



Designation: C 688 – 00

## Standard Specification for Functional Additions for Use in Hydraulic Cements<sup>1</sup>

This standard is issued under the fixed designation C 688; 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 approval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This specification covers methods to investigate the effectiveness of a material to beneficially change the properties of hydraulic cements when the material is interground with the clinker during manufacture of the cement.

1.2 The values stated in SI units are to be regarded as the standard.

1.3 The effect of additions in cement may markedly change properties other than those they are intended to modify. This specification is designed to test for such changes. Table 1 sets forth values for those properties of cement pastes and mortars that would permit a judgment of the changes effected by an addition. Likewise, Table 2 sets forth similar criteria for concrete. Certain additions may be found effective for more than one purpose as indicated in 3.1.4 and 3.1.5.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

- C 39 Test Method for Compressive Strength of Cylindrical Concrete Specimens<sup>2</sup>
- C 78 Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)<sup>2</sup>
- C 109/C 109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)<sup>3</sup>
- C 143 Test Method for Slump of Hydraulic Cement Concrete<sup>2</sup>
- C 150 Specification for Portland Cement<sup>3</sup>
- C 151 Test Method for Autoclave Expansion of Portland Cement<sup>3</sup>
- C 157 Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete<sup>2</sup>
- C 187 Test Method for Normal Consistency of Hydraulic Cement<sup>3</sup>
- C 191 Test Method for Time of Setting of Hydraulic Cement by Vicat Needle<sup>3</sup>

- C 219 Terminology Relating to Hydraulic Cement<sup>3</sup>
- C 226 Specification for Air-Entraining Additions for Use in the Manufacture of Air-Entraining Portland Cement<sup>3</sup>
- C 232 Test Method for Bleeding of Concrete<sup>2</sup>
- C 234 Test Method for Comparing Concretes on the Basis of the Bond Developed with Reinforcing Steel<sup>2</sup>
- C 266 Test Method for Time of Setting of Hydraulic Cement Paste by Gillmore Needles<sup>3</sup>
- C 403 Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance<sup>2</sup>
- C 451 Test Method for Early Stiffening of Portland Cement (Paste Method)<sup>3</sup>
- C 465 Specification for Processing Additions for Use in the Manufacture of Hydraulic Cements<sup>3</sup>
- C 595M Specification for Blended Hydraulic Cements<sup>3</sup>
- C 596 Test Method for Drying Shrinkage of Mortar Containing Portland Cement<sup>3</sup>
- C 666 Test Method for Resistance of Concrete to Rapid Freezing and Thawing<sup>2</sup>
- C 845 Specification for Expansive Hydraulic Cement<sup>3</sup>
- C 1157M Performance Specification for Blended Hydraulic Cement<sup>3</sup>

### 3. Terminology

#### 3.1 Definitions:

- 3.1.1 *accelerating addition*—a functional addition that accelerates the setting or early strength, or both, of concrete and mortar.
- 3.1.2 *retarding addition*—a functional addition that retards the setting of concrete and mortar.
- 3.1.3 *set-control addition*—a functional addition composed essentially of calcium sulfate in any hydration state from  $\text{CaSO}_4$  to  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ .
- 3.1.4 *water-reducing addition*—a functional addition used to reduce the quantity of mixing water required to produce concrete and mortar of a given consistency.
- 3.1.5 *water-reducing and accelerating addition*—a functional addition that reduces the quantity of mixing water required to produce concrete of a given consistency and that accelerates the setting or early strength development, or both, of concrete and mortar.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C01 on Cement and is the direct responsibility of Subcommittee C01.20 on Additions.

Current edition approved June 10, 2000. Published September 2000. Originally published as C 688 – 71 T. Last previous edition C 688 – 96.

<sup>2</sup> Annual Book of ASTM Standards, Vol 04.02.

<sup>3</sup> Annual Book of ASTM Standards, Vol 04.01.

**TABLE 1 Criteria for Evaluating Neat Cement and Mortar Containing Functional Cement Additions**

Tests	Type of Addition					
	Water Reducing	Retarding	Accelerating	Water-Reducing and Retarding	Water-Reducing and Accelerating	Set-Control
Normal consistency, deviation from control, percentage points <sup>A</sup>	-1.0 min	+1.0 max	+1.0 max	-1.0 min	-1.0 mm	±1.0 max
Standard consistency (flow) deviation from control, percentage points <sup>A</sup>	-4.0 min	+2.0 max	+2.0 max	-4.0 min	-4.0 min	±2.0 max
Setting time, (Gillmore) deviation from control, h:min						
Initial						
At least	...	1:00 later <sup>B</sup>		1:00 later <sup>B</sup>		...
Not more than	1:00 earlier nor 1:30 later	3:30 later	1:30 earlier nor 1:30 later	3:30 later	1:30 earlier nor 1:30 later	1:00 earlier nor 1:30 later
Setting time, Vicat Initial <sup>C</sup>						
At least	...	0:50 later <sup>B</sup>	...	0:50 later <sup>B</sup>	...	...
Not more than	0:50 earlier nor 1:15 later	2:50 later	1:15 earlier nor 1:15 later	0:50 later <sup>B</sup>	1:15 earlier nor 1:15 later	0:50 earlier nor 1:15 later
Final						
Not more than	1:00 earlier nor 1:30 later	3:30 later	1:00 earlier nor 1:30 later	3:30 later	1:00 earlier nor 1:30 later	1:00 earlier nor 1:30 later
Compressive strength, min, percent of control: <sup>D</sup>						
1 day in moist air	110	90	125 <sup>E</sup>	90	125	<sup>F</sup>
1 day in moist air, 2 days in water	110	90	125 <sup>E</sup>	100	125	
1 day in moist air, 6 days in water	110	90	100	110	110	
1 day in moist air, 27 days in water	110	95	95	110	110	
Autoclave Expansion						
max increase in % change in length compared to control	0.10	0.10	0.10	0.10	0.10	0.10
Drying Shrinkage of Mortar						
max % change in length compared to control	0.020	0.020	0.030	0.020	0.020	0.020

<sup>A</sup> The minus sign indicates that the percentage of water required shall be less than that of the control cement by at least the indicated percentage points.

<sup>B</sup> Or 50 % later, whichever is the lesser.

<sup>C</sup> Either Vicat or the Gillmore time of setting method shall be used at the choice of the manufacturer.

<sup>D</sup> The compressive strength of mortar containing the test cement shall be not less than 95 % of that attained at any previous test age. The objective of this limit is to require that the strength of mortar containing the addition under test shall not decrease with age.

<sup>E</sup> In cases where the accelerated set time only is required, the strength can be reduced to 100 % of the control.

<sup>F</sup> The grand average of the 1, 3, 7, and 28-day strengths shall be not less than 95 % of the grand average for the corresponding control cement.

### ASTM C688-00

3.1.6 *water-reducing and retarding addition*—a functional addition that reduces the quantity of mixing water required to produce concrete and mortar of a given consistency and simultaneously retards the setting of concrete and mortar.

NOTE 1—This section is intended to provide a specification that may be applied to calcium sulfates as defined in Terminology C 219.

NOTE 2—It should be realized that some calcium sulfates, particularly some byproduct calcium sulfates, have produced cements with undesired set behavior after storage.

## 4. Ordering Information

4.1 The purchaser shall specify the type of functional addition desired.

## 5. Materials

5.1 *Cements*—The cements used in the evaluation of the addition shall be as described in Section 4.1 of Specification C 465 with the following exceptions:

5.1.1 At least one of the Type I cements shall contain not less than 9 percent tricalcium aluminate (C<sub>3</sub>A).

5.1.2 Disregard the last sentence of Section 4.1.5 of Specification C 465 and substitute the following:“ Each control cement shall comply with all the requirements in the specification (C 150, C 595, C 845, and C 1157M) applicable to that type of cement. The method shall be adequate for the qualita-

tive and quantitative determination of the addition in the finished cement, and shall be fully described in the report of the tests on the addition.”

5.2 *Aggregates*—The aggregates used in the evaluation of the addition shall be in accordance with the Aggregates portion of the Materials section of Specification C 465, using proportions specified in Concrete Mixtures section of that specification.

## 6. General Requirements

6.1 The cement, mortar, and concrete in which each of the additions is used shall conform to the respective requirements prescribed in Table 1 and Table 2, except that if the test cement fails to meet the requirements of Table 1, but possesses all the requirements listed in Table 2, then the requirements of Table 2 shall govern approval of the addition.

6.2 The trade name, source, and character of the material shall be specified and the means for the quantitative determination of the proposed addition in the finished cement, shall be furnished by the manufacturer or seller of the addition, and the results of such pertinent quantitative analysis shall form a part of the record of tests of the addition.

6.3 At the request of the purchaser of an addition for a specific functional purpose, the manufacturer shall state in