



# 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 C 413; 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 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 to 0.4 in. (1.6 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 the standard. Within this text, the SI units shown in parentheses are given for information only.

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.*

## 2. Referenced Documents

### 2.1 ASTM Standards:

C 470 Specification for Molds for Forming Concrete Test Cylinders Vertically<sup>2</sup>

C 904 Terminology Relating to Chemical-Resistant Non-metallic Materials<sup>3</sup>

## 3. Terminology

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

## 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 to 5 in. (100 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  $1 \pm \frac{1}{32}$  in. ( $25 \pm 0.8$  mm) in diameter by  $1 \pm \frac{1}{32}$  in. ( $25 \pm 0.8$  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  $\frac{1}{4}$  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  $\frac{1}{4}$  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 strips of 2 in. wide masking tape.

NOTE 1—For use with sulfur materials, an additional piece of flat plastic sheet at least  $\frac{1}{8}$  in. (3 mm) thick containing a  $\frac{1}{4}$  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

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 04.02.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 04.05.

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  $2 \pm \frac{1}{16}$  in. ( $50 \pm 0.8$  mm). The height of the molds, measured separately for each cube compartment, shall be  $2 \pm \frac{1}{16}$  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 gage 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  $\frac{1}{16}$  in. (1.5 mm) nor from the prescribed height by more than  $\frac{1}{8}$  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. Single-use molds shall conform to Specification C 470.

**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  $73 \pm 4^\circ\text{F}$  ( $23 \pm 2^\circ\text{C}$ ).

## 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 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  $\frac{1}{4}$  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. (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 to 290°F (130 to 145°C). Fill the molds one-half full. Rod 25 times using a rounded  $\frac{5}{8}$  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  $\frac{1}{2}$  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  $73 \pm 4^\circ\text{F}$  ( $23 \pm 2^\circ\text{C}$ ), 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  $73 \pm 4^\circ\text{F}$ , 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,  $73 \pm 4^\circ\text{F}$  ( $23 \pm 2^\circ\text{C}$ ). 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

11.1 Precision and bias for this test method have not been established.

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

11.3 If any absorption value differs from the mean by more than 15 %, the farthest value from the mean shall be rejected and the mean recalculated. Repeat the process until all of the test values are within 15 % of the mean. If less than two thirds of the values remain, the test will be rerun.

## 12. Keywords

12.1 absorption; chemical-resistant grouts; chemical-resistant monolithic surfacings; chemical-resistant mortars; polymer concretes; porosity

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