Designation: C780 – 20

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 The text of this standard references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.7 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific hazards statements, see Section 8.

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the*

[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

Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

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/C231M 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/C617M 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/C1231M Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Cylindrical Concrete Specimens

C1324 Test Method for Examination and Analysis of Hardened Masonry Mortar

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 *disturbed sample, n*—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.

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

3.2.3 *as-mixed samples, n*—mortar samples that are obtained after mixing and prior to use of the mortar in construction.

3.2.4 *mortar board samples, n*—mortar samples that are obtained from the mortar board after some established time period from the end of mixing, and before retempering.

3.2.4.1 *Discussion*—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—Test Method for Consistency by Cone Penetration,

4.3.2 Annex A2—Test Method for Consistency Retention (Board Life) of Mortars for Unit Masonry Using a Cone Penetrometer,

4.3.3 Annex A3—Test Method for Initial Consistency and Consistency Retention (Board Life) of Masonry Mortars Using a Modified Concrete Penetrometer,

4.3.4 Annex A4—Test Method for Mortar Aggregate Ratio,

4.3.5 Annex A5—Test Method for Mortar Air Content, and

4.3.6 Annex A6—Test Method for 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

[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.

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 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