Designation: C780 – 17

Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry[1]

This standard is issued under the fixed designation C780; 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 U.S. Department of Defense.

INTRODUCTION

This test method provides a standard procedure for sampling and testing mortars for composition and plastic and hardened properties, either before or during actual construction. The procedures outlined in the Annexes are considered applicable for evaluating various combinations of portland cement, lime, and masonry cement for mortars common to plain and reinforced unit masonry construction.

The test procedures describe methods for the measurement of mortar composition and mortar properties. No attempt is made to claim or substantiate specific correlations between the measured properties and mortar performance in the masonry. However, data from these test methods can be combined with other information to formulate judgments about the quality of the masonry.

Testing using these procedures is limited to the preconstruction evaluation of masonry mortars within the laboratory, to the evaluation of masonry mortars at the construction site, and in establishing the degree of quality control exercised during mortar production at the construction site.

1. Scope*

1.1 This test method covers procedures for the sampling and testing of mortars for composition and for their plastic and hardened properties, either before or during their actual use in construction.

NOTE 1—Guide C1586 provides guidance on evaluating mortar and clarifies the purpose of both this test method and Specification C270.

NOTE 2—The testing agency performing this test method should be evaluated in accordance with Practice C1093.

1.2 *Preconstruction Evaluation*—This test method permits comparisons of mortars made from different materials under simulated field conditions. It is also used to establish baseline values for comparative evaluation of field mortars.

1.3 *Construction Evaluation*—Use of this method in the field provides a means for quality assurance of field-mixed mortar. It includes methods for verifying the mortar mix proportions, comparing test results for field mortars to preconstruction testing, and determining batch-to-batch uniformity of the mortar.

1.4 The test results obtained under this test method are not required to meet the minimum compressive values in accordance with the property specifications in Specification C270.

1.5 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.

1.6 *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.* For specific hazards statements, see Section 8.

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

[1] This test method is under the jurisdiction of ASTM Committee C12 on Mortars and Grouts for Unit Masonry and is the direct responsibility of Subcommittee C12.02 on Research and Methods of Test.

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens

C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)

C128 Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate

C173/C173M Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

C185 Test Method for Air Content of Hydraulic Cement Mortar

C187 Test Method for Amount of Water Required for Normal Consistency of Hydraulic Cement Paste

C231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

C270 Specification for Mortar for Unit Masonry

C470/C470M Specification for Molds for Forming Concrete Test Cylinders Vertically

C511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes

C617 Practice for Capping Cylindrical Concrete Specimens

C1093 Practice for Accreditation of Testing Agencies for Masonry

C1180 Terminology of Mortar and Grout for Unit Masonry

C1231 Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Cylindrical Concrete Specimens

C1586 Guide for Quality Assurance of Mortars

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

3. Terminology

3.1 Terminology defined in Terminology C1180 shall apply for this test method.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 Terms peculiar to testing masonry mortar are indicated and defined below:

3.2.2 *disturbed sample*—any plastic mortar test sample which is taken at some time after mixing and bulk sampling, that is further remixed or molded immediately prior to test, or both.

3.2.3 *undisturbed sample*—any plastic mortar test sample molded immediately after mixing and sampling that sits on a vibration-free surface until tested.

3.3 During sampling, the following descriptions will identify sample locations:

3.3.1 *Batch mixer samples* are those obtained during or immediately after the discharge of the mortar from the batch mixer.

3.3.2 *Mortar board samples* are those obtained from the mortar board after some established time period from the end of mixing, and before retempering. Retempered mortar board samples are those obtained from the mortar board after retempering. Since mortar on a mason's mortar board is disturbed by the activity of the mason, samples from a mason's mortar board shall be so identified to differentiate them from samples taken from a mortar board used exclusively for test purposes.

4. Summary of Test Method

4.1 Preconstruction evaluation of mortar systems involves the preparation of one or more trial batches which are mixed in the laboratory using mechanical batch mixers. These trial batches are sampled and used in establishing the plastic and hardened properties of the mixtures. Because all the trial mixtures are prebatched by weight, additional characteristics of the mortars may be calculated and used in an analysis of mortar performance.

4.2 During actual construction, evaluation of masonry mortars is possible by sampling the mortar at various stages of construction, and performing tests on both its plastic and hardened properties. The test results permit further verification of preconstruction testing, and reflect batch-to-batch variations introduced during mortar production and use at the construction site. More immediate corrective action for the mixing procedure is thereby attainable.

4.3 The following test methods may be singly or collectively incorporated into the testing to establish mortar composition, and mortar plastic and hardened properties:

4.3.1 Annex A1—Consistency by Cone Penetration Test Method,

4.3.2 Annex A2—Consistency Retention of Mortars for Unit Masonry,

4.3.3 Annex A3—Initial Consistency and Consistency Retention or Board Life of Masonry Mortars Using a Modified Concrete Pentrometer,

4.3.4 Annex A4—Mortar Aggregate Ratio Test Method,

4.3.5 Annex A5—Mortar Air Content Test Method, and

4.3.6 Annex A6—Compressive Strength of Molded Masonry Mortar Cylinders and Cubes.

5. Significance and Use

5.1 During preconstruction and construction evaluations, use of these test methods establishes specific and overall performance characteristics for the mortar system.

5.2 Preconstruction testing of mortars prebatched by weight provides information for the selection of the individual mortar system best suited for the masonry to be constructed. The recommended tests and their significance are as follows:

5.2.1 Consistency determinations by cone penetration (Annex A1) allow gaging the water additions for all mortars included in the preconstruction test series. Even if the mortar consistency as measured at the construction site is at a different penetration value than those measured during the preconstruction tests, the cone preparation test serves to standardize water additions for mortars being considered as alternatives before

[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.

construction. Additional testing of mortar water content-consistency relationships (Annex A4) will allow relating these two factors to batch-to-batch variations at the construction site.

5.2.2 Consistency retention by cone penetration (Annex A2) using disturbed or undisturbed mortar samples provides a means of establishing the early-age setting and stiffening characteristics of the mortars. Because laboratory testing is conducted under static climatic conditions, consistency retention test results reflect the relative performance of the mortar systems under test. The same general relationships are expected to hold during testing at the construction project, except as they are influenced by jobsite weather conditions.

5.2.3 Mortar water-content determinations (Annex A4) allow measurement of the water content of the mortar mixture. Mortars prebatched using moist masonry sand may be mathematically analyzed for mortar water content; however, this test, when used for preconstruction evaluation, establishes the effectiveness of the test method and serves as the control or base for tests performed at the construction site.

5.2.4 Mortar aggregate ratio testing (Annex A4) provides a method for determining the ratio of aggregate-to-cementitious materials. The sieving operation employed during this test is incapable of separating an individual cementitious material when more than one such material is used, but can accurately establish the aggregate-to-cementitious materials ratio of the mixture.

5.2.5 Mortar air-content testing (Annex A5) is useful in establishing the value of this component of the mortar. This test is of particular importance in evaluating mortars that contain air-entraining portland cement, air-entraining lime, masonry cement or any combination thereof.

5.2.6 Compressive strength testing (Annex A6) of molded mortar cylinders and cubes establishes one of the characteristics of hardened mortar. Mortar compressive strength test values are not representative of the actual compressive strength of mortar in the assembly and are not appropriate for use in predicting the compressive strength that would be attained by the mortar in the masonry assembly. The measured compressive strength of a molded mortar specimen is almost always lower than the strength of the same mortar in the wall, primarily as a result of differences in mortar water content and specimen shape. Mortar compressive strength is influenced by mortar water content at the time of set. Because molded mortar specimens are not in contact with absorptive masonry units and are not subjected to other mechanisms of water loss, they have higher water contents than mortar in the wall. Higher water contents almost always result in lower strengths. Specimen size and shape also affect compressive strength. Cylinders and cubes exhibit different strengths even when made from the same mortar mix. Both of these specimen configurations yield lower strengths than what would be attained if a specimen having the same size and configuration of a typical mortar joint could be reliably tested.

NOTE 3—When cube and cylinder test specimens from like mixtures are to be compared, the cylinder compressive strength is approximately 85 % of the cube compressive strength.

5.3 Testing during the actual construction may employ one or more of the test methods described in 4.2. Repetitive testing using these test methods on consecutive or intermittent batches provides a method for measurement of batch-to-batch variations in the mortar production. Testing during actual construction may be referenced to laboratory testing and used to predict later age mortar characteristics. In addition to the comments in 5.2, the following test meanings may be obtained from construction project testing:

5.3.1 Consistency by cone penetration (Annex A1) is used as a quick reference for indicating batch-to-batch variations in mix ingredients and mixing time. Erratic consistency readings indicate poor control during batching and mixing, but they do not indicate if cement, sand, or water additions are improper. Other test methods must be used to isolate and identify the unsatisfactory proportioning or mixing procedure, for example, cement to aggregate, mortar water, or air content tests.

5.3.2 Consistency retention by cone penetration (Annex A2) tests establishes the early-age setting and stiffening characteristics of the mortar. These properties are influenced by mix proportions and ingredients, weather conditions, effects of chemical additives, and mixing time.

5.3.3 Individual and repeated evaluations of mortar water content (Annex A4) show the ability of the mixer operator to properly and consistently add water to the mixer.

5.3.4 Individual and repeated tests for mortar aggregate ratio (Annex A4) show the ability of the mixer operator to properly and consistently add the cementitious material and sand to the mixer, and will establish batch-to-batch variations in the composition of the mortar.

5.3.5 Individual and repetitive tests for mortar air content (Annex A5) show the changes caused by variations in mixing time, mixing efficiency and other factors.

5.3.6 Comparison of compressive strength tests (Annex A6) of field batched mortars to preconstruction mortar compression tests, each conducted in accordance with this test method, can be used to identify variations in mortar mix constituents and/or proportions. Variations in compressive strength values typically indicate changes in mix water content, mixing procedures, mix materials, material proportions, and environmental conditions.

NOTE 4—Variations in the measured compressive strengths of field-sampled mortar and between the measured compressive strengths of construction and pre-construction mortar samples should be expected. Many of these variations result from sampling mortar from the mixer or mortarboard and do not necessarily translate into significant mortar strength variations in the wall. Unit suction will remove water from the mortar in the wall and the curing conditions are different. However, significant variation between measured compression strength values should prompt evaluation of probable causes of this variation. Conducting companion mortar aggregate ratio tests would assist in determining if changes in mix constituents and proportions are the likely cause. (See 5.2.6 for additional information).

6. Test Method Limitations

6.1 During mortar aggregate ratio testing, no attempt has been made to establish the proportions of either portland cement to lime or portland cement to masonry cement in the mixture. Additional testing could establish this proportioning, however, batching operations should be supervised to ensure the correct proportioning of these ingredients.

6.2 Due to the greater ability to weigh materials accurately, mix on a precise schedule, and control other factors relating to the production and testing of mortar under laboratory conditions as compared to field conditions, the principal purpose of this test method is to provide a means to identify, measure, evaluate, and control differences that exist between laboratory and jobsite mortars.

6.3 There is no ASTM standard method for measuring the composition or physical properties of hardened mortars removed from a structure.

7. Apparatus

7.1 The apparatus required for this test, along with the apparatus for sampling (see Section 9) are given in the individual tests included in the annexes.

8. Hazards

8.1 During any period that the alcohol used in the mortar aggregate ratio test is exposed to the atmosphere, and particularly when the test sample is being dried, the tester should be aware that alcohol is a very flammable material. Prior to drying the sample in an oven, place the sample in a shallow pan and flash off the alcohol by intentional ignition in an open, well-ventilated area.

9. Sampling

9.1 This section deals with the sampling of individual mortar ingredients and of the mortar itself for preconstruction evaluation in the laboratory and construction evaluation at the jobsite.

9.2 Complete the sampling of materials as follows:

9.2.1 Bagged material, such as portland cement, lime, and masonry cement, shall be of the type and brand that will be used or is being considered for use in the actual construction. Obtain full-bag lots in sufficient quantity for completing the desired tests.

9.2.2 Aggregate for test purposes shall be from the same source and of the same description as will be used or is being considered for use in the actual construction. Obtain a representative sample of sufficient quantity to complete the desired tests.

9.2.3 Water for test purposes need not be the same as that to be used in construction, except when it is known or suspected that the properties of the water available for mortar production at the construction site will have a measurable effect upon the mortar properties. In normal testing, clean, potable water shall be acceptable for test purposes.

9.3 Obtain plastic mortar samples both in the laboratory and at the construction project by taking uniformly distributed incremental samples, and mixing them to form a bulk sample from which the quantity of mortar required for a specific test or specimen can be randomly taken. When preconstruction testing is performed, the sampling method used in construction testing shall be the same as that used during preconstruction testing.

NOTE 5—Many factors, including sampling, can affect the characteristics of fresh mortar. Sampling should be done in a consistent manner. Unless specific time-dependent properties of the mortar are being evaluated, sampling should be done in accordance with 9.3.1.

9.3.1 Take batch mixer samples immediately after mixing, either during the discharge of the mixer or after the mortar has been discharged into the mortar receptacle. If samples are taken during the discharge of the mixer, they shall be taken at any time except for the first and last 10 % of the batch. Samples of the mortar taken after discharge from the mixer shall be representative of the entire batch.

9.3.2 Take mortar for mortar board tests in accordance with 9.3.1, and place upon mortar boards typical of those used or to be used at the project. For construction site testing, expose the test mortar on the board(s) to climatic conditions typical of those on the jobsite. When mortar from a mason's mortar board is used for test purposes, identify it further to reflect this exception for proper data interpretation. Thoroughly hand-mix mortar selected for testing with a trowel immediately before sampling for tests or specimens. Record the lapsed time from the end of mixing as part of the test data.

9.3.3 Take retempered mortar board samples from the mason's mortar board at recorded time periods after mixing and retempering. Thoroughly hand-mix all mortar on the board with a trowel before sampling.

9.4 *Time to Test:*

9.4.1 The test for cone penetration (Annex A1) shall be started within five minutes after obtaining the final portion of the sample.

9.4.2 The initial readings for consistency retention (Annex A2 and Annex A3) shall be started within five minutes after obtaining the final portion of the sample.

9.4.3 The mortar samples for mortar-aggregate ratio (Annex A4) shall be introduced into the containers with alcohol within five minutes after obtaining the final portion of the sample.

9.4.4 The test for air content (Annex A5) shall be started within five minutes after obtaining the final portion of the sample.

9.4.5 Molding of specimens for compressive strength (Annex A6) shall be started within 15 minutes after obtaining the final portion of the sample.

9.5 Record sampling procedures to include the date, time, place, and method of sampling. When applicable, note and record the climatic conditions.

10. Test Specimens

10.1 During preconstruction evaluation of masonry mortars, measure plastic mortar properties using a single test specimen for each part of the tests. For determining hardened mortar properties, prepare three test specimens for each test age and property.

10.2 During construction evaluation of masonry mortars, measure plastic mortar properties using a single test specimen for each part of the method of test. For determining hardened mortar properties, prepare three test specimens for each test age and property.

10.3 During actual construction evaluation of masonry mortars, and when batch-to-batch variations are to be established, sample three consecutive batches and test for plastic and hardened properties.

11. Procedure

11.1 *Mortar Preparation*—Prepare and mix the mortar for preconstruction evaluation in the laboratory using the materials (see 9.2.3, regarding water) and proportions intended for use in construction. Use a mechanical batch mixer similar to that intended for use in construction.

11.1.1 Use masonry sand in the damp, as-received condition, and handle in such a manner as to prevent segregation. Correct the water added to the mortar as free water in sands above the saturated, surface-dry condition, in accordance with Test Method C128. Report the total water used in the mix.

11.1.2 Prebatch the mortar materials, by weight, to meet the desired volume proportions.

11.1.3 *Mixing*—Mix the mortar following this sequence:

11.1.3.1 For each batch, mix mortar in accordance with mixing instructions provided. If no instructions are provided, mix in accordance with the method below. Charge the mixer for preconstruction evaluation tests as follows:

(1) approximately ½ to ¾ of the estimated mixing water required,

(2) ½ to all of the sand,

(3) all the cementitious materials and mix briefly, and

(4) add the remainder of the sand, if any, and the balance of the mixing water required to produce the desired consistency. Inasmuch as laboratory procedures permit a more rapid combination of materials than is generally achieved under actual construction conditions, time delays between the various mixing sequences must be made to approximate jobsite situations.

(5) Mix the mortar at normal speed for 3 to 5 min after the completion of the charging sequence. Mortar shall be mixed for a minimum of one minute after subsequent water additions.

NOTE 6—For best results, mix mortar in the same way each time it is sampled. Alternative mixing equipment may require shorter mixing times than traditional paddle mixers.

11.1.3.2 Determine the cone penetration value of the mortar for preconstruction evaluation tests in accordance with Annex A1.

NOTE 7—There is some disagreement regarding the relative values of the cone penetration test versus the flow table test. The cone penetration test is selected for this procedure since a flow table mounted in accordance with applicable ASTM specifications is not practically portable, and correlation between laboratory and field would be lost if one procedure used the flow table and the other the cone penetrometer.

11.2 Complete the preconstruction and construction evaluation in accordance with the test methods appended, Annex A1 – Annex A6.

12. Report

12.1 A complete report shall include the following information:

12.1.1 Name and address of the testing laboratory,

12.1.2 Identification of the report and the date of issue,

12.1.3 Name and address of the client and the identification of the project,

12.1.4 Description and identification of the test sample, including:

12.1.4.1 Description of constituent mortar materials,

12.1.4.2 Identification of mixing procedures,

12.1.4.3 For field-batched mortar, material proportions, and

12.1.4.4 For preblended dry mortar materials, reference to lot number, run number, or other marking provided by the manufacturer.

12.1.5 Date of receipt of the test sample,

12.1.6 Date(s) of sampling and identification of sampling method used,

12.1.7 Date(s) of test performance,

12.1.8 Identification of the standard test method used and a notation of any known deviation from the test method,

12.1.9 Name of the person(s) accepting technical responsibility for the test report,

12.1.10 Identification of subcontractor test results, if applicable.

12.2 A complete report shall also include the test results and all pertinent data relating to the conduct and conditions of the tests in the test report, as required by the applicable Annex. The data sheet in Appendix X1 is suggested as a general format for the development of report forms.

13. Keywords

13.1 aggregate ratio; air content; compressive strength; concrete penetrometer; cone penetrometer; consistency; consistency retention; mortar

ANNEXES

(Mandatory Information)

A1. CONSISTENCY BY CONE PENETRATION TEST METHOD

A1.1 Scope

A1.1.1 This test method covers a procedure for determining the consistency of mortars for unit masonry by measuring the penetration of a conical plunger into a mortar sample.

A1.2 Apparatus

A1.2.1 *Unit Measure*—A cylindrical measure conforming to the physical requirements of Test Method C185.

A1.2.2 *Straightedge*—A steel straightedge not less than 4 in. (101.6 mm) long and not less than 1⁄16 in. (1.59 mm) nor more than 1⁄8 in. (3.2 mm) in thickness.

A1.2.3 *Tamper*—In accordance with Test Method C109/C109M. The tamping face shall be flat and at right angles to the length of the tamper.

A1.2.4 *Tapping Stick*—A maple wood rod, having a diameter of 5⁄8 in. (15.9 mm) and a length of 6 in. (152.4 mm).

A1.2.5 *Spoon,* metal, kitchen-type, with the handle cut off to make the overall length approximately 9 in. (228.6 mm) and with the bowl of the spoon being approximately 4 in. (101.6 mm) long, 2½ in. (63.5 mm) in width at the widest portion, and ½ to ¾ in. (12.7 to 19.05 mm) deep.

A1.2.6 *Cone Penetrometer*—A Vicat apparatus, conforming to the physical requirements of Test Method C187, shall be modified to allow reading cone penetrations to a depth of 89 mm. The frame shall be raised 2 in. (50.8 mm) to accommodate the unit measure and the plunger in the raised position. The indicator scale shall be extended to allow measuring a full drop of 89 mm. The plunger shall be an aluminum cone, 15⁄8 in. (41.3 mm) in diameter by 35⁄8-in. (92.08-mm) long, blunted to a hemisphere a distance of 1⁄8 in. (3.2 mm) making the overall length 3½ in. (88.9 mm). The base of the cone shall be drilled and tapped on the centerline for threading to a stainless steel tube of proper size and able to slide freely in the guides of the apparatus. The weight of the tube shall be adjusted so that the combined weight of the cone, tube and index pointer is 200 ± 2 g.

A1.3 Procedure

A1.3.1 Begin filling the unit measure within five minutes of obtaining the final portion of the sample.

A1.3.2 Using the spoon, place the mortar gently into the measure in three layers of equal volume, tamping each layer 20 times with the tamper in one complete revolution around the inner surface of the measure. Consider one complete up-and-down motion of the tamper held in a vertical position as one tamping. In tamping the first layer, do not strike the tamper forcibly against the bottom of the measure. In tamping the second and third layers, each layer is tamped in one complete revolution (rotation) with only sufficient pressure to adequately fill the measure and eliminate voids within the mortar. After the measure has been filled and tamped in the above prescribed manner, tap the sides of the measure lightly with the side of the tapping stick once each at five different points at approximately equal spacing around the outside of the measure in order to preclude entrapment of extraneous air. Take care that no space is left between the mortar and the inner surface of the measure as a result of the tamping operation. Then cut the mortar off to a plane surface flush with the top of the measure, by drawing the straightedge with a sawing motion across the top of the measure, making two passes over the entire surface, the second pass being made at right angles to the first. Take care in the striking-off operation that no loose sand grains cause the straightedge to ride above the top surface of the measure. Complete the entire operation of filling and striking off the measure within 1½ min. Wipe off all mortar and water adhering to the outside of the measure.

A1.3.3 Raise the penetration plunger and slide the unit measure underneath the plunger until the point of the plunger rests on the edge of the container. Tighten the set screw just enough to hold the plunger and move the indicator opposite the zero point of the scale.

A1.3.4 Center the container under the plunger and release the plunger with a swift, definite turn of the set screw while holding the entire apparatus firmly with the other hand.

A1.3.5 Read the depth of penetration in millimetres at the end of 30 seconds.

A1.4 Report

A1.4.1 Report the depth of cone penetration to the nearest 1 mm.

A2. CONSISTENCY RETENTION OF MORTARS FOR UNIT MASONRY

A2.1 Scope

A2.1.1 This method describes a procedure for determining the consistency retention of mortars after various time intervals by the cone penetration test method. Both disturbed and undisturbed sample testing are included in the method. Unless otherwise stipulated, only the disturbed sample testing will be required.

A2.2 Apparatus

A2.2.1 In addition to the apparatus required for completing the cone penetration test in Annex A1, extra unit measures and glass cover plates are required when using the undisturbed sample test procedure for each test time to be included in the determination of consistency retention. No additional equipment is necessary using the disturbed mortar sample test procedure.

A2.3 Procedure

A2.3.1 Begin filling the unit measure(s) within five minutes of obtaining the final portion of the sample.

A2.3.2 *Disturbed Samples*—When testing disturbed mortar samples, sample and use the mortar in filling the mortar test container immediately prior to conducting the test. Sample the mortar as it is discharged from the mixer, and place on a mortar board reserved for test purposes. This mortar shall not be used by the mason, or disturbed until immediately prior to testing. Just before the test, remix the mortar sample with a trowel until it is of uniform consistency. Then agitate or handle the mortar just enough to allow proper consolidation of the mortar in the test container. After the mortar sample has been consolidated in the mold as described in Annex A1, immediately complete the test. The normal interval between tests is 15 min.

A2.3.3 *Undisturbed Samples*—When testing undisturbed mortar samples, prepare the test specimens for all test ages immediately after the mortar is discharged from the mixer. Prepare one test specimen in accordance with Annex A1 for each test age. One test container will be required for each test. Immediately after filling the test container, cover the sample with a cover plate and invert the entire assemblage and place upon a firm, level surface. Immediately prior to testing, turn the assemblage upright and remove the cover plate. The normal interval between tests is 15 min. Two options are available under this test procedure. The method given for undisturbed samples in A2.3.3 minimizes, by the use of the cover plate, the effects of surface moisture evaporation on the consistency of the mortar. Although a mason seldom uses a board of mortar which has sat undisturbed for some time without mixing it with his trowel first, some mortar study programs may wish to include determinations of these surface effects. If this is desired, vary the procedure by not covering and not inverting the test molds for the interval between their preparation and testing. The test report must note the use of this alternate procedure when it is employed.

A2.3.4 Determine the penetration of the cone into the mortar sample as described in Annex A1.

A2.3.5 Record the first measured penetration as P_o.

A2.3.6 Except when required by another standard, repeat the procedure in A2.3.4 at 15 minute intervals until the measured penetration is less than 70 % of P_o. See Note A2.1.

NOTE A2.1—Some specifications and test methods may reference the consistency by cone penetration test and provide reading intervals and test duration. When this information is provided in the standard that references ASTM C780, those test details should be used.

A2.4 Report

A2.4.1 The report shall include the following:

A2.4.1.1 Depth of penetration to the nearest 1 mm,

A2.4.1.2 Notation as to whether the data refers to disturbed or undisturbed samples, and

A2.4.1.3 Test time.

A3. INITIAL CONSISTENCY AND CONSISTENCY RETENTION OR BOARD LIFE OF MASONRY MORTARS USING A MODIFIED CONCRETE PENETROMETER

A3.1 Scope

A3.1.1 This method allows determination of initial consistency and board life of masonry mortars. The method is sufficiently restrictive to be used as a basis for acceptance of mortars. Results correspond to pounds per square inch of pressure required to penetrate a sample of mortar 1 in. with a disk of a given size and weight. English units of measure will be used throughout the method.

A3.2 Terminology

A3.2.1 *Definitions:*

A3.2.1.1 *board life*—the time period during which penetration resistance stays below a given value (P_f).

A3.2.1.2 P_o—the initial penetration resistance or consistency of a masonry mortar as measured, using this method.

A3.2.1.3 P_f—the penetration resistance or consistency of a masonry mortar when the mortar is too stiff for use.

A3.2.1.4 *rate of stiffening*—the ratio of the difference between P_o and P_f per time interval.

A3.2.1.5 T_o—the time when the initial penetration resistance measurement was made.

A3.2.1.6 T_f—the time when P_f was reached, obtained by interpolation.

A3.3 Significance and Use

A3.3.1 Data obtained from this method are used to determine consistency of a mortar, as well as board life of a mortar. The method is also useful for determining when a mortar is or is not acceptable for use due to stiffness. When penetration resistance is outside the desired range (P_o to P_f) the mortar is retempered or discarded.

A3.4 Apparatus

A3.4.1 *Concrete Penetrometer,* spring activated with calibration markings from 20 to 700 psi. The penetrometer shall be modified as required by A3.4.1.1. The modification of the penetrometer prevents direct use of the scale on the penetrometer. Therefore, the penetrometer shall be calibrated in accordance with A3.6.

A3.4.1.1 *Disk Modification*—The penetrometer shall be modified by securely attaching a disk perpendicular to the bottom of the penetrometer shaft. The disk shall be 1 ± 1⁄16 in. thick with a diameter of 2.65 to 3.05 in. The disk material shall be rigid and non-absorbent. See Note A3.1.

NOTE A3.1—Pocket-sized concrete penetrometers are available in different configurations. Satisfactory results have been achieved with a disk made of either (1) machined steel secured to the penetrometer shaft with a retaining sleeve and thumbscrew, or (2) vulcanized rubber (such as a regulation National Hockey League puck) secured to the penetrometer shaft by epoxying the shaft to a hole drilled into the center of the disk. Other materials and securing methods can be used as long as they meet the requirements of A3.4.1.1. It is recommended that the disk also be abrasion resistant and resistant to chemical attack by mortar.

A3.4.2 *Trowel*—A mason's trowel.

A3.4.3 *Shovel*—A square nosed shovel.

A3.4.4 *Ring*—A 16-in. inside diameter ring made of steel or other rigid, chemical and abrasive resistant material, 3 in. high with exterior, opposing handles.

A3.4.5 *Mortar Board*—A nominal 2 ft by 2 ft by ¾ in. mortar board of exterior grade plywood.

A3.4.6 *Straightedge*—A wooden straightedge of nominal dimensions, 2 in. by 4 in. and 24 in. in length (optional).

A3.5 Sampling, Test Specimens, and Test Units

A3.5.1 At least one specimen shall be prepared for each mortar.

A3.5.2 Test condition shall be either actual climatic conditions and construction practices at the construction site or simulated conditions considering temperature, humidity, wind, sand, water, mixing equipment, handling, mixing procedure, etc.

A3.6 Calibration and Standardization

A3.6.1 Calibrate the penetrometer by placing it on a weigh scale with a capacity of 30 lb and accurate to 0.05 lb. Place the penetrometer on the weigh scale platform and tare to zero. Push downward on the handhold of the penetrometer until the weigh scale registers 1 lb. This pressure shall be applied within for three seconds. Read and record penetrometer scale pressure. Repeat applications of downward force in increments of 1 lb from 1 to 30 lb and record each incremental penetrometer scale reading. Divide the total applied load plus the weight of the penetrometer by the cross sectional area of the disk. These values represent pressure at the face of disk. Prepare a calibration chart to allow converting penetrometer scale reading to penetration resistance, in psi. See Table A3.1.

TABLE A3.1 Penetrometer Calibration (5.67 in.^{2} Disk, 2.47 lb of Penetrometer and Disk)

NOTE 1—The pressure exerted on the specimen is the measured weight plus the weight of the penetrometer and disk divided by the area of the disk. For example, the disk weighs 2.47 lb and the area of the disk is 5.67 in.^{2}; 1 lb of measured weight + 2.47 lb weight of penetrometer and disk (tare)/5.67 in.^{2} = 0.61 psi.

Measured Weight, lb	Scale Readings	psi
1	20	0.61
2	40	0.79
3	60	0.96
4	80	1.14
5	100	1.32
6	120	1.49
7	140	1.67
8	160	1.85
9	180	2.02
10	200	2.20
11	220	2.38
12	240	2.55
13	260	2.73
14	280	2.90
15	300	3.08
16	320	3.26
17	340	3.43
18	360	3.61
19	380	3.79
20	400	3.96
21	420	4.14
22	440	4.32
23	460	4.49
24	480	4.67
25	500	4.84
26	520	5.02
27	540	5.20
28	560	5.37
29	580	5.55
30	600	5.73

A3.7 Procedure

A3.7.1 Mortar to be tested for board life shall be prepared so the initial penetration resistance (P_o) is either 0.94 ± 0.05 psi for mortar to be used with *brick sized units* or 1.24 ± 0.05 psi for mortar to be used with *heavier units requiring less plastic mortars for proper bedment*. Water additions to the mortar decrease penetration resistance. Prepare comparison mortars with varied composition and proportions controlling equipment and procedures.

A3.7.2 Begin filling the circular ring within five minutes of obtaining the final portion of the sample.

A3.7.3 Place the mortar in the circular ring, previously centered on the damp mortar board. Spade the mortar with the square-nosed shovel. Screed the top surface of the specimen to the surface of the ring using either the straightedge or trowel. Remove mold within three min after mortar mixing was completed. Immediately take three penetration readings. Position the disk of the penetrometer on the surface of the mortar at least one disk diameter from both the edge and previous test areas. Apply uniform pressure within three seconds so the disk penetrates the mortar a distance of 1 in., the disk thickness. Read the penetrometer scale to the nearest 5 psi and record penetrometer scale reading and time of readings. Reset scale marker to zero. Average the three readings and convert to applied pressure, in psi, using the calibration curve. Record this result as P_o, psi, and the time as T_o, min.

A3.7.4 Within two minutes after completing the three initial penetration readings, thoroughly remix the mortar using mason's trowel. Position ring, screed, and remove ring. Allow mortar to remain undisturbed for 15 min since T_o. Read and

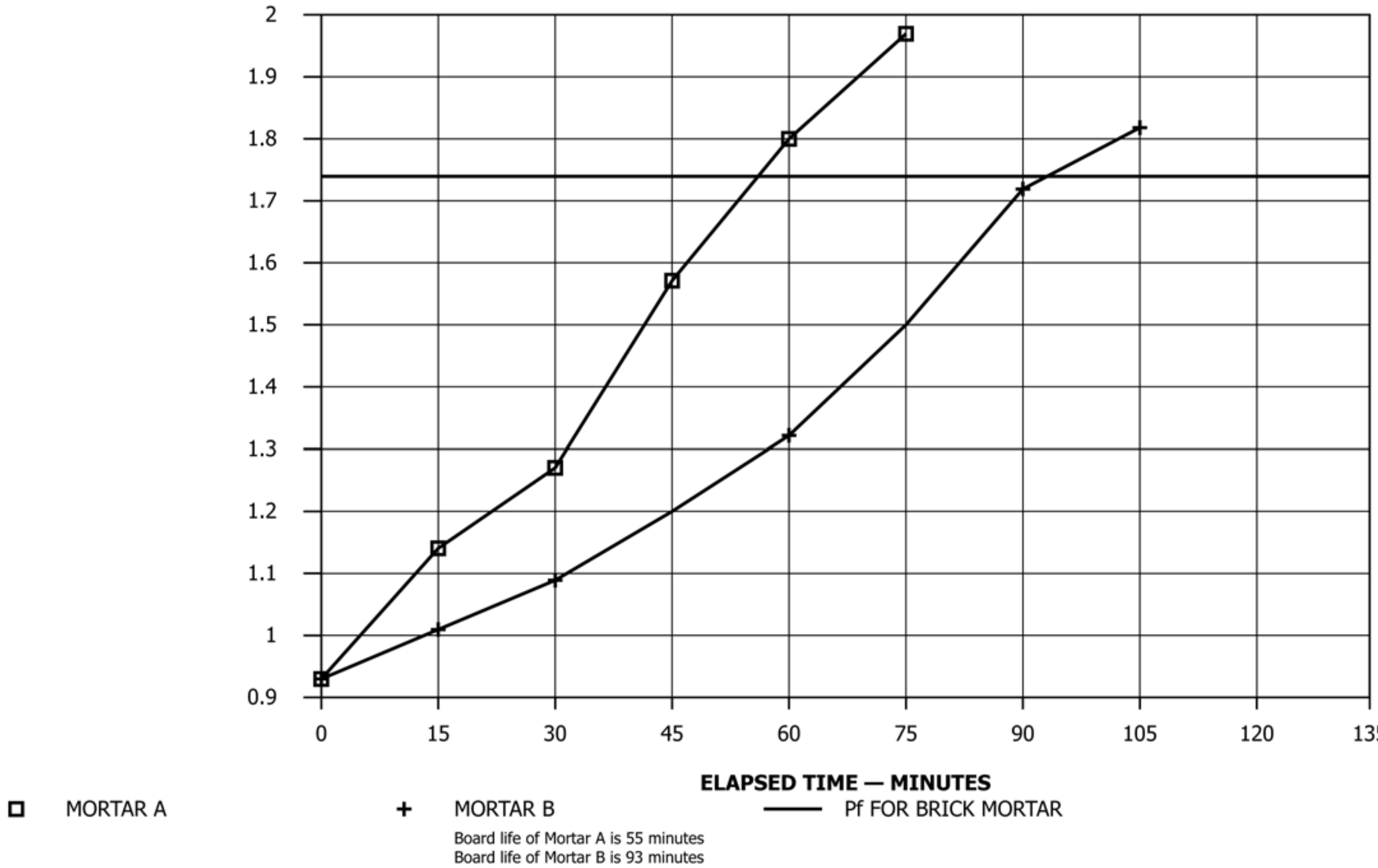

FIG. A3.1 Penetration Resistance Versus Elapsed Time

record three additional penetrations and time, using the procedures of A3.7.3. Repeat this procedure every 15 min till the average penetration resistance is either 1.74 psi for mortars to be used with brick sized units or 2.44 psi for mortars to be used with heavier units. (Note A3.2)

NOTE A3.2—Uniformly spaced measurements other than 15 min may be desirable for research and other testing needs.

A3.8 Report

A3.8.1 Report the following information:

A3.8.1.1 Plot data of penetration resistance, in psi, with elapsed time until P_f is reached.

A3.8.1.2 Calculate and report the rate of stiffening as:

$$\text{Rate of stiffening} = (P_f - P_o)/T_f, \text{ psi permin} \qquad (A3.1)$$

where:

P_f and P_o are as indicated:

Mortar for Brick Sized Units[A]	Mortar for Heavier Units
$P_f = 1.74$	$P_f = 2.44$
$P_o = 0.94$	$P_o = 1.24$

[A] The size, weight and bedding area of the unit should be considered in selecting the appropriate values of P_f and P_o.

$$T_f = \text{interpolated time when } P_f \text{ obtained.} \qquad (A3.2)$$

(see Note A3.3)

NOTE A3.3—For graphic illustration, see Fig. A3.1.

A3.8.2 Report T_f as board life, in minutes. P_f is approximately equal to the consistency when mortars are judged too stiff to be used properly.

A3.8.3 Report all penetration resistance data in psi and associated times in minutes.

A3.9 Precision and Bias

A3.9.1 The precision of the procedure in Test Method C780, Annex A3, for measuring consistency and board life is being determined.

A3.9.2 The procedure in Test Method C780, Annex A3, for measuring the consistency and board life of masonry mortars has no bias because the value of consistency and board life can be defined only in terms of a test method.

A4. MORTAR AGGREGATE RATIO TEST METHOD

A4.1 Scope

A4.1.1 This test method describes a procedure for determining the aggregate-to-cementitious materials ratio of mortars for unit masonry by determining the mortar fraction coarser than a 150-µm (No. 100) sieve and correcting for the sand finer than the 150-µm (No. 100) sieve. This test method also includes a procedure for determining the water content of mortar.

NOTE A4.1—Previous editions of this standard included a stand-alone method for determining water content of mortars. That method and the mortar aggregate method were so interrelated that they have been combined into one method. This method retains methods for calculating and reporting mortar water contents and can be performed with a single sample of mortar without determination of the ratio of aggregate to cementitious materials.

A4.1.2 This test method determines the aggregate-to-cementitious materials ratio by weight. For mortars specified by volume proportions, guidance for converting the ratio by weight to a ratio by volume is located in Note A4.3.

A4.2 Apparatus

A4.2.1 *Sand Sample Container*—A clean wide-mouth clear glass or plastic watertight container or waterproof sand bag of sufficient size to contain the sample.

A4.2.2 *Mortar Sample Container*—Two clean wide-mouth clear glass or plastic watertight containers of sufficient size to contain the samples and with sealable lids.

NOTE A4.2—A container with a volume of approximately 1 qt or 1 L is typically sufficient for containing the samples.

A4.2.3 *Spoon*—A stainless steel tea or soup spoon.

A4.2.4 *Sieves:*

A4.2.4.1 *Wash Sieve*—A 150-µm (No. 100) sieve conforming to the requirements of Specification E11.

A4.2.4.2 *Protection Sieve*—If used, a 1.18-mm (No. 16) sieve conforming to the requirements of Specification E11.

A4.2.5 *Oven*—An oven capable of maintaining a constant temperature of 230 ± 9°F (110 ± 5°C).

A4.3 Procedure

A4.3.1 Prior to going to the construction site, label one of the mortar sample containers as "H" and the other as "a," add 8.5 oz (250 mL) of isopropyl or methyl alcohol to both mortar sample containers, and determine and record the combined weight of each container and alcohol to the nearest 0.002 lb (1 g). Tightly seal the containers to prevent evaporation.

A4.3.2 Introduce the mortar samples into the sample containers within five minutes of obtaining the final portion of the sample.

A4.3.3 At the construction site, place 1.1 to 1.5 lb (500 to 700 g) of mortar into each mortar sample container with the alcohol, as rapidly as is practical. Tightly reseal the lids to minimize evaporation, then agitate the containers until no lumps are visible. Take care to minimize any loss of alcohol during mortar sampling and agitation. Record and report the time the mortar is mixed and the time the sample is placed in alcohol. Identify where that mortar is being installed on the project.

A4.3.4 At the construction site, obtain a representative sand sample in excess of 1.1 lb (500 g). Place the sand sample in the sand sample container.

A4.3.5 Upon returning to the laboratory, using the container labeled "H," determine and record as "I" the combined weight of the mortar sample, alcohol, and container to the nearest 0.002 lb (1 g). Then, using water, transfer the entire mortar sample to the 150-µm (No. 100) sieve for wet sieving. If a protection sieve is used, nest protection sieve on top of wash sieve, and place entire mortar sample onto the protection sieve. Wash the mortar with a gentle flow of water accompanied by a slight tilting of the screen in various positions until the wash water is clear and contains no visible particles of sand or cementitious material when viewed against a background of contrasting color such as a white sink basin. Dry the + 100-mesh fraction in the oven to constant weight without removing the material from the screen at 230 ± 9°F (110 ± 5°C). The sample is at constant weight when drying for an additional 15 min results in a weight change of less than 0.1 %. Determine the oven-dry weight of the + 100 fraction (including any material retained on the protection sieve) and record as "Y" to the nearest 0.002 lb (1 g).

A4.3.6 Weigh the sand sample, dry in the oven to constant weight at 230 ± 9°F (110 ± 5°C), and record the weight as "R" to the nearest 0.002 lb (1 g). Wet-sieve as described in A4.3.5, dry in the oven to constant weight at 230 ± 9°F (110 ± 5°C), weigh, and record as "W" the + 100 sand fraction to the nearest 0.002 lb (1 g).

A4.3.7 Using the container labeled "a," determine and record as "b" the combined weight of the mortar sample, alcohol, and container to the nearest 0.002 lb (1 g). Transfer the entire mortar sample to a weighing pan, washing the container and lid with water or isopropyl alcohol. Ignite the alcohol within the sample following the safety precautions of Section 8 of this test method, and then bring the partially dried sample in the oven at 230 ± 9°F (110 ± 5°C) to constant weight. Record as "d" the oven-dry weight of the mortar to the nearest 0.002 lb (1 g).

A4.4 Calculation

A4.4.1 Calculate the moisture content of the mortar, expressed on the wet and dry basis as follows:

$$\text{Mortar water content, wet basis, } \% = \left[(b - a - d)/(b - a)\right] \times 100 \tag{A4.1}$$

$$\text{Mortar water content, dry basis, } \% = G = \left[(b - a - d)/d\right] \times 100$$

where:

a = weight of the container and alcohol, lb (g),
b = weight of the container, alcohol, and mortar, lb (g), and
d = weight of the oven-dry mortar sample, lb (g).

A4.4.2 Calculate the ratio of the aggregate-to-cementitious materials as follows:

$$\text{Weight of wet mortar} = J = I - H \quad (A4.2)$$

$$\text{Weight of dry mortar} = K = J/[1+(G/100)]$$

$$\text{Weight of} + 100 \text{ mortar, dry, corrected} = Q = (Y \times R/W)$$

$$\text{Weight of} - 100 \text{ mortar, dry, corrected} = P = K - Q$$

$$\text{Aggregate} - \text{to} - \text{Cementitious Materials ratio} = Q/P \text{ to } 1$$

where:

H = weight of container and alcohol,
I = weight of container, alcohol and mortar,
G = mortar water content, dry basis, from A4.4.1,
Y = weight of + 100 fraction, dry,
R = weight of sand, oven dry, and
W = weight of the + 100 sand, dry.

NOTE A4.3—This test method does not differentiate between multiple cementitious materials, simply the total cementitious content as compared to the aggregate content. This method yields the aggregate-to-cementitious materials ratio by weight, yet aggregate-to-cementitious material ratios are typically specified by volume.

If the specified volume ratio is known, it can be converted to a weight ratio, which can then be compared with the result of this test method. Alternatively, if only one cementitious material is used in the mortar, the results of this method can be converted to a volume ratio, which can then be compared to the specified ratio. This method cannot be reliably used to convert the test result of mortar with multiple cementitious materials into a volume ratio.

When converting ratios, use the following material bulk densities:

Cementitious Material	Bulk Density
Portland Cement	94 lb/ft^3 (1505 kg/m^3)
Blended Cement	Obtain from bag or supplier
Masonry Cement	Obtain from bag or supplier
Mortar Cement	Obtain from bag or supplier
Lime Putty	80 lb/ft^3 (1280 kg/m^3)
Hydrated Lime	40 lb/ft^3 (640 kg/m^3)

Aggregate	Bulk Density
Sand	80 lb/ft^3 (1280 kg/m^3)

Example 1—To convert a cement and lime mortar specified to contain 1 part by volume of portland cement, 1¼ parts by volume of hydrated lime and 6¾ parts by volume of damp, loose sand (this represents a volume ratio of aggregate-to-cementitious material of 3 to 1) to a weight ratio, perform the following:

$$\begin{aligned}&\text{Aggregate} - \text{to} - \text{Cementitious Ratio (by wt)*}\\&= \frac{6.75 \text{ parts aggregate (by vol)} \times 80 \text{ lb/ft}^3}{[1 \text{ part portland cement (by vol)} \times 94 \text{ lb/ft}^3] + [1.25 \text{ parts hydrated lime (by vol)} \times 40 \text{ lb/ft}^3]}\\&= \frac{540}{94+50}\\&= \frac{540}{144}\\&= 3.75 \text{ or } 3.75 \text{ to } 1\end{aligned}$$

Example 2 (convert weight ratio as tested to volume ratio)—This conversion can only be performed on mortars in which the bulk density of the combined cementitious material is known. Consider a sample mortar in which the measured weight ratio using this method was determined to be 3.4 parts aggregate to 1 part cementitious material. Inspection of the mortar materials at the time of sampling shows a masonry cement (with a bulk density of 70 lb/ft^3 as shown on the bag) was the only cementitious material used. To convert this weight ratio to a volume ratio, perform the following:

$$\begin{aligned}&\text{Aggregate} - \text{to} - \text{Cementitious Ratio (by vol)*}\\&= \frac{\dfrac{3.4 \text{ parts aggregate}}{80 \text{ lb/ft}^3}}{\dfrac{1 \text{ part masonry cement}}{70 \text{ lb/ft}^3}}\\&= \frac{3.4 \text{ parts aggregate}}{80 \text{ lb/ft}^3} \times \frac{70 \text{ lb/ft}^3}{1 \text{ part cement}}\\&= \frac{238}{80}\\&= 2.98 \text{ or } 2.98 \text{ to } 1\end{aligned}$$

*Values shown in examples use English units. If English units are replaced with SI units, the resulting calculated proportions by weight would be identical to those shown here.

A4.5 Report

A4.5.1 Report the following information:

A4.5.1.1 The measured weights of all sample containers, mortar samples, sand samples, and oven-dried sample fractions to the nearest 0.002 lb (1 g).

A4.5.1.2 The mortar water content (on both a dry and wet basis) as determined in A4.4.1 to the nearest 0.1 %.

A4.5.1.3 The aggregate-to-cementitious materials ratio as determined in A4.4.2 to the nearest 0.1 %.

A5. MORTAR AIR CONTENT TEST METHOD

A5.1 Scope

A5.1.1 This test method covers a procedure for determining the air content of mortars for unit masonry using either the pressure meter method or the volumetric method.

A5.2 Apparatus

A5.2.1 For the pressure method (Section A5.3), the apparatus requirements and calibration procedures shall be in accordance with Test Method C231.

A5.2.2 For the volumetric method (Section A5.4), the apparatus requirements and calibration procedures shall be in accordance with Test Method C173/C173M.

A5.3 Pressure Method Procedure (Test Method C231)

A5.3.1 Begin the air content test within five minutes of obtaining the final portion of the sample.

A5.3.2 When determining the air content of the mortar by the pressure method, use the test procedures and calculations contained in Test Method C231.

A5.4 Volumetric Method Procedure (Test Method C173/C173M)

A5.4.1 Begin the air content test within five minutes of obtaining the final portion of the sample.

A5.4.2 When determining the air content of the mortar by the volumetric method, use the test procedures and calculations contained in Test Method C173/C173M.

A5.5 Report

A5.5.1 Report the air content, test method used, and type of air meter.

A6. COMPRESSIVE STRENGTH OF MOLDED MASONRY MORTAR CYLINDERS AND CUBES

A6.1 Scope

A6.1.1 This test method establishes sampling and testing procedures for determining compressive strength of preconstruction and construction mortars. Strength values for mortars obtained through these testing procedures are not required, nor expected, to meet strength requirements of laboratory Specification C270 mortars or necessarily represent the strength of the mortar in the wall. The values obtained from construction testing are to be correlated only with those of preconstruction mortars made with the same materials, in the same proportions, mixed to a similar consistency, cured under similar conditions, and tested at the same age.

A6.1.2 This method covers the procedure for determining the compressive strength of mortars for unit masonry using any of the following: 2 by 4-in. (50.8 by 101.6-mm) cylinders, 3 by 6-in. (76.2 by 152.4-mm) cylinders, or 2-in. (50.8-mm) cubes. Any of the listed specimen sizes can be used, but specimen size and shape affects the measured strengths and the results from different sized specimens are not the same.

A6.1.3 *Tests of Hardened Mortar Compressive Strengths*—There is no accepted standard for measuring individual hardened mortar joint compressive strengths.

A6.2 Preparation of Specimens

A6.2.1 *Apparatus:*

A6.2.1.1 *Molds*—Cylinder molds for 2 by 4 in. (50.8 by 101.6 mm) cylinders, or 3 by 6 in. (76.2 by 152.4 mm) cylinders, shall be single-use or reusable molds and shall comply with Specification C470/C470M. Molds for 2 in. (50.8 mm) cubic specimens shall comply with Test Method C109/C109M.

A6.2.1.2 *Straightedge*—A steel straightedge not less than 7 in. (178 mm) long, and not less than 1⁄16 in. (1.59 mm) nor more than 1⁄8 in. (3.18 mm) in thickness.

A6.2.1.3 *Spoon*—A stainless steel tea or soup spoon.

A6.2.1.4 *Maximum-Minimum Thermometer.*

A6.2.1.5 *Tamper,* in accordance with Test Method C109/C109M. The tamping face shall be flat and at right angles to the length of the tamper.

A6.2.1.6 *Trowel,* with blade 4 to 6 in. (101.2 to 152 mm) in length, with straight edges.

A6.2.1.7 *Nonabsorbent Container*—A metal or plastic bowl or bucket suitable for collecting field mortar samples.

A6.2.1.8 *Testing Machine*—The testing machine shall conform to the requirements of Test Method C39/C39M when testing cylindrical specimens and Test Method C109/C109M when testing cube specimens.

A6.2.1.9 *Scoop*—A stainless steel or aluminum scoop.

A6.2.1.10 *Moist Storage Facilities*—The moist cabinets and rooms shall conform to the requirements of Specification C511.

A6.3 Procedure

A6.3.1 Sample the mortar immediately after initial mixing has been completed using the procedures in Section 9 and test the mortar for consistency using the procedures in Annex A1.

A6.3.2 Begin fabricating test specimens within 15 minutes of obtaining the final portion of the sample.

A6.3.3 Fabricate the test specimens immediately after the mortar has been sampled using either the procedures in either A6.3.3.1 (cube specimens) or A6.3.3.2 (cylindrical specimens). Select the specimen casting area in close proximity to the area where the specimens will be stored for the first 24 to 48 h. Coat reusable metal molds with a light coating of mineral oil or other acceptable form release to minimize mortar sticking to the molds. A minimum of three specimens shall be made for each mortar sample and test age.

A6.3.3.1 Fabricate cube specimens using the procedures described in Test Method C109/C109M. To minimize evaporation, after fabrication, cover the top surface of the mold using either a cap, plastic bag, or other non-absorbent, non-permeable material.

A6.3.3.2 Cylindrical specimens shall be fabricated using the following procedures. Using the spoon or scoop, place the mortar gently into the cylinder mold in three layers of approximately equal volume, tamping each layer 20 times with the tamper in one complete revolution around the inner surface of the mold. Consider one complete up-and-down motion of the tamper, held in a vertical position, as one tamping. In tamping the first layer, do not strike the tamper forcibly against the bottom of the mold. In tamping the second and final layers, each layer is tamped in one complete revolution (rotation) with only sufficient pressure to adequately fill the measure and eliminate voids within the mortar. Slightly overfill the top layer of the mold prior to and during the period the top layer is tamped. After the mold has been filled and the mortar tamped, tap the sides of the mold lightly five to ten times with an open hand to release any large air bubbles that may have been trapped. Strike off the top surface of the specimen using the straightedge, so it is level with the top of the mold. To minimize evaporation, after fabrication, cover the top surface of the mold, using either a cap or a plastic bag.

A6.4 Storing the Test Specimens

A6.4.1 Immediately after completion of the molding, place the specimens in job site storage facility. Minimum job site facilities shall include an insulated container, in a vibration-free location, with a maximum-minimum thermometer placed beside the specimens to record the maximum and minimum temperatures until they are taken to the laboratory. When a 6- by 12-in. (152.4 by 304.8-mm) concrete cylinder mold is used for storing cube test specimens, it must comply with the following:

A6.4.1.1 The cylinder used for storage shall contain several thicknesses of wet paper towels underneath the molded specimens. The wet towels shall not touch the mortar specimen.

A6.4.1.2 The storage cylinder must be maintained so that the cube specimens are maintained in a horizontal upright position at all times and the cylinder must be sealed and covered with insulating material.

A6.4.1.3 The storage temperatures shall be maintained at not less than 40°F (4.4°C) nor greater than 90°F (32.2°C) as measured by a maximum-minimum thermometer placed beside the specimens. If temperatures exceed these limits, the specimens shall be discarded.

A6.4.2 Remove the specimens from their stored position at the end of 24 to 48 h and carefully transport them to the laboratory. Place the test specimens in a moist closet or moist room for the next 20 to 24 h with their upper surfaces exposed to the moist air but protected from dripping water. Following the 20 to 24-h period, remove the specimens from the molds. The specimens shall be maintained in a moist storage facility up to the testing age. The test age of preconstruction and construction test sets must match. Unless specified otherwise, tests shall be conducted at 7 days ± 3 h or 28 days ± 12 h after molding.

A6.4.3 Remove the cylindrical specimens from storage and cap using neat cement paste, sulfur mortar, or high strength gypsum paste following the the procedures in Practice C617 or use unbonded caps using the procedures in Practice C1231. Different methods of capping shall not be used on specimens from the same project. When unbonded caps are used on cylindrical specimens expected to test lower than 1500 psi (10.3 MPa), the user or supplier of the pad caps shall qualify the caps and retainers using Sections 8 and 9 of Practice C1231 for the lower strength requirements.

A6.4.4 Maintain moist-cured cylindrical specimens in a moist condition between capping and testing by returning them to moist storage or wrapping them with a double layer of wet burlap. Do not immerse specimens in water. Do not store specimens with gypsum plaster caps in a moist room for more than 4 h. If stored in a moist room, protect the plaster cap surfaces from dripping water.

A6.4.5 Keep cube and cylindrical specimens moist after their removal from the moist storage facility and prior to testing using a wet burlap or towel covering.

A6.4.6 Prior to testing the cube specimens, determine the size of the specimens using procedures described in Test Method C109/C109M. Prior to testing the cylindrical specimens, determine the size of the specimens using the procedures described in Test Method C39/C39M.

A6.4.7 Test cube specimens using procedures described in Test Method C109/C109M. Test cylindrical specimens using procedures described in Test Method C39/C39M.

A6.5 Calculation

A6.5.1 Calculate the compressive strength of the specimen by dividing the maximum load carried by the specimen during the test by the average cross-sectional area, determined as described in Test Method C109/C109M or Test Method C39/C39M, as appropriate, and express the result to the nearest 10 psi (0.07 MPa).

A6.6 Report

A6.6.1 In addition to the general reporting requirements of Section 12, the report shall include the following:

A6.6.1.1 A description of the specimen by size and type (cube or cylinder),

A6.6.1.2 The test mold material,

A6.6.1.3 The mortar consistency, curing procedure and duration, and

A6.6.1.4 For cylindrical specimens, the capping method used (bonded or unbonded), and

A6.6.1.5 Dimensions, total load, and compressive strength of the individual specimens for each test age and the specimen set average.

A6.6.2 Report any deviations from the test method, including storage temperature or relative humidity.

APPENDIX

(Nonmandatory Information)

X1. SAMPLE REPORT FOR PRECONSTRUCTION AND CONSTRUCTION EVALUATION OF MORTARS FOR PLAIN AND REINFORCED UNIT MASONRY

ASTM C780 Test Report – General Information

		Report ID:	________
		Report Date:	________
Client:	________	Testing Agency:	________
Address:	________	Address:	________
	________		________
Project:	________	Mortar Specified:	________
	________		

Mortar Materials and Batch Description:

	Description	Proportion	Volume
Cement, portland:	________	________	________
Cement, masonry:	________	________	________
Cement, mortar:	________	________	________
Lime:	________	________	________
Sand:	________	________	________
Water:	________	________	________
Admixture:	________	________	________
Other:	________	________	________

Mixing and Sampling Information:

Mixer Type:	________	Mixer Manufacturer:	________
Time of Mixer Charging:	________	Mixing Duration:	________
Sampling Location:	________	Time of Sampling:	________

Ambient Conditions:

Mixing Conditions:		Job Site Curing Conditions	
Temperature:	________	Maximum Temp:	________
Relative Humidity:	________	Minimum Temp:	________
		Average Temp:	________

Annex A1 – Consistency by Cone Penetration

Depth of Penetration (mm):	________	Time From Mixing To Test (min):	________

Annex A2 – Consistency Retention by Cone Penetration

Method Used (disturbed for undisturbed): ________________

Time:			
	0 min	Depth of Penetration (mm)	________________
	15 min	Depth of Penetration (mm)	________________
	45 min	Depth of Penetration (mm)	________________
	60 min	Depth of Penetration (mm)	________________

Annex A4 – Mortar-Aggregate Ratio

Mortar-Aggregate Ratio		*Mortar Water Content*	
Wt. Container & Alcohol (H), g	_______	Wt. Container & Alcohol (*a*), g	_______
Wt. Container, Alcohol, Mortar (I), g	_______	Wt. Container, Alcohol, Mortar (*b*), g	_______
Wt. Mortar, Wet (J), g	_______	Wt. Oven Dry Mortar (*d*), g	_______
Wt. Mortar, Dry (K), g	_______	Mortar Water Content, wet basis %	_______
Wt. Sand, initial (R), g	_______	Mortar Water Content, dry basis (G) %	_______
Wt. +100 Sand (W), g	_______		
Wt. of +100 Fraction (Y), g	_______		
Wt. +100 Mortar, Corrected (Q), g	_______		
Wt. –100 Mortar, corrected (P), g	_______		
Aggregate – to – Cementitious Materials Ratio	1 to _______		

Annex A5 – Mortar Air Content

Meter Used	________________	Agg. Corr. Factor	________________
Gross Air Content %	________________	Net Air Content %	________________

Annex A6 – Mortar Compressive Strength

Specimen Description:	____________	Date Molded:	____________
Mold Material:	____________	Curing Procedure:	____________
Specimen Configuration:	____________	Specimen Size:	____________
Deviations Noted:	____________	Mortar Consistency:	____________

	Age (days)	Load (lb)	Strength (psi)
Specimen 1	____________	____________	____________
Specimen 2	____________	____________	____________
Specimen 3	____________	____________	____________
Average		____________	____________

	Age (days)	Load (lb)	Strength (psi)
Specimen 1	____________	____________	____________
Specimen 2	____________	____________	____________
Specimen 3	____________	____________	____________
Average		____________	____________

	Age (days)	Load (lb)	Strength (psi)
Specimen 1	____________	____________	____________
Specimen 2	____________	____________	____________
Specimen 3	____________	____________	____________
Average		____________	____________

SUMMARY OF CHANGES

Committee C12 has identified the location of selected changes to this standard since the last issue (C780 – 16a) that may impact the use of this standard. (June 1, 2017)

(1) Revised to not allow capped specimens to be immersed in water.
(2) Modified A6.4.3 to allow use of unbonded caps on specimens less than 1500 psi, require qualification of cap systems, and require the same type of capping to be used in preconstruction and construction testing. Added A6.6.1.4 to require reporting of the type of capping used.
(3) Revised Annexes to make testing times consistent with Section 9 of the standard.

Committee C12 has identified the location of selected changes to this standard since the last issue (C780 – 16) that may impact the use of this standard. (December 1, 2016)

(1) Revised A6.4.4 to not allow capped specimens to be immersed in water.

Committee C12 has identified the location of selected changes to this standard since the last issue (C780 – 15a) that may impact the use of this standard. (September 1, 2016)

(1) Modified A3.4 to move requirements for penetrometer disk from a note, and allow for a vulcanized rubber disk as an alternative to the steel disk.