Designation: C617/C617M – 23

Standard Practice for Capping Cylindrical Concrete Specimens[1]

This standard is issued under the fixed designation C617/C617M; 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.

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

1. Scope*

1.1 This practice covers apparatus, materials, and procedures for capping freshly molded concrete cylinders with neat cement and hardened cylinders and drilled concrete cores with high-strength gypsum paste or sulfur mortar.

1.2 The text of this standard refers to notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.3 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined. Combining values from the two systems may result in non-conformance with the 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.* For specific precaution statements see 4.3.1 and 6.2.4.1.

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:*[2]

C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens)

C150/C150M Specification for Portland Cement

C472 Test Methods for Physical Testing of Gypsum, Gypsum Plasters, and Gypsum Concrete

C595/C595M Specification for Blended Hydraulic Cements

C1231/C1231M Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Cylindrical Concrete Specimens

2.2 *ANSI Standard:*[3]

B46.1 Standard for Surface Texture (Surface, Roughness, Waviness and Lay)

3. Significance and Use

3.1 This practice describes procedures for providing plane surfaces on the ends of freshly molded concrete cylinders, hardened cylinders, or drilled concrete cores when the end surfaces do not conform with the planeness and perpendicularity requirements of applicable standards. Practice C1231/C1231M describes alternative procedures using unbonded caps or pad caps.

4. Capping Equipment

4.1 *Capping Plates*—Neat cement caps and high-strength gypsum-paste caps shall be formed against a glass plate at least 6 mm [¼ in.] thick, a machined metal plate at least 11 mm [0.45 in.] thick, or a polished plate of granite or diabase at least 75 mm [3 in.] thick. Sulfur mortar caps shall be formed against similar metal or stone plates except that the recessed area which receives molten sulfur shall not be deeper than 12 mm [½ in.]. In all cases, plates shall be at least 25 mm [1 in.] greater in diameter than the test specimen and the working surfaces shall not depart from a plane by more than 0.05 mm [0.002 in.] in 150 mm [6 in.]. The surface roughness of newly finished metal plates shall not exceed that set forth in Table 4 of American National Standard B46.1, or 3.2 µm [125 µin.] for any type of surface and direction of lay. The surface, when new, shall be free of gouges, grooves, or indentations beyond

[1] This practice 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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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

*A Summary of Changes section appears at the end of this standard

those caused by the finishing operation. Metal plates that have been in use shall be free of gouges, grooves, and indentations greater than 0.25 mm [0.010 in.] deep or greater than 30 mm^2 [0.05 $in.^2$] in surface area.

NOTE 1—A Rockwell hardness of 48 HRC is suggested for capping plates of devices used to form sulfur mortar caps.

4.2 *Alignment Devices*—Suitable alignment devices, such as guide bars or bull's-eye levels, shall be used in conjunction with capping plates to ensure that no single cap will depart from perpendicularity to the axis of a cylindrical specimen by more than 0.5° (See Note 2). The same requirement is applicable to the relationship between the axis of the alignment device and the surface of a capping plate when guide bars are used. In addition, the location of each bar with respect to its plate must be such that no cap will be off-centered on a test specimen by more than 2 mm [1⁄16 in.].

NOTE 2—A deviation from perpendicularity of 0.5° is equal to a slope of approximately 1 mm in 100 mm [1⁄8 in. in 12 in.].

4.3 *Melting Pots for Sulfur Mortars*—Pots used for melting sulfur mortars shall be equipped with automatic temperature controls and shall be made of metal or lined with a material that is nonreactive with molten sulfur.

4.3.1 **Warning**—Melting pots equipped with peripheral heating will ensure against accidents during reheating of cooled sulfur mixture that have a crusted-over surface. When using melting pots not so equipped, a build-up of pressure under the hardened surface crust on subsequent reheating may be avoided by use of a metal rod that contacts the bottom of the pot and projects above the surface of the fluid sulfur mix as it cools. The rod should be of sufficient size to conduct enough heat to the top on reheating to melt a ring around the rod first and thus avoid the development of pressure. A large metal ladle can be substituted for the rod.

4.3.1.1 Use sulfur melting pots in a hood to exhaust the fumes to outdoors. Heating over an open flame is dangerous because the flash point of sulfur is approximately 207°C [405°F] and the mixture can ignite due to overheating. If the mixture starts to burn, covering will snuff out the flame. Recharge the pot with fresh material after the flame has been extinguished.

5. Capping Materials

5.1 The strength of the capping material and the thickness of the caps shall conform to the requirements of Table 1.

TABLE 1 Compressive Strength and Maximum Thickness of Capping Materials

Cylinder Compressive Strength MPa [psi]	Minimum Strength of Capping Material	Maximum Average Thickness of Cap	Maximum Thickness Any Part of Cap
3.5 to 50 MPa [500 to 7000 psi]	35 MPa [5000 psi] or cylinder strength whichever is greater	6 mm [¼ in.]	8 mm [5⁄16 in.]
greater than 50 MPa [7000 psi]	Compressive strength not less than cylinder strength, except as provided in 5.1.1	3 mm [⅛ in.]	5 mm [3⁄16 in.]

5.1.1 If sulfur mortar, high strength gypsum paste and other materials except neat cement paste are to be used to test concrete with a strength greater than 50 MPa [7000 psi] and their compressive strength is less than the cylinder compressive strength, the manufacturer or the user of the material must provide documentation:

5.1.1.1 That the average strength of 15 cylinders capped with the material is not less than 98 % of the average strength of 15 companion cylinders capped with neat cement paste or 15 cylinders ground plane to within 0.05 mm [0.002 in.].

5.1.1.2 That the standard deviation of the strengths of the capped cylinders is not greater than 1.57 times that of the standard deviation of the reference cylinders.

5.1.1.3 That the cap thickness requirements were met in the qualification tests, and

5.1.1.4 Of the hardening time of the caps used in the qualification tests.

5.1.2 Additionally, the qualification test report must include the compressive strength of 50 mm [2 in.] cubes of the material qualified and of neat cement paste cubes, if used. Capping materials conforming to these requirements is permitted to be used for cylinders with strengths up to 20 % greater than the concrete tested in these qualification tests. The manufacturer must requalify lots of material manufactured on an annual basis or whenever there is a change in the formulation or the raw materials. The user of the material must retain a copy of the qualification results, and the dates of manufacture of material qualified and of the material currently being used.

NOTE 3—Table 2 is an example of a report of test results to qualify a capping material.

5.1.3 The compressive strength of capping materials shall be determined by testing 50 mm [2 in.] cubes following the procedure described in Test Method C109/C109M. Except for sulfur mortars, molding procedures shall be as in Test Method C109/C109M unless other procedures are required to eliminate large entrapped air voids. See Test Methods C472 for alternative compaction procedures. Cure cubes in the same environment for the same length of time as the material used to cap specimens.

5.1.4 The strength of the capping material shall be determined on receipt of a new lot and at intervals not exceeding three months. If a given lot of the capping material fails to conform to the strength requirements, it shall not be used, and strength tests of the replacement material shall be made weekly until four consecutive determinations conform to specification requirements.

5.2 *Neat Hydraulic Cement Paste:*

5.2.1 Make qualification tests of the neat hydraulic cement paste prior to use for capping to establish the effects of water-cement ratio and age on compressive strength of 50 mm [2 in.] cubes.

NOTE 4—The cements used generally conform to Specification C150/C150M Types I, II or III; however, Specification C595/C595M blended cements, calcium aluminate or other hydraulic cements producing acceptable strength may be used.

5.2.2 Mix the neat cement paste to the desired consistency at a water-cement ratio equal to or less than that required to

TABLE 2 Example of Report of Qualification of a Capping Material

NOTE 1—Manufacturer: Testing Supplies Co.
Capping Material: Super Strong AAA-Sulfur mortar
Lot: 12a45 Date Tested: 11/3/XX
Signed by:_____ (testing agency and responsible official)

Item	Capping Material	Control Cylinders	Ratio Cap/Control	Criteria	Pass/Fail
		Concrete Cylinder Test Data			
Type of capping material	Sulfur	Ground			
Average Concrete Strength, psi	11 061	11 008	1.005	>0.98	Pass
Standard Deviation, psi	376	250	1.504	≤1.57	Pass
Number of cylinders tested	15	15			
Cap age when cylinders tested	7 days	na			
		Capping Material Test Data			
Average cap thickness, in.	0.11	na			
Compressive strength of 2 in. cubes, psi	12 195				
Cube age when tested.	7 days				
Maximum concrete strength qualified, psi				1.2 Av. Str = 13 273[A]	

[A] Nominally a specified strength of 11 000 psi and perhaps somewhat higher.

produce the required strength, generally 2 to 4 h before the paste is to be used (Note 5). Remix as necessary to maintain acceptable consistency (Note 6). Some retempering of the paste is acceptable if the required water-cement ratio is not exceeded. Optimum consistency is generally produced at water-cement ratios of 0.32 to 0.36 by mass for Type I and Type II cements and 0.35 to 0.39 by mass for Type III cements.

NOTE 5—Freshly mixed pastes tend to bleed, shrink, and make unacceptable caps. The 2 h to 4 h period is generally appropriate for portland cements.

NOTE 6—The required consistency of the paste is determined by the appearance of the cap when it is stripped. Fluid paste results in streaks in the cap. Stiff paste results in thick caps.

5.3 *High-Strength Gypsum Cement Paste:*

5.3.1 No fillers or extenders may be added to neat high-strength gypsum cement paste subsequent to the manufacture of the cement. (Note 7) Qualification tests shall be made to determine the effects of water-cement ratio and age on compressive strength of 50 mm [2 in.] cubes. Retarders may be used to extend working time, but their effects on required water-cement ratio and strength must be determined. (Note 8)

NOTE 7—Low-strength molding plaster, plaster of paris, or mixtures of plaster of paris and portland cement are unsuitable for capping.

NOTE 8—The water-gypsum cement ratio should be between 0.26 and 0.30. Use of low water-cement ratios and vigorous mixing will usually permit development of 35 MPa [5000 psi] at ages of 1 h or 2 h. Higher water-gypsum cement ratios extend working time, but reduce strength.

5.3.2 Mix the neat gypsum cement paste at the desired water-cement ratio and use it promptly since it sets rapidly.

5.4 *Sulfur Mortar:*

5.4.1 Proprietary or laboratory prepared sulfur mortars are permitted if allowed to harden a minimum of 2 h before testing concrete with strength less than 35 MPa [5000 psi]. For concrete strengths of 35 MPa [5000 psi] or greater, sulfur mortar caps must be allowed to harden at least 16 h before testing, unless a shorter time has been shown to be suitable as specified in 5.1.1.

5.4.2 *Determination of Compressive Strength*—Prepare test specimens using a cube mold and base plate conforming to the requirements of Test Method C109/C109M and a metal cover plate conforming in principle to the design shown in Fig. 1 (Note 9). Bring the various parts of the apparatus to a temperature of 20 °C to 30 °C [68 °F to 86 °F], lightly coat the surfaces that will be in contact with the sulfur mortar with mineral oil, and assemble near the melting pot. Bring the temperature of the molten-sulfur mortar in the pot within a range of 130 °C to 145 °C [265 °F to 290 °F], stir thoroughly, and begin casting cubes. Using a ladle, or other suitable pouring device, quickly fill each of the three compartments until the molten material reaches the top of the filling hole. Allow sufficient time for maximum shrinkage, due to cooling, and solidification to occur (approximately 15 min) and refill each hole with molten material (Note 10). After solidification is complete, remove the cubes from the mold without breaking off the knob formed by the filling hole in the cover plate. Remove oil, sharp edges, and fins from the cubes and check the planeness of the bearing surfaces in the manner described in Test Method C109/C109M. After storage at room temperature to the desired age, but not less than 2 h, test cubes in compression following the procedure described in Test Method C109/C109M, and calculate the compressive strength.

NOTE 9—If desired, a 3-mm [⅛ in.] thick plate of thermosetting plastic (such as phenol formaldehyde), provided with three appropriately spaced filling holes, may be inserted between the cover plate and the mold to slow the rate of cooling of test specimens.

NOTE 10—The second filling helps to prevent the formation of a large void or shrinkage pipe in the body of a cube. However, such defects may occur no matter how much care is exercised, and it therefore is advisable to inspect the interior of tested sulfur mortar cubes for homogeneity whenever the strength values obtained are significantly lower than anticipated.

6. Capping Procedures

6.1 *Freshly Molded Cylinders*—Use only neat portland cement pastes (Note 11) to cap freshly molded cylinders. Make caps as thin as practicable. Do not apply the neat paste to the exposed end until the concrete has ceased settling in the molds, generally from 2 h to 4 h after molding. During the molding of the cylinder, strike off the upper end even with or slightly