



## Standard Specification for Modifiers for Masonry Mortars<sup>1</sup>

This standard is issued under the fixed designation C 1384; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope \*

1.1 This specification pertains to modifiers for masonry mortars. Modifiers are used to improve one or more of the recognized desirable properties of conventional masonry mortar.

1.2 Acceptance of a modifier is based on its performance in a modified mortar. Acceptance of the modified masonry mortar is based on attainment of performance either equivalent to that required for conventional mortar or improved performance of one or more indicated properties, while maintaining required performance levels for other properties.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

NOTE 1—The testing laboratory performing the test methods referenced in this specification should be evaluated in accordance with Practice C 1093.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

- C 91 Specification for Masonry Cement<sup>2</sup>
- C 144 Specification for Aggregate for Masonry Mortar<sup>3</sup>
- C 150 Specification for Portland Cement<sup>2</sup>
- C 207 Specification for Hydrated Lime for Masonry Purposes<sup>2</sup>
- C 270 Specification for Mortar for Unit Masonry<sup>3</sup>
- C 305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency<sup>2</sup>
- C 403 Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance<sup>4</sup>
- C 595 Specification for Blended Hydraulic Cements<sup>2</sup>
- C 723 Practice for Chemical-Resistant Resin Grouts for Brick or Tile<sup>3</sup>
- C 778 Specification for Standard Sand<sup>2</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C12 on Mortars and Grouts for Unit Masonry and is the direct responsibility of Subcommittee C12.09 on Modified Mortars.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 04.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 04.05.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 04.02.

C 780 Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry<sup>3</sup>

C 1093 Practice for Accreditation of Testing Agencies for Unit Masonry<sup>3</sup>

C 1152 Test Method for Acid-Soluble Chloride in Mortar and Concrete<sup>4</sup>

C 1218 Test Method for Water-Soluble Chloride in Mortar and Concrete<sup>4</sup>

C 1329 Specification for Mortar Cement<sup>2</sup>

C 1357 Test Method for Evaluating Masonry Bond Strength<sup>3</sup>

C 1403 Test Method for Rate of Water Absorption of Masonry Mortars<sup>3</sup>

### 3. Terminology

#### 3.1 Definitions of Terms Specific to This Standard:

3.1.1 *bond enhancer, n*—substance incorporated into a masonry mortar to increase the bond strength between the mortar and the masonry unit.

3.1.2 *modified mortar, n*—masonry mortar that deviates from those combinations of materials recognized by Specification C 270 in that it also contains a modifier.

3.1.3 *modifier, n*—substance added to a masonry mortar as an ingredient that improves one or more chemical or physical properties of the conventional masonry mortar.

3.1.4 *reference mortar, n*—mortar of the same composition as a modified mortar except that the reference mortar does not include the modifier and may contain a different amount of water to obtain an equivalent flow or penetration as the modified mortar.

3.1.5 *set accelerator, n*—substance incorporated into a masonry mortar to shorten the time of setting of a mortar.

3.1.6 *set retarder, n*—substance incorporated into a masonry mortar to lengthen the time of setting of a mortar.

3.1.7 *water repellent, n*—substance incorporated into a masonry mortar to decrease the rate of water absorption of the hardened mortar.

3.1.8 *workability enhancer, n*—substance incorporated into a masonry mortar to increase the ease of being worked and used. A workability enhancer will increase the board life and maintain the water retention of a mortar.

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

#### 4. Classification

4.1 Modifiers are classified by their effect on the performance characteristics of conventional masonry mortars. Modified mortars are classified by their modified properties, as compared to a reference mortar. The following classifications are recognized:

- 4.1.1 Bond Enhancer.
- 4.1.2 Workability Enhancer.
- 4.1.3 Set Accelerator.
- 4.1.4 Set Retarder.
- 4.1.5 Water Repellent.

#### 5. Materials

5.1 *Cements*—The cement used in the evaluation of the modifier shall conform to applicable requirements specified in 5.1.1-5.1.4.

5.1.1 *Cement, Portland*—When the modifier is evaluated in a mortar containing portland cement, the portland cement shall conform to the requirements for Type I, IA, II, IIA, III, or IIIA of Specification C 150.

5.1.2 *Cement, Blended Hydraulic*—When the modifier is evaluated in a mortar containing blended hydraulic cement, the blended hydraulic cement shall conform to the requirements for Type IS, IS-A, IP, IP-A, I(PM) or I(PM)-A of Specification C 595.

5.1.3 *Cement, Masonry*—When the modifier is evaluated in a mortar containing a masonry cement, the masonry cement shall conform to the requirements of Specification C 91.

5.1.4 *Cement, Mortar*—When the modifier is evaluated in a mortar containing a mortar cement, the mortar cement shall conform to the requirements of Specification C 1329.

5.2 *Lime*—When the modifier is evaluated in a cement-lime mortar, the hydrated lime shall conform to Specification C 207.

5.3 *Sand*—The fine aggregate used in the tests will vary dependent on the test procedure.

5.3.1 Sands used for flexural bond strength and rate of water absorption tests shall be a blend of equal parts by weight of graded standard sand and standard 20-30 sand conforming with Specification C 778.

5.3.2 Sands used for soluble chloride, compressive strength, water retention, determination of air content of plastic mortar, board life, and time of setting tests shall conform to the requirements of Specification C 144.

#### 6. Chemical Composition

6.1 The modifier shall not react adversely with embedded or attached materials common to masonry.

NOTE 2—Currently, there is no standard test method for determining the corrosion potential of masonry mortars toward embedded and attached materials. Nonetheless, the modifier shall not be offered for sale if the manufacturer has evidence that the modifier does react adversely with embedded or attached materials common to masonry.

6.2 At the maximum recommended dosage, the mortar modifier shall add not more than 0.15 kg/m<sup>3</sup> (0.0094 lb/ft<sup>3</sup>) water-soluble chloride, or 0.20 kg/m<sup>3</sup> (0.0125 lb/ft<sup>3</sup>) acid-soluble chloride to the mortar's overall chloride content as determined by testing of the reference and modified mortars in accordance with 9.1.1.

#### 7. Physical Properties

7.1 All modified masonry mortars shall comply with the property specification requirements of Specification C 270. In

TABLE 1 Physical Requirements<sup>A</sup>

	Bond Enhancer	Workability Enhancer	Set Accelerator	Set Retarder	Water Repellent
Compressive strength, min % of reference:					
7 day	80	80	80	70	80
28 day	80	80	80	80	80
Water retention, min % of reference:	report	100	report	report	report
Air content of plastic mortar, %	report	report	report	report	report
Board life, min % of reference	report	120	report	120	report
Time of setting <sup>B</sup> , allowable deviation from reference, h: min:					
Initial: at least	...	...	1:00 earlier	1:00 <sup>C</sup> later	...
not more than	1:00 earlier nor 1:30 later	1:00 earlier nor 3:30 later	3:30 earlier	8:00 <sup>C</sup> later	1:00 earlier nor 1:30 later
Final: at least	...	...	1:00 earlier	...	...
not more than	1:00 earlier nor 1:30 later	1:00 earlier nor 3:30 later	...	8:00 <sup>C</sup> later	1:00 earlier nor 1:30 later
Flexural bond strength, min % of reference	110	...	...	...	...
Rate of water absorption max % of reference 24 h	...	...	...	...	50

<sup>A</sup> The values in the table include allowance for normal variation in test results. In addition to meeting the requirements in this table, all modified mortars must meet the property requirements of Specification C 270.

<sup>B</sup> All time of setting tests shall be performed at 23 ± 3°C (73.4 ± 5.4°F), except those for set accelerators, which shall be performed at 5 ± 2°C (41 ± 3.6°F) as specified in 9.1.5.

<sup>C</sup> The manufacturer's maximum recommended dosage rate shall be used when testing the initial and final set times for a set retarder.

addition, the modified mortars shall conform to all of the specific classification requirements in Table 1 for which the modifier is obtaining qualification. Unless more specimens are required by a specific test method, a minimum of three specimens shall be tested and the results averaged. These result averages shall meet the requirements of this section.

7.2 Modifier compliance tests shall be the responsibility of the manufacturer of the modifier. These compliance tests shall be completed within the past five (5) years and prior to any modifier composition change.

## 8. Mortar Types and Proportions

8.1 Design the reference mortar to be a specific type of cement/lime, mortar cement, or masonry cement mortar in conformance with the proportion specification of Specification C 270 except that the aggregate ratio shall be fixed at three times the sum of the separate volumes of cementitious materials. In addition, the aggregate shall meet the requirements in 5.3.

8.2 The corresponding modified mortars shall have the same composition as the reference mortars but also shall include the modifier, and the water content shall be adjusted to yield the flow or penetration appropriate for each test method. The modifier dosage rate, time of addition, and mixing sequence shall follow the manufacturer's recommendations.

8.3 A complete set of tests shall be run for all applicable cement/lime, mortar cement, and masonry cement types for which the modifier is to be qualified.

## 9. Test Methods

9.1 For all required tests, test both the reference mortar and the modified mortar in accordance with the following test methods:

9.1.1 *Soluble Chloride Content*—Prepare six mortar cubes in accordance with the specimen preparation section of Test Method C 1403 including the drying procedure, except that mortar proportions shall be as specified in Section 8 and aggregates shall be as specified in 5.3. After 28 days of age, determine the water-soluble chloride content of three cubes, as percent chloride by mass of mortar, in accordance with Test Method C 1218 and the acid-soluble chloride content of the other three cubes, as percent chloride by mass of mortar, in accordance with Test Method C 1152. Determine the chloride mass per volume of mortar in accordance with 9.1.1.1.

9.1.1.1 Using calipers, measure the length of each specimen cube to the nearest 0.5 mm at three locations along its height and record as  $L_1$ , the average length in millimeters to the nearest 0.5 mm. Using calipers, measure the width of each specimen cube to the nearest 0.5 mm at three locations along its height and record as  $L_2$ , the average width in millimeters to the nearest 0.5 mm. Using calipers, measure the height of each specimen cube to the nearest 0.5 mm at three locations along its length and record as  $L_3$ , the average height in millimeters to the nearest 0.5 mm. Record the weight,  $W$ , in grams to the nearest 0.1 g of each specimen cube immediately prior to testing. Calculate the chloride mass per volume of mortar,  $Cl$ , of each specimen cube as follows:

$$Cl \text{ (kg/m}^3\text{)} = \%Cl \times W \times 10\,000 / (L_1 \times L_2 \times L_3) \quad (1)$$

$$Cl \text{ (lb/ft}^3\text{)} = Cl \text{ (kg/m}^3\text{)} \times 0.06242 \quad (2)$$

where:

$\%Cl$  = the percent chloride by mass of mortar as determined by Test Method C 1152 or C 1218, as appropriate,

$W$  = the weight of the specimen cube, immediately prior to testing, in grams to the nearest 0.1 g,

$L_1$  = the average length of the mortar specimen cube in mm to the nearest 0.5 mm,

$L_2$  = the average width of the mortar specimen cube in mm to the nearest 0.5 mm,

$L_3$  = the average height of the mortar specimen cube in mm to the nearest 0.5 mm.

9.1.2 *Compressive Strength*—Prepare and test mortar in accordance with Specification C 270, except that mortar proportions shall be as specified in Section 8 and aggregates shall be as specified in 5.3. Test three specimens at 7 days and three specimens at 28 days.

9.1.3 *Water Retention*—Prepare and test mortar in accordance with Specification C 270, except that mortar proportions shall be as specified in Section 8 and aggregates shall be as specified in 5.3.

9.1.4 *Air Content of Plastic Mortar*—Prepare mortar and determine air content of the plastic mortar in accordance with Specification C 270 except that mortar proportions shall be as specified in Section 8 and aggregates shall be as specified in 5.3. Calculate the air content to the nearest 0.1 % as follows:

$$D = \frac{(W_1 + W_2 + W_3 + W_4 + W_5 + V_w)}{\frac{W_1}{P_1} + \frac{W_2}{P_2} + \frac{W_3}{P_3} + \frac{W_4}{P_4} + \frac{W_5}{P_5} + V_w} \quad (3)$$

$$A = 100 - \frac{W_M}{4D}$$

where:

$D$  = density of air-free mortar, g/cm<sup>3</sup>,

$W_1$  = weight of portland cement, g,

$W_2$  = weight of hydrated lime, g,

$W_3$  = weight of mortar cement or masonry cement, g,

$W_4$  = weight of sand, g,

$W_5$  = weight of mortar modifier, g,

$V_w$  = mL of water used,

$P_1$  = density of portland cement, g/cm<sup>3</sup>,

$P_2$  = density of hydrated lime, g/cm<sup>3</sup>,

$P_3$  = density of mortar cement or masonry cement, g/cm<sup>3</sup>,

$P_4$  = density of sand, g/cm<sup>3</sup>,

$P_5$  = density of mortar modifier, g/cm<sup>3</sup>,

$A$  = volume of air, %, and

$W_M$  = weight of 400 mL of mortar, g.

9.1.5 *Board Life*—Test mortar in accordance with Test Method C 780, Annex A2 or, alternately, Annex A3, except for the modifications in this section. The mortar proportions shall be as specified in Section 8 and aggregates shall be as specified in 5.3. Prepare the mortar in accordance with the procedures of Test Method C 780, modifying those as appropriate when the modifier is added to the mortar. Mix the mortar for 5 min, timing from when water and cementitious materials are combined or as recommended by the manufacturer. The mixer used shall conform to that described in Practice C 305, or to that

described in Practice C 723, or shall be a paddle-type field mortar mixer.

9.1.5.1 If Test Method C 780, Annex A2 is used, prepare the mortar to have an initial penetration of  $60 \pm 5$  mm. Measure the initial penetration within 2 min from the completion of the mixing. Record the initial penetration as  $P_o$  and the time of this measurement as  $T_o$ . Test the sample using the disturbed sample procedure and measure the penetration at 15-min intervals until the penetration is less than 70 % of  $P_o$ . Record as  $T_f$  the interpolated time at which the penetration equals 70 % of  $P_o$ . Board life is defined as  $(T_f - T_o)$ , in minutes.

9.1.5.2 If Test Method C 780, Annex A3 is used, prepare the mortar to have an initial penetration resistance ( $P_o$ ) of either  $0.94 \pm 0.05$  psi or  $1.24 \pm 0.05$  psi as specified in the Annex A3. Board life is defined as  $T_f$  as specified in the Annex A3.

9.1.6 *Time of Setting*—Test mortar in accordance with Test Method C 403 except for the modifications in this section. The mortar proportions shall be as specified in Section 8 and aggregates shall be as specified in 5.3. Prepare the mortar in accordance with the procedures of Test Method C 780, modifying those as appropriate when the modifier is added to the mortar. Mix the mortar for 5 min, timing from when water and cementitious materials are combined or as recommended by the manufacturer. The mixer used shall conform to that described in Practice C 305, or to that described in Practice C 723, or shall be a paddle-type field mortar mixer. Prepare the mortar to have a flow of  $110 \pm 5$ . Prepare and test the mortar at a temperature of  $23 \pm 3^\circ\text{C}$  ( $73.4 \pm 5.4^\circ\text{F}$ ) for all modifier classifications except set accelerators. Prepare and test the mortar at a temperature of  $5 \pm 2^\circ\text{C}$  ( $41 \pm 3.6^\circ\text{F}$ ) for set accelerators.

9.1.7 *Flexural Bond Strength*—Prepare and test mortar in accordance with the Test Method for Laboratory-Prepared Specimens in Test Method C 1357 except that mortar proportions shall be as specified in Section 8 and aggregates shall be as specified in 5.3.

9.1.8 *Rate of Water Absorption*—Prepare and test mortar in accordance with Test Method C 1403, except that mortar proportions shall be as specified in Section 8 and aggregates shall be as specified in 5.3.

## 10. Product Marking

10.1 When the modifier is delivered in packages or contain-

ers, the modifier classification, the trade name of the modifier, the name of the manufacturer, and the weight of the modifier shall be marked clearly on each package or container.

10.2 If the total chloride content of the modifier is greater than 0.1 % by mass, then the modifier package or container shall have a label stating that the modifier contains chloride. In this case, the modifier package or container shall contain a label stating that at the maximum recommended dosage, the mortar modifier shall add not more than  $0.15 \text{ kg/m}^3$  ( $0.0094 \text{ lb/ft}^3$ ) water-soluble chloride or  $0.20 \text{ kg/m}^3$  ( $0.0125 \text{ lb/ft}^3$ ) acid-soluble chloride to the mortar's overall chloride content when tested according to this specification. If the modifier contains less than or equal to 0.1 % by mass, then no label referring to chloride is necessary.

## 11. Report

11.1 Report the following information:

11.1.1 Trade name, manufacturer, classification(s) of the modifier, and the type(s) of mortar for which the modifier is qualified.

11.1.2 Results of the tests specified in Sections 6 and 7 for each type of mortar for which the modifier is qualified. Include the results for both the reference mortar and the modified mortar. Also, include the flow or penetration value of the mortar used in each test as specified in each test method.

11.1.3 Brand name, manufacturer, and type of cement used in the test evaluation.

11.1.4 Brand name, manufacturer, and type of lime, if any, used in the test evaluation.

11.1.5 Description of, and test data on, the sand used in the test evaluation.

11.1.6 The mix design and weight of each component, including water, used in the mortar for each test batch. For those batches which contain a modifier, include the modifier dosage rate and time of addition.

## 12. Keywords

12.1 admixture; absorption; absorption rate; bond enhancer; masonry mortar; modified mortar; set accelerator; set retarder; water repellent; workability enhancer

**SUMMARY OF CHANGES**

Committee C12 has identified the location of selected changes to the standard since the C 1384–99 version that may impact the use of this standard.

(1) Sections 6.2 and 10.2 were revised to change the acceptable chloride limits from a “chloride as a weight percent of portland cement” basis to a “chloride per volume of mortar” basis.

(2) Section 9.1.1 was revised and section 9.1.1.1 was added to

change the sample preparation method, to specify a method for determining the mortar specimen volume and to specify a test calculation method so that “chloride per volume of mortar” can be determined.

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