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Standard Specification for Functional Additions for Use in Hydraulic Cements[1]

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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 incorporated during manufacture of the cement.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this 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:*[2]

C10/C10M Specification for Natural Cement
C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens
C78 Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
C143/C143M Test Method for Slump of Hydraulic-Cement Concrete
C150 Specification for Portland Cement
C151 Test Method for Autoclave Expansion of Hydraulic Cement
C157/C157M Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
C187 Test Method for Amount of Water Required for Normal Consistency of Hydraulic Cement Paste
C219 Terminology Relating to Hydraulic Cement
C226 Specification for Air-Entraining Additions for Use in the Manufacture of Air-Entraining Hydraulic Cement
C232 Test Methods for Bleeding of Concrete
C234 Test Method for Comparing Concretes on the Basis of the Bond Developed with Reinforcing Steel (Discontinued 2000) (Withdrawn 2000)[3]
C266 Test Method for Time of Setting of Hydraulic-Cement Paste by Gillmore Needles
C403/C403M Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
C451 Test Method for Early Stiffening of Hydraulic Cement (Paste Method)
C465 Specification for Processing Additions for Use in the Manufacture of Hydraulic Cements
C595 Specification for Blended Hydraulic Cements
C596 Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement
C666/C666M Test Method for Resistance of Concrete to Rapid Freezing and Thawing
C845 Specification for Expansive Hydraulic Cement
C1157 Performance Specification for Hydraulic Cement

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 $CaSO_4$ to $CaSO_4 \cdot 2H_2O$.

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

[1] This specification is under the jurisdiction of ASTM Committee C01 on Cement and is the direct responsibility of Subcommittee C01.20 on Additions.

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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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

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

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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[A]	−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[A]	−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[B]		1:00 later[B]		...
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[C]						
At least	...	0:50 later[B]	...		...	...
Not more than	0:50 earlier nor 1:15 later	2:50 later	1:15 earlier nor 1:15 later	0:50 later[B] 2:50 later	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:[D]						
1 day in moist air	110	90	125[E]	90	125	[F]
1 day in moist air, 2 days in water	110	90	125[E]	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

[A] 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.
[B] Or 50 % later, whichever is the lesser.
[C] Either Vicat or the Gillmore time of setting method shall be used at the choice of the manufacturer.
[D] 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.
[E] In cases where the accelerated set time only is required, the strength can be reduced to 100 % of the control.
[F] 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.

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required to produce concrete of a given consistency and that accelerates the setting or early strength development, or both, of concrete and mortar.

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 C219.

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 3.1, Cements, of Specification C465 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_3A).

5.1.2 Disregard the last sentence of Section 3.1.6 of Specification C465 and substitute the following: " Each control cement shall comply with all the requirements in the specification (C10/C10M, C150, C595, C845, and C1157) applicable to that type of cement. The method shall be adequate for the qualitative 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 C465, 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