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

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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 *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.

1.6 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

2. Referenced Documents

2.1 *ASTM Standards:*

C 91 Specification for Masonry Cement[2]

C 109/C 109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)[2]

C 138 Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete[3]

C 144 Specification for Aggregate for Masonry Mortar[4]

C 150 Specification for Portland Cement[2]

C 187 Test Method for Normal Consistency of Hydraulic Cement[2]

C 191 Test Method for Time of Setting of Hydraulic Cement by Vicat Needle[2]

C 207 Specification for Hydrated Lime for Masonry Purposes[2]

C 260 Specification for Air-Entraining Admixtures for Concrete[3]

C 305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency[2]

C 348 Test Method for Flexural Strength of Hydraulic Cement Mortars[2]

C 349 Test Method for Compressive Strength of Hydraulic Cement Mortars (Using Portions of Prisms Broken in Flexure)[2]

C 359 Test Method for Early Stiffening of Portland Cement (Mortar Method)[2]

C 494 Specification for Chemical Admixtures for Concrete[3]

C 595/C 595M Specification for Blended Hydraulic Cements[2]

C 618 Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete[3]

C 666 Test Method for Resistance of Concrete to Rapid Freezing and Thawing[3]

E 72 Methods of Conducting Strength Tests of Panels for Building Construction[5]

E 96 Test Methods for Water Vapor Transmission of Materials[6]

E 119 Test Methods for Fire Tests of Building Construction and Materials[7]

E 447 Test Methods for Compressive Strength of Masonry Prisms[4]

E 514 Test Method for Water Penetration and Leakage Through Masonry[4]

E 518 Test Methods for Flexural Bond Strength of Masonry[4]

[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] *Annual Book of ASTM Standards,* Vol 04.01.

[3] *Annual Book of ASTM Standards,* Vol 04.02.

[4] *Annual Book of ASTM Standards,* Vol 04.05.

[5] *Annual Book of ASTM Standards*, Vol 04.11.

[6] *Annual Book of ASTM Standards*, Vol 04.06.

[7] *Annual Book of ASTM Standards,* Vol 04.07.

E 519 Test Method for Diagonal Tension (Shear) in Masonry Assemblages[4]

3. Terminology

3.1 *Definition:*

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 C 150.

4.1.1.2 *Blended Hydraulic Cements*—Type IS, ISA, IP, or IPA of Specification C 595.

4.1.1.3 *Masonry Cement*—Specification C 91.

4.1.2 *Hydrated Lime*—Type S or SA of Specification C 207.

4.1.3 *Pozzolan*—Class N, F, or S of Specification C 618.

4.1.4 *Aggregates*—Aggregates shall conform to Specification C 144 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 C 260 and C 494.

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.

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.

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 six modified cubes)		
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

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* 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 C 305, 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 4000 ± 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 nine 1.575 by 1.575 by 6.3-in. (40 by 40 by 160-mm) prisms.

9.3.1 Calculate the unit weight in pounds/cubic foot (kilograms/cubic metre) and yield in cubic feet (cubic metres) or the yield in square feet/inch (square metres/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/cubic foot (kilograms/cubic metre) in accordance with Test Method C 138 (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:

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

$$U = 0.156\, W_m$$

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

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 C 887 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/inch (square metres/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 70°F (21°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 E 96.

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 C 305.

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/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 ± 1.6 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 C 187, 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, 1 5⁄8 in. (41.3 mm) in diameter by 3 5⁄8 in. (92.08 mm) long, blunted to a hemisphere a distance of 1⁄8 in. (3.2 mm) making the overall length 3½ in. (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 C 348, 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 C 348.

A3.5 Procedure

A3.5.1 The quantity of surface bonding mortar to be mixed at one time in a batch shall be 4 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 C 348, 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:

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

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 the 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 for the test specimens 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 C 349.

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 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 8.6.3 of Test Method C 109. 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 cube 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