Designation: C 348 – 97

Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars[1]

This standard is issued under the fixed designation C 348; 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 This test method covers the determination of the flexural strength of hydraulic-cement mortars.

1.2 The values stated in SI units are to be regarded as the standard. The values shown in parentheses are for information only.

1.3 Values in SI units shall be obtained by measurement in SI units or by appropriate conversion, using the Rules for Conversion and rounding given in Standard IEEE/ASTM SI 10, of measurements made in other units.

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 109/C 109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)[2]

C 230 Specification for Flow Table for Use in Tests of Hydraulic Cement[2]

C 305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency[2]

C 349 Test Method for Compressive Strength of Hydraulic Cement Mortars (Using Portions of Prisms Broken in Flexure)[2]

C 670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials[3]

C 778 Specification for Standard Sand[2]

IEEE/ASTM SI 10 Standard for Use of the International System of Units (SI): The Modern Metric System[4]

3. Summary of Test Method

3.1 The test mortar used consists of 1 part cement and 2.75 parts of sand proportion by mass. Portland or air-entraining portland cements are mixed at specified water-cement ratios. Water content of other cements is that sufficient to obtain a flow of 110 ± 5 % with 25 drops of the flow table. Test prisms, 40 by 40 by 160-mm are molded by tamping in two layers. Prisms are cured one day in the molds and stripped until tested by center point loading.

4. Significance and Use

4.1 This test method provides a means for determining the flexural strength of hydraulic cement mortars. Portions of the mortar prisms tested in flexure according to this test method may be used for the determination of compressive strength in accordance with Test Method C 349.

4.2 The values are determined from this test method for research or reference purposes only and are not used for determining compliance with specification requirements.

5. Apparatus

5.1 *Weights, Weighing Devices and Glass Graduates*, shall conform to the Apparatus Section of Test Method C 109/C 109M.

5.2 *Mixer, Bowl and Paddle*, an electrically driven mechanical mixer of the type equipped with paddle and mixing bowl, as specified in the Apparatus Section of Practice C 305.

5.3 *Flow Table and Flow Mold*, shall conform to Specification C 230.

5.4 *Specimen Molds*—Molds for the 40 by 40 by 160-mm prism specimens shall be triple-gang molds and shall be so designed that the specimens will be molded with their longitudinal axes in a horizontal position. The molds shall be made of a hard metal, not attacked by cement mortar, and with a Rockwell hardness of not less than HRB 55. The parts of the molds shall be matchmarked and, when assembled, shall be tight-fitting and positively held together. The sides of the molds shall be sufficiently rigid to prevent spreading or warping. The interior faces of the molds shall be plane surfaces with a permissible variation, in any 50-mm line on a surface, of 0.03 mm for new molds and 0.05 mm for molds in use. The distance between opposite sides shall be 40 ± 0.13 mm for new molds and 40 ± 0.3 mm for molds in use. The height of the molds shall be 40 mm with permissible variations of +0.25 and −0.15 mm for new molds, and +0.25 and −0.40 mm for molds in use. The inside length of the molds shall be 160 ± 2.5 mm. The angle between adjacent interior faces and top and bottom

[1] This test method is under the jurisdiction of ASTM Committee C-1 on Cement and is the direct responsibility of Subcommittee C01.27 on Strength.

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[2] *Annual Book of ASTM Standards*, Vol 04.01.

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

[4] *Annual Book of ASTM Standards*, Vol 14.02.

planes of the mold shall be 90 ± 0.5°, measured at points slightly removed from the intersections of the faces. The base plate shall be approximately 10 mm in thickness and shall have a plane surface 200 by 180 mm with a permissible variation in any 50-mm line on the surface of 0.03 mm.

5.5 *Tamper*—The tamper (see Fig. 1) shall be made of nonabsorptive, nonabrasive material, such as a rubber compound having a Shore A durometer hardness of 80 ± 10 or seasoned oak wood rendered nonabsorptive by immersion for 15 min in paraffin at approximately 200°C (392°F). The face of the tamper shall be 22 by 85 mm.

5.6 *Tamper Guide*—The tamper guide (see Fig. 2), shall be made of metal (such as brass of Rockwell hardness not less than HRB 55) not attacked by the cement mortar. It shall lie flat on the mold and shall not protrude over any interior edge of the form more than 0.40 mm. The height of the guide shall be 25 mm.

5.7 *Trowel*—The trowel shall have a steel blade 115 by 250 mm (4.5 by 10 in.) in length, with straight edges.

5.8 *Flexure Testing Device*—The centerpoint loading method shall be used in making flexure tests on the prism specimens. The device used shall be designed such that the forces applied to the specimen will be vertical only and applied without eccentricity. A device that accomplishes this purpose, for use in a compression testing machine, is shown in Fig. 3. Apparatus for making flexure tests of mortar specimens shall be designed to incorporate the following principles:

5.8.1 The distance between supports and points of load application shall remain constant.

5.8.2 The load shall be applied normal to the loaded surface of the specimen and in such a manner as to avoid all eccentricity of loading.

5.8.3 The direction of the reactions should be parallel to the direction of the applied load at all times during the test.

5.8.4 The load should be applied at a uniform rate and in a manner to avoid shock.

5.9 *Compression Testing Machine*—The compression testing machine used with the flexure testing device, as shown in Fig. 3, shall be of the hydraulic type and conform to the requirements prescribed in Test Method C 109/C 109M.

NOTE 1—Most hydraulic compression machines designed for breaking 50-mm (2-in.) cubes have a relatively small diameter lower bearing surface directly centered below the upper spherically seated head, on which close-fitting pedestals of appropriate heights are set for breaking 50-mm cubes and 50-mm (2-in.) and 50 by 100-mm (2 by 4-in.) or 75 by 150-mm (3 by 6-in.) cylinders. The base plate of the flexure testing apparatus shown in Fig. 3 is designed to rest on the low pedestal intended for tests on 75 by 150-mm (3 by 6-in.).

NOTE 2—In the absence of self-centering arrangements on machines with large lower bearing surfaces, the center of this surface directly below the center of the upper spherically seated head shall be accurately located. A circle or concentric circles of appropriate diameters shall be scribed on the lower bearing surface around this point. A cylindrical pedestal of appropriate diameter and height shall be obtained. End faces of the pedestal must be plane and parallel and at 90° to the axis of the cylinder. The upper face shall have a diameter of 77.5 mm (3.05 in.).

6. Materials

6.1 *Graded Standard Sand*:

6.1.1 The sand used for making test specimens shall be natural silica sand and conform to Specification C 778.

7. Number of Specimens

7.1 Three or more specimens shall be made for each period of test specified.

8. Preparing Specimen Molds

8.1 Prepare the specimen molds as prescribed in Test Method C 109/C 109M.

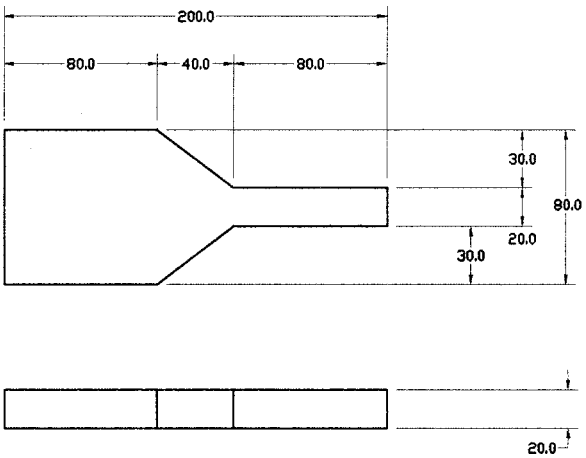
9. Procedure

9.1 *Proportioning, Consistency, and Mixing of Mortars*—The proportioning, consistency, and mixing of the standard mortar shall be in accordance with the Procedure Section of Test Method C 109.

9.2 *Determination of Flow*—The flow shall be determined in accordance with Test Method C 109.

9.3 *Molding Test Specimens*:

9.3.1 Immediately following completion of the flow test, return the mortar from the flow table to the mixing bowl. Quickly scrape down into the batch the mortar that may have collected on the side of the bowl and then remix the entire batch 15 s at medium speed. Upon completion of mixing, the mixing paddle shall be shaken to remove excess mortar into the mixing bowl.



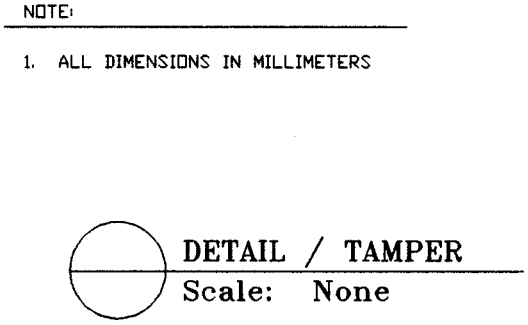


FIG. 1 Tamper

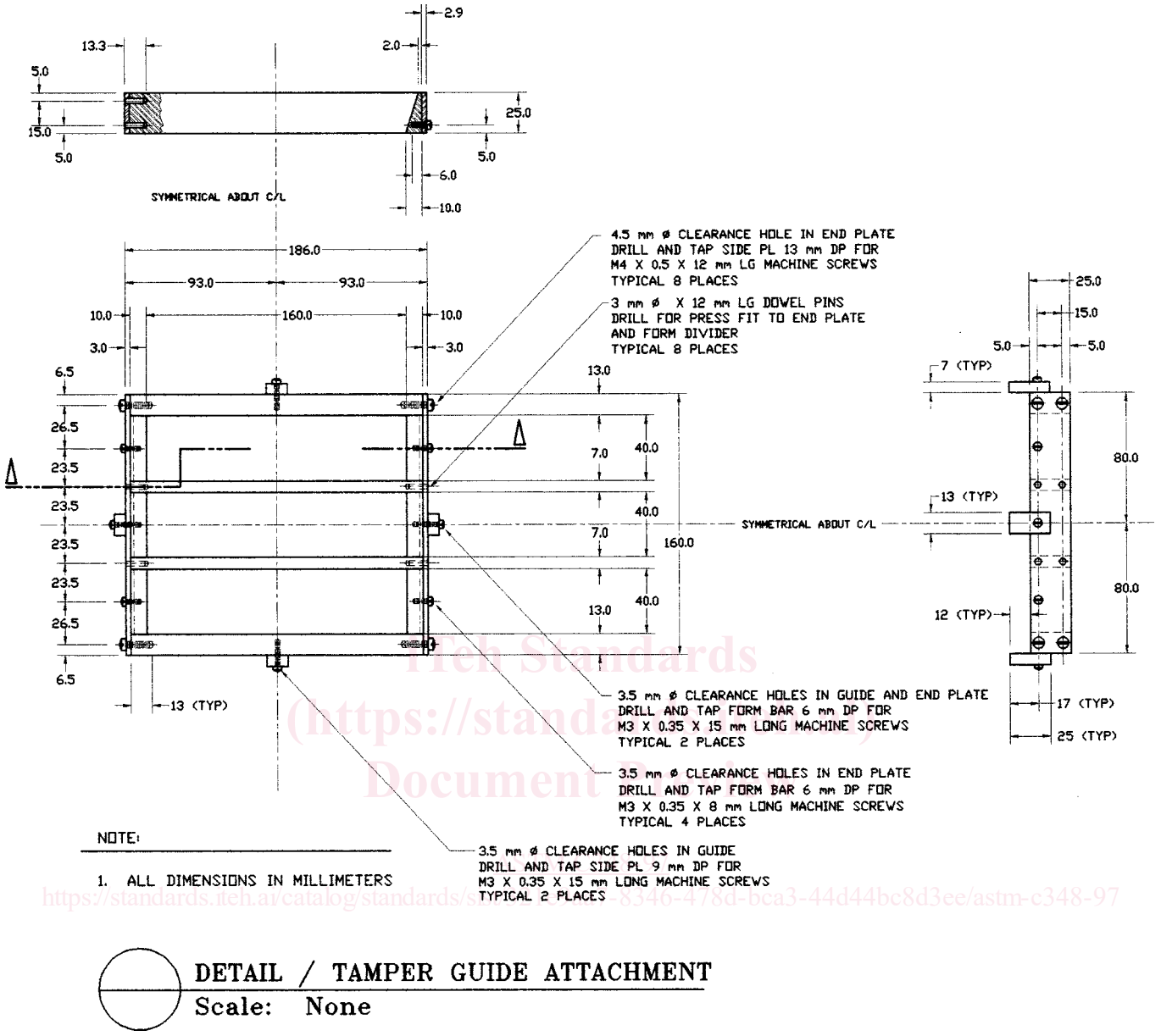


FIG. 2 Tamper Guide Attachment

9.3.2 When a duplicate batch is to be made immediately for additional specimens, the flow test may be omitted and the mortar allowed to remain in the mixing bowl for 90 s without covering. During the last 15 s of this interval, quickly scrape down into the batch the mortar that may have collected on the side of the bowl. Then remix for 15 s at medium speed.

9.3.3 Start molding the specimens within a total elapsed time of not more than 2 min and 30 s after completion of the original mixing of the mortar batch.

9.3.4 Evenly distribute a layer of mortar about 20 mm in thickness in each of the three molds with the tamper guide in place. Then compact the mortar in each mold by twelve strokes of the tamper, applied in three rounds of four strokes each, as shown in Fig. 4. Complete the twelve strokes in about 15 s. For each stroke hold the tamper face in horizontal position about 25 mm above the mortar level and then thrust directly downward with sufficient force to squeeze out a small amount of mortar from under the tamping surface. Fill the molds with mortar which shall be uniformly distributed and tamped in the same manner as the bottom layer. Then remove the tamper guide and smooth off the specimens by drawing the flat side of the trowel (with the leading edge slightly raised) once along the length of the molds. Cut the mortar off flush with the top of the molds by the straight edge of the trowel (held nearly perpendicular to the molds) with a sawing motion over the length of the molds. Following the cutting operation repair tears or cracks in the top surfaces and then make the surfaces of the specimens plane by two or three light longitudinal strokes of the trowel held with the leading edge slightly raised.

9.4 *Storage of Test Specimens*—Store the test specimens in accordance with Test Method C 109/C 109M.

9.5 *Determination of Flexural Strength*: