Designation: C887 – 13

Standard Specification for Packaged, Dry, Combined Materials for Surface Bonding Mortar[1]

This standard is issued under the fixed designation C887; 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.

1. Scope

1.1 This specification covers the materials, properties, and packaging of dry, combined materials for use as surface bonding mortar with concrete masonry units that have not been prefaced, coated, or painted.

1.2 This specification does not cover design or application. Consult the manufacturer for specific recommendations.

1.3 Appendix X1 of this specification contains the recommended tests for evaluation of surface bonded masonry assemblages used to establish design loads for the composite wall.

1.4 Appendix X2 through Appendix X5 of this specification contain additional tests that may be performed on surface bonding mortar.

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.* This hazard statement applies only to Section 9 of this specification.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C91 Specification for Masonry Cement

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

C138/C138M Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete

C144 Specification for Aggregate for Masonry Mortar

C150 Specification for Portland Cement

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

C191 Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle

C207 Specification for Hydrated Lime for Masonry Purposes

C260 Specification for Air-Entraining Admixtures for Concrete

C305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency

C348 Test Method for Flexural Strength of Hydraulic-Cement Mortars

C349 Test Method for Compressive Strength of Hydraulic-Cement Mortars (Using Portions of Prisms Broken in Flexure)

C359 Test Method for Early Stiffening of Hydraulic Cement (Mortar Method)

C494/C494M Specification for Chemical Admixtures for Concrete

C595/C595M Specification for Blended Hydraulic Cements

C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

C666/C666M Test Method for Resistance of Concrete to Rapid Freezing and Thawing

C1157 Performance Specification for Hydraulic Cement

C1600 Specification for Rapid Hardening Hydraulic Cement

E72 Test Methods of Conducting Strength Tests of Panels for Building Construction

E96/E96M Test Methods for Water Vapor Transmission of Materials

E119 Test Methods for Fire Tests of Building Construction and Materials

E447 Test Method for Compressive Strength of Laboratory Constructed Masonry Prisms (Withdrawn 1997)[3]

E514 Test Method for Water Penetration and Leakage Through Masonry

[1] This specification is under the jurisdiction of ASTM Committee C12 on Mortars and Grouts for Unit Masonry and is the direct responsibility of Subcommittee C12.06 on Surface Bonding.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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

E518 Test Methods for Flexural Bond Strength of Masonry
E519 Test Method for Diagonal Tension (Shear) in Masonry Assemblages

3. Terminology

3.1 *Definitions:*

3.1.1 *surface bonding mortar*—a product containing hydraulic cement, glass fiber reinforcement with or without inorganic fillers, or organic modifiers in a prepackaged form requiring only the addition of water prior to application.

4. Materials and Manufacture

4.1 The materials used as ingredients in packaged, dry, combined materials for surface bonding mortar shall conform to the following requirements:

4.1.1 *Hydraulic Cements*—Hydraulic cements used shall conform to the following ASTM specifications:

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

4.1.1.2 *Blended Hydraulic Cements*—Type IS, ISA, IP, or IPA of Specification C595/C595M.

4.1.1.3 *Hydraulic Cement*—Type GU, HE, MS, or MH of Specification C1157.

4.1.1.4 *Masonry Cement*—Specification C91.

4.1.1.5 *Rapid Hardening Hydraulic Cement,* Type GRH, MRH, VRH, or URH of Specification C1600.

4.1.2 *Hydrated Lime*—Type S or SA of Specification C207.

4.1.3 *Pozzolan*—Class N, F, or S of Specification C618.

4.1.4 *Aggregates*—Aggregates shall conform to Specification C144 with the exception of grading. The maximum allowable particle size shall not exceed one third of the recommended application thickness of the surface bonding mortar with uniform distribution of particle size.

4.1.4.1 All aggregates shall be dried, without decomposition, to a moisture content of less than 0.1 weight %, computed on material dried substantially to constant weight at 221 to 230°F (105 to 110°C).

4.1.5 *Glass Fibers*—Glass fibers shall be chopped strands of a minimum ½-in. (13-mm) length to provide significant reinforcement in a cementitious matrix.

4.1.5.1 Glass fibers for use in surface bonding mortar, that will be subjected to wetting, humid atmosphere, or contact with moist ground have the potential to react with the available alkalies present in the portland-cement matrix, causing strength reduction of the surface bonding mortar.

4.1.5.2 The producer shall show evidence satisfactory to the purchaser that glass composition, cement matrix, or both, have been designed to reduce significantly or eliminate this unfavorable reaction.

4.1.6 *Additives*—Additives may be added as part of the packaged, dry, combined materials for purposes such as plasticity, air entrainment, water repellency, set acceleration, chemical bonding, and coloring. See Specifications C260 and C494/C494M.

4.1.6.1 Admixtures or mortar colors shall not be added to the surface bonding mortars at the time of mixing unless provided for in the contract specifications, and, after the materials are so added, the surface bonding mortars shall conform to the physical requirements prescribed in Table 1.

TABLE 1 Physical Requirements

Flexural Strength[A] (average of three prisms)		
The flexural strength of prisms of surface bonding mortar prepared and tested in accordance with this specification shall be equal to or higher than the values specified for the ages indicated as follows:		
	psi	(MPa)
1 day	450	3.1
7 days	700	4.8
28 days	800	5.5
Compressive Strength (average of prisms broken in flexure)		
The compressive strength of modified cubes of surface bonding mortar prepared and tested in accordance with this specification shall be equal to or higher than the values specified for the ages indicated as follows:		
	psi	(MPa)
1 day	1600	11
28 days	3500	24.1
Time of setting, Vicat needle, initial set, minimum, min		45
final set, max, h		8
Water retention flow after suction, min, % of original flow, min		75

4.1.6.2 *Antifreeze Compounds*—No antifreeze liquid, salts, or other substances shall be used in surface bonding mortar to lower the freezing point.

NOTE 1—Calcium chloride, when provided for in the contract specifications, and expressly recommended by the manufacturer, may be used as an accelerator in amounts not exceeding ½ % by weight of the total bag weight.

5. Proportioning

5.1 The proportions of materials such as hydraulic cements, aggregate, and glass fibers shall be such that the requirements of Table 1 will be met when an amount of mixing water is used that is recommended by the manufacturer to produce a working consistency or that produces a consistency penetration of 65 to 75 mm by the Cone Penetrometer Test Method of Annex A2.

6. Physical Requirements

6.1 Packaged, dry, combined materials for surface bonding mortar shall conform to requirements for physical properties prescribed in Table 1, when the prescribed amount of water is added.

7. Sampling and Testing

7.1 *Accuracy of Measurement:*

7.1.1 Weigh all surface bonding mortar on scales conforming to the applicable sections of National Institute of Standards and Technology Handbook 44, "Specifications, Tolerances and Regulations for Commercial Weighing and Measuring Devices."

NOTE 2—New and reconditioned scales shall be accurate to ±0.1 % of the total capacity of the scale. When scales have been in use, they shall be accurate to ±0.4 % of the total capacity of the scale.

7.1.2 Record all weights in pounds or kilograms to a minimum accuracy of 0.1 lb (0.05 kg). Record all weights in grams to an accuracy of 1 g or 0.1 %, whichever is greater.

8. Sampling Surface Bonding Mortar

8.1 Use the contents of an entire package of surface bonding mortar as a sample. Weigh the package, then place it in a clean,

watertight container. Open the package by cutting it down one side and across the top and bottom. Empty the contents of the package into the container then carefully remove and weigh the empty bag. Mix the contents thoroughly by hand, using a scoop or trowel, then secure a representative sample weighing not less than 9 lb (4 kg) nor more than 12 lb (5.4 kg). If the package from which the sample is secured weighs 20 lb (9 kg) or more, reduce its contents to the required weight by quartering.

9. Mixing and Testing Surface Bonding Mortar

9.1 Mortar mixing equipment shall be as specified in Practice C305, except that the clearance adjustment bracket shall be set for the largest size aggregate in the mix being tested. The mixing procedure shall be as given in Annex A1.

9.2 Determine the surface bonding mortar plastic and hardened properties using the following appended test methods:

9.2.1 Annex A3—Flexural Strength of Surface Bonding Mortar.

9.2.2 Annex A4—Compressive Strength of Surface Bonding Mortar.

9.2.3 Annex A5—Time of Setting of Surface Bonding Mortar.

9.2.4 Annex A6—Water Retention of Surface Bonding Mortar.

9.3 Mix a representative portion of the sample of the dry, combined surface bonding mortar weighing 3000 ± 3 g. Use a proportionate amount of the water recommended by the manufacturer to produce a working consistency or a sufficient amount of mixing water to produce a cone penetration of 2½ to 3 in. (65 to 75 mm). Determine the consistency and weight of 400 mL of the mortar, in accordance with Annex A2, then mold 1.575 by 1.575 by 6.3-in. (40 by 40 by 160-mm) prisms in the quantity necessary to test for the desired ages. If insufficient mortar is available, make further batches of mortars using the same water to achieve the required consistency.

9.3.1 Calculate the unit weight in pounds per cubic foot (kilograms per cubic metre) and yield in cubic feet (cubic metres) or the yield in square feet per inch (square metres per millimetre) of thickness, from the weight of the mortar in the 400-mL measure used for the consistency test in Annex A2.

9.3.2 Specimens for flexural strength shall be 1.575 by 1.575 by 6.3-in. (40 by 40 by 160-mm) prisms molded, cured, and tested in accordance with Annex A3, with the broken halves of prisms tested in compression as modified cubes in accordance with Annex A4.

9.3.3 Determine the time of setting by Vicat needles in accordance with Annex A5.

9.3.4 Determine the water retention in accordance with Annex A6.

9.4 The report of the tests shall include the following:

9.4.1 Net weight of dry, combined material in the bag determined to 0.1 lb (0.05 kg), by subtracting the weight of the empty bag from the gross weight of the package.

9.4.2 Amount of mixing water, W, calculated in pounds (kilograms) per bag based on printed weight of the bag (Note 3).

9.4.3 Unit weight, U, in pounds per cubic foot (kilograms per cubic metre) in accordance with Test Method C138/C138M (Note 3).

9.4.4 Yield, Y, of surface bonding mortar calculated from the unit weight in cubic feet (cubic metres) per bag, based on printed weight of bag (Note 1).

NOTE 3—Calculate W, U, and Y as follows:

$$W = R_w B \quad (1)$$

$$U = 0.156\, W_m$$

$$Y = \left(1 + R_w\right) B/U$$

where:

R_w = ratio of weight of mixing water to weight of dry, combined material in batch of surface bonding mortar calculated to three decimal places,
B = the printed bag weight, and
W_m = weight in grams of surface bonding mortar in the 400-mL measure.

9.4.5 Water retention in percent.

9.4.6 Flexural Strength at ages specified in Table 1.

9.4.7 Compressive strength at ages specified in Table 1.

9.4.8 Time of setting, initial and final in hours.

10. Basis of Rejection

10.1 The packaged, dry, combined surface bonding mortar may be rejected if it fails to meet any of the requirements of this specification.

10.2 Packages varying more than 2 % from the weight printed on the bag or produce a yield less than that printed on the bag may be rejected, and if the average weight of packages in any shipment as shown by weighing 50 packages taken at random is less than that printed on the bag, the entire shipment may be rejected.

10.3 All broken packages may be rejected.

11. Marking and Packaging

11.1 All packages shall be identified as conforming to Specification C887 and the net weight in each bag printed thereon.

11.2 All packages shall be marked appropriately with the manufacturer's code or open date of production. All containers shall have a prominently located **CAUTION STATEMENT**, warning of potential hazard to handlers of materials therein.

11.3 The minimum yield in cubic feet (cubic metres) or the yield in square feet per inch (square metres per millimetre) of thickness, and the amount of water recommended for mixing shall be marked on the package.

NOTE 4—The amount of water recommended by the manufacturer should be the amount required to produce a working consistency under normal 73.4°F (23°C) climatic conditions.

11.4 *Container Construction*—The material from which the containers are made shall have water vapor transmission not greater than 100 g/m^2 in 24 h as determined in accordance with Procedure B of Test Methods E96/E96M.

12. Keywords

12.1 dry stacked; fiber reinforced; mortar; packaged; surface bonding

ANNEXES

(Mandatory Information)

A1. LABORATORY MECHANICAL MIXING OF SURFACE BONDING MORTAR

A1.1 Scope

A1.1.1 This method covers the mechanical mixing of surface bonding mortars of plastic consistency.

A1.2 Apparatus

A1.2.1 The apparatus shall be in accordance with the requirements of Practice C305.

A1.3 Temperature and Humidity

A1.3.1 The temperature of the room shall be maintained between 68 and 81.5°F (20 and 27.5°C), and the temperature of the dry materials, paddle, and bowl shall be within the above range at the time of test. The temperature of the mixing water shall not vary from 73.4°F (23°C) by more than ±3°F (1.7°C).

A1.3.2 The relative humidity of the laboratory shall be not less than 50 %.

A1.4 Procedure for Mixing Surface Bonding Mortar

A1.4.1 Place the dry paddle and dry bowl in the mixing position in the mixer and introduce the materials for a batch as follows:

A1.4.1.1 Place all the mixing water in the bowl.

A1.4.1.2 Add the surface bonding mortar to the water.

A1.4.1.3 Start the mixer and mix at a slow speed (140 ± 5 rad/min) for 1 min.

A1.4.1.4 Quickly switch to medium speed (285 ± 10 rpm) and mix for 30 s.

A1.4.1.5 Stop the mixer and let the mortar stand for 1½ min. During the first 15 s of this interval, quickly scrape down into the batch any material that may have collected on the sides of the bowl; then, for the remainder of this interval, cover the bowl with the lid.

A1.4.1.6 Remove the lid and finish mixing for 1 min at medium speed (285 ± 10 rad per min).

A1.4.1.7 In any case requiring a remixing interval, any mortar adhering to the side of the bowl shall be scraped quickly down into the batch with the scraper prior to remixing.

A2. CONSISTENCY TEST OF SURFACE BONDING MORTAR BY CONE PENETROMETER

A2.1 Scope

A2.1.1 This method covers the procedure for determining the consistency of surface bonding mortars by measuring the penetration of a conical plunger into a mortar sample.

A2.2 Apparatus

A2.2.1 *Unit Measure*—A cylindrical measure having an inside diameter of 3 ± 1/16 in. (76 ± 1.5 mm) and a depth of approximately 3 15/32 in. (88.1 mm), adjusted by standardization with water to contain 400 ± 1 mL at 73.4°F (23°C) (see Note A2.1). For purposes of this test, the capacity of the measure in millilitres is the weight of the water content of the measure, in grams, divided by 0.998. The measure shall have a uniform wall thickness. The thickness of the wall and bottom shall be not less than 0.115 in. The measure shall be made of a metal not attacked by the cement mortar.

NOTE A2.1—The 400-mL measure can be calibrated readily by filling with distilled water at 73°F (23°C) to a point where the meniscus extends appreciably above the top of the measure, placing a clean piece of plate glass on the top of the measure, and allowing the excess water to be squeezed out. The absence of air bubbles as seen through the glass ensures that the measure is completely full. Care should be taken that the excess water is wiped from the sides of the container before weighing.

A2.2.2 *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.

A2.2.3 *Spatula*—A spatula with a metal blade 6 in. (152.4 mm) in length and ½ in. (12.7 mm) in width with straight edges and a wooden handle.

A2.2.4 *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).

A2.2.5 *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.

A2.2.6 *Cone Penetrometer*—A Vicat apparatus, conforming to the physical requirements of Method C187, shall be modified to allow reading cone penetrations to a depth of 3½ in. (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, 1⅝ in. (41.3 mm) in diameter by 3⅝ in. (92.08 mm) long, blunted to a hemisphere a distance of ⅛ in. (3.2 mm) making the overall length 3½ in. (89 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.

A2.3 Procedure

A2.3.1 Immediately after the surface bonding mortar is mixed, in accordance with Annex A1, fill the unit measure. Using the spoon, place the mortar gently into the measure in three layers of equal volume, spading each layer 20 times with the spatula in one complete revolution around the inner surface of the measure. After the measure has been filled and spaded, 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. 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 or glass fibers 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.

A2.3.2 Weigh the filled 400-mL measure to the nearest 1 g.

A2.3.3 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.

A2.3.4 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.

A2.3.5 Read the depth of penetration in millimetres when the plunger comes to rest or at the end of 30 s.

A2.4 Report

A2.4.1 Report the depth of cone penetration to the nearest 1 mm.

A2.4.2 Report the weight of mortar in the 400-mL measure to the nearest 1 g.

A3. FLEXURAL STRENGTH OF SURFACE BONDING MORTAR

A3.1 Scope

A3.1.1 This method covers the determination of the flexural strength of surface bonding mortar. The portions of the mortar prisms tested in flexure according to this method shall be used for the determination of compressive strength (Annex A4).

A3.2 Apparatus

A3.2.1 The apparatus required for this test is that specified in Test Method C348, except that the consistency test shall be in accordance with Annex A2.

A3.3 Number of Specimens

A3.3.1 Three or more specimens shall be made for each period of test specified.

A3.4 Preparing Specimen Molds

A3.4.1 Prepare the specimen molds in accordance with Test Method C348.

A3.5 Procedure

A3.5.1 The quantity of surface bonding mortar to be mixed at one time in a batch shall be 3 kg.

A3.5.2 *Preparation of Mortar*—Mechanically mix in accordance with the procedure given in Annex A1.

A3.5.3 *Determination of Consistency*—Following the procedure outlined in Annex A2, fill the unit measure and weigh to the nearest 1.0 g. Then immediately determine the cone penetration.

A3.5.4 *Molding Test Specimens:*

A3.5.4.1 Immediately after completion of the cone penetration test and within a total elapsed time of not more than 2½ min after completion of mixing, start molding the test specimens.

A3.5.4.2 Evenly distribute a layer of surface bonding mortar about ¾ in. (19 mm) in thickness in each of the three molds. Puddle each specimen with the gloved fingers about 20 times per layer by pressing the mortar into the corners and along the surface of the mold until a homogeneous specimen is obtained. Fill the molds to about 110 % of capacity and puddle the top layer. Then smooth off the specimens by drawing the flat side of the trowel (with the leading edge slightly raised) once along the length of the molds. Cut the mortar off flush with the top of the molds by the straight edge of the trowel (held nearly perpendicular to the molds) with a sawing motion over the length of the molds. Following the cutting operation, repair

tears or cracks in the top surfaces and then make the surfaces of the specimens plane by two or three light longitudinal strokes of the trowel held with the leading edge slightly raised.

A3.5.5 *Storage of Test Specimens*—Immediately upon completion of molding, place the test specimens in the moist closet or moist room. Keep all test specimens, immediately after molding, in the molds on the base plates in the moist closet or moist room from 20 to 24 h with their upper surfaces exposed to the moist air but protected from dripping water. Then remove the prisms from the molds and place in the moist cabinet until age of test in such a manner as to allow free circulation of air around at least five faces of the specimens.

A3.5.6 *Determination of Flexural Strength*—Test the specimens in accordance with the applicable sections of Test Method C348, except that the portions of prisms to be tested in compression as modified cubes shall be covered with plastic until time of test regardless of test age.

A3.6 Calculation

A3.6.1 Record the total maximum load indicated by the testing machine and calculate the flexural strength in pounds per square inch or kilopascals as follows:

A3.6.1.1 In U.S. Customary Units:

$$S_1 = 1.8\,P \quad \text{(A3.1)}$$

where:

S_1 = flexural strength, psi, and
P = total maximum load, lbf.

A3.6.1.2 In SI units:

$$S_1 = 0.28\,P \quad \text{(A3.2)}$$

where:

S_1 = flexural strength, MPa, and
P = total maximum load, N.

A3.7 Faulty Specimens and Retests

A3.7.1 Test specimens that are manifestly faulty or that give strengths differing by more than 10 % from the average value of all test specimens made from the same sample and tested at the same period shall not be considered in determining the flexural strength. After discarding specimens or strength values, if less than two strength values are left for determining either compressive or flexural strength at any given period, a retest shall be made.

A4. COMPRESSIVE STRENGTH OF SURFACE BONDING MORTAR

A4.1 Scope

A4.1.1 This method covers determination of the compressive strength of surface bonding mortars, using portions of prisms made and broken in flexure in accordance with Annex A3.

A4.2 Apparatus

A4.2.1 The apparatus required for this test is that specified in Test Method C349.

A4.3 Test Specimens

A4.3.1 Both portions from each prism broken in flexure shall be used for compression testing, except that the broken portions of prisms selected for the compression test shall have a length of not less than 2.5 in. (64 mm) and shall be free of cracks, chipped surfaces, or other obvious defects.

A4.4 Procedure

A4.4.1 *Determination of Compressive Strength*—During the interval between flexure tests of the prisms and testing the broken portions as modified cubes, cover the specimens with plastic cloth. Wipe the specimen to a surface dry condition, and remove any sand grains or incrustations from the faces that will be in contact with the bearing plates of the testing apparatus. Check these faces by application of a straightedge. If there is appreciable curvature, grind the face or faces to plane surfaces or discard the specimen (Note A4.1). Center the pedestal usually provided for breaking 50 mm (2 in.) cubes or 2 by 4-in. (50 by 100-mm) cylinders on the base bearing block of the machine, and center the bearing plate assembly on top of this pedestal. If the testing machine has no provisions for automatic accurate centering of a pedestal exactly below the center of its upper spherical bearing head, a hardened cylindrical steel block of suitable diameter and height and with parallel plane end faces may be used, provided that the bearing plate assembly is centered accurately below the center of the upper bearing head after the bearing plate assembly. Apply the specimen aligning guide to the outside of one of the aligning plates of the bearing plate assembly, with the lugs at each end resting on or slightly above the edge of the bearing face of the bottom plate. Turn the specimen on its side with respect to its position as molded and place it in the device with the bottom as molded in contact with the aligning lugs, holding the aligning guide against the aligning plate firmly with one hand. Then remove the aligning guide without disturbing the position of the specimen and apply the load in accordance with Test Method C109/C109M. The testing of the broken portions as modified cubes shall follow breaking in flexure within 10 min for 24-h specimens and within 30 min for all other specimens.

NOTE A4.1—*Modified Cube Faces*—Results much lower than the true strength will be obtained by loading faces of the modified cubes that are not truly plane surfaces. It is essential, therefore, that molds be kept scrupulously clean, as otherwise large irregularities in the surfaces will occur. Instruments for cleaning molds should always be softer than the metal in the molds to prevent wear. In case grinding of modified cube faces is necessary, it can be accomplished best by rubbing the specimen on a sheet of fine emery paper or cloth glued to a plane surface, using only moderate pressure. Since such grinding is tedious for more than a few thousandths of an inch or hundredth of a millimetre, it is recommended that where more than this is found necessary, the specimen be discarded.

A4.5 Calculation

A4.5.1 Record the total maximum load indicated by the testing machine and calculate the compressive strength in pounds per square inch to the nearest 10 psi or in kilopascals to the nearest 0.070 MPa as follows:

A4.5.1.1 In inch-pound units:

$$S_c = 0.40\,P \quad \text{(A4.1)}$$

where:

S_c = compressive strength, psi, and
P = total maximum load, lbf.

A4.5.1.2 In S1 units:

$$S_c = 0.062\,P \quad \text{(A4.2)}$$

where:

S_c = compressive strength, MPa, and
P = total maximum load, N.

A4.6 Faulty Specimens and Retests

A4.6.1 Specimens that are manifestly faulty or that give strengths differing more than 10 % from the average value of all test specimens made from the same sample and tested at the same period shall not be considered in determining the compressive strength. After discarding strength values, if less than two strength values are left for determining the compressive strength at any given period, a retest shall be made.

NOTE A4.2—Reliable strength results depend upon careful observance of all of the specified requirements and procedures. Erratic results at a given test period indicate that some of the requirements and procedures have not been carefully observed; for example, those covering the testing of the modified cubes, as prescribed in A4.3 and A4.4. Specimens exhibiting oblique fractures on breaking, due to improper centering in the compression machine or to lateral movement of one of the testing machine heads during loading, will often indicate lower strengths than specimens showing a normal pyramidal fracture.

A5. TIME OF SET OF SURFACE BONDING MORTAR

A5.1 Scope

A5.1.1 This method is intended for determining the time of setting of surface bonding mortar by means of the Vicat needle.

A5.2 Apparatus

A5.2.1 The apparatus required for this test shall be that specified in Test Method C191.

A5.3 Procedure

A5.3.1 The quantity of surface bonding mortar to be mixed at one time in a batch shall be 3 kg.

A5.3.2 *Preparation of Mortar:*

A5.3.2.1 Mechanically mix in accordance with the procedure given in Annex A1 using the amount of mixing water recommended by the manufacturer to produce a working consistency or that previously determined, following the procedure of Annex A2 to produce a consistency penetration of 65 to 75 mm.

A5.3.2.2 Upon completion of mixing, place a layer of mortar about 20 mm in thickness in the mold and puddle with the gloved fingers to consolidate the mortar. Then fill the mold to overflowing with mortar and puddle the top layer. Cut off the mortar to a plane surface flush with the top of the mold in two operations: first, with the trowel held at about a 20° angle, start at one side of the mold 1 cm above the mold and finish the stroke by cutting the mortar off the top of the mold at the opposite side. Second, starting from the opposite direction, cut the mortar flush with the top of the mold by drawing the straight edge of the trowel (held nearly perpendicular to the mold) with a sawing motion across the top of the mold.

A5.3.3 *Determination of Time of Initial Setting*—Allow the time of setting specimen to remain in the moist cabinet for 30 min after molding without being disturbed. Determine the penetration of the 1-mm needle at this time and every 15 min thereafter until a penetration of 25 mm or less is obtained. For the penetration test, lower the needle D of the rod B until it rests on the surface of mortar. Tighten the set screw, E, and set the indicator, F, at the upper end of the scale, or take an initial reading. Release the rod quickly by releasing the set screw, E, and allow the needle to settle for 30 s; then take the reading to determine the penetration. Return specimen to the moist cabinet immediately after measuring the penetration. (If the mortar is obviously quite soft on the early readings, the fall of the rod may be retarded to avoid bending the 1-mm needle, but the rod shall be released only by the set screw when actual determinations for the setting time are made.) No penetration test shall be made closer than ¼ in. (6.4 mm) from any previous penetration and no penetration test shall be made closer than ⅜ in. (9.5 mm) from the inside of the mold. Record

the results of all penetration tests, and, by interpolation, determine the time when a penetration of 25 mm is obtained. This is the initial setting time.

A5.3.4 For the determination of the final time of setting, the surface bonding mortar shall be considered to have acquired its final set when, upon applying the needle gently to the surface of the test specimen, only the needle makes an impression according to Test Method C191. If a scum forms on the surface of the test block, use the underside of the test block for determining the final set.

A5.3.5 *Caution*—All the apparatus shall be free of vibration during the penetration test. Take care to keep the 1-mm needle straight, and the needle must be kept clean as the collection of surface bonding mortar on the sides of the needle may retard the penetration, while mortar on the point may increase the penetration. The time of setting is affected not only by the percentage and the temperature of the water used and the amount of mixing received, but also by the temperature and humidity of the air, and its determination is therefore only approximate.

A6. WATER RETENTION OF SURFACE BONDING MORTAR

A6.1 Scope

A6.1.1 This method covers the determination of water retention of surface bonding mortar by measuring the percentage of flow retention following suction.

A6.2 Apparatus

A6.2.1 The apparatus required for this test is that specified in Specification C91.

A6.3 Procedure

A6.3.1 The quantity of surface bonding mortar to be mixed at one time in a batch shall be 3 kg.

A6.3.2 *Preparation of Mortar:*

A6.3.2.1 Mechanically mix in accordance with the procedure given in Annex A1, using the amount of mixing water recommended by the manufacturer to produce a working consistency or that previously determined, following the procedure of Annex A2 to produce a consistency penetration of 65 to 75 mm.

A6.3.2.2 *Determination of Flow:*

(a) Carefully wipe the flow table top clean and dry, and place the flow mold at the center. Place a layer of mortar about 1 in. (25 mm) in thickness in the mold and puddle with the fingers. The pressure shall be just sufficient to ensure uniform filling of the mold. Then fill the mold with surface bonding mortar and puddle as specified for the first layer. Cut off the mortar to a plane surface, flush with the top of the mold, by drawing the straight edge of a trowel (held nearly perpendicular to the mold) with a sawing motion across the top of the mold. Wipe the table top clean and dry, being especially careful to remove any water from around the edge of the flow mold. Lift the mold away from the mortar 1 min after completing the mixing operation. Immediately, drop the table through a height of ½ in. (12.7 mm) 15 times in 10 s. The flow is the resulting increase in average base diameter of the mortar mass, measured on at least four diameters at approximately equi-spaced intervals, expressed as a percentage of the original base diameter.

(b) Immediately after making the flow test, return the mortar on the flow table to the mixing bowl and remix the entire batch for 15 s at medium speed. Immediately after remixing the mortar, fill the perforated dish (containing the hardened very smooth, not rapid filter paper which is of such diameter that it will lie flat and completely cover the bottom of the dish) with the mortar to slightly above the rim. Puddle the mortar with the fingers over the entire area of the dish. The pressure shall be just sufficient to ensure filling of the dish. On completion of the puddling, the top of the mortar should extend slightly above the rim of the dish. Smooth off the mortar by drawing the flat side of the straightedge (with the leading edge slightly raised) across the top of the dish. Then cut off the mortar to a plane surface flush with the rim of the dish by drawing the straightedge with a sawing motion across the top of the dish in two cutting strokes, starting each cut from near the center of the dish. If the mortar is pulled away from the side of the dish during the process of drawing the straightedge across the dish, gently press the mortar back into contact with the side of the dish using the fingers.

(c) Turn the stopcock to apply the vacuum to the funnel. The time elapsed from the start of mixing the surface bonding mortar and water to the time of applying the vacuum shall not exceed 8 min. After suction for 60 s, quickly turn the stopcock to expose the funnel to atmospheric pressure. Immediately slide the perforated dish off from the funnel, touch it momentarily on a damp cloth to remove droplets of water, and set the dish on the table. Then, using the rubber bowl scraper, plow and mix the mortar in the dish for 15 s. Upon completion of mixing, place the mortar in the flow mold and determine the flow. The entire operation shall be carried out without interruption and as quickly as possible, and shall be completed within an elapsed time of 11 min after the start of mixing the surface bonding mortar and water for the first flow determination. Both flow determinations shall be made in accordance with (*a*).

A6.4 Calculation

A6.4.1 Calculate the water retention value for the surface bonding mortar as follows:

$$\text{Water retention value} = (A/B) \times 100 \qquad (A6.1)$$

where:

A = flow after suction, and
B = flow immediately after mixing.

APPENDIXES

(Nonmandatory Information)

X1. RECOMMENDED TESTS FOR EVALUATION OF SURFACE BONDED MASONRY ASSEMBLAGES

X1.1 Scope

X1.1.1 This is to provide the list of tests to be conducted on surface bonded masonry assemblages using a surface bonding mortar that has been shown to comply with the provisions of the specification.

X1.2 Recommended tests of surface bonded masonry assemblages:

	ASTM Designation
Fire endurance	E119
Water resistance	E514
Compressive strength:	
Walls	E72
Prisms	E447
Flexural strength:	
Walls	E72
Prisms	E518
Racking strength	E519

NOTE X1.1—Substrates used in these tests should conform to the requirements of the ASTM specification appropriate for that substrate. Surface bonding should not be used on prefaced concrete masonry units. The results of the tests must be evaluated by the purchaser to confirm the composite wall performance meets his design requirements.

X2. A GUIDE FOR ADDITIONAL TESTS THAT MAY BE PERFORMED ON SURFACE BONDING MORTAR AS REQUIRED BY THE USER

X2.1 Scope

X2.1.1 This guide is to provide the list of tests that can be conducted on surface bonding mortar in addition to those required by the specification.

X2.2 Additional Tests of Surface Bonding Mortar X2.2

	ASTM Designation	Appendix Number	Report
Absorption	None	X3	g/1 h
Resistance to freezing and thawing	C666	X4	Number of cycles
Early stiffening	C359	X5	Penetration at 11 min, 45 mm

X3. ABSORPTION OF SURFACE BONDING MORTAR

X3.1 Scope

X3.1.1 This method covers the determination of absorption of surface bonding mortar.

X3.2 Apparatus

X3.2.1 The apparatus required for this test is that specified in Test Method C109/C109M.

X3.3 Procedure

X3.3.1 The quantity of surface bonding mortar to be mixed at one time in a batch shall be 3 kg.

X3.3.2 *Preparation of Mortar*—Mechanically mix in accordance with the procedure given in Annex A1 using the amount of mixing water recommended by the manufacturer to produce a working consistency or that previously determined, following the procedure of Annex A2, to produce a consistency penetration of 65 to 75 mm.

X3.3.3 *Molding Test Specimens*—For surface bonding mortars, mold the cubes in accordance with 8.4.3 of Test Method C109/C109M, except that the surface bonding mortar shall be puddled with the gloved fingers rather than tamped. Molds shall not be greased or oiled.

X3.3.4 *Storage of Test Specimens*—After 24-h storage in the moist cabinet, they shall be removed from the molds and placed in the moist cabinet for six days in such a manner as to allow free circulation of air around at least five faces of the

specimens. At the age of seven days, they shall be placed in a drying oven maintained at a temperature of 105 to 110°C for 20 to 24 h, then removed, placed in air at 23 ± 3°C for 2 h, weighed to the nearest 0.1 g, and then placed in water at 23 ± 1.7°C to a depth of ¼ in. with the top side as cast placed downward. At the end of 1 h, the specimens shall be removed, drained for 5 min, wiped with a damp cloth, and again weighed to the nearest 0.1 g.

X3.4 Calculation

X3.4.1 The average gain in weight of three specimens shall be reported as the 1-h absorption.

X4. RESISTANCE OF SURFACE BONDING MORTAR TO FREEZING AND THAWING

X4.1 Scope

X4.1.1 This method covers the determination of the resistance of surface bonding mortar specimens to rapidly repeated cycles of freezing and thawing in the laboratory by two different procedures: Procedure A, Rapid Freezing and Thawing in Water, and Procedure B, Rapid Freezing in Air and Thawing in Water. Both procedures are intended for use in determining the resistance of the surface bonding mortar to the freezing-and-thawing cycles specified in the particular procedure. Neither procedure is intended to provide a quantitative measure of the length of service that may be expected from a surface bonding mortar.

X4.2 Apparatus

X4.2.1 The apparatus shall comply with the requirements of Test Method C666/C666M.

X4.3 Procedure

X4.3.1 Follow the procedures in accordance with Sections 4, 5, and 6 of Test Method C666/C666M, including specimen size, fabrication, and initial storage and performance of freezing and thawing tests.

X4.4 Calculations

X4.4.1 Calculate the relative dynamic modulus of elasticity and durability factor as specified in Test Specimens 7 of Test Method C666/C666M.

X4.5 Report

X4.5.1 The report shall include such of the following as are pertinent to the variables or combination of variables studied in the test:

X4.5.1.1 *Mixing, Molding, and Curing Procedures*—Report any departures from the standard procedures for mixing, molding, and curing as prescribed in X4.3.

X4.5.1.2 *Procedure*—Report which of the two procedures was used.

X4.5.1.3 *Characteristics of Test Specimens:*

(a) Dimensions of specimens at 0 cycles of freezing and thawing.

(b) Weight of specimens at 0 cycles of freezing and thawing, and

(c) Any defects in each specimen present at 0 cycles of freezing and thawing.

X4.5.1.4 *Results:*

(a) Values for the durability factor of each specimen and for the average durability factor for each group of similar specimens, and the specified values for minimum relative dynamic modulus and maximum number of cycles (Note X4.1).

(b) Values of weight loss or gain for each specimen and average values for each group of similar specimens, and

(c) Any defects in each specimen that develop during testing, and the number of cycles at which such defects were noted.

NOTE X4.1—It is recommended that the results of the test on each specimen, and the average of the results on each group of similar specimens, be plotted as curves showing the value of relative modulus of elasticity against time expressed as the number of cycles of freezing and thawing.

X5. EARLY STIFFENING OF SURFACE BONDING MORTAR

X5.1 Scope

X5.1.1 This method covers the determination of early stiffening in surface bonding mortar.

X5.2 Apparatus

X5.2.1 The apparatus required for this test is that specified in Test Method C359.

X5.3 Procedure

X5.3.1 The quantity of surface bonding mortar to be mixed at one time in a batch shall be 3 kg.

X5.3.2 *Preparation of Mortar*—The mixing shall utilize the apparatus specified in Annex A1 performed in the following manner.

X5.3.2.1 Place the dry paddle and dry bowl in the mixing position in the mixer and introduce the materials for a batch as follows:

X5.3.2.2 Place all the mixing water in the bowl.

X5.3.2.3 Add the surface bonding mortar and mix for 15 s at slow speed (140 ± 5 rad per min).

X5.3.2.4 Quickly switch to medium speed (285 ± 10 rad per min) and continue the mixing for 60 s.

X5.3.2.5 Stop the mixer, scrape the sides of the mixing bowl with the rubber scraper. Allow to stand undisturbed for the remainder of a 45-s interval from time of stopping the mixer.

X5.3.2.6 Start the mixer and mix for 15 s at medium speed.

X5.3.3 *Filling Container:*

X5.3.3.1 Immediately after completion of the mixing, remove the bowl from the mixer and uniformly distribute a portion of the mortar with a spoon into the container until the container is heaping full. Quickly and gently place each spoonful of mortar in the container. When removing mortar from the bowl, do not remove the material pushed up on the side of the bowl by the paddle. After the container has been filled, reassemble the mixer, cover the bowl with a lid, and retain the remaining mortar for a remix test to be performed later. Compact the mortar in the container by lifting the container approximately 3 in. (80 mm) from the table with both hands and rapping it twice against the table surface.

X5.3.3.2 Strike off the mortar with one stroke of the trowel, with the leading edge slightly raised, along the length of the mold. Then, remove the excess mortar by means of a sawing motion with the straight edge of the trowel along the length of the container in a direction opposite to that used in striking off. Then, smooth the surface of the mortar with a single stroke of the trowel.

X5.3.4 *Penetration Tests:*

X5.3.4.1 Immediately following the filling of the container, place the 10-mm plunger of the Vicat apparatus in contact with the surface of the mortar at the midpoint of the container on the longitudinal center line. Set the movable indicator at zero. Release the plunger 3 min after the beginning of the wet mixing and record, as the initial penetration, the depth in mm to which the plunger has settled below the surface 10 s after being released. Generally, the plunger will settle to the bottom of the container and the initial penetration will, accordingly, be recorded as 50 + mm.

X5.3.4.2 Immediately withdraw and clean the plunger. In a similar manner, determine, after moving the vicat apparatus to the desired location, the penetrations at intervals of 5, 8, and 11 min after the beginning of the mixing. Do not move the filled container until these measurements are completed. Make all penetrations along the longitudinal centerline of the container. Obtain 5 and 8-min penetrations at a distance of approximately 1½ in. (40 mm) from each end of the container, respectively, and determine the 11-min penetration at a point approximately midway between the points at which the initial and 5-min penetrations were determined.

X5.3.4.3 At the completion of the measurement of the 11-min penetration, immediately return the mortar in the container to the bowl. Start the mixer, raise the bowl into mixing position, and remix the contents of the bowl at medium speed for 1 min. Fill a clean container as outlined above and determine the penetration 45 s after completion of the mixing.

X5.4 Report

X5.4.1 The report shall show the depth of penetration as follows:

	Depth of Penetration, mm
Initial penetration	...
5-min penetration	...
8-min penetration	...
11-min penetration	...
Remix penetration	...

X5.5 Interpretation of Results

X5.5.1 This method is used to determine the relative tendency of a surface bonding mortar to manifest early stiffening.

X5.5.2 Severe early stiffening in a surface bonding mortar may cause difficulty, from a placing and handling standpoint. Because of the glass fibers, prolonged mixing must be avoided, therefore, one may not be able to mix through a severe early stiffening surface bonding mortar.

X5.5.3 Early stiffening, as such, has no deleterious effects on the quality of surface bonding mortar; however, surface bonding mortar with severe false setting usually requires slightly more mixing water to produce the same consistency that may be expected to result in slightly lower strengths.

X5.5.4 Quick set of a severity sufficient to cause difficulties, from a placing and handling standpoint, usually will cause the surface bonding mortar to fail the requirements for time of set.