Designation: C 1600/C 1600M – 07

# Standard Specification for Rapid Hardening Hydraulic Cement[1]

This standard is issued under the fixed designation C 1600/C 1600M; 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 is for rapid hardening hydraulic cements. 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 very early compressive strength development.

1.3 The values stated in either SI units or inch-pound units shall be regarded separately as standard. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

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.* (**Warning—**Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.[2])

## 2. Referenced Documents

2.1 *ASTM Standards:* [3]

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 151 Test Method for Autoclave Expansion of Hydraulic Cement

C 183 Practice for Sampling and the Amount of Testing of Hydraulic Cement

C 186 Test Method for Heat of Hydration of Hydraulic Cement

C 191 Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle

C 219 Terminology Relating to Hydraulic Cement

C 227 Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)

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 596 Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement

C 1012 Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution

C 1038 Test Method for Expansion of Hydraulic Cement Mortar Bars Stored in Water

C 1437 Test Method for Flow of Hydraulic Cement Mortar

## 3. Terminology

3.1 *Definitions*:

3.1.1 For definitions of terms used in this specification, see Terminology C 219.

3.2 *Definitions of Terms Specific to This Standard:*

3.3 *Rapid Hardening Hydraulic Cement*, *n*—a hydraulic or blended hydraulic cement which exhibits rapid strength gain during the first 24 h of hydration, with or without other constituents, processing additions, and functional additions.

## 4. Nomenclature, Classifications and Use

4.1 Cements conforming to this specification shall be designated "Rapid Hardening Hydraulic Cement" with the high early strength gain characteristic indicated by type in accordance with the types described in section 4.2. When the type is not specified, the requirement of Type GRH shall apply.

4.2 The specification is for four types of rapid hardening cement as follows:

4.2.1 *Type URH*—Ultra Rapid Hardening For use where *ultra high* early strength is desired (See Table 1).

[1] This test method is under the jurisdiction of ASTM Committee C01 on Cement and is the direct responsibility of Subcommittee C01.13 on Special Cements.

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[2] See the section on Safety, Manual of Cement Testing, *Annual Book of ASTM Standards*, Vol 04.01.

[3] 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.

**TABLE 1 Standard Physical Requirements**

(must be reported on manufacturer's certification)

| | Cement Type | | | |
|---|---|---|---|---|
| | URH | VRH | MRH | GRH |
| Compressive Strength (See Section 9 for procedures), min, MPa (psi) | | | | |
| 1½ h | 21 [3000] | 12 [1770] | . . . | . . . |
| 3 h | 28 [4000] | 15 [2280] | 10 [1500] | 7 [1000] |
| 6 h | . . . | . . . | 14 [2000] | 10 [1500] |
| 1 day | 35 [5000] | 24 [3480] | 17 [2500] | 14 [2000] |
| 7 days | 41 [6000] | 28 [4000] | 24 [4000] | 24 [3500] |
| 28 days | 57 [8300] | 35 [5000] | 31 [4500] | 28 [4000] |
| Drying Shrinkage, max % | | | | |
| 7 days | 0.06 | 0.06 | 0.08 | 0.10 |
| 28 days, air storage | 0.07 | 0.07 | 0.09 | 0.12 |
| Min Time of Final Set C 191 apparatus Minutes[A] | 10 | 10 | 10 | 10 |
| Autoclave, max expansion % | 0.8 | 0.8 | 0.8 | 0.8 |

[A]The initial setting time typically ranges from 10 to 45 min for rapid hardening cements of various types and composition.

4.2.2 *Type VRH*—Very Rapid Hardening For use where *very high* early strength is desired (See Table 1).

4.2.3 *Type MRH*—Medium Rapid Hardening for use where *mid-range* rapid hardening high early strength is desired (See Table 1).

4.2.4 *Type GRH*—General Rapid Hardening for use when the higher strength properties of a Type VRH or a Type MRH cement is not required (See Table 1).

## 5. Ordering Information

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

5.1.1 This specification designation and date.

5.1.2 The quantity of cement desired.

5.1.3 The type of cement desired.

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

## 6. 6. Chemical Composition

6.1 The chemical composition for the cement is not specified. However, the purchaser shall have the option to request the cement composition from the producer. If analyzed, the procedure used shall be Test Methods C 114.

## 7. Physical Properties

7.1 Cement of the type specified shall conform to all of the applicable standard physical requirements in Table 1.

7.2 The water/cement ratio used to determine strength requirement compliance shall be reported in the manufacturer's certification.

7.3 The density for the cement is not specified. However, the density shall be determined by the manufacturer and reported in the manufacturer's certification.

## 8. Sampling

8.1 When the purchaser desires that the cement be sampled and tested to verify compliance with this specification, the finished cement shall be sampled in accordance with Practice C 183 at the mill or at the job site in accordance with the purchaser's requirements (See Note 1).

NOTE 1—Practice C 183 is not designed for manufacturing quality control and is not required for manufacturer's certification.



## 9. Test Methods

9.1 When testing cement for compliance with this specification, use the following methods, with modifications or exceptions as indicated:

9.1.1 *Autoclave Expansion*—Determine autoclave expansion by Test Method C 151 as specified in Table 1.

9.1.2 *Time of Setting*—Determine the time of setting using Test Method C 191 as specified in Table 1. Immediately after molding the test specimen in the conical ring, determine the penetration of the needle at this time and every 3 min. until the needle no longer penetrates to the bottom of the specimen, then every 1 min. until final set is determined.

9.1.3 *Compressive Strength*—Determine compressive strength using Test Method C 109/C 109M as modified herein. Tests shall be run at each age specified in Table 1. The mixing water requirement in Test Method C 109/C 109M shall be adjusted to produce a flow of 110 ± 5 as determined using Test Method C 1437.

9.1.4 *Drying Shrinkage of Mortar*—Determine drying shrinkage of mortar as specified in Table 1 using Test Method C 596.

9.1.5 *Heat of Hydration*—Determine heat of hydration using Test Method C 186 (See Table 2).

9.1.6 *Sulfate Resistance*—Determine sulfate resistance using Test Method C 1012 (See Table 2).

9.1.7 *Alkali Silica Reactivity*—Determine reactivity of cement with alkali-reactive aggregate (Option R) using Test Method C 227 using crushed borosilicate glass, as described in Test Method C 441, as aggregate (See Table 2).

9.1.8 *Expansion in Water*—Determine expansion of hydraulic cement mortar bars stored in water by Test Method C 1038 (See Table 2).