Designation: C 579 – 01

Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes[1]

This standard is issued under the fixed designation C 579; 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 determination of the compressive strength of chemical-resistant mortars, grouts, monolithic surfacings, and polymer concretes. These materials may be based on resin, silicate, silica, or sulfur binders.

1.2 Test Method A outlines the testing procedure generally used for systems containing aggregate less than 0.0625 in. (1.6 mm) in size. Test Method B covers the testing procedure generally used for systems containing aggregate from 0.0625 to 0.4 in. (1.6 to 10 mm) in size. Test Method C is used for systems containing aggregate larger than 0.4 in.

1.3 These test methods provide two different methods for controlling the testing rate.

1.4 *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.*

1.5 The values stated in inch-pound units are to be regarded as standard. Within this text, the SI units shown in parentheses are provided for information only.

2. Referenced Documents

2.1 *ASTM Standards:*

C 470 Specification for Molds for Forming Concrete Test Cylinders Vertically[2]

C 904 Terminology Relating to Chemical-Resistant Nonmetallic Materials[3]

E 4 Practices for Force Verification of Testing Machines[4]

3. Terminology

3.1 *Definitions*—For definitions of terms used in these test methods, see Terminology C 904.

4. Significance and Use

4.1 These test methods offer a means of determining the compressive strength of chemical-resistant mortars, grouts, monolithic surfacings, and polymer concretes.

5. Apparatus

5.1 *Equipment*, capable of weighing materials or specimens to ±0.3 % accuracy.

5.2 *Specimen Molds*:

5.2.1 *Test Method A*— These molds shall be right cylinder 1 ± 1⁄32 in. (25 ± 0.8 mm) in diameter by 1 ± 1⁄32 in. high. The molds may be constructed in any manner that will allow formation of a test specimen of the desired size. Typical molds consist of a 1-in. thick, flat plastic sheet in which 1-in. diameter, smooth-sided holes have been cut, and to the bottom of which a 1⁄4-in. (6-mm) thick, flat plastic sheet (without matching holes) is attached by means of screws or bolts. Alternately, the molds may consist of sections of round plastic tubing or pipe, 1-in. inside diameter and 1 in. long, having sufficient wall thickness to be rigid and retain dimensional stability during the molding operation, and a 1⁄4-in. thick, flat plastic sheet on which one open end of each section can be rested. With the latter style of mold, the tubing segment may be sealed with a material, such as caulking compound or stopcock grease. For most types of specimens it is satisfactory to simply seal one end of the tubing segment with masking tape.

NOTE 1—For use with sulfur mortars an additional piece of flat plastic sheet at least 1⁄8 in. (3 mm) thick containing a 1⁄4-in. (6-mm) hole and a section of plastic tubing or pipe 1 in. (25 mm) in diameter by 1 in. high are required. They are used to form a pouring gate and reservoir in the preparation of sulfur mortar specimens.

5.2.2 *Test Method B*— Molds for the 2 in. (50 mm) cube specimens shall be tight fitting and leakproof. The molds shall have not more than three cube compartments and shall be separable into not more than three parts. The parts of the molds, when assembled, shall be positively held together. The molds shall be made of materials not attacked by the product being tested. The sides of the molds shall be sufficiently rigid to prevent spreading or warping. The interior faces of the molds shall be manufactured to ensure plane surfaces with a permissible variation of 0.002 in. (0.05 mm). The distances

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

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

[4] *Annual Book of ASTM Standards*, Vol 03.01.

between opposite faces shall be 2 ± 1⁄16 in. (50 ± 0.8 mm). The height of the molds, measured separately for each cube compartment, shall be 2 ± 1⁄16 in. The angle between adjacent interior faces and between interior faces and top and bottom planes of the mold shall be 90 ± 0.5° measured at points slightly removed from the intersection of the faces.

5.2.3 *Test Method C*— Molds shall be right cylinders made of heavy gage metal or other rigid nonabsorbent material. The cylinder diameter shall be at least four times the nominal maximum aggregate size in the mix. The minimum cylinder diameter shall be 2 in. (50 mm). The cylinder height shall be two times the diameter. The plane of the rim of the mold shall be at right angles to the axis within 0.5°. The mold shall be at right angles to the axis within 0.5°. The mold shall not vary from the prescribed diameter by more than 1⁄16 in. (1.5 mm) nor from the prescribed height by more than 1⁄8 in. (3 mm). Molds shall be provided with a flat base plate with a means for securing it to the mold at a right angle to the axis of the cylinder in the instance of reusable metal molds. For molds other than metal, a mechanically attached smooth flat metal or integrally molded flat bottom of the same material, as the sides shall be used. Single-use molds shall conform to Specification C 470.

NOTE 2—The material from which the mold is constructed must be chemically inert and have antistick properties. Polyethylene, polypropylene, polytetrafluorethylene, and metal forms having either a sintered coating of tetrafluoroethylene or a suitable release agent compatible with the material being tested are satisfactory. Because of their superior heat resistance, only trifluorochloroethylene and tetrafluoroethylene mold release agents should be used with sulfur materials.

5.3 The testing machine may be of any type of sufficient capacity which will provide the rates of loading prescribed. It shall have been verified to have an accuracy of 1.0 %, or better, within twelve months of the time of use in accordance with Practices E 4. The testing machine shall be equipped with two steel bearing blocks with hardened faces, one of which is a spherically seated block that will bear on the top bearing plate, and the other a plain rigid block that will support the bottom bearing plate. The diameter of the spherical bearing block shall be at least 75 % of the width of the specimen. The bearing faces shall not depart from a plane by more than 0.001 in. (0.025 mm) in any 6-in. (150-mm) diameter circle.

6. Test Specimens

6.1 Make all specimens for a single determination from a single mix.

6.2 *Test Method A*— Prepare test specimens to be used in accordance with Test Method A as described in 6.5. Test specimens shall be right cylinders 1 + 1⁄32, − 1⁄16 in. (25 + 0.8, − 1.6 mm) in diameter by 1 ± 1⁄16in. (25 ± 1.6 mm) high. If the faces of the specimen are not flat, smooth, and normal to the cylinder axis, they may be sanded, ground, or machined to specification. Exercise care that the frictional heat developed during such operations does not damage the specimens.

6.3 *Test Method B*— Prepare test specimens to be used in accordance with Test Method B as described in 6.5. Test specimens shall be cubes with dimensions of 2 + 1⁄16, − 1⁄8 in. (50 + 1.5, − 3.0 mm). If the faces of the cube are not flat, smooth, and normal to each other, they may be sanded, ground, or machined to specification. Exercise care that the frictional heat developed during such operations does not damage the specimens.

6.4 *Test Method C*— Prepare test specimens to be used in accordance with Test Method C as described in 6.6.

6.4.1 Do not test specimens if any individual diameter of a cylinder differs from any other diameter of the same cylinder by more than 2 %.

6.4.2 Neither end of compressive test specimens, when tested, shall depart from perpendicular to the axis by more than 0.5° (approximately equivalent to 1⁄8in. in 12 in. (3 mm in 300 mm). Cap the ends of compression test specimens that are not flat within 0.002 in. (0.05 mm) in accordance with 6.6, sawed or ground. Determine the diameter used for calculating the cross-sectional area of the test specimen to the nearest 0.01 in. (0.25 mm) by averaging two diameters measured at right angles to each other at about mid-height of the specimen.

6.5 *Specimen Preparation for Test Methods A and B*:

6.5.1 *Resin, Silicate, and Silica Materials*—Mix a sufficient amount of the components in the proportions and in the manner specified by the manufacturer of the materials. Fill the molds one-half full. Remove any entrapped air by using a cutting and stabbing motion with a spatula or rounded-end rod. Fill the remainder of the mold, working down into the previously placed portion. Upon completion of the filling operation, the tops of the specimens should extend slightly above the tops of the molds. When the molds have been filled, strike off the excess material, even with the top of the mold. Permit the material to remain in the mold until it has set sufficiently to allow removal without danger of deformation or breakage.

6.5.1.1 *Silicate Materials*—Some silicates may require covering during the curing period. After removal from the molds, acid-treat the specimens, if required, in accordance with the recommendations given by the manufacturer. No other treatment shall be permitted. Record the method of treatment in 9.1.8.

6.5.2 *Sulfur Materials*:

6.5.2.1 *Sulfur Mortars*— Slowly melt a minimum of 2 lb (900 g) of the material in a suitable container at a temperature of 265 to 290°F (130 to 145°C) with constant agitation. Stir to lift and blend the aggregate without beating air into the melt. Place the piece of plastic sheet containing the 1⁄4-in. (6-mm) round hole over the open face of the mold with the hole centered on the face. On top of the piece of plastic sheet and surrounding the hole, place a section of plastic tubing or pipe 1 in. (25 mm) in diameter by 1 in. high. Pour the melted material through the hole into the mold and continue to pour until the section of tubing or pipe is completely filled. The excess material contained in the hole in the plastic sheet acts as a reservoir to compensate for shrinkage of the material during cooling.

6.5.2.2 Allow the specimen to remain in the mold until it has completely solidified. Upon removal, file, grind, or sand the surface flush, removing the excess material remaining at the pouring gate.

6.5.2.3 *Sulfur Concrete*— Heat and mix a sufficient amount of aggregate components and sulfur cement in the proportions and in the manner specified by the manufacturer to a temperature of 265 to 290°F (130 to 145°C). Fill the molds one-half full. Rod 25 times using a rounded ⅝-in. (15-mm) diameter rod. Distribute the strokes uniformly over the cross section of the mold. Repeat with two additional portions allowing the rod to penetrate about ½ in. (12 mm) into the underlying layer. After consolidation, the tops of the specimens should extend slightly above the tops of the molds. Finish the top surface by striking off the excess material even with the top of the mold. Permit the material to remain in the mold until it has cooled sufficiently to allow removal without danger of deformation or breakage.

6.5.3 *Number of Test Specimens*—Prepare six test specimens for each material formulation.

6.6 *Specimen Preparation for Test Method C*—Prepare specimens in accordance with 6.5 with the following additional considerations:

6.6.1 Use of vibrators is generally not required for sulfur concrete but may be required for other materials using Test Method C. The type and method of vibrating will be as recommended by the manufacturer and shall be specified in the test report.

6.6.2 *Filling and Capping for Cylindrical Resin, Silica, and Silicate Specimens*—The top layer may be filled to slightly below the top edge of the mold except for sulfur materials. For sulfur materials, fill slightly above the top edge and strike off flush with the top edge. The top surface of the specimen shall be finished as much as practicable to a plane perpendicular to the axis of the specimen. The flatness of the finished specimen shall be within 0.010 in. (0.25 mm). Specimens exceeding this tolerance shall be machined flat or a capping compound shall be applied if the test load is to be applied to the surface.

6.6.2.1 Capping, if used, shall be made as thin as practicable and shall be applied before removal of the polymer concrete from the molds.

6.6.2.2 If a polymer paste or mortar is used for capping, it is preferable that the polymer used be the same as the one used to make the specimen. Fillers used may be the fine portion used in the polymer concrete or another mineral powder.

6.6.2.3 For capping in the mold, a suitable capping compound may be made from a polymer mortar. The surface of the polymer concrete shall be wiped off after hardening, and a polymer mortar or polymer paste with suitable fillers shall be deposited and pressed down uniformly to the top edge of the mold with a capping plate. In order to prevent the capping plate from bonding to the paste or mortar, the underside of the capping plate shall be covered with a release agent.

6.6.2.4 For capping after mold removal, stiff polymer paste or mortar or a low-melting-point alloy for capping shall be used. A suitable apparatus to maintain parallel ends on the specimens shall be used.

NOTE 3—Any capping compound to be used with polymer concrete should be tested to ascertain that its strength is high enough to prevent premature failure in the cap when testing in high compressive strength polymer concretes. Cap failure may result in substantially lower compressive strength results.

7. Conditioning

7.1 *Resin and Silica Materials*—Age the test specimens in air at 73°F ± 4°F (23°C ± 2°C) for a period of seven days, including the time in the mold before testing.

7.2 *Silicate Materials*—Follow the same procedure as given in 7.1, the only exception being that the relative humidity of the surrounding air must be kept below 80 %.

7.3 *Sulfur Materials*— Age the test specimens in air at 73°F ± 4°F for at least 24 h including the time in the mold, before testing.

8. Procedure

8.1 *Measurement of Specimens*:

8.1.1 *Test Method A and Test Method C*—Immediately following the conditioning period, measure the diameter of all test specimens to the nearest 0.001 in. (0.0254 mm), using a micrometer. Make two measurements at right angles to each other at mid-height and record the diameter as the average of the two.

8.1.1.1 Immediately after measuring, proceed to test as described in 8.2.

8.1.2 *Test Method B*— Immediately following the conditioning period, measure the cross-sectional dimensions of all test specimens to the nearest 0.001 in. (25 µm) using a micrometer. Take two measurements for each dimension at mid-height and perpendicular to the load axis and average them.

8.1.2.1 Immediately after measuring, proceed to test as described in 8.2.

8.2 *Compression Testing*:

8.2.1 Compression tests shall be performed at 73 ± 4°F.

8.2.2 *Placing the Specimen*—Place the bearing block, with its hardened face up, on the table or platen of the testing machine directly under the spherically seated (upper) bearing block. Wipe clean the bearing faces of the upper and lower bearing blocks and of the test specimen and place the test specimen on the lower bearing block. As the spherically seated block is brought to bear on the specimen, rotate its movable portion gently by hand so that uniform seating is obtained.

8.2.3 *Rate of Loading*:

8.2.3.1 *Load Rate I*—Apply the load continuously and without shock. Test at a rate of 6000 psi/min (41 MPa/min). Make no adjustment in the controls of the testing machine while a specimen is rapidly yielding, immediately before failure.

8.2.3.2 *Load Rate II*—Set the testing machine to a crosshead speed of 0.1 to 0.125 in./min times the specimen height in inches (0.1 to 0.125 cm/min times the specimen height in centimetres) when the machine is running without load.

NOTE 4—The above methods of controlling machine crosshead rate are not identical and may produce different compressive strength values.

8.2.4 Load the test specimen to failure and record the maximum load (W).

8.3 *Calculation*:

8.3.1 *Test Method A and Test Method C*:

8.3.1.1 Calculate compressive strength(s) as follows:

$$S = (4W)/(\pi \times D^2) \tag{1}$$

where:

S = compressive strength, psi (MPa),
W = maximum load, lb (N), and
D = diameter measured in 8.1.1, in. (mm).

8.3.2 *Test Method B*:

8.3.2.1 Calculate compressive strength(s) as follows:

$$S = (W)/(L_1 \times L_2) \quad (2)$$

where:
S = compressive strength, psi (MPa),
W = maximum load, lb (N), and
L_1 and L_2 = cross-section dimensions of cube measured in 8.1.2, in. (mm).

9. Report

9.1 Report the following information:

9.1.1 Complete material identification, date,

9.1.2 Mixing ratio,

9.1.3 Use of Test Method A, Test Method B, or Test Method C,

9.1.3.1 Use of Load Rate I or II.

9.1.4 Capping material and method, if used,

9.1.5 Specimen dimensions,

9.1.6 Description of failure including type of failure, appearance of specimen, and whether aggregate was fractured,

9.1.7 Defects in specimens,

9.1.8 Conditioning procedure,

9.1.9 Test conditions (temperature and humidity),

9.1.10 Loading rate,

9.1.11 Maximum load indicated by testing machine, and

9.1.12 Individual and average compressive strength values.

10. Precision and Bias

10.1 Test specimens that are manifestly faulty should be rejected and not considered in determining the compressive strength.

10.2 If any strength value(s) differs from the mean by more than 15 %, the value farthest from the mean shall be rejected and the mean recalculated. If any value(s) still differs from the new mean by more than 15 %, the farthest value should again be rejected and the mean recalculated. If any value(s) remains 15 % from the mean, the test should be rerun.

11. Keywords

11.1 brick mortars; chemical-resistant; compressive strength; machinery grouts; monolithic surfacings; polymer concrete; resin materials; silicate materials; sulfur materials; tile grouts