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Standard Specification for Blended Hydraulic Cements¹

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

1. Scope*

1.1 This specification pertains to blended hydraulic cements for both general and special applications, using slag, pozzolan, limestone, or some combination of these, with portland cement or portland cement clinker or slag with lime.

NOTE 1—This specification prescribes ingredients and proportions, with some performance requirements, whereas Performance Specification C1157/C1157M is a hydraulic cement specification in which performance criteria alone govern the products and their acceptance.

1.2 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.

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

1.4 *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.*

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. Referenced Documents

2.1 ASTM Standards:²

- C51 Terminology Relating to Lime and Limestone (as Used by the Industry)
- 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/C150M Specification for Portland Cement
- C151/C151M Test Method for Autoclave Expansion of Hydraulic Cement
- C183/C183M Practice for Sampling and the Amount of Testing of Hydraulic Cement
- C185 Test Method for Air Content of Hydraulic Cement Mortar
- C187 Test Method for Amount of Water Required for Normal Consistency of Hydraulic Cement Paste
- 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 and Other Inorganic Cements
- C226 Specification for Air-Entraining Additions for Use in the Manufacture of Air-Entraining Hydraulic Cement
- C311/C311M Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
- C430 Test Method for Fineness of Hydraulic Cement by the 45-μm (No. 325) Sieve
- C465 Specification for Processing Additions for Use in the Manufacture of Hydraulic Cements
- C563 Guide for Approximation of Optimum SO₃ in Hydraulic Cement
- C688 Specification for Functional Additions for Use in Hydraulic Cements

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.

*A Summary of Changes section appears at the end of this standard



C821 Specification for Lime for Use with Pozzolans
 C1012/C1012M Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution
 C1038/C1038M Test Method for Expansion of Hydraulic Cement Mortar Bars Stored in Water
 C1157/C1157M Performance Specification for Hydraulic Cement
 C1702 Test Method for Measurement of Heat of Hydration of Hydraulic Cementitious Materials Using Isothermal Conduction Calorimetry
 C1778 Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete
 C1891 Test Method for Fineness of Hydraulic Cement by Air Jet Sieving at 45- μm (No. 325)
 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 The terms used in this specification are defined in Terminology C219, except for the terms below.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *binary blended cement, n*—a blended hydraulic cement consisting of portland cement with either a slag, a pozzolan, or a limestone.

3.2.2 *slag, n*—the term slag is used within this specification to denote either slag cement or granulated blast-furnace slag.

3.2.3 *ternary blended cement, n*—a blended hydraulic cement consisting of portland cement with either a combination of two different pozzolans, slag and a pozzolan, a pozzolan and a limestone, or a slag and a limestone.

NOTE 2—Relevant terms in Terminology C219 applicable to this specification include portland cement, portland-cement clinker, hydraulic cement, slag cement, granulated blast-furnace slag, pozzolan, and calcium sulfate. Limestone is defined in Terminology C51.

4. Classification

4.1 This specification applies to the following types of blended cement that generally are intended for use as indicated.

4.1.1 Blended hydraulic cements for general concrete construction.

4.1.1.1 *Type IS*—Portland blast-furnace slag cement.

4.1.1.2 *Type IP*—Portland-pozzolan cement.

4.1.1.3 *Type IL*—Portland-limestone cement.

4.1.1.4 *Type IT*—Ternary blended cement.

4.2 Reporting:

4.2.1 The naming practice for blended cements shall be made by adding the suffix (X) to the type designation under 4.1.1, where (X) equals the targeted percentage of slag, pozzolan or limestone, in the product expressed as a whole number by mass of the final blended product, within the allowable variation as stated in 15.3.

4.2.2 The naming practice for ternary blended cements shall be made by adding the suffixes (AX) and (BY) to the Type IT designation under 4.1.1, where:

A is either “S” for slag, “P” for pozzolan, or “L” for limestone, whichever is present in larger amount by mass,

X is the targeted percentage by mass of constituent A,

B is either “S” for slag, “P” for pozzolan, or “L” for limestone, and

Y is the targeted percentage by mass of constituent B.

Both X and Y values are expressed as a whole number by mass of the final blended product, within the allowable variation as stated in 15.3. If X and Y are the same, list the two constituents in alphabetical order by constituent type (limestone, pozzolan, or slag).

NOTE 3—Examples of the naming practice in accordance with 4.2.1 and 4.2.2 are shown below (all percentages by mass):

Binary blended cement with 80 % portland cement and 20 % slag = Type IS(20).

Binary blended cement with 85 % portland cement and 15 % pozzolan = Type IP(15).

Binary blended cement with 90 % portland cement and 10 % limestone = Type IL(10).

Ternary blended cement with 70 % portland cement, 20 % slag and 10 % pozzolan = Type IT(S20)(P10).

Ternary blended cement with 65 % portland cement, 25 % of one pozzolan and 10 % of another pozzolan = Type IT(P25)(P10).

Ternary blended cement with 60 % portland cement and 20 % of slag and 20 % pozzolan = Type IT(P20)(S20).

Ternary blended cement with 80 % portland cement, 10 % limestone and 10 % pozzolan = Type IT(L10)(P10).

Ternary blended cement with 75 % portland cement, 15 % slag and 10 % limestone = Type IT(S15)(L10).

4.2.3 A simplified naming practice is used in this specification for practicality and clarity when referring to specific requirements for binary and ternary blended cements that are applicable to a range of products or in ternary blended cements when requirements are applicable to only one constituent within a specific range (%) (see Note 4).

NOTE 4—Examples of the simplified naming practices in accordance with 4.2.3 are shown below:

(1) An example when requirements are applicable to a range of products can be found in Table 1, where the maximum SO_3 content of 3 % applies to: binary blended cements with slag contents <70 %, indicated as IS(<70); and ternary blended cements with a pozzolan content less than the slag content and the slag content is less than 70 %, indicated as IT(P<S<70).

(2) An example when requirements are applicable to only one constituent within a specific range (%) of that constituent can be found in 9.2, where testing is required only when the slag content is <25 %. Because the requirement is based on the slag content only with no relation to the pozzolan or limestone content, a simplified naming practice is employed and the range of ternary blended cements is indicated as Type IT(S<25).

4.3 Special Properties:

4.3.1 Air-entraining cement, when desired by the purchaser, shall be specified by adding the suffix (A) to the type designation under 4.1.1.

NOTE 5—A given mass of blended cement has a larger absolute volume than the same mass of portland cement. This should be taken into consideration in purchasing cements and in proportioning concrete mixtures.

4.3.2 Moderate heat of hydration, when desired by the purchaser, shall be specified by adding the suffix (MH) to the type designation under 4.1.1.

4.3.3 Moderate sulfate resistance, when desired by the purchaser, shall be specified by adding the suffix (MS) to the type designation under 4.1.1.

4.3.4 High sulfate resistance, when desired by the purchaser, shall be specified by adding the suffix (HS) to the type designation under 4.1.1.



TABLE 1 Chemical Requirements

Cement Type ^A	Applicable Test Method	IS(<70), IT(P<S<70), IT(L<S<70)	IS(≥70), IT(S≥70)	IP, IT(P≥S), IT(P≥L)	IL, IT(L≥S), IT(L≥P)
Magnesium oxide (MgO), max, %	C114	6.0	...
Sulfate reported as SO ₃ , max, % ^B	C114	3.0	4.0	4.0	3.0
Sulfide reported as S ²⁻ , max, %	C114	2.0	2.0
Insoluble residue, max, % ^C	C114	1.0	1.0
Loss on ignition, max, %	C114	3.0 ^D	4.0 ^D	5.0 ^D	10.0

^A The chemical requirements in this table are applicable to all air-entrained cement equivalents.

^B It is permissible to exceed the values in the table for SO₃ content, provided it has been demonstrated by Test Method C1038/C1038M that the cement with the increased SO₃ will not develop expansion exceeding 0.020 % at 14 days. When the manufacturer supplies cement under this provision, supporting data shall be supplied to the purchaser (see Note 10).

^C Insoluble residue maximum limit does not apply to ternary blended cements.

^D For ternary blended cements with limestone, loss on ignition is a maximum of 10.0 % by mass.

4.3.5 Low heat of hydration, when desired by the purchaser, shall be specified by adding the suffix (LH) to the type designation under 4.1.1.

NOTE 6—Special properties attributable to slag, pozzolan or limestone will vary based on quantities contained within the blended cements.

NOTE 7—Guide C1778 provides guidance on use of blended hydraulic cements in concrete mixtures where potential for deleterious alkali-silica reaction is of concern.

4.3.6 High early strength, when desired by the purchaser, shall be specified by adding the suffix (HE) to the type designation under 4.1.1.

5. Ordering Information

5.1 Orders for material under this specification shall include the following:

5.1.1 Specification number,

5.1.2 Type or types required.

5.1.2.1 Indicate allowable slag, pozzolan, or limestone maximum or minimum percentage by mass, if required,

5.1.3 Optional special properties required (see 4.3),

5.1.3.1 MS if moderate sulfate resistance is required,

5.1.3.2 HS if high sulfate resistance is required,

5.1.3.3 MH if moderate heat of hydration is required,

5.1.3.4 LH if low heat of hydration is required,

5.1.3.5 HE if high early strength is required,

5.1.3.6 A if air entraining is required,

5.1.3.7 Accelerating addition, if required,

5.1.3.8 Retarding addition, if required,

5.1.3.9 Water reducing addition, if required,

5.1.3.10 Water reducing and accelerating addition, if required, and

5.1.3.11 Water reducing and retarding addition, if required, and.

5.1.4 Certification, if desired (see Section 15).

NOTE 8—It is important to check for availability of various options. Some multiple options are mutually incompatible or unattainable.

6. Materials

6.1 Materials permitted to be used as ingredients in cements manufactured to comply with this specification are:

6.1.1 *Portland Cement*—For purposes of this specification, portland cement meeting the requirements of Specification C150/C150M is suitable. Portland cement or other hydraulic

materials, or both, containing high free lime are not prohibited from use as long as the autoclave test limits for the blended cement are met.

6.1.2 *Portland Cement Clinker*.

6.1.3 *Slag*—Slag shall be slag cement or granulated blast-furnace slag and comply with requirements in Section 9.

6.1.4 *Pozzolan*—Pozzolan shall comply with requirements in Section 9.

6.1.5 *Limestone*—Limestone, as defined in Terminology C51, shall be naturally occurring and comply with the requirements indicated in 8.2.

6.1.6 *Hydrated Lime*—Hydrated lime used as part of a blended cement shall meet the requirements of Specification C821, except that when interground in the production process there shall be no minimum fineness requirement.

6.1.7 *Air-entraining Addition*—When air-entraining cement is specified, an addition meeting the requirements of Specification C226 shall be used.

6.1.8 When processing additions are used in the manufacture of cement, they shall have been shown to meet the requirements of Specification C465 in the amounts used or greater (see 15.2).

6.1.9 When functional additions (used at the sole option of the purchaser) are used they shall have been shown to meet the requirements of Specification C688 when tested with the cement to be used, in the amount used or greater (see 15.2).

6.1.10 *Other Additions*—The cement covered by this specification shall contain no additions except as provided for above except that water or calcium sulfate (see Terminology C219), or both, if added, shall be in amounts so that the limits shown in Table 1 for sulfate reported as SO₃ and loss on ignition are not exceeded.

7. Manufacture

7.1 *Binary Blended Cement*—Binary blended cement shall be a hydraulic cement consisting of an intimate and uniform blend (see Note 9) produced either by intergrinding or blending or by a combination of intergrinding and blending portland cement clinker or portland cement with a pozzolan or a slag, or a limestone. Any slag, pozzolan, or limestone used as an ingredient or addition in portland cement used to manufacture a binary blended cement shall be included in the total amount