



# Standard Performance Specification for Hydraulic Cement<sup>1</sup>

This standard is issued under the fixed designation C1157/C1157M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope\*

1.1 This performance specification covers hydraulic cements for both general and special applications. There are no restrictions on the composition of the cement or its constituents (See [Note 1](#)).

NOTE 1—There are two related hydraulic cement standards, Specification [C150](#) for portland cement and Specifications [C595](#) for blended cements, both of which contain prescriptive and performance requirements

1.2 This performance specification classifies cements 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-silica-reactive aggregates and for air-entraining cements.

1.3 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. Values in SI units [or inch-pound units] shall be obtained by measurement in SI units [or inch-pound units] or by appropriate conversion, using the Rules for Conversion and Rounding given in [IEEE/ASTM SI 10](#), of measurements made in other units [or SI units]. Values are stated in only SI units when inch-pound units are not used in practice.

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.*

<sup>1</sup> This performance 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. Referenced Documents

### 2.1 *ASTM Standards:*<sup>2</sup>

- [C109/C109M](#) Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
- [C114](#) Test Methods for Chemical Analysis of Hydraulic Cement
- [C150](#) Specification for Portland Cement
- [C151](#) Test Method for Autoclave Expansion of Hydraulic Cement
- [C183](#) Practice for Sampling and the Amount of Testing of Hydraulic Cement
- [C185](#) Test Method for Air Content of Hydraulic Cement Mortar
- [C186](#) Test Method for Heat of Hydration of Hydraulic Cement
- [C188](#) Test Method for Density of Hydraulic Cement
- [C191](#) Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle
- [C204](#) Test Methods for Fineness of Hydraulic Cement by Air-Permeability Apparatus
- [C219](#) Terminology Relating to Hydraulic Cement
- [C227](#) Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
- [C359](#) Test Method for Early Stiffening of Hydraulic Cement (Mortar Method)
- [C430](#) Test Method for Fineness of Hydraulic Cement by the 45- $\mu$ m (No. 325) Sieve
- [C441](#) Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
- [C451](#) Test Method for Early Stiffening of Hydraulic Cement (Paste Method)
- [C595](#) Specification for Blended Hydraulic Cements
- [C596](#) Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement
- [C1012](#) Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution
- [C1038](#) Test Method for Expansion of Hydraulic Cement

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto: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

**Mortar Bars Stored in Water**  
**IEEE/ASTM SI 10 Standard for Use of the International**  
**System of Units (SI): the Modern Metric System**

tics of other concrete materials, mix design, production, handling, and environmental conditions. For performance properties of concrete, including permeability, resistance to freeze-thaw cycles and deicer salt scaling, additional information may be obtained through the use of comparative testing of concretes.

4.2 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 4.2.1-4.2.6. When the type is not specified, the requirements of type GU shall apply.

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

4.2.2 *Type HE*—High Early-Strength.

4.2.3 *Type MS*—Moderate Sulfate Resistance.

4.2.4 *Type HS*—High Sulfate Resistance.

4.2.5 *Type MH*—Moderate Heat of Hydration.

4.2.6 *Type LH*—Low Heat of Hydration.

### 3. Terminology

#### 3.1 Definitions:

3.1.1 Terms used in this specification are defined in Terminology C219.

### 4. Classification and Use

4.1 The types of hydraulic cement covered by this specification are given in 4.2.1-4.2.6 and are classified in accordance with specific properties defined in Table 1 (See Note 2).

NOTE 2—This specification is based on hydraulic cement attributes related to concrete performance, including strength development, sulfate resistance, heat of hydration, and resistance to alkali-silica reactivity. Concrete performance is dependent on many factors such as characteris-

**TABLE 1 Standard Physical Requirements**

| Cement Type   | Applicable Test Method | GU               | HE               | MS               | HS               | MH               | LH               |
|---|------------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Fineness  | C204,<br>C430          | A                | A                | A                | A                | A                | A                |
| Autoclave length change, max, %   | C151                   | 0.80             | 0.80             | 0.80             | 0.80             | 0.80             | 0.80             |
| Time of setting, vicat test <sup>B</sup>                                    | C191                   |                  |                  |                  |                  |                  |                  |
| 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, max, % <sup>C</sup>                           | C185                   | 12               | 12               | 12               | 12               | 12               | 12               |
| Compressive strength minimum, MPa [psi] <sup>D</sup>                        | C109/C109M             |                  |                  |                  |                  |                  |                  |
| 1 day   |                        | ...              | 12.0 [1740]      | ...              | ...              | ...              | ...              |
| 3 days  |                        | 13.0 [1890]      | 24.0 [3480]      | 11.0 [1600]      | 11.0 [1600]      | 5.0 [725]        | ...              |
| 7 days  |                        | 20.0 [2900]      | ...              | 18.0 [2610]      | 18.0 [2610]      | 11.0 [1600]      | 11.0 [1600]      |
| 28 days   |                        | 28.0 [4060]      | ...              | ...              | 25.0 [3620]      | ...              | 21.0 [3050]      |
| Heat of hydration   | C186                   |                  |                  |                  |                  |                  |                  |
| 7 days, max, kJ/kg [kcal/kg]  |                        | ...              | ...              | ...              | ...              | 290 [70]         | 250 [60]         |
| 28 days, max, kJ/kg [kcal/kg]   |                        | ...              | ...              | ...              | ...              | ...              | 290 [70]         |
| Mortar bar expansion  | C1038                  |                  |                  |                  |                  |                  |                  |
| 14 days, % max  |                        | 0.020            | 0.020            | 0.020            | 0.020            | 0.020            | 0.020            |
| Sulfate expansion (sulfate resistance) <sup>E</sup>                         | C1012                  |                  |                  |                  |                  |                  |                  |
| 6 months, max, %  |                        | ...              | ...              | 0.10             | 0.05             | ...              | ...              |
| 1 year, max, %  |                        | ...              | ...              | ...              | 0.10             | ...              | ...              |
| Optional Physical Requirements  |                        |                  |                  |                  |                  |                  |                  |
| Option A—Air entraining <sup>C,F</sup>                                      | C185                   |                  |                  |                  |                  |                  |                  |
| Air content of mortar, vol %  |                        |                  |                  |                  |                  |                  |                  |
| max   |                        | 22               | 22               | 22               | 22               | 22               | 22               |
| min   |                        | 16               | 16               | 16               | 16               | 16               | 16               |
| Option R—Low reactivity with alkali-silica-reactive aggregates <sup>G</sup> | C227                   |                  |                  |                  |                  |                  |                  |
| Expansion at  |                        |                  |                  |                  |                  |                  |                  |
| 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            |
| Early stiffening, final penetration, min, %                                 | C451                   | 50               | 50               | 50               | 50               | 50               | 50               |
| Compressive strength, <sup>D</sup> 28 days, min, MPa                        | C109/C109M             | ...              | ...              | 28.0             | ...              | 22.0             | ...              |
| Drying shrinkage, %   | C596                   | ... <sup>H</sup> | ... <sup>H</sup> | ... <sup>H</sup> | ... <sup>H</sup> | ... <sup>H</sup> | ... <sup>H</sup> |

<sup>A</sup> Both amount retained when wet sieved on the 45- $\mu$ m (No. 325) sieve and specific surface area by air permeability apparatus in m<sup>2</sup>/kg shall be reported on all certificates of test results requested from the manufacturer.

<sup>B</sup> Time of setting refers to initial setting time in Test Method C191.

<sup>C</sup> A given value of air content in mortar does not necessarily assure that the desired air content will be obtained in concrete.

<sup>D</sup> Cements may be shipped prior to later-age test data being available. In such cases, the test value may be left blank. Alternatively, the manufacturer can generally provide estimates based on historical production data. The report shall indicate if such estimates are provided.

<sup>E</sup> 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 1-year limit.

<sup>F</sup> When this option is invoked, it replaces the maximum air content of mortar listed in the default table requirements. The minimum compressive strength of air-entraining cements shall be no less than 80 % of that of the comparable non-air-entraining cement type.

<sup>G</sup> Compliance with this requirement shall not be requested unless the cement will be used with alkali-reactive aggregate.

<sup>H</sup> At the request of the purchaser, data on drying shrinkage shall be supplied.

4.3 *Additional Options*—The following additional purchase options apply for any of the principal types listed. When one or both of these options is invoked, its letter designation and title shall follow immediately after the respective letter designation and title of the principal type (for example, Type MS(R) or Type MS(A)).

4.3.1 *Option R (low reactivity with alkali-silica-reactive aggregates)*—When tested for potential activity with reactive aggregates, the cement shall meet the requirements of [Table 1](#) for Option R.

4.3.2 *Option A (air-entraining)*—Air-entraining cements shall meet the air content requirements of [Table 1](#) for Option A.

## 5. Ordering Information

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

5.1.1 The specification designation ASTM C1157, and date,

5.1.2 The type of cement required. If no type is specified, Type GU shall be supplied.

5.1.3 A statement that an option is invoked, when such is desired, and

5.1.4 Manufacturer's certification, if required.

## 6. Chemical Composition

6.1 The chemical composition for the cement is not specified. However, the cement shall be analyzed for informational purposes.

## 7. Physical Properties

7.1 Cement of the type specified shall conform to all of the applicable standard physical requirements of [Table 1](#).

7.2 When optional requirements are specified, the cement shall conform to the applicable optional limits of [Table 1](#).

## 8. Sampling

8.1 When the purchaser requires that the cement be sampled and tested to verify compliance with this specification, sample in accordance with [Practice C183](#). Provide adequate facilities for sampling the finished cement. Sample the finished cement at the mill or at the site of transfer of ownership as may be specified by the purchaser.

8.2 [Practice C183](#) is not designed for manufacturing quality control and is not required for manufacturer's certification.

## 9. Test Methods

9.1 When testing a cement for compliance with this specification, or for general characterization, use the following methods, with modifications or exceptions as indicated.

9.2 *Chemical Analysis*—Chemically analyze the cement using Test Methods [C114](#) for major and minor oxides present in greatest quantity that together, including loss-on-ignition, constitute at least 98 % of the total mass of the cement.

9.3 *Fineness*:

9.3.1 Determine fineness by Test Method [C204](#).

9.3.2 Determine amount retained on the 45- $\mu\text{m}$  (No. 325) sieve by Test Method [C430](#).

9.4 Determine autoclave expansion by Test Method [C151](#), except that for cements with 1-day compressive strengths anticipated to be below 3.4 MPa [500 psi], store the test specimen in a moist cabinet for a period of 48 h before demolding and measuring their length.

9.5 Determine the time of setting using Test Method [C191](#). Only the time of initial setting is required.

9.6 Test the mortar for air content using Test Method [C185](#) using the actual density of the cement, as determined by Test Method [C188](#), if it differs from 3.15 Mg/m<sup>3</sup> by more than 0.05 Mg/m<sup>3</sup>.

9.7 Determine compressive strength using Test Method [C109/C109M](#). Tests shall be conducted at each age specified in [Table 1](#).

9.8 Determine heat of hydration using Test Method [C186](#).

9.9 Determine sulfate resistance using Test Method [C1012](#).

9.10 Determine reactivity of cement with alkali-silica-reactive aggregate (Option R) using Test Method [C227](#) using crushed borosilicate glass, as described in Test Method [C441](#), as aggregate.

9.11 Determine early stiffening using Test Method [C451](#) (See [Note 3](#)).

NOTE 3—Additional characterization information may be obtained with Test Method [C359](#).

9.12 Determine mortar bar expansion using Test Method [C1038](#) using a 14-day immersion period.

9.13 Determine drying shrinkage using Test Method [C596](#).

## 10. Testing Time Requirements

10.1 The purchaser shall make necessary arrangements for shipment of samples to the testing laboratory. Add the time required for transport to the laboratory to the minimum time intervals allowed from receipt of the samples by the testing laboratory.

10.2 The minimum time allowed from receipt of samples by the testing laboratory to the report of test results shall be determined by the required age of specimen at the time of testing plus seven days.

10.3 A written report of results of applicable tests shall be available within not more than three days of the interval indicated in [10.2](#).

10.4 These time limits do not apply to retesting or additional testing. Such testing shall not provide the basis for initial acceptance or rejection of the cement (See [Note 4](#)).

NOTE 4—Aging effects on small samples of cement stored for long periods of time can produce test results that are not representative of the fresh cement nor of cement stored in large quantity for equal periods of time.

## 11. Testing by the Manufacturer

11.1 Test samples of cement for compliance with this specification, and for chemical analysis, air content, and fineness. Location and frequency of sampling are at the discretion of the manufacturer and are permitted to be changed upon agreement between the purchaser and supplier. Sampling

and testing shall be either part of, or in addition to, the manufacturer's normal quality control.

### 11.2 *Special Testing:*

11.2.1 The following requirements for testing apply only to tests for sulfate resistance and low reactivity with alkali-silica-reactive aggregates.

11.2.1.1 For sulfate resistance of Types MS and HS and for Option R of any cement, make tests at least once every 12 months.

1. Retest if the amount of an ingredient making up 10 % by mass or more of the cement is changed by  $\pm 5$  % or more by mass (See **Note 5**).

**NOTE 5**—For example, if the cement met the applicable requirement with a slag or fly ash content of 25 % by mass, retesting is required if the slag or fly ash content is changed beyond the range of 20 to 30 %.

2. Retest if the amount of an ingredient making up less than 10 % by mass of the cement is changed by  $\pm 50$  % or more of the amount previously shown to satisfy the applicable requirements (See **Note 6**).

**NOTE 6**—For example, if the cement met the applicable requirement with a silica fume content of 5 % by mass, retesting is required if the silica fume content is changed beyond the range of 2.5 to 7.5 %.

3. Retest if the mass % of SiO<sub>2</sub> or CaO in the cement, or if the mass % of CaO or SiO<sub>2</sub> in an ingredient making up 10 % by mass or more of the cement, is changed by  $\pm 3$  % or more by mass (See **Note 7**).

**NOTE 7**—For example, if the SiO<sub>2</sub> content of the cement met the requirement at 20 % by mass of the cement, retesting is required if the SiO<sub>2</sub> content changes beyond the range of 17 to 23 %.

## 12. Inspection

12.1 Inspection of the material shall be as agreed upon between the purchaser and the seller as part of the purchase contract.

## 13. Rejection

13.1 At the option of the purchaser, material that fails to conform to the applicable requirements of this specification for the type specified shall be rejected. Report rejection to the manufacturer or supplier promptly and in writing, stating the specific reasons for rejection.

13.2 At the option of the purchaser, packages more than 2 % below the mass marked thereon shall be rejected, and if the average mass of packages in any shipment, as shown by determining the mass of 50 packages taken at random, is less than that marked on the packages, reject the entire shipment.

13.3 At the option of the purchaser, bulk cement remaining in storage for more than six months after testing, or packaged cement remaining in the possession of a vendor for more than three months, shall be sampled and retested and rejected if it fails to meet any of the applicable requirements of this specification.

## 14. Certification

14.1 Upon request of the purchaser in the contract or order, a manufacturer's report shall be furnished at the time of

shipment stating the results of tests made on samples of the material taken during production or transfer and certifying that the cement conforms to applicable requirements of this specification.

14.2 At the request of the purchaser in the contract or order, the manufacturer shall state in writing the types and amounts of the ingredients used in manufacture of the hydraulic cement.

14.3 *Sulfate resistance (Types MS and HS); low reactivity with aggregates (Option R); and Air Entraining (Option A)*—When specified, results from the tests demonstrating compliance with this specification shall be available for inspection and the manufacturer's report shall state that the applicable requirements of this specification for those properties have been met.

## 15. Package Marking

15.1 When the cement is delivered in packages, words stating the type of cement, the name and brand of manufacturer, the mass of cement contained therein, and a list of ingredients, using generic names in decreasing order of abundance (See **Note 8**), shall be plainly marked on each package. Provide similar information with the manufacturer's certification accompanying the shipment of packaged or bulk cement.

**NOTE 8**—The following list contains suggested generic names for some possible ingredients of hydraulic cements. The list is representative and is not inclusive.

| Class of Ingredient | Examples of Generic Terms   |
|---------------------|---|
| Cement              | Portland cement, portland cement clinker.   |
| Calcium Ingredient  | Calcium carbonate, limestone, lime, hydrated lime, cement kiln dust (CKD).  |
| Pozzolan            | Class F fly ash, Class C fly ash, uncalcined natural pozzolan, calcined natural pozzolan, silica fume.                        |
| Slag                | Granulated iron blast-furnace slag.   |
| Additions           | Calcium sulfate, water reducer, accelerator, retarder, water-reducing retarder, air-entraining addition, processing addition. |

## 16. Storage

16.1 The cement shall be stored in such a manner as to permit reasonable access for proper inspection and identification of each shipment and in a suitable weather-tight building, container, or package that will protect the cement from dampness and minimize warehouse set.

## 17. Uniformity of Source

17.1 Upon request of the purchaser in the contract or order, the manufacturer shall provide a report on the uniformity of strength of cement from the source.

## 18. Keywords

18.1 blended hydraulic cement; hydraulic cement; performance

SUMMARY OF CHANGES

Committee C01 has identified the location of selected changes to this performance specification since the last issue, C1157/C1157M–10, that may impact the use of this performance specification. (Approved Oct. 1, 2011)

(I) Added Option A, Air Entaining.

Committee C01 has identified the location of selected changes to this performance specification since the last issue, C1157/C1157M–09, that may impact the use of this performance specification. (Approved April 1, 2010)

(I) Revised **Table 1**.

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