *Air-Entraining Portland Cement* shall contain an interground air-entraining addition.

4.4 *Blended Hydraulic Cements*:

4.4.1 *Modified Portland Cements* contain up to 15 % of a mineral ingredient besides portland-cement clinker, and, as selected by the producer, are designated “[ingredient]-modified portland cement” in accordance with the identity of the mineral ingredient used.

4.4.2 *Other Blended Hydraulic Cements* contain more than 15 % of two or more mineral ingredients and, as selected by the producer, are named in accordance with the two or, if more appropriate, three constituents present in greatest amount, listed in decreasing order of abundance by mass.

5. Additions

5.1 *Processing Additions*—If processing additions are used in the manufacture of cement, they shall conform to the requirements of Specification C 465.

5.2 *Functional Additions*—If functional additions of the types defined in Specification C 226 or C 688 are used in a cement, they shall conform to the requirements of the applicable specification.

6. Classification and Use

6.1 The types of hydraulic cement covered by this specification are given in 6.2.1-6.2.6 and are classified in accordance with specific properties.

6.2 Cements conforming to this specification shall be designated in accordance with the nomenclature with special characteristics indicated by type in accordance with the types in 6.2.1-6.2.6. When the type is not specified, the requirement of type GU shall apply.

6.2.1 *Type GU*—Hydraulic cement for general construction. Use when one or more of the special types are not required.

6.2.2 *Type HE*—High Early-Strength.

6.2.3 *Type MS*—Moderate Sulfate Resistance.

6.2.4 *Type HS*—High Sulfate Resistance.

6.2.5 *Type MH*—Moderate Heat of Hydration.

6.2.6 *Type LH*—Low Heat of Hydration.

6.3 *Additional Option*—The following additional purchase option applies for any of the principal types listed. When this option is invoked, its letter designation and title shall follow immediately after the respective letter designation and title of the principal type.

6.3.1 *Option R*—Low Reactivity with Alkali-Reactive Aggregates. When tested for potential activity with alkali-reactive aggregates, the cement shall meet the requirement (Table 1) for low reactivity with alkali-reactive aggregates.

7. Ordering Information

7.1 Orders for cement meeting the requirements of this specification shall include:

7.1.1 The specification designation ASTM C 1157,

7.1.2 The specification date, if other than the latest published version,

7.1.3 The quantity of cement desired,

7.1.4 The nomenclature (see Section 4) and the type of cement desired (if no type is specified, the cement shipped shall meet the requirements for Type GU).

7.1.5 *Compressive Strength Options*—Three options for compressive strength are listed in this specification. If strength other than the default minima (7.1.5.1) of Table 1 are desired, verify that the option selected is available in the area where required. Strength at an age listed in Table 1 for the Type of cement shall not be less than the strength at an earlier listed age.

7.1.5.1 *Minimum Compressive Strengths (Default)*—If the minimum strengths of the ranges listed in Table 1 are acceptable, specify the minimums of Table 1. When another option is not stated, the applicable compressive strength requirements are the minimums of the Table 2 Strength Ranges listed for each age in Table 1 for the Type of cement.

7.1.5.2 *Minimum Strength at a Listed Age*—When a minimum strength greater than a default minimum is required at a listed age, specify the minimum of one Strength Range listed in Table 2 at one age listed in Table 1 for that Type of cement.

TABLE 1 Standard Physical Requirements

Cement Type	Applicable Test Method	GU	HE	MS	HS	MH	LH
Fineness	C 204	A	A	A	A	A	A
Autoclave length change, max, %	C 151	0.80	0.80	0.80	0.80	0.80	0.80
Time of setting, vicat test ^B	C 191						
Initial, not less than, minutes		45	45	45	45	45	45
Initial, not more than, minutes		420	420	420	420	420	420
Air content of mortar volume, %	C 185	C	C	C	C	C	C
Strength range ^D	C 109/C 109M						
1 day		...	10	...	...	...	...
3 days		10	17	10	5	5	...
7 days		17	...	17	10	10	5
28 days		...	...	...	17	...	17
Heat of hydration	C 186						
7 days, max, kJ/kg (kcal/kg)		...	...	...	...	290 (70)	250 (60)
28 days, max, kJ/kg (kcal/kg)		...	...	...	...	...	290 (70)
Mortar bar expansion	C 1038						
14 days, % max		0.020	0.020	0.020	0.020	0.020	0.020
Sulfate expansion (sulfate resistance) ^E	C 1012						
6 months, max, %		...	...	0.10	0.05	...	...
1 year, max, %		...	...	...	0.10	...	...
Option R—Low Reactivity with Alkali-Reactive Aggregates ^F							
Expansion	C 227						
14 days, max, %		0.020	0.020	0.020	0.020	0.020	0.020
56 days, max, %		0.060	0.060	0.060	0.060	0.060	0.060
Optional Physical Requirements							
Early stiffening, final penetration, min,%	C 451	50	50	50	50	50	50
Compressive strength, ^G	C 109/C 109M						
28 days, min, MPa (psi)		28.0 (4060)	...	28.0 (4060)	...	22.0 (3190)	...

^A Both amount retained when wet sieved on the 45- μ m (No. 325) sieve and specific surface area by air permeability apparatus in m²/kg shall be reported on all certificates of test results requested from the manufacturer.

^B Time of setting refers to initial setting time in Test Method C 191.

^C Air content shall be reported on all certificates of test results requested from the manufacturer. A given value in mortar does not necessarily assure that the desired air content will be obtained in concrete.

^D Lowest Strength Range whose minimum shall apply at the specified age unless a higher Strength Range is specified by the purchaser. See Table 2 for the applicable strength limits.

^E In the testing of HS cement, testing at one year shall not be required when the cement meets the 6 month limit. An HS cement failing the 6 month limit shall not be rejected unless it also fails the one year limit.

^F Compliance with this requirement shall not be requested unless the cement will be used with alkali-reactive aggregate.

^G When 28-day strengths are specified, sufficient time must be allowed for completion of the test. When required on a certificate of test results, special arrangements shall be made for storage of the cement pending completion of the test.

TABLE 2 Strength Range Limits

Strength Range	Applicable Test Method	5	10	17	25	35	45
Compressive strength min, Mpa (psi)	C 109/C 109M	5 (725)	10 (1450)	17 (2465)	25 (3625)	35 (5075)	45 (6525)
Compressive strength max, Mpa (psi)	C 109/C 109M	15 (2175)	20 (2900)	30 (4350)	40 (5800)	60 (8700)	...

7.1.5.3 Strength Range at a Listed Age—When cement is required that is within a particular range of strength, specify cement as being within one Strength Range from Table 2 at one age listed for that cement Type in Table 1.

NOTE 2—Listed ages for Type HE in Table 1 are 1 and 3 days; listed ages for Types GU, MH, and MS are 3 and 7 days; listed ages for Type HS are 3, 7, and 28 days; listed ages for Type LH are 7 and 28 days.

7.1.5.4 Strength Range at Desired Age—When cement is required that is within a particular range of strength, specify cement as being within one Strength Range from Table 2 at one age selected from among 3, 7, and 28 days, except that when Type HE is specified, one Strength Range shall be selected

from among 1, 3, 7, or 28 days. If no Strength Range is specified, only the minimum strengths of all the ranges in Table 1, as established in Table 2, shall apply.

7.1.6 A statement that the low reactivity with alkali-reactive aggregates option is invoked, when such is desired, and

7.1.7 A request for the manufacturer's certification, if desired.

7.1.8 When the purchaser desires that the cement be sampled and tested to verify compliance with this specification, perform sampling and testing in accordance with Practice C 183.

7.1.9 Practice C 183 is not designed for manufacturing quality control and is not required for manufacturer's certification.

8. Chemical Composition

8.1 The chemical composition for the cement is not specified. However, the cement and the individual constituents interground or blended to produce it shall be analyzed.

9. Physical Properties

9.1 Cement of the type specified shall conform to all of the applicable physical requirements of Table 1.