



Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete¹

This standard is issued under the fixed designation C 472; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

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

1. Scope

1.1 These test methods cover the physical testing of gypsum, gypsum plasters, and gypsum concrete.

1.2 The test methods appear in the following sections:

Sections

Precautions for Physical Tests	4
Reagents and Materials	5
Free Water	6
Fineness	7
Normal Consistency of Gypsum Plaster	8
Normal Consistency of Gypsum Concrete	9
Setting Time	10
Setting Time (Temperature Rise Method)	11
Compressive Strength	12
Density	13

1.3 The values regarded as the standard are either in inch-pound units or SI (metric). The values stated first shall be regarded as the standard. Values following in parentheses are approximate and are provided for information purposes only.

1.4 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) are not requirements of the standard.

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.* For a specific precautionary statement, see X1.2.1.

2. Referenced Documents

2.1 *ASTM Standards:*²

- C 11 Terminology Relating to Gypsum and Related Building Materials and Systems
- C 778 Specification for Standard Sand
- E 11 Specification for Wire Cloth and Sieve for Testing Purposes

3. Terminology

3.1 *Definitions:*

3.1.1 For useful definitions refer to Terminology C 11.

4. Precautions for Physical Tests

4.1 Gypsum products are greatly affected by small amounts of impurities introduced by careless laboratory manipulation. In order to obtain accurate results, it is absolutely essential to observe the following precautions:

4.1.1 Keep all apparatus thoroughly clean. Remove all traces of set plaster.

NOTE 1—For mixing pastes and mortars, a 500-ml rubber dental bowl is a convenience.

NOTE 2—Use care when drying gypsum, gypsum plasters, or gypsum concrete. Exceeding the specified drying temperatures may calcine the specimens, which will cause inaccurate test results.

5. Reagents and Materials

5.1 *Distilled or Deionized Water*—free of chlorides and sulfates at a temperature of 21 ± 1°C (70 ± 2°F).

5.2 *Standard Sand*— Specification C 778, 20–30 sand.

6. Free Water

6.1 *Significance and Use*—This test method determines the free water contained in gypsum, gypsum plasters, and gypsum concrete samples, and prepares the sample for subsequent testing.

6.2 *Apparatus:*

6.2.1 *Balance*, capable of weighing not less than 500 g at a precision of 0.1 g.

6.2.2 *Drying Oven*, set at 45 ± 3°C.

6.2.3 *Desiccator*, containing calcium chloride or equivalent desiccant.

6.3 *Procedure:*

¹ These test methods are under the jurisdiction of ASTM Committee C11 on Gypsum and Related Building Materials and Systems and are the direct responsibility of Subcommittee C11.01 on Specifications and Test Methods for Gypsum Products.

Current edition approved May 1, 2004. Published June 2004. Originally approved in 1961. Last previous edition approved in 1999 as C 472–98.

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.

6.3.1 Weigh a sample of not less than 500 g of the material as received to the nearest 0.1 g and spread it to a thin layer in a suitable vessel. Place in an oven (6.2.2) and dry for 2 h; then cool in a desiccator (6.2.3) and weigh again.

6.3.2 Retain the dried sample in an airtight container until used for the fineness test (Section 7).

6.4 Report—Report the loss in weight as a percentage of the original weight of the sample as received to a precision of 0.1%.

6.5 Precision and Bias—The precision and bias of the free water test method have not been determined.

7. Fineness

7.1 Significance and Use—This test method covers a procedure for determining the fineness of gypsum and gypsum plasters and is used to determine compliance with gypsum and gypsum plaster specifications. The degree of correlation between the results of this test method and service performance has not been determined.

7.2 Apparatus:

7.2.1 Sieves, as required by a particular gypsum or gypsum plaster specification, in accordance with Specification E 11.

7.2.2 Balance, capable of weighing not less than 1000 g at a precision of 0.1 g.

7.2.3 Mechanical Sieving Machine

7.3 Procedure:

7.3.1 Determine fineness by sieving a known weight of the dried sample through sieves of the specified sizes (Note 3 and Note 4). The size of the sample to be used in determining fineness depends upon the particle size of the material. If the material will pass a 6.3-mm (1/4-in.) sieve, a 100-g sample will be sufficient; if the largest particles are more than 25 mm (1 in.) in diameter, use not less than a 1000-g sample. With these limitations the size of sample to be used is left to the discretion of the operator. Shake the sample through each sieve with as little abrasion as possible (Note 5). Weigh the amount of material retained on each sieve and calculate the fineness, expressed as a percentage of the weight of the original sample.

7.3.2 If a mechanical sieving machine is used, make a series of tests at one minute intervals, with each type of material and sieve size combination to be used. When not more than 0.5 g passes each sieve in a one minute interval, use that time as the standard sieving time for that test procedure on that machine.

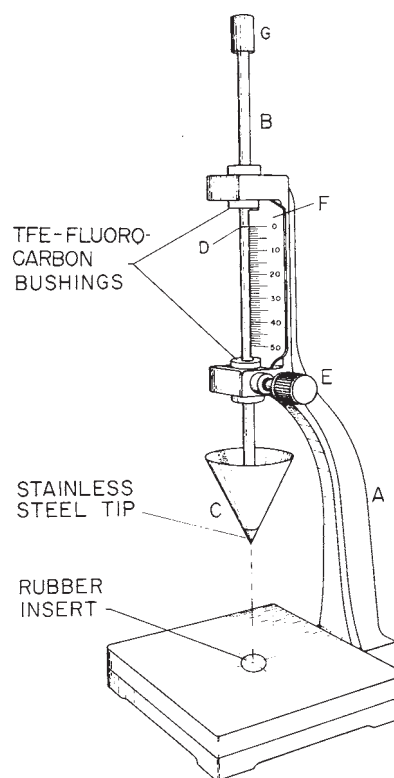
NOTE 3—For suggested method of sieving gypsum through a 45-µm (No. 325) sieve, see Appendix X1.

NOTE 4—The sizes of the sieves to be used are given in the specifications of ASTM covering the particular product in question.

NOTE 5—When sieving by hand through a 150-µm (No. 100) sieve, use a lateral motion, and tap the side of the sieve with the palm of the hand. Continue without brushing until not more than 0.5 g passes through during 1 min of sieving. If the sieve openings become clogged, transfer the retained material temporarily to another vessel, invert the sieve over a sheet of paper on the table and tap it sharply against the table. Then transfer all the retained material back into the sieve and continue sieving.

7.4 Report—Report the percent by weight retained on each sieve or passing particular sieves in accordance with the material specification to the nearest full percentage point.

7.5 Precision and Bias—The precision and bias of the fineness test method have not been determined.



A—Hinged support bracket
 B—Plunger support rod
 C—Conical plunger
 D—Graduation mark
 E—Lock screw
 F—Modified scale
 G—Weight

FIG. 1 Modified Vicat Apparatus (Conical Plunger Method)

8. Normal Consistency of Gypsum Plaster

8.1 Significance and Use—This test method is used to determine the volume of water required for mixing gypsum plaster when performing the setting time and compressive strength tests.

8.2 Apparatus:

8.2.1 Modified Vicat Apparatus—The modified Vicat apparatus (Fig. 1)³ shall consist of a bracket, A, bearing a movable brass rod, B, 6.3 mm in diameter and of suitable length to fit the Vicat Bracket. A conical plunger made of aluminum with an apex angle of 53° 08 min and a height of 45 mm shall be attached to the lower end of the rod. The total weight of the rod and plunger shall be 35 g. A means shall be provided for adding a weight, G, to the rod, increasing the total weight to 50 g. The rod shall be capable of being held in any position by a screw, E. The rod shall have a mark, D, midway between the ends which moves under a scale, F, graduated in millimetres, attached to the bracket, A.

8.2.2 Mold—The conical ring mold shall be made of a noncorroding, nonabsorbent material, and shall have an inside diameter of 60 mm at the base and 70 mm at the top and a height of 40 mm.

³ This method is described by Kuntze, R. A., "An Improved Method for the Normal Consistency of Gypsum Plasters," *ASTM Bulletin No. 246*, ASTM, May 1960, p. 35.

8.2.3 *Base Plate*—The base plate for supporting the ring mold shall be of plate glass and about 100 mm square.

8.2.4 *Balance*, capable of weighing not less than 500 g at a precision of 0.1 g.

8.2.5 *Graduated Cylinder*, shall be made to deliver the indicated volume at 20°C (68°F) and shall be subdivided to not less than 1 mL.

8.3 *Procedure:*

8.3.1 Clean the plunger, mold, and base plate of the modified Vicat apparatus. Apply a thin coat of petroleum jelly or other suitable lubricant to the upper surface of the base plate in order to prevent leaks during the test.

8.3.2 Sift a weighed quantity of the sample (200 to 300 g as required to fill the mold) into a known volume of water (See 5.1). If the plaster is unretarded, add to the mixing water 0.2 g of sodium citrate per 100 g of sample. After allowing the sample to soak for 2 min, stir the mixture for 1 min to an even fluidity. Pour this sample into the ring mold, work slightly to remove air bubbles, and then strike off flush with the top of the mold. Wet the plunger of the modified Vicat apparatus and lower it to the surface of the sample at approximately the center of the mold. Read the scale and release the plunger immediately. After the rod has settled, read the scale again. Make three determinations on each mix, care being taken to have the mold completely filled and the plunger clean and wet.

8.3.3 Test gypsum molding plaster and gypsum gauging plaster with different amounts of water until a penetration of 30 ± 2 mm is obtained. Use the rod and plunger for this determination weighing 35 g.

8.3.4 Test all gypsum mixtures containing aggregates with different amounts of water until a penetration of 20 ± 2 mm is obtained. Add weight to the rod and plunger to bring the total weight to 50 g for these determinations.

8.3.5 Mix gypsum neat plaster with standard sand (see 5.2) in the ratio of 200 g of sand to 100 g of plaster before testing for normal consistency.

8.4 *Report:*

Report the normal consistency as the average number of millilitres of water required to be added to 100 g of the dry mixture to the nearest whole millilitre.

8.5 *Precision and Bias*—The precision and bias of the test method for normal consistency of gypsum plaster have not been determined.

9. Normal Consistency of Gypsum Concrete

9.1 *Significance and Use*—This test method is used to determine the volume of water required for mixing gypsum concrete when performing the setting time and compressive strength tests.

9.2 *Apparatus:*

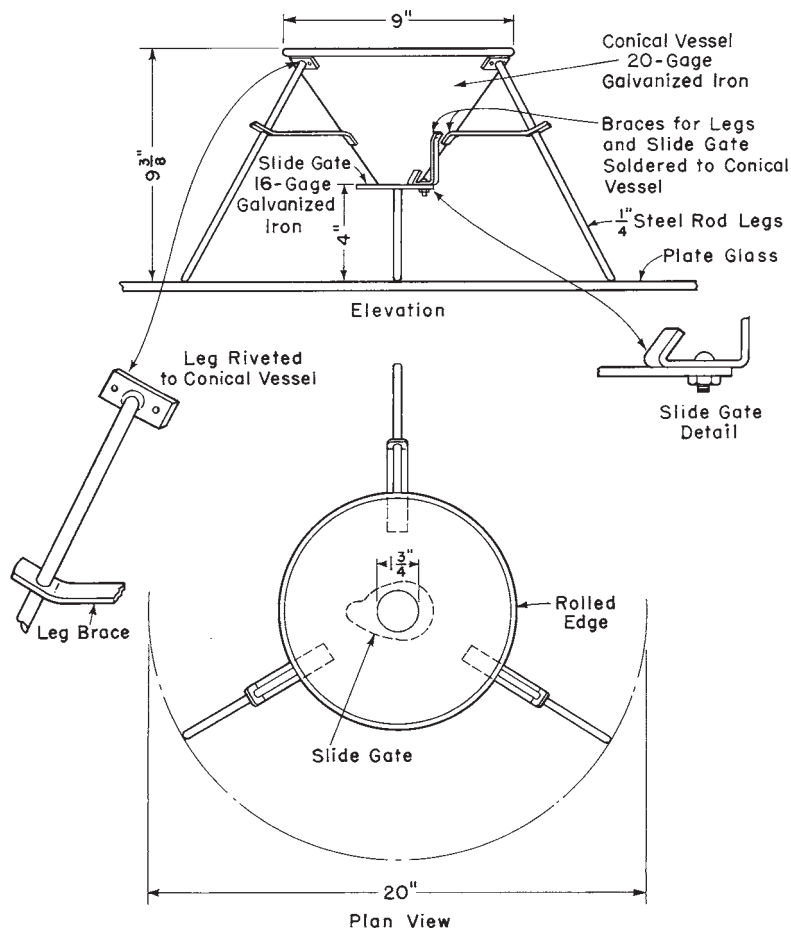


FIG. 2 Consistometer

9.2.1 *Consistometer (Fig. 2)*—The consistometer consists of a conical vessel made of noncorroding, nonabsorbent material, and having an inside diameter of 9 in. (229 mm) at the top and 1¾ in. (44.5 mm) at the bottom, and a height of 5½ in. (139.7 mm). It shall be provided with a sliding gate at the bottom and supported so that the bottom is 4 in. (102 mm) above the base plate. The base plate shall be of plate glass, free of scratches and about 18 in. (457 mm) square.

9.2.2 *Balance*, capable of weighing not less than 2000 g at a precision of 1 g.

9.3 *Procedure:*

9.3.1 Clean and dry the consistometer and the base plate and close the sliding gate.

9.3.2 Sift 2000 g of the sample into a known volume of water (see 5.1) to which 1.0 g of sodium citrate has previously been added. After allowing the sample to soak for 1 min, stir the mixture for 3 min to an even fluidity. Pour the mixture into the consistometer until level with the top. Then rapidly and completely open the sliding gate, allowing the mixture to run out onto the base plate. When the sliding gate is opened, take care to avoid jarring the consistometer.

9.3.3 Measure the resulting patty along its major and minor axes and determine the average diameter.

9.3.4 Test gypsum concrete with different amounts of water until a patty diameter of 380 ± 13 mm (15 ± ½ in.) is obtained.

9.4 *Report*—Report the normal consistency as the number of millilitres of water to the nearest whole millilitre required to be added to 100 g of the gypsum concrete.

9.5 *Precision and Bias*—The precision and bias of the test method for normal consistency of gypsum concrete have not been determined.

10. *Setting Time*

10.1 *Significance and Use*—This test method is used to determine the setting time of gypsum plaster and gypsum concrete, and is used to determine compliance with gypsum plaster and gypsum concrete specifications. Since variable job conditions influence the setting time, the degree of correlation between this test method and service performance has not been determined.

10.1.1 This test method does not determine the time of complete hydration of gypsum plaster or gypsum concrete. To determine the time of complete hydration see Setting Time, (Temperature Rise Method,) Section 11.

10.2 *Apparatus:*

10.2.1 *Vicat Apparatus*—The Vicat apparatus (Fig. 3) shall consist of a frame, A, bearing a movable rod, B, weighing 300 g, one end, C, the plunger end, being 10 mm in diameter for a distance of not less than 50 mm, the other end having a removable needle, D, 1 mm in diameter and 50 mm in length. The rod, B, shall be reversible, shall be able to be held in any position by a screw, E, and shall have an adjustable indicator, F, that moves over a scale (graduated in millimetres) attached to the frame, A. The paste shall be held in a rigid conical ring, G, resting on a glass plate, H, about 100 mm square. The ring shall be made of a noncorroding, nonabsorbent material and shall have an inside diameter of 70 mm at the base and 60 mm at the top, and a height of 40 mm.

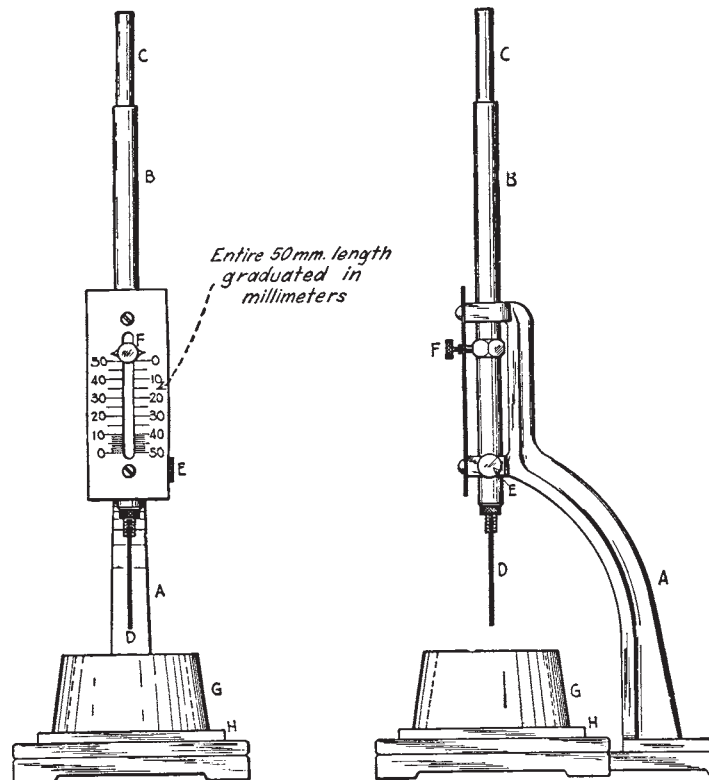


FIG. 3 Vicat Apparatus



10.2.2 In addition, the Vicat apparatus shall conform to the following requirements:

Weight of plunger	300 ± 0.5 g
Diameter of larger end of plunger	10 ± 0.05 mm
Diameter of needle	1 ± 0.05 mm
Inside diameter of ring at bottom	70 ± 3 mm
Inside diameter of ring at top	60 ± 3 mm
Height of ring	40 ± 1 mm
Graduated scale	The graduated scale, when compared with a standard scale accurate to within 0.1 mm at all points, shall not show a deviation at any point greater than 0.25 mm.

NOTE 6—Automatic setting time apparatus are commercially available and may be used provided they can be shown to give the same results as the specified apparatus and procedure.

10.2.3 *Balance*, capable of weighing not less than 500 g at a precision of 0.1 g.

10.2.4 *Stopwatch or Clock*, for determining setting time.

10.2.5 *Temperature and Humidity Controlled Cabinet*, capable of maintaining a temperature of $21 \pm 1^\circ\text{C}$ ($70 \pm 2^\circ\text{F}$) and a relative humidity of not less than 85 %.

10.3 *Procedure*:

10.3.1 *Gypsum Concrete and All Gypsum Plasters, Except Gypsum Neat Plaster*—Start the timing of the test approximately at the moment of contact of the dry material with the water (see 5.1). Mix enough paste to fill the conical ring. For the quantity of water and directions for mixing, see Section 8, but do not add retarder. Place the conical ring on the base plate and fill the ring with the paste level with the top of the ring. Position the end of the needle so that it just touches the top surface of the paste and tighten the screw. Release the screw so that the needle falls freely into the paste. After each penetration, wipe the needle clean, and move the base plate and ring slightly so that the needle will not strike the same place twice. Test the sample at intervals according to the table in 10.3.3. Setting time is complete when the needle no longer penetrates to the bottom of the paste. When setting times are expected to be longer than $\frac{1}{2}$ h, store the test specimens in the cabinet described in 10.2.5.

10.3.2 *Gypsum Neat Plaster*—Test gypsum neat plaster for setting time as mixed with three parts by weight of standard sand (see 5.2). Mix dry a 100-g sample of the gypsum neat plaster and 300 g of the sand, and then add sufficient water to produce a normal consistency. For the quantity of water (see 5.1) and mixing instructions, see Section 8, but do not use retarder. Stir for 1 min to an even, lump-free consistency. Place the mortar in the conical ring and test for setting time as described in 10.3.1.

10.3.3 *Frequency of Testing*—Test the materials according to the following schedule:

Kind of Material	First Test	Frequency of Subsequent Tests
Molding plaster	15 min	5 min
Keene's cement:		
Standard	15 min	1 h
Quick set	15 min	5 min
Gypsum concrete	15 min	5 min
Ready mixed plaster	$\frac{1}{2}$ h	1 h
Neat plaster	2 h	1 h
Wood-fibered plaster	$\frac{1}{2}$ h	1 h

Bond plaster	$\frac{1}{2}$ h	1 h
Gauging plaster:		
Slow set	40 min	2 h
Quick set	15 min	5 min

10.4 *Report*—Report the setting time as the elapsed time in minutes from the time when the sample was first added to the water to the time when set is complete.

10.5 *Precision and Bias*—The precision and bias for the setting time test method have not been determined.

11. Setting Time (Temperature Rise Method)

11.1 *Significance and Use*:

11.1.1 This test method determines the hydration time by measuring the maximum temperature rise of gypsum plaster or gypsum concrete. The temperature rise is caused by the reaction of calcium sulfate hemihydrate with water to form calcium sulfate dihydrate. It is assumed that the maximum temperature rise coincides with the completion of the reaction. This test method is not used to determine compliance with specifications for gypsum plaster or gypsum concrete unless it is specified in the purchase contract.

11.1.2 The setting time determined by this test method is usually longer than the setting time determined in Section 10.

11.1.3 The degree of correlation between this test method and service performance has not been determined.

11.2 *Apparatus*:

11.2.1 *Potentiometer*—A single- or multiple-channel recording potentiometer or thermistor bridge shall be used to record the temperature change of the sample under test. The chart speed shall be not less than 1 in. (25 mm)/h. Imprints recording the temperature shall not be longer than 1 min apart for each sample.

11.2.2 *Temperature Sensors*—Temperature changes shall be indicated by either thermocouples or thermistors which shall be movable or in a fixed position. Temperature sensing elements shall be of such capacity and sensitivity that, when connected to the recording potentiometer, a temperature change of 0.5°C (1°F) in the sample shall be recorded on the chart.

11.2.3 *Sample Cups*—Cups with a capacity of 175 to 275 mL (6 to 9 oz) shall be used. The cup containing the mixture under test shall be placed inside a matching cup held in an insulated block or beaker, as specified in 11.2.4. The temperature sensor, in this case, shall be positioned 25 to 33 % of the distance up from the bottom and between the inner and outer cup. Alternately, the cup containing the test mixture shall be positioned over a spring-loaded sensor to ensure close contact with the bottom of the cup.

11.2.4 *Insulated Block or Beaker*, with walls and bottom having a thermal resistance of not less than R_6 ($1.1 \text{ (m}^2\cdot\text{K)/W}$) ($6 \text{ (h}\cdot\text{ft}^2\cdot^\circ\text{F)/Btu}$), and a centered cavity into which the sample cup fits snugly.

NOTE 7—An insulating block may be constructed from a block of expanded polystyrene. Carve a cavity in the block so that the sample cup fits snugly, leaving walls and bottom not less than 40 mm (1.5 in.) thick. An insulating beaker may be made by stuffing glass fiber or mineral wool insulation not less than 50.8 mm (2 in.) thick around the sample container and within the walls of a beaker. The insulated block or beaker should have an insulated cover of the same insulating material through which the temperature probe can extend into the test material.

11.3 *Test Conditions*— Perform tests in a room or cabinet maintained at a temperature of $21 \pm 1.1^\circ\text{C}$ ($70 \pm 2^\circ\text{F}$). Maintain materials and mixing water used for the test at a temperature of $21 \pm 1.1^\circ\text{C}$ ($70 \pm 2^\circ\text{F}$).

NOTE 8—If a constant-temperature cabinet is not available, a constant-temperature water bath may be fitted with a cover which will admit the body of the cup holder but not its rim, so that the cup holder is in contact with the water in the bath.

11.4 Procedure:

11.4.1 *Gypsum Concrete and All Gypsum Plasters, Except Gypsum Neat Plaster*—Start the timing of the test at the moment of contact of the dry material with the water. Mix approximately 200 g of the sample to make a paste of normal consistency. Place the paste in a clean dry sample cup to about 20 mm ($\frac{3}{4}$ in.) from the top. Place the filled cup in an empty cup in the insulated block or beaker and adjust the sensing element as required in 11.2.3. Cover the cup with a watch glass or plastic film or cover the surface of the paste with mineral oil to a depth of approximately 5 mm ($\frac{1}{4}$ in.).

11.4.2 *Gypsum Neat Plaster*—Prepare the plaster in accordance with 10.3.2 and test in accordance with 11.4.1.

11.5 *Report*—Report the setting time as the elapsed time in minutes from the time when the sample was first added to the water to the time when maximum temperature rise is attained.

11.6 *Precision and Bias*—The precision and bias for the setting time, temperature rise method, have not been determined.

12. Compressive Strength

12.1 *Significance and Use*—This test method is used to determine the compressive strength of gypsum plaster and gypsum concrete and is used to determine compliance with applicable specifications. The correlation between this test method and service performance has not been determined.

12.2 Apparatus:

12.2.1 *Specimen Molds*—Molds for making test specimens shall be 2-in. (50.8 mm) split cube molds made of noncorrodible material and shall be sufficiently rigid to prevent spreading during molding. The molds shall have not more than three cube compartments and shall be separable into not more than two parts. When assembled, the parts of the molds shall be held firmly together, and dimensions shall conform to the following requirements: Interior faces shall be plane surfaces with a maximum variation of 0.001 in. (0.03 mm) for new molds and 0.002 in. (0.05 mm) for old molds; distance between opposite faces, and height of the molds, measured separately for each cube compartment, shall be 2 ± 0.005 in. (50.8 ± 0.13 mm) for new molds or 2 ± 0.020 in. (50.8 ± 0.51 mm) for old molds, angle between adjacent interior faces and between interior faces and top and bottom planes of the mold shall be $90 \pm 0.5^\circ$, measured at points slightly removed from the intersection of the faces.

12.2.2 *Testing Machine*, either the hydraulic or the screw type, with sufficient opening between the upper bearing surface and the lower bearing surface of the machine for the use of verifying apparatus. The load applied to the test specimen shall be indicated with an accuracy of $\pm 1.0\%$. The load indicating device shall have a means of indicating maximum load. The

upper bearing shall be a spherically seated, hardened metal block firmly attached at the center of the upper head of the machine. The center of the sphere shall lie at the center of the surface of the block in contact with the specimen. The block shall be free to tilt in any direction. A hardened metal bearing block shall be used beneath the specimen to minimize wear of the lower platen of the machine. The lower bearing block shall have concentric circles at $\frac{1}{4}$ -in. intervals centered on the block to facilitate accurate centering of the test specimen. The bearing block surfaces intended for contact with the specimen shall have a Rockwell hardness number not less than 60 HRC. These surfaces shall not depart from plane surfaces by more than 0.0005 in. (0.013 mm) when the blocks are new and 0.001 in. (0.025 mm) after use.

12.2.3 *Drying Oven*, a mechanical convection oven maintained at a temperature of $45 \pm 3^\circ\text{C}$ and a relative humidity not more than 50 %.

12.2.4 *Desiccator*, containing magnesium perchlorate or calcium chloride that is capable of being tightly sealed and of such a size as to hold not less than one set of 6 cubes.

12.3 Test Specimens:

12.3.1 Mix sufficient sample at normal consistency to produce not less than 1000 mL (34 fluid oz) of mixed mortar and cast into six specimen molds (see 12.2.1). Premix neat gypsum plaster dry with two parts by weight of standard sand (see 5.2). For the quality and quantity of water, see 5.1 and Section 8, but do not add retarder. Place the required amount of water in a clean 2-L (2-qt) mixing bowl.

12.3.2 For all gypsum plasters except gypsum concrete, add the required amount of dried plaster and allow to soak for 2 min. Mix vigorously (about 150 complete circular strokes per minute) for 1 min with a metal spoon, stiff-bladed spatula or mechanical mixer (see Note 9) to produce a mortar of uniform consistency. For gypsum concrete, soak for 1 min, and stir vigorously (about 150 complete circular strokes per minute) with a large spoon or mechanical mixer for 3 min. Setting time of the mortar, as determined by Sections 10-10.5, shall be within the time limits shown in Table 1.

NOTE 9—The Hobart N-50 mixer has been found satisfactory for this purpose.

12.3.3 If setting times as determined in accordance with Section 10 are more than the maximum limits shown in Table 1, discard the cubes and adjust the setting time by adding

TABLE 1 Setting-Time Limits for Mortar

Kind of Material	Setting Time, min	
	min	max
Molding plaster	20	140
Keene's cement:		
Standard	40	120
Quick set	20	40
Gypsum concrete	20	40
Ready-mixed plaster	90	120
Neat plaster (with 2 parts sand)	120	150
Wood-fibered plaster	90	120
Bond plaster	120	150
Gauging plaster:		
Slow set	40	120
Quick set	20	40
Veneer plaster	30	90

freshly ground gypsum accelerator to the plaster, or add molding plaster to Keene's cement. Do not use more gypsum accelerator or molding plaster than 1 % of the dry weight of plaster or Keene's cement.

12.3.4 Coat the molds with a thin film of mineral oil or other mold release agent and place on an oiled glass or metal plate. Place a layer of mortar about 25 mm (1 in.) in depth in each mold and puddle ten times across the mold between each pair of opposite faces with a 25 mm (1 in.) wide spatula to remove air bubbles. Fill the molds to a point slightly above the tops of the molds, by the same filling and puddling procedure used for the first layer. Also fill the conical mold for the Vicat apparatus described in 10.2.1 and 10.2.2 and determine the setting time (see 10.3). As soon as the mortar or paste has set, cut off the excess to a plane surface flush with the top of the mold, using a stiff broad knife or similar implement.

12.3.5 Place the filled molds in moist air (90 to 100 % relative humidity). Remove the cubes from the molds at any time after they are thoroughly hardened, but retain in the moist air for not less than a total of 16 h. Place the cubes in an oven as specified in 12.2.3. Dry until successive weights are identical to 0.1 g (or differ by no more than 0.1 g). Then place the cubes in a desiccator as described in 12.2.4 for a minimum of 16 h before testing. Test the cubes immediately on removal from the desiccator.

12.4 *Procedure*—As soon as the cube specimens have been dried (12.3), determine their compressive strengths. (If density is to be determined, do so at this time. (See Section 13)). Position the cubes in the testing machine so that the load is applied on surfaces formed by faces of the molds, not on top and bottom. Apply the load continuously and without shock, at a constant rate within the range 15 to 40 psi/s. Do not exceed 40 psi/s (275 kPa/s) after 50 % of the maximum load has been reached.

12.5 *Report*—Report the average compressive strength as the compressive strength of the material, in psi (Mpa) rounded to the nearest whole psi (0.1 Mpa) except that if the strengths of one or two of the cubes vary more than 15 % from the average of the six, discard them and report the compressive strength as the average of the remaining specimens. In case the compressive strengths of three or more cubes vary more than 15 % from the average, discard the results and repeat the test.

12.6 *Precision and Bias*—The precision and bias for the compressive strength test method have not been determined.

13. Density

13.1 *Significance and Use*—This test method is used to determine the density of cast gypsum concrete and is used to determine compliance with the specification for gypsum concrete. The correlation between this test method and service performance has not been determined.

13.2 Apparatus:

13.2.1 *Balance*, capable of weighing not less than 1500 g to the nearest gram.

13.3 *Procedure*—Determine the density of gypsum concrete by weighing the six cubes to the nearest gram after drying and cooling, as described in 12.3.4, and before determining the compressive strength.

13.4 *Calculation*—Calculate the density by multiplying the total weight of the six cubes by 0.0794.

13.5 *Report*—Report the density in pounds per cubic foot to the nearest 1 lb/ft³ (10 kg/m³).

13.6 *Precision and Bias*—The precision and bias for the density test method have not been determined.

14. Keywords

14.1 compressive strength; density; free water; fineness; gypsum; gypsum concrete; gypsum plasters; normal consistency; setting time

APPENDIX

(Nonmandatory Information)

X1. ALCOHOL WASH METHOD OF SIEVING GYPSUM AND GYPSUM PRODUCTS

X1.1 Scope

X1.1.1 This appendix covers a sieve test for fine gypsum and gypsum products using an alcohol wash method.

X1.2 Significance and Use

X1.2.1 It is impractical to sieve dry gypsum through a fine sieve, and water cannot be used as a washing agent without introducing errors due to hydration or solution. This method is used when a purchase order specifies fineness through fine sieves.

X1.3 Apparatus

X1.3.1 Sieves, complying with Specification E 11.

X1.3.2 Mechanical Sieving Machine.

X1.3.3 Vessel, with a diameter not less than 50 mm greater than the sieves, and a depth not less than 75 mm greater than the height of the sieves.

X1.3.4 Balance, capable of reading to a precision of 0.01 g.

X1.4 Reagents

X1.4.1 Isoprophyl alcohol, 99%. The alcohol may be reused after decanting or filtering, provided its strength does not fall below 95%

X1.4.1.1 **Caution**—When using isoprophyl alcohol, keep fire away, provide good ventilation, and avoid excessive inhalation of vapor.

X1.5 Calibration and Standardization

X1.5.1 See 7.3.2 for method of calibrating a mechanical sieving machine.

X1.6 Procedure

X1.6.1 Place the alcohol in a vessel (X1.3.3) to a depth of 50 mm more than the height of the sieve. Weigh approximately 50 g of the sample to a precision of 0.01 g and place on a 45- μm or coarser sieve up to and including the 150 μm (No. 100).

X1.6.2 Lower the sieve into the alcohol until the specimen is wetted throughout. Lift the sieve out of the alcohol, with a swirling motion, permitting the alcohol to drain through the specimen back into the vessel. Repeat this operation not less than eight times, until the alcohol passes freely through the sieve and the specimen is essentially free from fines. Wash the residue retained on the sieve with about 100 mL of clear alcohol, and then blot the bottom of the sieve with a soft, dry, lint-free cloth. Dry the sieve containing the residue at $45 \pm 3^\circ\text{C}$.

X1.6.3 Shake the sieve on a mechanical shaker for $2 \text{ min} \pm 2 \text{ s}$. If desired, to permit simultaneous determinations of coarser fractions, transfer the residue after drying and before shaking to a series of coarser sieves up to and including the 150

μm nested in sequential order above the 45- μm sieve. Weigh the material retained on each sieve to the nearest 0.01 g.

X1.7 Calculation

X1.7.1 Calculate the percent of the original specimen retained on or through each sieve as follows:

$$\% \text{ retained} = (B/A) \cdot 100$$

$$\% \text{ through} = \frac{A - B}{A} \cdot 100$$

where:

A = Weight of original specimen, and

B = weight of specimen retained on sieve.

X1.8 Report

X1.8.1 Report the percent retained or through each sieve to the nearest 0.1 percent.

X1.9 Precision and Bias

X1.9.1 The precision and bias of the alcohol wash method of sieving gypsum and gypsum products has not been determined.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).