**Designation: C 905 – 01**

# Standard Test Methods for Apparent Density of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes[1]

This standard is issued under the fixed designation C 905; 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.

## 1. Scope

1.1 These test methods cover the procedures for determining the uncured (wet) and conditioned (dry) densities of resin, silicate, silica, and sulfur-based chemical-resistant mortars, grouts, monolithic surfacings, and polymer concretes.

1.2 Mold Method A outlines the molding procedure generally used for systems containing aggregate less than 0.2 in. (5 mm) in size. Mold Method B covers the molding procedure generally used for systems containing aggregate from 0.2 to 0.4 in. (10 mm) in size. Mold Method C is for systems containing aggregate larger than 0.4 in.

1.3 *Density Method I: Apparent Uncured Density of Resin, Silica, and Silicate Materials*—This test method is not applicable to sulfur materials.

1.4 *Density Method II: Apparent Conditioned Density of Resin and Sulfur-based Materials*—This test method may be applicable to silica or silicate materials if they are not water-sensitive.

1.5 *Density Method III: Apparent Conditioned Density of Silica and Silicate Materials that are Water Sensitive* .

1.6 *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[2]

C 904 Terminology Relating to Chemical-Resistant Nonmetallic Materials[2]

C 1312 Practice for Making and Conditioning Chemical-Resistant Sulfur Polymer Cement Concrete Test Specimens in the Laboratory[2]

## 3. Terminology

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

## 4. Significance and Use

4.1 The results obtained by these test methods may be used for estimating purposes, as a means of checking on uniformity of a product, or even to help identify a specific product.

## 5. Apparatus

5.1 *Balance for Determining Density*, capable of weighing the specimen to four significant numbers. The balance shall be equipped with either a below-balance weighing hook or a "pan straddle" or similar support plus wire assembly basket or loop to allow for density determinations.

5.2 *Equipment for Mixing Resin, Silica, and Silicate Materials*—Use a flat-bottom container of suitable size, preferably made of corrosion-resistant metal or porcelain, and a trowel having a 4 to 5 in. (100 to 125 mm) blade.

5.2.1 *Equipment for Mixing Sulfur Materials*—Use a stainless steel or cast iron pot for melting the material along with a power-driven revolving paddle mixer.

5.3 *Specimen Molds*:

5.3.1 *Mold Method A*—These molds shall be right cylinders 1± 1/32 in. (25 ± 0.8 mm) in diameter by 1 ± in. high.

5.3.1.1 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. (25-mm) thick plastic sheet in which 1–in. diameter, smooth-sided holes have been cut, and the bottom being a ¼–in. (6–mm) thick, flat plastic sheet which can be attached by means of screws or bolts.

5.3.1.2 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 ¼–in. thick, flat plastic sheet on which one open end of each section can be rested. The tubing segment may be sealed with a material such as caulking compound or stopcock grease. For most materials, it is satisfactory to simply seal one end of the tubing segment with strips of 2–in. (51–mm) wide masking tape.

NOTE 1—For use with sulfur mortars, 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 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.

5.3.2 *Mold Method B*—Molds for the 2 in. (50 mm) cube

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

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 ± 1/16 in. (50 ± 1.6 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.

5.3.3 *Mold 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. (1.6 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. 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 anti-stick 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.

5.4 *Weighing Equipment for Mixing Materials*, shall be capable of weighing to ±0.3 % accuracy.

## 6. Test Specimens

6.1 *Number of Specimens*—Four specimens shall be prepared from the same mix.

6.2 *Resin, Silica, and Silicate Materials*—Mix a sufficient amount of the components in the proportions and in the manner specified by the manufacturer of the materials. All materials should be at 73 ± 4°F. 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. Strike off the excess material even with the top of the mold. Leave the specimen in the mold until it has set sufficiently to allow removal without danger of deformation or breakage.

6.3 *Sulfur Materials*:

6.3.1 *Sulfur Mortars*—Slowly melt a minimum of 2 lb (900 g) of 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 the shrinkage of the material during cooling. Allow the specimen to remain in the mold until it has completely solidified.

6.3.2 *Sulfur Concrete*—Prepare specimens in accordance with Practice C 1312.

## 7. Calibration of Molds

7.1 All molds used shall be calibrated for volume, prior to use in accordance with the following procedure:

7.1.1 Weigh each mold to four significant numbers and then fill the mold carefully, until it is even with the face of the mold, with distilled water at 73 ± 1°F (23 ± 0.5°C) and reweigh to four significant numbers. Calculate the volume of each mold to four significant numbers as follows:

$$V = \frac{W_b - W_a}{0.9975}$$

where:

$V$ = volume of mold, $cm^3$,
$W_a$ = weight of unfilled mold, g,
$W_b$ = weight of mold filled with water, g, and
0.9975 = density of water at 23°C, $g/cm^3$.

## 8. Conditioning

8.1 For determination of the uncured density of any material, no conditioning is necessary.

8.2 *For Determination of Conditioned Density*:

8.2.1 *Resin Materials*—In accordance with the manufacturer's specifications, the test specimen shall not be demolded until it has set sufficiently to allow removal without danger of deformation or breakage. Age the test specimens at 73 ± 4°F (23 ± 2°C) for a period of at least 7 days, including the cure time in the molds, before testing.

8.2.2 *Silicate and Silica Materials*—Follow 8.2.1, except the relative humidity of the surrounding air shall be kept below 80 %. 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 and Treatment.

8.2.3 *Sulfur Materials*—After filling the molds, allow the specimens to remain in the molds until they are completely solidified. Upon removal from the molds, file, grind, or sand the surface of the specimens to remove the excess material remaining at the pouring gate. Age the specimens for at least 24 h, including the time in the mold.

## 9. Procedure

9.1 *Density Method I*—Immediately after filling as described in Section 6, weigh the mold to four significant numbers, and then calculate the uncured density of the test material as follows:

$$D_u = \frac{W_m - W_a}{V}$$

where:
$D_u$ = apparent uncured density, g/cm$^3$,
$W_m$ = weight of mold plus material, g,
$W_a$ = weight of unfilled mold, g, and
$V$ = volume of mold, cm$^3$.

9.2 *Density Method II*:

9.2.1 *Determination of Conditioned Weight*—Weigh the conditioned specimens to four significant numbers.

9.2.2 *Determination of Suspended Weight*—Attach the wire assembly to the below-balance or pan-support hook so that the basket or loop which will hold the specimen is completely immersed in water (Note 3) to the same depth as is used when the specimens are in place. Tare the balance and place the specimen in the basket or loop. Remove adhering air bubbles from the specimen with a fine wire and weigh to four significant numbers (Note 4). Calculate the conditioned density of the test specimen as follows:

$$D_c = \frac{0.9975\ S}{S - I}$$

where:
$D_c$ = apparent conditioned density, g/cm$^3$,
$S$ = weight of specimen in air, g, and
$I$ = weight of specimen immersed in water, g.

NOTE 3—Use distilled water at 73 ± 1°F (23 ± 0.5°C).

NOTE 4—If the suspended weight cannot be obtained due to a porous specimen absorbing liquid rapidly, the density should be obtained by measuring the dimensions of the specimen to obtain volume.

9.3 *Density Method III*:

9.3.1 *Determination of Conditioned Weight*—Weigh the conditioned specimens to four significant numbers.

9.3.2 *Determination of Suspended Weight*—Attach the wire assembly to the below-balance or pan-support hook so that the basket or loop that will hold the specimen is completely immersed in xylene (Note 5) to the same depth as is used when the specimens are in place. Tare the balance and place the specimen in the basket or loop. Remove adhering air bubbles from the specimen with a fine wire and weigh to four significant numbers (Note 4). Calculate the conditioned density of the test specimen as follows:

$$D_c = \frac{d_s\ S}{S - I_s}$$

where:
$D_c$ = apparent conditioned density, g/cm$^3$,
$S$ = weight of specimen, g,
$I_s$ = weight of specimen in xylene (or of solvent used if other than xylene), g, and
$d_s$ = density of xylene (or of solvent used if other than xylene), g/cm$^3$.

NOTE 5—The density of commercial xylene is approximately 0.870 g/cm$^3$. Any suitable solvent that does not affect the integrity of the specimen may be used in place of xylene. When making the density calculations, be sure to use the density for the actual solvent used in the procedure.

## 10. Report

10.1 Report the following information:
10.1.1 Complete material identification,
10.1.2 Mixing ratio,
10.1.3 Conditioning and treatment,
10.1.4 Density Method(s) I, II, or III,
10.1.5 Mold Method(s) A, B, or C,
10.1.6 Specimen Dimensions for Method C, and
10.1.7 Individual and averaged density results in lb/ft$^3$(g/cm$^3$).

## 11. Precision and Bias

11.1 Test specimens that are manifestly faulty or that give density values differing by more than 2 % from the average value of all specimens made from the same sample material and tested in the same series shall not be considered in determining the average density. If after discarding outlying values, there are less than three density values remaining for the determination of the average density, the entire test shall be repeated.

## 12. Keywords

12.1 apparent density; brick mortars; chemical-resistant; density; machinery grouts; monolithic surfacings; polymer concrete; resin materials; silicate materials; sulfur materials; tile grouts