



Designation: C 470/C 470M – 02a

## Standard Specification for Molds for Forming Concrete Test Cylinders Vertically<sup>1</sup>

This standard is issued under the fixed designation C 470/C 470M; 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.

### 1. Scope

1.1 This specification covers molds for use in forming cylindrical concrete specimens. The provisions of this specification include the requirements for both reusable and single-use molds.

NOTE 1—Sizes included are molds having diameters from 50 mm [2 in.] to 900 mm [36 in.]. Dimensions of commonly used single-use molds are given in Fig. 1.

1.2 The values stated in either SI units or in other units shall be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system must be used independently of the other, without combining in any way. The inch-pound units are shown in brackets.

1.3 The following safety hazards caveat pertains only to the test method described in this specification: *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.*

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

### 2. Referenced Documents

2.1 *ASTM Standards:*

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<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.61 on Testing for Strength.

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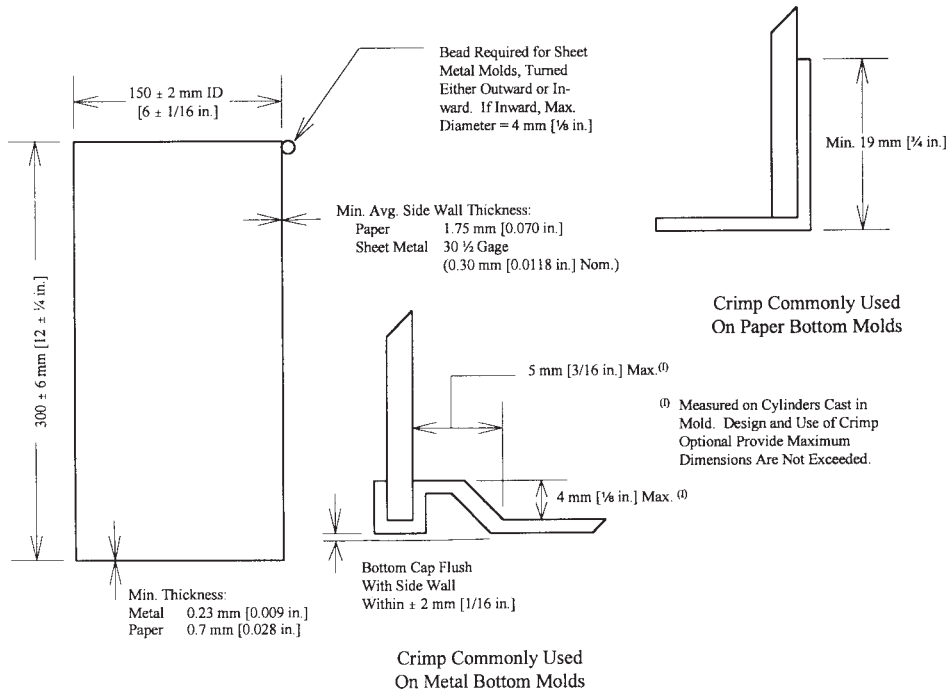


FIG. 1 Dimensions of Single Use 150 by 300 mm [6 by 12-in.] Paper or Sheet Metal Cylinder Molds

- C 31/C 31M Practice for Making and Curing Concrete Test Specimens in the Field<sup>2</sup>
- C 33 Specification for Concrete Aggregates<sup>2</sup>
- C 192/C 192M Practice for Making and Curing Concrete Test Specimens in the Laboratory<sup>2</sup>
- D 256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics<sup>3</sup>
- D 570 Test Method for Water Absorption of Plastics<sup>3</sup>

### 3. General Requirements

3.1 The following provisions apply to both reusable and single-use molds:

3.1.1 Molds shall be constructed in the form of right circular cylinders which stand with the cylindrical axis vertical and the top open to receive the concrete. They shall be made of materials that do not react with concrete containing portland or other hydraulic cements. They shall be watertight and sufficiently strong and tough to permit their use without tearing, crushing, or deforming.

NOTE 2—Reusable lids may be used on molds to reduce moisture loss.

3.1.2 Molds shall have a nominal inside height equal to twice the nominal inside diameter. The diameter of a mold, consisting of the average of two measurements taken at right angles to each other at the top of the mold, shall not differ from the nominal diameter by more than 1 %. The height, determined by averaging two measurements taken 180° apart, shall not differ from the nominal height by more than 2 %. The planes of the top rim of the mold and the bottom shall be perpendicular to the axis of the mold within 0.5 degrees—approximately equivalent to 3 mm in 300 mm [1/8 in. in 12 in.]. No diameter of a mold shall differ from any other diameter of the same mold by more than 2 % except that molds that fail to meet this requirement may be used when the user is able to demonstrate that no diameter of hardened concrete specimen produced in a similar mold differs from any other diameter on the same specimen by more than 2 % (see Note 3).

NOTE 3—Certain single-use molds may require the use of a special device such as a tube of heavy-gage metal around the mold during molding to maintain the dimensional tolerances specified in 3.1.2.

3.1.3 The bottom inside surface of the mold shall not depart from a plane by more than 2 mm in 150 mm [1/16 in. in 6 in.] (1 % of the diameter of the mold).

### 4. Reusable Molds

4.1 Reusable molds are those which are designed to be used more than a single time. Reusable molds shall be made of nonabsorptive materials, and constructed as either one piece or several pieces (see Note 4).

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

<sup>3</sup> Annual Book of ASTM Standards, Vol 08.01.

4.2 Reusable molds shall be provided with a closure or base on the lower end at right angles to the axis of the cylinder. Molds may be single piece molds or made from castings with a separate detachable base plate or a base that is an integral part of the sidewall. The mold shall be either coated or made of a material that will prevent adherence to the concrete. At the time of use, molds shall not leak water. An inside fillet, if any, at the bottom of the side wall shall have an indentation around the circumference no more than 3 mm [ $\frac{1}{8}$  in.] in the vertical direction or no more than 5 mm [ $\frac{3}{16}$  in.] in the horizontal direction (see Fig. 1).

4.3 Reusable molds shall be tested for water leakage as described in 7.6.4, for resistance to damage as described in 7.6.3.1, and for dimensional stability in accordance with 3.1.2 and 3.1.3 after every 50 uses or every six months, whichever comes first.

NOTE 4—Satisfactory molds can be made from lengths of steel tubing or pipe that is slit on one side parallel to the axis and fitted with a means of closing the vertical slit as well as a means of attaching a base plate. The required dimensional tolerances must be maintained after slitting, clamping, and attaching the base plate. Other nonabsorptive materials which have been used include iron, brass, steel, and various plastics. Although aluminum and magnesium alloys have been used, some of these alloys may be reactive with cement constituents and are therefore unacceptable.

## 5. Single-Use Molds

5.1 Single-use molds may be made of sheet metal, plastic, suitably treated paper products, or other materials and must conform to the requirements of this specification.

5.2 *Physical Requirements*—The molds as prepared for use shall comply with the following:

5.2.1 *Water Leakage*— When tested as described in Section 7.6, there shall be no visible leakage.

5.2.2 *Absorptivity*— When tested as described in Section 7.6, the absorption shall not exceed the values given in Table 1. Intermediate values are proportional to the square of the height.

5.2.3 *Elongation*—When tested as described in Section 7.6, the elongation after test shall not exceed 0.2 % of height.

5.3 *Single-use Plastic Molds*—Molds shall conform to the following additional requirements when plastic is the predominant material used in construction:

5.3.1 *Wall Thickness*—The side walls shall be of sufficient stiffness to meet the requirements of 3.1 (See Note 5).

NOTE 5—This can be achieved through sufficient side wall thickness alone, or in combination with a stiffened top.

5.3.2 *Bottom Design*—The bottom shall be designed so that it will be flush with the bottom of the sidewall within a tolerance of 2 mm [ $\frac{1}{16}$  in.]. An inside fillet, if any, at the bottom of the sidewall shall have an indentation around the circumference no more than 4 mm [ $\frac{1}{8}$  in.] in the vertical direction or no more than 5 mm [ $\frac{3}{16}$  in.] in the radial direction. The bottom shall be of adequate rigidity to prevent permanent deformation when specimens are molded in accordance with the applicable provisions of Practice C 31/C 31M or C 192/C 192M.

5.3.3 *Material*—The mold manufacturer shall certify that: (1) the plastic material used in molds has a maximum water absorption of less than 0.5 % in 24 h when tested in accordance with Test Method D 570; (2) the plastic has an Izod impact toughness of at least 117 J/m [ $2.2$  ft lb/in.] of notch for a 4 mm [ $\frac{1}{8}$  in.] thick specimen tested in accordance with Test Methods D 256; and (3) after being held at 12°C [ $10^{\circ}$ F] for 24 h, the plastic shall not fracture when subject to tapping and jarring that is judged to be typical of what occurs when specimens are molded in accordance with the applicable provisions of Practice C 31/C 31M or C 192/C 192M.

5.4 *Paper Molds*— When paper or other potentially absorptive fiber material is used as the primary structural material in the construction of the side walls or bottom of the mold, the mold shall conform to the following additional requirements:

5.4.1 *Side Walls*—The side walls of paper molds shall be made with a minimum of three plies having a combined thickness of not less than 2 mm [ $0.070$  in.]. Seams on the inside of the mold shall not be open by more than 2 mm [ $\frac{1}{16}$  in.].

NOTE 6—The minimum thickness of material used in side walls and bottoms is considered adequate for cylinders up to 150 mm [6 in.] in diameter. For larger cylinders thicker material may be required to meet requirements of 3.1.

5.4.2 *Bottom Caps*— The bottom cap of the mold shall be made of either metal or paper. If metal, it shall not be less than 0.23 mm [ $0.009$  in.] in thickness and coated to prevent corrosion (Note 6). It shall be designed so that it will be flush with the bottom edge of the side wall within a tolerance of 2 mm [ $\frac{1}{16}$  in.] and the inside crimp, if any, shall produce an indentation around the circumference of the cylinder no more than 5 mm [ $\frac{3}{16}$  in.] in the radial, and no more than 4 mm [ $\frac{1}{8}$  in.] in the vertical direction (see Fig. 1). If made of paper, the bottom cap of the mold shall be of parchment-lined cap stock not less than 0.7 mm [ $0.028$  in.] thick (Note 6). It shall be glued to the outside of the walls by means of a flange not less than 19 mm [ $\frac{3}{4}$  in.] high. The glue shall

**TABLE 1 Limits for Absorption and Elongation**

Nominal Mold Height, mm [in.]	Absorption, max g	Elongation, max mm [in.]
100 [4]	2.7	0.2 [0.008]
150 [6]	6.0	0.3 [0.012]
200 [8]	11	0.4 [0.016]
300 [12]	24	0.6 [0.024]
450 [18]	54	0.9 [0.036]
600 [24]	96	1.2 [0.048]
900 [36]	216	1.8 [0.072]

be water-insoluble adhesive of the resin type that will not react with fresh concrete. Only the practicable minimum amount of adhesive shall be exposed on the inner side of the bottom of the mold.

5.4.3 *Waterproofing*— The mold made from paper or fiber shall be completely coated on inside and outside, side walls, and bottom with a suitable waterproofing medium (Note 7). The top edge shall be waterproofed, or coated, to limit absorption. The surfaces of metal bottoms, which must comply with 5.4.2, need not be coated. Any waterproofing coating used in this application shall have a melting point not less than 49°C [120°F] (Note 8). The coating shall provide a film over the inside that will minimize adherence of the concrete to the side walls and the bottom.

NOTE 7—Paraffin coating for this use may be of the grade known to the trade as crude scale wax or of any superior grade. In general, a film of paraffin of sufficient thickness to accomplish the intended purposes will permit one to raise a curl of paraffin with the thumbnail.

NOTE 8—Such coatings may be unsuitable for molds that are subjected to temperatures above 49°C [120°F], either before or after filling with concrete.

5.5 *Single-Use Sheet Metal Molds*—Molds shall conform to the following additional requirements when light-gage sheet metal is the predominant material used in their construction:

5.5.1 *Metal Thickness*— The side wall of steel sheet metal molds shall be manufactured from sheet metal not thinner than can-making quality blackplate and shall have a minimum metal thickness corresponding to that of 48.5-kg [107-lb] blackplate, which is approximately 0.300 mm [0.0118 in.] thick or 30½ gage. The metal for the bottom of the mold shall have a minimum thickness of 0.23 mm [0.009 in.] (Note 6).

5.5.2 *Bottom Design*— The bottom shall be so designed that it will be flush with the bottom of the side wall within a tolerance of 2 mm [1/16 in.]. An inside crimp, if used, shall produce an indentation around the circumference of the cylinder no more than 4 mm [1/8 in.] in the vertical or 5 mm [3/16 in.] in the radial direction (see Fig. 1).

5.5.3 *Top Edge*—The top edge of the side wall shall be curled or beaded to strengthen the mold and protect the user from sharp edges. If such bead protrudes to the inside of the mold, the indentation produced in the concrete cylinder shall not exceed 4 mm [1/8 in.] in either a radial or vertical direction.

5.5.4 *Coating*—If the mold is made of material which will rust, corrode, react, or adhere to the freshly mixed or hardened concrete, it must be coated with a protective coating of lacquer or other suitable material.

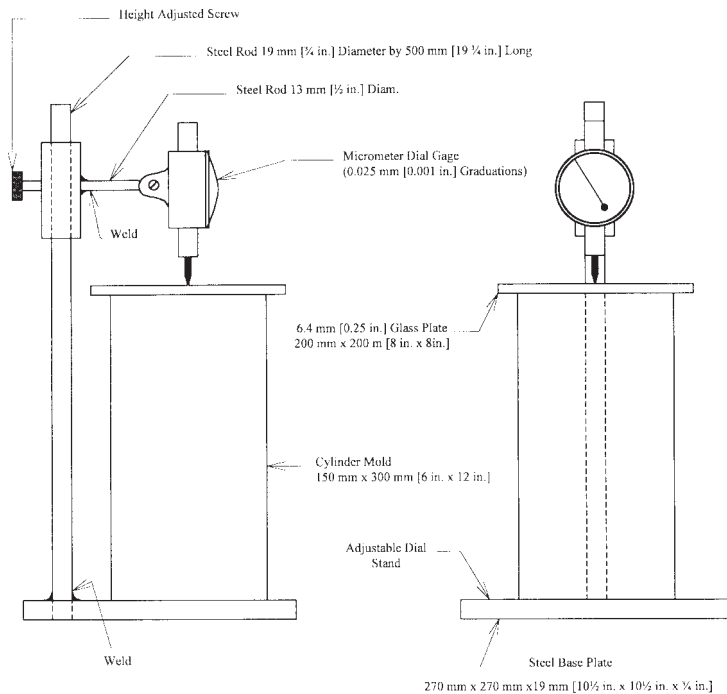
## 6. Samples

6.1 At least three single-use and reusable molds shall be selected at random from each shipment by the purchaser to ensure that the molds are in compliance with the specification.

## 7. Test Methods for Elongation, Absorption, and Water Leakage

76.1 *Apparatus*—The assembly used for the absorption-elongation test shall follow the principles illustrated in Fig. 2.

76.2 *Specimens*—Molds shall be selected as described in Section 2. Single-use molds shall not be reused nor the same mold retested.



**FIG. 2 Apparatus for Absorption-Elongation Test of Paper Molds**

### 76.3 Test Procedure for Molds:

76.3.1 Samples of all types of single-use molds and reusable plastic molds shall be subjected to the dry rodded coarse aggregate test as described in 76.3.2 to evaluate their resistance to damage under use and to the water leakage test described in 6.3.3 and 6.3.4. Paper or other potentially absorptive molds shall additionally be tested for absorptivity, elongation, absorptivity and water leakage. Lightweight elongation described in 6.3.5. Plastic and sheet metal and other obviously nonabsorptive molds need not be tested for elongation and absorption, but should be tested for water leakage. Dimensional requirements for all molds shall be verified.

76.3.2 Prepare the mold for test by filling with dry crushed stone coarse aggregate meeting the grading requirements of Specification C 33 size No. 57, 25.0 to 4.75 mm [1 in. to No. 4] or No. 67, 19.0 to 4.75 mm [ $\frac{3}{4}$  in. to No. 4]. Fill and compact the mold by the rodding procedure specified in Practice C 192/C 192M for compression test specimens using the tamping rod, number of layers and number of strokes per layer specified. It will generally not be possible to obtain the penetration of the tamping rod specified in Practice C 192/C 192M. After rodding the final layer, empty the coarse aggregate, wipe lightly with a dry cloth and examine the mold for physical damage.

76.3.3 After completion of 76.3.2, determine the mass of the mold and record to the nearest 0.004 g/mm [0.1 g/in.] of mold height. Place the mold on a firm, flat surface and fill with water at room temperature to a depth of 90 to 95 % of the mold height. Then place the mold on the dial stand, cover with the glass or metal plate and record the initial length by dial micrometer to the nearest 0.025 mm [0.001 in.].

76.3.4 Allow the mold to stand for 3 h and take a final reading of the micrometer. Examine and record any visible leakage. Empty water from the mold, dry lightly with a trowel and record the final mass to the nearest 0.04 g/cm [0.1 g/in.] of mold height.

76.3.5 Calculate the elongation as the difference between the final length and initial length. Calculate the absorption as the difference between the final weight mass and initial weight mass of the mold.

76.3.6 Verify all dimensional requirements.

### 76.4 Water Leakage Test for Assembled Reusable Molds:

76.4.1 Assemble reusable molds with the sealant to be used, if required. Fill molds with water to a depth of 90 to 95 % of the nominal height. Subject the mold to tapping and jarring which is judged to be typical of ~~that which~~ what occurs when specimens are molded in accordance with the applicable provision of Practice C 31/C 31M or C 192/C 192M.

76.4.2 One hour after tapping, examine for visible leakage.

## **7. Sampling and Rejection**

7.1 At least three single-use and reusable molds shall be selected at random from each shipment by the purchaser to ensure that the molds are in compliance with this specification.

7.2 Failure of any one of the three molds to comply with this specification shall be basis for rejection of the shipment.

## **8. Rejection**

8.1 ~~Molds may~~ Report to be rejected Prepared by the Purchaser

8.1 Where applicable for the type of mold tested, report the following information for each mold tested:

8.1.1 Brand or source of molds,

8.1.2 Shipment or lot from which the mold was taken,

8.1.3 Date sampled and date tested,

8.1.4 Brief general description of the mold including nominal dimensions, type of mold, and materials of which it is made,

8.1.5 Total absorption, g, if specified,

8.1.6 Total expansion, mm [in.], if specified, and

8.1.7 Water leakage reported in terms of compliance, or failure by leakage.

8.2 Where applicable for the type ~~o-ef~~ mold tested, report the following information for sampl~~y~~es which do not meet the requirements of the specification:

8.2.1 Average diameter or height, mm [in.],

8.2.2 Maximum and minimum diameters or heights, mm [in.],

8.2.3 Nonconformance with ~~any~~ required perpendicularity of rim or base to the ~~provisions~~ axis of the mold,

8.2.4 Apparent reaction between mold materials and concrete or mortar or corrosion of metal in contact with concrete,

8.2.5 Melting point less than 49°C [120°F],

8.2.6 Minimum thickness of materials in side walls or bottom, and

8.2.7 Dimension of crimp in bottom, top edge or caonstruction of paper bottom.

## **9. Report**

9.1 ~~Where applicable for the type of mold tested, report the following information for each mold tested:~~

9.1.1 ~~Brand or source of molds,~~

9.1.2 ~~Shipment or lot from which the mold was taken,~~

9.1.3 ~~Date sampled and date tested,~~

9.1.4 ~~Brief general description of the mold including nominal dimensions, type of mold, and materials of which it is made,~~

~~9.1.5 Total absorption, g, if specified;~~

~~9.1.6 Total expansion, mm [in.], if specified, and~~

~~9.1.7 Water leakage reported in terms of compliance, or failure by leakage.~~

~~9.2 Where applicable for the type of mold tested, report the following information for samples which do not meet the requirements of the specification:~~

~~9.2.1 Average diameter or height, mm [in.];~~

~~9.2.2 Maximum and minimum diameters or heights, mm [in.];~~

~~9.2.3 Nonconformance with required perpendicularity of rim or base to the axis of the mold;~~

~~9.2.4 Apparent reaction between mold materials and concrete or mortar or corrosion of metal in contact with concrete;~~

~~9.2.5 Melting point less than 49°C [120°F];~~

~~9.2.6 Minimum thickness of materials in side walls or bottom, and~~

~~9.2.7 Dimension of crimp in bottom, top edge or construction of paper bottom.~~

## **10. Keywords**

~~10.1~~ concrete; molds; test cylinders

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