



Designation: C413 – 18 (Reapproved 2023)

# Standard Test Method for Absorption of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes<sup>1</sup>

This standard is issued under the fixed designation C413; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

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

## 1. Scope

1.1 This test method covers the determination of the absorption of chemical-resistant mortars, grouts, monolithic surfacings, and polymer concretes. These materials may be based on resin, silicate, silica, or sulfur binders.

1.2 Mold Method A is used for systems containing aggregates less than 0.0625 in. (1.6 mm) in size. Mold Method B is used for systems containing aggregates from 0.0625 in. to 0.4 in. (1.6 mm to 10 mm) in size. Mold Method C is used for systems containing aggregates larger than 0.4 in.

1.3 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.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

[C470/C470M Specification for Molds for Forming Concrete Test Cylinders Vertically](#)

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.46 on Industrial Protective Coatings.

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

[C904 Terminology Relating to Chemical-Resistant Nonmetallic Materials](#)

[E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods](#)

[E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method](#)

## 3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, see Terminology [C904](#).

## 4. Significance and Use

4.1 The results obtained by this test method should serve as a guide in, but not as the sole basis for, selection of a chemical-resistant material for a particular application. No attempt has been made to incorporate in the test method all the various factors which may affect the performance of a material when subjected to actual service.

4.2 This is not a test for permeability and the test results are not to be interpreted as a measurement of, or indication of, the permeability properties of the materials tested.

## 5. Apparatus

5.1 *Equipment*, capable of weighing materials or specimens and for determining specific gravity to  $\pm 0.03$  % accuracy.

5.2 *Equipment for Mixing*, consisting of a flat-bottom container of suitable size, preferably corrosion-resistant, and a trowel having a 4 in. to 5 in. (100 mm to 125 mm) blade, and a spatula or a rounded-end rod.

5.3 *Container*, a glass flask of suitable size to hold the specimens and the water and connected reflux condenser.

5.4 *Equipment for Heating*, a hot plate or heating mantle.

5.5 *Specimen Molds:*

5.5.1 *Mold Method A*—These molds shall be right cylinders 1 in.  $\pm$   $\frac{1}{32}$  in. (25 mm  $\pm$  0.8 mm) in diameter by 1 in.  $\pm$   $\frac{1}{32}$  in. (25 mm  $\pm$  0.8 mm) high. The molds may be constructed in any manner that will allow formation of a test specimen of the desired size. Typical molds may 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 ¼ in. (6 mm) thick flat plastic sheet (without matching holes), is attached by means of screws or bolts. Alternatively, the molds may consist of sections of round plastic tubing or pipe, 1 in. in inside diameter and 1 in. long, having sufficient wall thickness to be rigid and retain dimensional stability during the molding operation, and a ¼ 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 strips of 2 in. wide masking tape.

**NOTE 1**—For use with sulfur materials, an additional piece of flat plastic sheet at least ⅛ in. (3 mm) thick containing a ¼ in. (6 mm) hole and a section of plastic tubing 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 material specimens.

**5.5.2 Mold Method B**—Molds for the 2 in. (50 mm) cube specimens shall be tight fitting and leakproof. The parts of the molds, when assembled, shall be positively held together. The molds shall be made of metal not attacked by the material. 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 between opposite faces shall be 2 in.  $\pm$  ⅛ in. (50 mm  $\pm$  0.8 mm). The height of the molds, measured separately for each cube compartment, shall be 2 in.  $\pm$  ⅛ in. The angle between adjacent 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.

**5.5.3 Mold Method C**—Molds shall be right cylinders made of heavy gauge metal or other 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  $0.5^\circ$ . The mold shall be at right angles to the axis within  $0.5^\circ$ . The mold shall not vary from the prescribed diameter by more than ⅛ in. (1.5 mm) nor from the prescribed height by more than ⅛ 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. Single-use molds shall conform to Specification **C470/C470M**.

**NOTE 2**—The material from which the mold is constructed must be corrosion resistant and have antistick properties. Polyethylene, polypropylene, polytetrafluoroethylene, 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.

## 6. Temperature

**6.1** The temperature in the vicinity of the mixing operation shall be  $73^\circ\text{F} \pm 4^\circ\text{F}$  ( $23^\circ\text{C} \pm 2^\circ\text{C}$ ).

## 7. Test Specimens

**7.1 Number of Specimens**—At least six specimens shall be prepared.

### 7.2 Preparation of Specimens:

**7.2.1 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.

**7.2.2 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 the report section under Conditioning Procedure.

#### 7.2.3 Sulfur Materials:

**7.2.3.1 Sulfur Mortars**—Slowly melt a minimum of 2 lb (900 g) of the material in a suitable container at a temperature of  $265^\circ\text{F}$  to  $290^\circ\text{F}$  ( $130^\circ\text{C}$  to  $145^\circ\text{C}$ ) with constant agitation. Stir to lift and blend the aggregate without beating air into the melt. Place the piece of plastic sheet containing the ¼ 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. (25 mm) 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.

**7.2.3.2** 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.

**7.2.3.3 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  $265^\circ\text{F}$  to  $290^\circ\text{F}$  ( $130^\circ\text{C}$  to  $145^\circ\text{C}$ ). 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.

**NOTE 3**—Use of vibrators is generally not required for sulfur concrete but may be required for other materials using Mold Method C. The type and method of vibrating will be as recommended by the manufacturer and shall be specified in the test report.

### 7.3 Conditioning Test Specimens:

7.3.1 *Resin and Silica Materials*—Age the 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. Use longer cure times if recommended by the manufacturer.

7.3.2 *Silicate Materials*—Follow the same procedure as given in 7.3.1, the only exception being that the relative humidity of the surrounding air must be kept below 80 %.

7.3.3 *Sulfur Materials*—The standard conditioning time for the specimen, in air at 73 °F ± 4 °F, is to be 24 h, including the time in the mold. If conditioning time is more or less than 24 h, report the actual time conditioned, including the time in the mold.

## 8. Procedure

8.1 After the conditioning period, weigh the specimens to the nearest 1 mg (see *D* in 9.1.)

8.2 Place the weighed specimens in the flask (Note 4), and add water (for resin and sulfur materials) or xylene (for silicate or silica materials) until the specimens are completely covered. Install the water-cooled condenser, and heat the flask by means of a hot plate or heating mantle.

NOTE 4—The flask shall have a wire screen or glass beads on the bottom to prevent the specimens from coming in contact with the heated bottom of the flask.

8.3 Boil the liquid for 2 h.

NOTE 5—For sulfur materials, the temperature shall be held at 190 °F (88 °C) instead of boiling.

8.4 After the heating period, cool the flask to room temperature, 73 °F ± 4 °F (23 °C ± 2 °C). The cooling may be accelerated by running cold water over the outside of the flask while swirling the flask.

8.5 After cooling the flask, remove and blot each specimen with a damp cotton cloth to remove all liquid droplets from the surface, and determine the saturated weight, *W*, to the nearest 1 mg. Excessive blotting will introduce error by withdrawing liquid from the pores of the specimen.

## 9. Calculation

9.1 Calculate the absorption, in weight % as follows:

$$A = [(W - D)/D] \times 100$$

where:

- A* = absorption, %,
- W* = saturated weight of specimen, g (see 8.5), and
- D* = weight of specimens after conditioning, g (see 8.1).

## 10. Report

10.1 Report the following information:

- 10.1.1 Complete material identification, date,
- 10.1.2 Mixing ratio,
- 10.1.3 Conditioning Procedure, including whether silicate or silica materials were acid treated, and how,
- 10.1.4 Whether water or xylene was used,
- 10.1.5 Individual and average values for the specimens as percentage of absorption, and
- 10.1.6 Conditioning time.

10.2 Report the average values for the six specimens as percentage of absorption.

## 11. Precision and Bias<sup>3</sup>

11.1 The precision of this test method is based on an interlaboratory study of ASTM C413, Standard Test Method for Absorption of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes, conducted in 2017. Six facilities participated in this study. Each participant reported three replicate test results. Every “test result” reported represents the average of six individual determinations. Except for the inclusion of just a single material type, Practice E691 was followed for the design and analysis of the data; the details are given in ASTM Research Report RR:D01-1186.

11.1.1 *Repeatability (r)*—The difference between repetitive results obtained by the same operator in a given laboratory applying the same test method with the same apparatus under constant operating conditions on identical test material within short intervals of time would in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

11.1.1.1 Repeatability can be interpreted as the maximum difference between two results, obtained under repeatability conditions, that is accepted as plausible due to random causes under normal and correct operation of the test method.

11.1.1.2 Repeatability estimates are listed in Table 1.

11.1.2 *Reproducibility (R)*—The difference between two single and independent results obtained by different operators applying the same test method in different laboratories using different apparatus on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

11.1.2.1 Reproducibility can be interpreted as the maximum difference between two results, obtained under reproducibility conditions, that is accepted as plausible due to random causes under normal and correct operation of the test method.

11.1.2.2 Reproducibility estimates are listed in Table 1.

11.1.3 The above terms (repeatability and reproducibility) are used as specified in Practice E177.

11.1.4 Any judgment in accordance with statements 11.1.1 and 11.1.2 would normally have an approximate 95 % probability of being correct, however the precision statistics obtained in this ILS must not be treated as exact mathematical quantities which are applicable to all circumstances and uses. The limited number of materials tested guarantees that there will be times when differences greater than predicted by the ILS results will arise, sometimes with considerably greater or smaller frequency than the 95 % probability limit would imply. The repeatability limit and the reproducibility limit should be considered as general guides, and the associated probability of 95 % as only a rough indicator of what can be expected.

11.2 Test specimens that are manifestly faulty should be rejected and not considered in determining the percentage of absorption.

<sup>3</sup> Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D01-1186. Contact ASTM Customer Service at service@astm.org.