Designation: C150/C150M – 22

Standard Specification for Portland Cement[1]

This standard is issued under the fixed designation C150/C150M; 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 (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification covers ten types of portland cement, as follows (see Note 2):

1.1.1 *Type I*—For general use, when the special properties specified for any other type are not required.

1.1.2 *Type IA*—Air-entraining cement for the same uses as Type I, where air-entrainment is desired.

1.1.3 *Type II*—For general use, more especially when moderate sulfate resistance is desired.

1.1.4 *Type IIA*—Air-entraining cement for the same uses as Type II, where air-entrainment is desired.

1.1.5 *Type II(MH)*—For general use, more especially when moderate heat of hydration and moderate sulfate resistance are desired.

1.1.6 *Type II(MH)A*—Air-entraining cement for the same uses as Type II(MH), where air-entrainment is desired.

1.1.7 *Type III*—For use when high early strength is desired.

1.1.8 *Type IIIA*—Air-entraining cement for the same use as Type III, where air-entrainment is desired.

1.1.9 *Type IV*—For use when a low heat of hydration is desired.

1.1.10 *Type V*—For use when high sulfate resistance is desired.

NOTE 1—Some cements are designated with a combined type classification, such as Type I/II, indicating that the cement meets the requirements of the indicated types and is being offered as suitable for use when either type is desired.

NOTE 2—Cement conforming to the requirements for all types are not carried in stock in some areas. In advance of specifying the use of cement other than Type I, determine whether the proposed type of cement is or can be made available.

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 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 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.*

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

C183/C183M Practice for Sampling and the Amount of Testing of Hydraulic Cement

C185 Test Method for Air Content of Hydraulic Cement Mortar

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

C266 Test Method for Time of Setting of Hydraulic-Cement Paste by Gillmore Needles

[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.

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

C451 Test Method for Early Stiffening of Hydraulic Cement (Paste Method)
C452 Test Method for Potential Expansion of Portland-Cement Mortars Exposed to Sulfate
C465 Specification for Processing Additions for Use in the Manufacture of Hydraulic Cements
C563 Guide for Approximation of Optimum SO_3 in Hydraulic Cement
C1038/C1038M Test Method for Expansion of Hydraulic Cement Mortar Bars Stored in Water
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
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
IEEE/ASTM SI 10 American National Standard for Metric Practice

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions pertinent to this specification, see Terminology C219.

4. Ordering Information

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

4.1.1 This specification number and date,

4.1.2 Type or types allowable. If no type is specified, Type I shall be supplied,

4.1.3 Any optional chemical requirements from Table 2, if desired, and

4.1.4 Any optional physical requirements from Table 4, if desired.

5. Ingredients

5.1 The cement covered by this specification shall contain no ingredients except as follows:

5.1.1 *Portland Cement Clinker.*

5.1.2 *Water or Calcium Sulfate, or Both*—The amounts shall be such that the limits shown in Table 1 for sulfur trioxide and loss-on-ignition are not exceeded.

5.1.3 *Limestone*—The amount shall not be more than 5.0 % by mass such that the chemical and physical requirements of this specification are met (see Note 3). The limestone, defined in Terminology C51, shall be naturally occurring and consist of at least 70 % by mass of one or more of the mineral forms of calcium carbonate. If limestone is used, the manufacturer shall report the amount used, expressed as a percentage of cement mass, as determined using Annex A2, along with the oxide composition of the limestone.

NOTE 3—This specification permits portland cement to contain limestone, but does not require that limestone be an ingredient in the cement. Cement without ground limestone can be specified in the contract or order.

5.1.4 *Inorganic Processing Additions*—The amount shall be not more than 5.0 % by mass of cement. Not more than one

TABLE 1 Standard Composition Requirements

Cement Type[A]	Applicable Test Method	I and IA	II and IIA	II(MH) and II(MH)A	III and IIIA	IV	V
Aluminum oxide (Al_2O_3), max, %	C114	. . .	6.0	6.0	. . .	. . .	. . .
Ferric oxide (Fe_2O_3), max, %	C114	. . .	6.0[B]	6.0[B,C]	. . .	6.5	. . .
Magnesium oxide (MgO), max, %	C114	6.0	6.0	6.0	6.0	6.0	6.0
Sulfur trioxide (SO_3),[D] max, %	C114						
When $(C_3A)^E$ is 8 % or less		3.0	3.0	3.0	3.5	2.3	2.3
When $(C_3A)^E$ is more than 8 %		3.5	[F]	[F]	4.5	[F]	[F]
Loss on ignition, max, %	C114						
When limestone is not an ingredient		3.0	3.0	3.0	3.0	2.5	3.0
When limestone is an ingredient		3.5	3.5	3.5	3.5	3.5	3.5
Insoluble residue, max, %	C114	1.5	1.5	1.5	1.5	1.5	1.5
Equivalent alkalies (Na_2O + 0.658 K_2O), %	C114	[G]	[G]	[G]	[G]	[G]	[G]
Tricalcium silicate (C_3S),[E] max, %	See Annex A1	. . .	. . .	. . .	. . .	35[C]	. . .
Dicalcium silicate (C_2S),[E] min, %	See Annex A1	. . .	. . .	. . .	. . .	40[C]	. . .
Tricalcium aluminate (C_3A),[E] max, %	See Annex A1	. . .	8	8	15	7[C]	5[B]
Sum of C_3S + 4.75(C_3A),[H] max, %	See Annex A1	. . .	. . .	100[C,I]	. . .	. . .	. . .
Tetracalcium aluminoferrite plus twice the tricalcium aluminate (C_4AF + 2(C_3A)), or solid solution (C_4AF + C_2F), as applicable, max, %	See Annex A1	. . .	. . .	. . .	. . .	. . .	25[B]

[A] See Note 2.
[B] Does not apply when the sulfate resistance limit in Table 4 is specified.
[C] Does not apply when the cement complies with the heat of hydration limit in Table 4.
[D] It is permissible to exceed the values in the table for SO_3 content, provided it has been demonstrated by Test Method C1038/C1038M that the cement with the increased SO_3 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 7).
[E] See Annex A1 for calculation.
[F] Not applicable.
[G] Report equivalent alkalies as part of the manufacturer's certification (see Note 5).
[H] See Note 6.
[I] In addition, three-day heat of hydration testing by Test Method C1702 shall be conducted at least once every six months. Such testing shall not be used for acceptance or rejection of the cement, but results shall be reported for informational purposes.

TABLE 2 Optional Composition Requirements[A]

Cement Type	Applicable Test Method	I and IA	II and IIA	II(MH) and II(MH)A	III and IIIA	IV	V	Remarks
Tricalcium aluminate (C_3A),[B] max, %	See Annex A1	. . .	. . .	. . .	8	. . .	. . .	For moderate sulfate resistance.
Tricalcium aluminate (C_3A),[B] max, %	See Annex A1	. . .	. . .	. . .	5	. . .	. . .	For high sulfate resistance.

[A] These optional requirements apply only when specifically requested. Verify availability before ordering (see Note 2).
[B] See Annex A1 for calculation.

TABLE 3 Standard Physical Requirements

Cement Type[A]	Applicable Test Method	I	IA	II	IIA	II(MH)	II(MH)A	III	IIIA	IV	V
Air content of mortar,[B] volume %:	C185										
max		12	22	12	22	12	22	12	22	12	12
min		. . .	16	. . .	16	. . .	16	. . .	16	. . .	. . .
Fineness, specific surface, m^2/kg											
Air permeability test	C204										
min		260	260	260	260	260	260	. . .	. . .	260	260
max		. . .	. . .	. . .	. . .	430[C]	430[C]	. . .	. . .	430	. . .
Strength, not less than the values shown for the ages indicated as follows:[D]											
Compressive strength, MPa [psi]:	C109/C109M										
1 day		. . .	. . .	. . .	. . .	. . .	. . .	12.0 [1740]	10.0 [1450]	. . .	. . .
3 days		12.0 [1740]	10.0 [1450]	10.0 [1450]	8.0 [1160]	10.0 [1450]	8.0 [1160]	24.0 [3480]	19.0 [2760]	. . .	8.0 [1160]
7 days		19.0 [2760]	16.0 [2320]	17.0 [2470]	14.0 [2030]	17.0 [2470]	14.0 [2030]	. . .	. . .	7.0 [1020]	15.0 [2180]
28 days		. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	17.0 [2470]	21.0 [3050]
Time of setting; Vicat test:[E]	C191										
Time of setting, minutes, not less than		45	45	45	45	45	45	45	45	45	45
Time of setting, minutes, not more than		375	375	375	375	375	375	375	375	375	375

[A] See Note 2.
[B] Compliance with the requirements of this specification does not necessarily ensure that the desired air content will be obtained in concrete.
[C] Maximum fineness limits do not apply if the sum of $C_3S + 4.75(C_3A)$ is less than or equal to 90, or the cement complies with the heat of hydration limit in Table 4.
[D] The strength at any specified test age shall be not less than that attained at any previous specified test age.
[E] The time of setting is that described as initial setting time in Test Method C191.

TABLE 4 Optional Physical Requirements[A]

Cement Type	Applicable Test Method	I and II	IA and IIA	II(MH)	II(MH)A	III	IIIA	IV	V
Early stiffening, final penetration, min, %	C451	50	50	50	50	50	50	50	50
Heat of hydration:									
Isothermal Conduction Calorimetry:									
3 days, max, kJ/kg [cal/g]	C1702	. . .	. . .	335 [80][B]	335 [80][B]	. . .	. . .	200 [50][C]	. . .
7 days, max, kJ/kg [cal/g]		. . .	. . .	. . .	. . .	. . .	. . .	225 [55][C]	. . .
Strength, not less than the values shown:									
Compressive strength, MPa [psi]	C109/C109M								
28 days		28.0 [4060]	22.0 [3190]	28.0 [4060]	22.0 [3190]	. . .	. . .	. . .	. . .
Sulfate resistance,[D] 14 days, max, % expansion	C452	. . .[E]	. . .[E]	. . .[E]	. . .[E]	. . .	. . .	. . .	0.040
Gillmore test:	C266								
Initial set, min, not less than		60	60	60	60	60	60	60	60
Final set, min, not more than		600	600	600	600	600	600	600	600

[A] These optional requirements apply only when specifically requested. Verify availability before ordering (see Note 2).
[B] The limit for the sum of $C_3S + 4.75(C_3A)$ in Table 1 shall not apply when the cement complies with this limit.
[C] The limits of C_3S, C_2S, C_3A, and Fe_2O_3 in Table 1 shall not apply when the cement complies with this limit.
[D] When the sulfate resistance is specified, it shall be instead of the limits of C_3A, $C_4AF + 2(C_3A)$, and Fe_2O_3 listed in Table 1.
[E] Cement meeting the high sulfate resistance limit for Type V is deemed to meet the moderate sulfate resistance requirement of Type II and Type II(MH).

inorganic processing addition shall be used at a time. For amounts greater than 1.0 %, they shall have been shown to meet the requirements of Specification C465 for the inorganic processing addition in the amount used or greater. If an