



STUDY GUIDE

WACEL

CONCRETE/MASONRY STRENGTH TESTING TECHNICIAN

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Study Guide

Concrete/Masonry Strength Testing Technician

General:

This study guide describes in detail the organization and content of WACEL's certification program for Concrete/Masonry Strength Testing Technician. The goals of the program are twofold:

- a. To ensure that laboratory technicians who are employed by WACEL members have demonstrated the skills, knowledge, and abilities to test the more common concrete and masonry strength specimens.
- b. To ensure that WACEL members and their technicians who are involved in the testing of concrete and masonry strength specimens are qualified as specified in industry standards.

The goals and substance of this program are fully in agreement with WACEL's laboratory accreditation requirements for concrete laboratories. The procedures and processes that are part of this certification can and will be revisited during concrete laboratory accreditation visits or annual audits.

This certification program was originally intended to parallel and be the equivalent to the written component of the American Concrete Institute's Strength Testing Technician Certification. What has evolved is an expanded scope that also incorporates drilled cores and the more-routine masonry specimens that several WACEL members test. This expansion addresses what most WACEL laboratories actually do and attempts to more fully comply with the intent of ASTM E 329.

Examinations:

Certification as a WACEL Concrete/Masonry Strength Testing Technician requires the successful completion of a 2-hour, written examination. This written examination is an open-book 60-question test that reasonably represents the learning objectives and references incorporated into this study guide. References a. through h. listed below can be used. A grade of 80 percent is required for passing.

The primary responsibility for the performance evaluation component of this certification rests with individual laboratories using tools such as the attached checklist. Evaluations of the skills covered by this certification will also be confirmed as part of laboratory accreditation visits and annual audits. A checklist covering these evaluations is attached.

References:

- a. ASTM C 39-05, "Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens."
- b. ASTM C 42-04, "Obtaining and Testing Drilled Cores and Sawed Beams of Concrete."



- c. ASTM C 78-02, “Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).”
- d. ASTM C 109-05, “Compressive Strength of Hydraulic Cement Mortar.”
- e. ASTM C 617-98 (2003) (sulfur mortar only), “Standard Practice for Capping Cylindrical Concrete Specimens.”
- f. ASTM C 780-06a, “Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.”
- g. ASTM C 1019-05, Sampling and Testing Grout.
- h. ASTM C1231-00, “Standard Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders.”
- i. “Concrete Strength Testing.” A video tape prepared by the Construction Materials Engineering Council; available from the American Concrete Institute (ACI).
- j. “Concrete Strength Testing Technician,” ACI Technician Workbook CP-19 (02).

Learning Objectives:

- I. Can safely and properly cap cylindrical concrete specimens using molten sulfur mortar as delineated in ASTM C617:
 - A. Knows how to select the correct type and size capping plates.
 - B. Understands how to correctly heat and use sulfur mortar to include continuous venting, peripheral heating, correct temperature, reuse of material, and fire danger considerations.
 - C. Can properly evaluate the end conditions of cylinder specimens to determine if capping can proceed without further actions such as cleaning and/or sawing.
 - D. Is familiar with the need and reason for warming the capping plate prior to use.
 - E. Knows the testing requirements to determine the suitability of sulfur mortar capping material to include:
 - 1. Testing on receipt of a new lot.
 - 2. Quarterly testing within a lot.
 - 3. Minimum strength requirements.
 - 4. Special qualification testing for specimens with a strength greater than 7,000 psi (50 MPa).
 - F. Is aware of the requirement to lightly oil the capping plate prior to use.
 - G. Can correctly apply a sulfur mortar cap using an alignment device and/or a bull’s eye level.
 - H. Knows criteria for and can correctly check applied caps for both planeness and perpendicularity.



- I. Demonstrates an understanding of the standards for maximum cap thickness (both individual and average thicknesses) and the testing requirements to confirm compliance with these standards.
 - J. Knows how to check applied sulfur mortar caps for voids or steam pockets.
 - K. Knows how long sulfur mortar caps should be allowed to harden prior to testing.

- II. Can correctly use unbonded caps in the testing of cylindrical concrete specimens as specified in ASTM C1231.
 - A. Knows the upper and lower compressive strength limits for using unbonded caps.
 - B. Is aware that unbonded caps are not to be used for drilled cores.
 - C. Is knowledgeable of requirements and criteria for checking retaining rings for excessive gauges, grooves, or indentations.
 - D. Knows standards for sizes of retaining rings in relation to the specimens being tested.
 - E. Knows the minimum depth and size of retaining rings in relation to the caps being used.
 - F. Is knowledgeable of the different durometer hardness available for neoprene caps and how they affect use.
 - G. Knows limits on the number of uses of neoprene caps and the need to document such uses.
 - H. Is aware of criteria to discard caps if excessive wear or damage is noted.
 - I. Understands the end condition limitations for using unbonded caps and the action to be taken if they are exceeded.
 - J. Is aware that the typical fracture sketches shown in ASTM C39 not necessarily descriptive when using unbonded caps.
 - K. Knows that special qualification testing is required for using unbonded caps when the specimen strengths are greater than 7,000 psi.
 - L. Knows to recheck a specimen being tested for perpendicularity after applying approximately 10 percent of the anticipated load.

- III. Can correctly determine the compressive strength of cylindrical concrete specimens in accordance with ASTM C39.
 - A. Understands that the compressive strength of concrete test specimens is dependent on many variables to include size and shape of the specimen, age, temperature, mix proportioning, and moisture during curing and at testing.
 - B. Is aware that this test procedure is limited to test specimens having a unit weight in excess of 50 lb/ft³.
 - C. Knows the calibration requirements for testing machines.
 - D. Is aware that testing machines must be power operated and capable of applying loads continuously, rather than intermittently, and without shock.
 - E. Knows that the compressive axial load must be applied at a prescribed rate.
 - F. Knows that testing machines must have two steel bearing blocks.



1. One must be solid and the other must be spherically seated.
 2. The spherically seated block must be designed so that it does not permanently deform under repeated use with loads up to 12,000 psi on the test specimen.
- G. Understands that the spherically seated block must be kept clean and lubricated with petroleum – type oil such as conventional motor oil.
- H. Knows that specimens are not to be tested if a measured diameter of a test specimen varies by more than 2 percent from any other diameter or the same specimen.
- I. Knows that the diameter used to determine the cross-sectional area of the specimen is the average of two diameters taken at right angles to each other at about mid-height of the specimen.
- J. Is knowledgeable of the criteria for using and average diameter for a day's testing and can correctly determine the value to be used.
1. All molds from the same lot.
 2. All diameters consistently fall within a range of 0.02 in (0.5 mm).
 3. Average diameters of at least three specimens per day or for each ten specimens, whichever is greater.
- K. Understands that moist-cured specimens should be tested as soon as practical after removal from moist storage or kept moist during the period between removal and testing.
- L. Knows the allowable time tolerances for testing specimens of a designated age.
- M. Knows that the rate of loading a specimen should be within the range of $35 \pm$ psi/second, that a higher rate may be applied during the first half of the loading cycle, and can compute an acceptable loading rate based on specimen diameter.
- N. Understands how to apply an appropriate correction factor if the length to diameter ratio of the test cylinder is less than 1.8.
- O. Can correctly compute and report the compressive strength of a specimen given a maximum load and a diameter.
- P. Can describe the type of fracture of a cylindrical specimen using the sketches provided in ASTM C39.
- IV. Can properly test a cast, flexural strength test specimen using third-point loading as specified in ASTM C78.
- A. Knows that the flexural strength of cast or sawed beams is calculated and reported as the "Modulus of Rupture".
 - B. Understands that cross-sections of a beam must be geometrically true with sides at right angles with the top and bottom and that all surfaces shall be smooth and free of scars, indentations, or inscribed marks.
 - C. Is aware that cast beams are loaded on their side with respect to the position as molded; and that sawed beams are loaded so that the tension face corresponds to the top or bottom of the specimen as cut from the parent material.



- D. Knows that any gaps between the specimen and the load-applying or support blocks are checked with feeler gauges after the loading system is positioned and approximately 3 to 6 percent of the estimated ultimate load is applied.
- E. Understands that smaller gaps up to 0.015 inch (0.38 mm) can be shimmed using leather strips extending across the full width of the specimen
- F. Is aware that flexural specimens should be loaded continuously and without shock and at a rate such that the extreme fiber stress increases between 125 and 175 psi/minute (using the formula provided in ASTM C78).
- G. Knows that the average width and depth are determined by taking three measurements for each (each edge and center) across one of the fractured faces.
- H. Based on the location of the fracture can correctly selected and apply the appropriate formula to determine the modulus of rupture.
- I. Understands that test results should be disregarded if fracture in the tension surface is outside the middle third of the span length by more than 5 percent of the span length.
- J. Knows to record the following information for the preparation of a complete report:
1. Specimen identification.
 2. Average width.
 3. Average depth.
 4. Span length.
 5. Maximum applied load.
 6. Calculated modulus of rupture.
 7. Curing history and moisture condition when tested.
 8. Use of shims, capping, or grinding if applicable.
 9. Test age of specimen.
- V. Can correctly prepare and test drilled cores for compressive strength testing in accordance with ASTM C42.
- A. Understands that drilled cores for compressive strength testing should normally have a diameter three times the normal maximum size of the coarse aggregate with a preferred minimum diameter of 3.70 inches (94 mm).
- B. Understands that the moisture conditions of the drilled cores prior to test focus more on reproducible test results that minimizing the effects of drilling rather than replicating the moisture condition of the concrete in the structure.
1. Wipe dry after drilling.
 2. When surface appears dry, but not later than 1 hour after drilling, place core in a sealed plastic bag to prevent moisture loss.
 3. Deliver to laboratory.
 4. If water used for sawing, accomplish end preparation within 2 days of drilling. Wipe off excess moisture, allow the core to dry and replace it in the plastic bag.



5. Note: capping in accordance with ASTM C617 may be desired at the same time.
 6. Allow cores to remain in sealed plastic bags for at least 5 days after last being wetted prior to testing.
- C. Knows that the preferred length of the capped or ground core is between 1.9 and 2.1 times the diameter and that any prepared core with a height less than its diameter should not be tested.
 - D. Understands that sawing will be required to remove end projections that extend more than 0.2 inches (5 mm) above the surface or when end surfaces depart from perpendicularity to the longitudinal axis by more than 0.5 degrees.
 - E. Is aware that capping is needed that bonded caps meeting ASTM C617 are required. Unbonded caps are not permitted.
 - F. Is knowledgeable the perpendicularity and planeness requirements of ASTM C39 apply to drilled cores.
 - G. Knows that average diameter used to compute the compressive strength of a core is the average of two diameters taken at right angles to each other at mid-height of the specimen.
 1. Measure to the nearest 0.01 inch (0.2 mm) when differences in diameters do not exceed 2 percent of their average.
 2. Do not test core if a diameter exceeds 5 percent of their average.
- VI. Can correctly determine the compressive strength of masonry mortar cubes in accordance with ASTMs C109 and C780.
- A. Knows that cube molds must be made of hard metal of sufficient rigidity to prevent spreading and warping.
 - B. Is aware that loose sand grains and incrustations must be removed from cube faces that will come in contact with bearing blocks of the testing machine.
 - C. Understands rate of loading should be such that the maximum load is reached in not less than 20 seconds nor more than 80 seconds.
 1. For anticipated loads of less than 3,000 lb, the rate of loading must be constant throughout the test.
 2. For anticipated loads of greater than 3,000 lb, up to one half of the anticipated load can be applied at any convenient rate.
 - D. Knows that a single cube should not be tested if more than minor grinding is required to obtain a plane surface.
 - E. Knows that the compressive strength results of a single cube of field-prepared mortar should not be considered if its results vary from the set average by more than 10 percent.
 - F. Understands that the compressive strength results of the mortar cubes of the same sample and test age should be averaged and reported to the nearest pound per square inch.



VII. Can correctly and properly determine the compressive strength of masonry grout prisms as specified in ASTM C1019.

- A. Knows that at least three specimens must be tested at each age specified.
- B. Is knowledgeable that the ASTM C617 requirements and the ASTM C39 requirements for testing apply to grout prisms.
- C. Can calculate average cross-sectional area by measuring the width of each face at about mid-height, by averaging the width of opposite faces, and by multiplying the average widths.
- D. Knows the load is to be applied continuously and without shock.
- E. Knows that compressive strength results for grout prisms at a specified age are to be reports individually as well as a set average.
- F. Can properly compute and report compressive strength results of grout prisms.