T 231

CAPPING CONCRETE TEST SPECIMENS

FOP FOR AASHTO T 231

T 231

CAPPING CONCRETE TEST SPECIMENS

FOP FOR AASHTO T 231

CAPPING CONCRETE TEST SPECIMENS FOP FOR AASHTO T 231

02

Scope

This FOP covers the apparatus, materials, and procedures for capping hardened concrete specimens using either high-strength gypsum plaster or sulfur mortar.

Capping of freshly molded specimens with neat cement paste is not covered. (Refer to AASHTO T 231 for a discussion of this procedure)

03

Significance

Procedures are described for preparing surfaces of hardened concrete cylinders, drilled cores, or beams in preparation for strength testing when the surfaces do not conform to the requirements of the applicable testing procedures.

04

Apparatus

- **Capping Plates:** Capable of providing surfaces plane to within 0.002 in. across any dimension.

  In all cases, plates shall be at least 1 in. larger than the specimen being prepared.

  Glass plates at least 0.25 in. thick, metal plates at least 0.45 in. thick, or polished granite or diabase plates at least 3 in. thick shall be used for high-strength gypsum plaster capping.

  Sulfur mortar capping plates shall consist of metal or stone plates as described for gypsum plaster.

  When new, metal plates shall be free of gouges, grooves, or indentations beyond those caused by the finishing operation. When in use, they shall be free of gouges, grooves, or indentations having surface area greater than 0.05 in.^{2} or depth greater than 0.010 in.

Note: It is advisable to case-harden the capping surface of metal plates to a Rockwell hardness of HRC 48 to help maintain the capping surface free of objectionable defects.

05

- **Alignment Devices:** Guide bars or bulls-eye levels must be used to ensure that no cap departs from perpendicularity to the axis by more than 0.125 in. in 12 in. When guide bars are used for

cylinders, they must be positioned such that no cap is more than 0.06 in. off center.

Caution: Sulfur mortar reacts with organic compounds such as oil to release hydrogen sulfide gas. In high concentrations it is lethal. It is advisable that the melting pot and capping area be within a vent hood with fumes exhausted out of doors to prevent buildup of the gas.

06

07

- **Melting Pot for Sulfur Mortar:** Melting pots equipped with peripheral heating suitable to prevent accidents when reheating cooled capping material. In lieu of peripheral heating elements, a steel rod may be used to transfer heat and provide a "halo" of melted material in the crust during reheating.

  Melting pots should be thermostatically controlled to prevent sulfur fires. Pots should only be used under a vent hood exhausting the fumes out of doors.

- **Cube Molds:** Molds capable of forming cubes of 2-inch size (50mm molds are also permitted), consisting of two pieces and a base plate. Molds shall have a maximum of three compartments, meeting the requirements of Table 1.

- **Cover Plate (for cube molds):** Conforming to Figure 1 of AASHTO T 231, providing a means of overfilling the molds when pouring sulfur mortar strength specimens.

- **Testing Machine:** Complying with AASHTO T 106 for testing compressive strength of capping materials.

Table 1 – Permissible Variations of Cube Molds 08

Parameter	2-inch Cube Molds	
	New	In Use
Deviation from planeness of sides	< 0.001 inch	< 0.002 inch
Distance between opposite sides	2 inches ± 0.005	2 inches ± 0.02
Height of each compartment	2 inches + 0.01 to –0.005 inches	2 inches + 0.01 to –0.015 inches
Angle between adjacent faces	90 ± 0.5^{o}	90 ± 0.5^{o}

09

Capping Materials

Strength Requirements and Cap Thickness: Sulfur mortar or high-strength gypsum plaster may be used provided they meet the requirements shown in Table 2 (including note).

Table 2 – Compressive Strength and Maximum Thickness of Capping Materials 10-13

Cylinder Compressive Strength (psi)	Minimum Strength of Capping Material	Maximum Average Thickness of Cap	Maximum Thickness (Any Part of Cap)
500 to 7000 psi	5000 psi or cylinder strength, whichever is greater	0.25 inch	0.31 inch
Greater than 7000 psi	Not less than cylinder strength [1]	0.125 inch	0.20 inch

Note 1 – The manufacturer or user must provide the following documentation:

- That the average strength of 15 cylinders capped with the material is not less than 98 percent of the average strength of 15 companion cylinders capped with neat cement paste or 15 cylinders ground plane to within 0.002 in.,
- 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,
- That the cap thickness requirements were met in the qualification tests, and
- Of the hardening time of the caps used in the qualification tests.

The qualification test report must include the compressive strength of 2-in. cubes of the material qualified and of neat cement paste cubes, if used. Capping materials conforming to these requirements are permitted to be used for cylinders with strengths up to 20 percent 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 of 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.

14
- Strength verification of capping materials must be made for each lot of material and at intervals not exceeding three months.
- Prior to testing cube strength for verification of capping materials, allow the cubes to cure in the same environment for the same length of time as the materials used to cap specimens.

15
- If a given lot fails the strength test, it shall not be used and replacement material must be obtained. The replacement material will be tested weekly until four consecutive tests indicate compliance with strength requirements.
- The proportion of water used for mixing gypsum plaster capping material should be between 26 and 30 percent by mass of the high-strength gypsum cement.

16 **Determining compressive strength**:

- For high-strength gypsum plaster, mold specimens as required by AASHTO T 106. Conduct strength tests according to steps 7 through 9 for sulfur mortar (see sulfur mortar procedure below).

17 - For sulfur mortar, mold cubes and conduct strength testing as follows:

    1. Apply a light coat of mineral oil to the cube mold and cover plate. Assemble the mold and attach the cover plate.
    2. Bring the assembled apparatus to a temperature of 68 to 86ºF. Place the apparatus near the capping area.
    3. Bring the temperature of the molten sulfur mortar in the pot to a range of 265 to 290ºF, stir thoroughly, and begin casting cubes.

18 4. Using a ladle, pour the molten sulfur mortar into the filling holes of the cover plate until level with the top of the filling holes.

    5. Allow the material to cool such that maximum shrinkage occurs (usually about 15 minutes), then refill with molten sulfur mortar to the top of the filling holes.
    6. After cubes have solidified, remove the mold without breaking off knobs formed by filling holes and remove oil, sharp edges, and fins.

19 7. After the required curing period at room temperature (not less than 2 hours), check planeness of bearing surfaces, and measure dimensions. Calculate cross-sectional area.

8. Test for compressive strength according to AASHTO T 106, applying the test load at a rate of 200 to 400 pounds/second.

9. Calculate compressive strength by dividing the total load by the cross-sectional area.

20 **Capping Procedure – General**

- During each day's capping operation check planeness of the caps at least three times (at the beginning, middle, and end of the run).
- Ensure that caps do not depart from a plane by more than 0.002 in. Check across at least 3 diameters or dimensions using a straightedge and feeler gauge.

- Cap thickness should comply with the requirements of Table 2. Caps should be as thin as possible, normally about 0.125 in. Thickness of any portion of a cap may not exceed 0.20 in. or 0.31 in., depending on cylinder strength.

21

22
- If specimens have any material adhering to them that would interfere with bonding to the cap, this material should be removed prior to capping. Light scoring of smooth surfaces is permissible to improve bond with the capping material.
- A thin coating of mineral oil or grease may be used on capping plates to prevent bonding of the capping material to these surfaces. In no case may the specimen surfaces be oiled.

23
- After capping, at least two hours of hardening must be allowed prior to testing of specimens having compressive strength less than 5000 psi (at least sixteen hours of hardening for specimens 5000 psi or greater), unless a shorter time has been shown to be suitable during qualification testing.

24 **Capping Procedure**

High-Strength Gypsum Plaster:

1. Mix the material at the same percent of mixing water as used for qualification tests.
2. Rapidly spread the capping material on the capping plate.
3. Immediately place the specimen on the capping material, using guide plates or a bulls-eye level to assure perpendicularity of the axis to the capped surface.

25

4. Carefully isolate each specimen from the surrounding gypsum plaster without disturbing the material coating the end of the specimen (scribing around the perimeter with the finger is effective).
5. Allow material to harden sufficiently to avoid damage during removal from the capping plate.

26 **Sulfur Mortar:**

1. Empty the pot and refill with fresh material with sufficient frequency to assure that material is not being used more than five times. Capping material must be kept dry to prevent foaming.
2. Preheat sulfur mortar to about 265ºF.
3. Warm the capping plate to slow hardening, thus permitting production of thin caps.
4. Oil capping plate lightly and stir capping compound prior to pouring each cap.

27

5. Dry off specimen surfaces to prevent foaming and air bubbles between the specimen and capping compound.

28

6. Pour capping material into the mold and immediately place the specimen in the compound, using alignment devices to assure perpendicularity of the capped surface to the axis.
7. Allow sufficient time for the cap to harden prior to removal from mold.

29

Protection of Specimens After Capping

- Moist cured specimens must be maintained in a moist surface condition between capping and testing by returning them to moist storage or wrapping with at least two layers of wet burlap.
- Specimens with gypsum plaster caps should not be stored in moist rooms longer than four hours after capping and capped surfaces must be protected from water dripping on them.

Tips! 30

- Check capping plate condition frequently for planeness and surface defects.
- Check strength of capping material at required intervals.
- Check capped surfaces for conformance with planeness requirements.
- Use guide bars or bulls-eye level to assure conformance with perpendicularity requirements.
- Make sure that sulfur mortar is dry to prevent foaming.
- When using sulfur mortar, dry the surfaces of specimens to prevent inclusion of gas bubbles in the caps. 31
- When capping with gypsum plaster, mix material at the same water percentage as used for qualification tests.
- Take precautions to prevent buildup of hydrogen sulfide gas in lab facility by having capping pot and capping area under a vent hood that exhausts gas out of doors.

REVIEW QUESTIONS

1. Describe the requirements for capping plates.

2. Describe the requirements for high-strength gypsum capping material.

3. Describe how caps are checked for dimensional tolerances.

4. Describe the process for conducting strength tests of sulfur mortar for compliance testing.

5. Describe the capping process using high-strength gypsum plaster.

6. Describe the capping process using sulfur mortar.

7. Discuss safety precautions for using sulfur mortar.