Designation: C270 – 12

Standard Specification for Mortar for Unit Masonry[1]

This standard is issued under the fixed designation C270; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This specification covers mortars for use in the construction of non-reinforced and reinforced unit masonry structures. Four types of mortar are covered in each of two alternative specifications: (*1*) proportion specifications and (*2*) property specifications.

NOTE 1—When the property specification is used to qualify masonry mortars, the testing agency performing the test methods should be evaluated in accordance with Practice C1093.

1.2 The proportion or property specifications shall govern as specified.

1.3 When neither proportion or property specifications are specified, the proportion specifications shall govern, unless data are presented to and accepted by the specifier to show that mortar meets the requirements of the property specifications.

1.4 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.

1.5 The terms used in this specification are identified in Terminologies C1180 and C1232.

1.6 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.7 The following safety hazards caveat pertains only to the test methods section of this specification: *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C5 Specification for Quicklime for Structural Purposes
C91 Specification for Masonry Cement
C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
C110 Test Methods for Physical Testing of Quicklime, Hydrated Lime, and Limestone
C128 Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
C144 Specification for Aggregate for Masonry Mortar
C150 Specification for Portland Cement
C188 Test Method for Density of Hydraulic Cement
C207 Specification for Hydrated Lime for Masonry Purposes
C305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency
C511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
C595 Specification for Blended Hydraulic Cements
C780 Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
C952 Test Method for Bond Strength of Mortar to Masonry Units
C979 Specification for Pigments for Integrally Colored Concrete
C1072 Test Methods for Measurement of Masonry Flexural Bond Strength
C1093 Practice for Accreditation of Testing Agencies for Masonry
C1157 Performance Specification for Hydraulic Cement
C1180 Terminology of Mortar and Grout for Unit Masonry
C1232 Terminology of Masonry
C1324 Test Method for Examination and Analysis of Hardened Masonry Mortar

[1] This specification is under the jurisdiction of ASTM Committee C12 on Mortars and Grouts for Unit Masonryand is the direct responsibility of Subcommittee C12.03 on Specifications for Mortars.

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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**

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C1329 Specification for Mortar Cement
C1357 Test Methods for Evaluating Masonry Bond Strength
C1384 Specification for Admixtures for Masonry Mortars
C1489 Specification for Lime Putty for Structural Purposes
C1506 Test Method for Water Retention of Hydraulic Cement-Based Mortars and Plasters
C1586 Guide for Quality Assurance of Mortars
E72 Test Methods of Conducting Strength Tests of Panels for Building Construction
E514 Test Method for Water Penetration and Leakage Through Masonry
E518 Test Methods for Flexural Bond Strength of Masonry

2.2 *Masonry Industry Council:*[3]
Hot and Cold Weather Masonry Construction Manual, January 1999

3. Specification Limitations

3.1 Specification C270 is *not* a specification to determine mortar strengths through field testing.

3.2 Laboratory testing of mortar to ensure compliance with the property specification requirements of this specification shall be performed in accordance with 5.3. The property specification of this standard applies to mortar mixed to a specific flow in the laboratory.

3.3 The compressive strength values resulting from field tested mortars do not represent the compressive strength of mortar as tested in the laboratory nor that of the mortar in the wall. Physical properties of field sampled mortar shall not be used to determine compliance to this specification and are not intended as criteria to determine the acceptance or rejection of the mortar (see Section 8).

4. Materials

4.1 Materials used as ingredients in the mortar shall conform to the requirements specified in 4.1.1 to 4.1.4.

4.1.1 *Cementitious Materials*—Cementitious materials shall conform to the following ASTM specifications:

4.1.1.1 *Portland Cement*—Types I, IA, II, IIA, III, IIIA, or V of Specification C150.

4.1.1.2 *Blended Hydraulic Cements*—Types IS(<70), IS(<70)-A, IP, IP-A of Specification C595.

4.1.1.3 *Hydraulic Cements*—Types GU, HE, MS, and HS of Specification C1157 (Types MH and LH are limited to use in the property specifications only).

4.1.1.4 *Portland Blast-Furnace Slag Cement (for Use in Property Specifications Only)*—Types IS(≥70) or IS(≥70)-A of Specification C595.

4.1.1.5 *Masonry Cement*—See Specification C91.

4.1.1.6 *Mortar Cement*—See Specification C1329.

4.1.1.7 *Quicklime*—See Specification C5.

4.1.1.8 *Hydrated Lime*—Specification C207, Types S or SA. Types N or NA limes are permitted if shown by test or performance record to be not detrimental to the soundness of the mortar.

4.1.1.9 *Lime Putty*—See Specification C1489.

4.1.2 *Aggregates*—See Specification C144.

4.1.3 *Water*—Water shall be clean and free of amounts of oils, acids, alkalies, salts, organic materials, or other substances that are deleterious to mortar or any metal in the wall.

4.1.4 *Admixtures*—Admixtures shall not be added to mortar unless specified. Admixtures shall not add more than 65 ppm (0.0065 %) water soluble chloride or 90 ppm (0.0090 %) acid soluble chloride to the mortar's overall chloride content, unless explicitly provided for in the contract documents.

4.1.4.1 *Classified Admixtures*—Admixtures which are classified as bond enhancers, workability enhancers, set accelerators, set retarders, and water repellents shall be in accordance with Specification C1384.

4.1.4.2 *Color Pigments*—Coloring pigments shall be in accordance with Specification C979.

4.1.4.3 *Unclassified Admixtures*—Mortars containing admixtures outside the scopes of Specifications C1384 and C979 shall be in accordance with the property requirements of this specification and the admixture shall be shown to be nondeleterious to the mortar, embedded metals, and the masonry units.

4.1.4.4 *Calcium Chloride*—When explicitly provided for in the contract documents, calcium chloride is permitted to be used as an accelerator in amounts not to exceed 2 % by weight of the portland cement content or 1 % of the masonry cement content, or both, of the mortar.

NOTE 2—If calcium chloride is allowed, it should be used with caution as it may have a detrimental effect on metals and on some wall finishes.

5. Requirements

5.1 Unless otherwise stated, a cement/lime mortar, a mortar cement mortar, or a masonry cement mortar is permitted. A mortar type of known higher strength shall not be indiscriminately substituted where a mortar type of anticipated lower strength is specified.

5.2 *Proportion Specifications*—Mortar conforming to the proportion specifications shall consist of a mixture of cementitious material, aggregate, and water, all conforming to the requirements of Section 4 and the proportion specifications' requirements of Table 1. See Appendix X1 or Appendix X3 for a guide for selecting masonry mortars.

5.3 *Property Specifications*—Mortar conformance to the property specifications shall be established by tests of laboratory prepared mortar in accordance with Section 6 and 7.2. The laboratory prepared mortar shall consist of a mixture of cementitious material, aggregate, and water, all conforming to the requirements of Section 4 and the properties of the laboratory prepared mortar shall conform to the requirements of Table 2. See Appendix X1 for a guide for selecting masonry mortars.

5.3.1 No change shall be made in the laboratory established proportions for mortar accepted under the property specifications, except for the quantity of mixing water. Materials with different physical characteristics shall not be utilized in the mortar used in the work unless compliance with the requirements of the property specifications is re-established.

[3] Available from the Mason Contractors Association of America, 1910 South Highland Avenue, Suite 101, Lombard, IL 60148.

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TABLE 1 Proportion Specification Requirements

NOTE 1—Two air-entraining materials shall not be combined in mortar.

Mortar	Type	Proportions by Volume (Cementitious Materials)							Aggregate Ratio (Measured in Damp, Loose Conditions)
		Cement[A]	Mortar Cement			Masonry Cement			Hydrated Lime or Lime Putty	
			M	S	N	M	S	N		
Cement-Lime	M	1	...	...	...	...	...	...	¼	
	S	1	...	...	...	...	...	...	over ¼ to ½	
	N	1	...	...	...	...	...	...	over ½ to 1¼	
	O	1	...	...	...	...	...	...	over 1¼ to 2½	
Mortar Cement	M	1	...	...	1	...	...	...	...	Not less than 2¼ and not more than 3 times the sum of the separate volumes of cementitious materials
	M	...	1	...	...	...	...	...	...	
	S	½	...	...	1	...	...	...	...	
	S	...	...	1	...	...	...	...	...	
	N	...	...	...	1	...	...	...	...	
	O	...	...	...	1	...	...	...	...	
Masonry Cement	M	1	...	...	...	...	...	1	...	
	M	...	...	...	...	1	...	...	...	
	S	½	...	...	...	...	...	1	...	
	S	...	...	...	...	...	1	...	...	
	N	...	...	...	...	...	...	1	...	
	O	...	...	...	...	...	...	1	...	

[A] Includes Specification C150, C595, and C1157 cements as described in 4.1.1.

TABLE 2 Property Specification Requirements[A]

Mortar	Type	Average Compressive Strength at 28 days, min, psi (MPa)	Water Retention, min, %	Air Content, max, %[B]	Aggregate Ratio (Measured in Damp, Loose Conditions)
Cement-Lime	M	2500 (17.2)	75	12	
	S	1800 (12.4)	75	12	
	N	750 (5.2)	75	14[C]	
	O	350 (2.4)	75	14[C]	
Mortar Cement	M	2500 (17.2)	75	12	Not less than 2 ¼ and not more than 3 ½ the sum of the separate volumes of cementitious materials
	S	1800 (12.4)	75	12	
	N	750 (5.2)	75	14[C]	
	O	350 (2.4)	75	14[C]	
Masonry Cement	M	2500 (17.2)	75	18	
	S	1800 (12.4)	75	18	
	N	750 (5.2)	75	20[D]	
	O	350 (2.4)	75	20[D]	

[A] Laboratory prepared mortar only (see Note 4).
[B] See Note 5.
[C] When structural reinforcement is incorporated in cement-lime or mortar cement mortar, the maximum air content shall be 12 %.
[D] When structural reinforcement is incorporated in masonry cement mortar, the maximum air content shall be 18 %.

NOTE 3—The physical properties of plastic and hardened mortar complying with the proportion specification (5.1) may differ from the physical properties of mortar of the same type complying with the property specification (5.3). For example, laboratory prepared mortars batched to the proportions listed in Table 1 will, in many cases, considerably exceed the compressive strength requirements of Table 2.

NOTE 4—The required properties of the mortar in Table 2 are for laboratory prepared mortar mixed with a quantity of water to produce a flow of 110 ± 5 %. This quantity of water is not sufficient to produce a mortar with a workable consistency suitable for laying masonry units in the field. Mortar for use in the field must be mixed with the maximum amount of water, consistent with workability, in order to provide sufficient water to satisfy the initial rate of absorption (suction) of the masonry units. The properties of laboratory prepared mortar at a flow of 110 ± 5, as required by this specification, are intended to approximate the flow and properties of field prepared mortar after it has been placed in use and the suction of the masonry units has been satisfied. The properties of field prepared mortar mixed with the greater quantity of water, prior to being placed in contact with the masonry units, will differ from the property requirements in Table 2. Therefore, the property requirements in Table 2 cannot be used as requirements for quality control of field prepared mortar. Test Method C780 may be used for this purpose.

NOTE 5—Air content of non-air-entrained portland cement-lime mortar is generally less than 8 %.

6. Test Methods

6.1 *Proportions of Materials for Test Specimens*—Laboratory mixed mortar used for determining conformance to this property specification shall contain construction materials in proportions indicated in project specifications. Measure

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materials by weight for laboratory mixed batches. Convert proportions, by volume, to proportions, by weight, using a batch factor calculated as follows:

$$\text{Batch factor} = 1440/(80 \text{ times total sand volume proportion}) \quad (1)$$

Determine weight of material as follows:

$$\text{Mat. Weight} = \text{Mat.Volume Proportion} \times \text{Bulk Density} \times \text{Batch Factor} \quad (2)$$

NOTE 6—See Appendix X4 for examples of material proportioning.

6.1.1 When converting volume proportions to batch weights, use the following material bulk densities:

Material	Bulk Density
Portland Cement	Obtain from bag or supplier
Blended Cement	Obtain from bag or supplier
Hydraulic Cement	Obtain from bag or supplier
Slag Cement	Obtain from bag or supplier
Masonry Cement	Obtain from bag or supplier
Mortar Cement	Obtain from bag or supplier
Lime Putty	80 pcf (1280 kg/m^3)
Hydrated Lime	40 pcf (640 kg/m^3)
Sand	80 pcf (1280 kg/m^3)

NOTE 7—All quicklime should be slaked in accordance with the manufacturer's directions. All quicklime putty, except pulverized quicklime putty, should be sieved through a No. 20 (850 µm) sieve and allowed to cool until it has reached a temperature of 80°F (26.7°C). Quicklime putty should weigh at least 80 pcf (1280 kg/m^3). Putty that weighs less than this may be used in the proportion specifications, if the required quantity of extra putty is added to meet the minimum weight requirement.

NOTE 8—The sand is oven-dried for laboratory testing to reduce the potential of variability due to sand moisture content and to permit better accounting of the materials used for purposes of air content calculations. It is not necessary for the purposes of this specification to measure the unit weight of the dry sand. Although the unit weight of dry sand will typically be 85–100 pcf (1360–1760 kg/m ^{3}), experience has shown that the use of an assumed unit weight of 80 pcf (1280 kg/m^3) for dry sand will result in a laboratory mortar ratio of aggregate to cementitious material that is similar to that of the corresponding field mortar made using damp loose sand. A weight of 80 lb (36 kg) of dry sand is, in most cases, equivalent to the sand weight in 1 ft^3 (0.03 m^3) of loose, damp sand.

6.1.2 Oven dry and cool to room temperature all sand for laboratory mixed mortars. Sand weight shall be 1440 g for each individual batch of mortar prepared. Add water to obtain flow of 110 ± 5 %. A test batch provides sufficient mortar for completing the water retention test and fabricating three 2-in. cubes for the compressive strength test.

6.2 *Mixing of Mortars*—Mix the mortar in accordance with Practice C305.

6.3 *Water Retention*—Determine water retention in accordance with Specification C1506, except that the laboratory-mixed mortar shall be of the materials and proportions to be used in the construction.

6.4 *Air Content*—Determine air content in accordance with Specification C91 *except* that the laboratory mixed mortar is to be of the materials and proportions to be used in the construction. Calculate the air content to the nearest 0.1 % as follows:

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

$$A = 100 - \frac{W_m}{4D} \quad (3)$$

where:

D = density of air-free mortar, g/cm^3,
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 oven-dry sand, g,
V_w = millilitres of water used,
P_1 = density of portland cement, g/cm^3,
P_2 = density of hydrated lime, g/cm^3,
P_3 = density of mortar cement or masonry cement, g/cm^3,
P_4 = density of oven-dry sand, g/cm^3,
A = volume of air, %, and
W_m = weight of 400 mL of mortar, g.

6.4.1 Determine the density of oven-dry sand, P_4, in accordance with Test Method C128, except that an oven-dry specimen shall be evaluated rather than a saturated surface-dry specimen. If a pycnometer is used, calculate the oven-dry density of sand as follows:

$$P_4 = X_1/(Y + X_1 - Z) \quad (4)$$

where:

X_1 = weight of oven-dry specimen (used in pycnometer) in air, g,
Y = weight of pycnometer filled with water, g, and
Z = weight of pycnometer with specimen and water to calibration mark, g.

6.4.1.1 If the Le Chantelier flask method is used, calculate the oven-dry density of sand as follows:

$$P_4 = X_2/[0.9975\,(R_2 - R_1)] \quad (5)$$

where:

X_2 = weight of oven-dry specimen (used in Le Chantelier flask) in air, g,
R_1 = initial reading of water level in Le Chantelier flask, and
R_2 = final reading of water in Le Chantelier flask.

6.4.2 Determine the density of portland cement, mortar cement, and masonry cement in accordance with Test Method C188. Determine the density of hydrated lime in accordance with Test Methods C110.

6.5 *Compressive Strength:*

6.5.1 Determine compressive strength in accordance with Test Method C109/C109M. The mortar shall be composed of materials and proportions that are to be used in the construction with mixing water to produce a flow of 110 ± 5.

6.5.2 *Alternative Molding Procedure*—Immediately after determining the flow and mass of 400 mL of mortar, return all of the mortar to the mixing bowl and remix for 15 s at the medium speed. Then mold the test specimen in accordance with Test Method C109/C109M, except that the elapsed time for mixing mortar, determining flow, determining air entrainment, and starting the molding of cubes shall be within 8 min.

6.5.3 *Specimen Storage*—Keep mortar cubes for compressive strength tests in the molds on plane plates in a moist room or a cabinet meeting the requirements of Specification C511, from 48 to 52 h in such a manner that the upper surfaces shall

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be exposed to the moist air. Remove mortar specimens from the molds and place in a moist cabinet or moist room until tested.

6.5.4 *Testing*—Test specimens in accordance with Test Method C109/C109M.

7. Construction Practices

7.1 *Storage of Materials*—Cementitious materials and aggregates shall be stored in such a manner as to prevent deterioration or intrusion of foreign material.

7.2 *Measurement of Materials*—The method of measuring materials for the mortar used in construction shall be such that the specified proportions of the mortar materials are controlled and accurately maintained.

7.3 *Mixing Mortars*—All cementitious materials and aggregate shall be mixed between 3 and 5 min in a mechanical batch mixer with the maximum amount of water to produce a workable consistency. Hand mixing of the mortar is permitted with the written approval of the specifier outlining hand mixing procedures.

NOTE 9—These mixing water requirements differ from those in test methods in Section 6.

7.4 *Tempering Mortars*—Mortars that have stiffened shall be retempered by adding water as frequently as needed to restore the required consistency. No mortars shall be used beyond 2½ h after mixing.

7.5 *Climatic Conditions*—Unless superseded by other contractual relationships or the requirements of local building codes, hot and cold weather masonry construction relating to mortar shall comply with the Masonry Industry Council's "Hot and Cold Weather Masonry Construction Manual."

NOTE 10—*Limitations*—Mortar type should be correlated with the particular masonry unit to be used because certain mortars are more compatible with certain masonry units.

The specifier should evaluate the interaction of the mortar type and masonry unit specified, that is, masonry units having a high initial rate of absorption will have greater compatibility with mortar of high-water retentivity.

8. Quality Assurance

8.1 Compliance to this specification is verified by confirming that the materials used are as specified, meet the requirements as given in Section 2.1, and added to the mixer in the proper proportions. Proportions of materials are verified by one of the following:

8.1.1 Implementation and observation of appropriate procedures for proportioning and mixing approved materials, as described in Section 7.

8.1.2 Test Method C780 Annex 4, Mortar Aggregate Ratio to determine the aggregate to cementitious material ratio of mortars while they are still in a plastic state.

8.2 Guide C1586 is suitable for developing quality assurance procedures to determine compliance of mortars to this standard.

8.3 Test Method C780 is suitable for the evaluation of masonry mortars in the field. However, due to the procedural differences between Specification C270 and C780, the compressive strength values resulting from field sampled mortars are not required nor expected to meet the compressive strength requirements of the property specification of Specification C270, nor do they represent the compressive strength of the mortar in the wall.

8.4 Test Method C1324 is available to determine the proportions of materials in hardened masonry mortars. There is no ASTM method for determining the conformance of a mortar to the property specifications of Specification C270 by testing hardened mortar samples taken from a structure.

NOTE 11—The results of tests using Test Methods C780 Annex 4 and C1324 can be compared with Specification C270 proportion requirements; however, precision and bias have not been determined for these test methods.

NOTE 12—The results of tests done using Test Method C1324 can be compared with the Specification C270 proportion requirements, however, precision and bias have not been determined for this test method.

NOTE 13—Where necessary, testing of a wall or a masonry prism from the wall is generally more desirable than attempting to test individual components.

NOTE 14—The cost of tests to show initial compliance are typically borne by the seller. The party initiating a change of materials typically bear the cost for recompliance.

Unless otherwise specified, the cost of other tests are typically borne as follows:

If the results of the tests show that the mortar does not conform to the requirements of the specification, the costs are typically borne by the seller.

If the results of the tests show that the mortar does conform to the requirements of the specification, the costs are typically borne by the purchaser.

9. Keywords

9.1 air content; compressive strength; masonry; masonry cement; mortar; portland cement-lime; water retention; water retentivity

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