



Structural Concrete Special Inspector

Study Guide

March 2023

Structural Concrete Special Inspector

Study Guide

Scope:

A technician who is currently certified in both the WACEL Concrete Level I (or approved equivalent) and Reinforced Concrete Special Inspector (previously Concrete Level II) and who meets the prerequisite experience requirements is eligible for certification as a Structural Concrete Special Inspector.

Structural Concrete Special Inspector is the highest level of WACEL concrete certification. Advance knowledge of basic concrete construction, materials behavior, plan reading, formwork, reinforcing steel and testing are prerequisites for this certification.

WACEL Concrete I Technician introduces the entry-level technician to the basics of concrete as a construction material. It also concentrates on the more-common quality control tests that may be specified.

Reinforced Concrete Special Inspector covers basic plan reading; proper placement of reinforcing-steel; concrete placement; consolidation; and curing. More significantly, however, Reinforced Concrete Special Inspector (RCSI) exposes technicians to many of the publications that significantly contribute to the required knowledge of mid-level inspectors. These documents include applicable ASTM, ACI, CRSI and PCA publications. The careful integration of these industry standards with approved drawings and specifications are stressed.

Candidates for certification as Structural Concrete Special Inspectors expands the previously acquired body of knowledge even further. In addition, two specialty topics are introduced. They are post-tensioned concrete using unbonded tendons and tilt-up concrete construction. Special inspection of post-tensioned concrete and tilt-up concrete should be performed by certified Structural Concrete Special Inspectors. Industry publications from the PTI and the TCA are also introduced.

Building on knowledge introduced as part of Reinforced Concrete Special Inspection certification, Structural Concrete Special Inspector places a much greater reliance on a knowledge of and the proper use of industry-approved reference documents. Structural Concrete Inspectors are expected to know how to research and resolve questions and technical issues that may be unfamiliar to them. The ability to properly and promptly use available information and resources is equally – if not more – important, than rote memorization of a list of details and requirements.

Also, a working knowledge of the *International Building Code's* Special Inspection Program is required. This area of knowledge was introduced in RCSI and is being expanded on as a part of the Structural Concrete Special Inspector certification.

Examination:

The Structural Concrete Special Inspector Examination is based on required references. Technicians have up to 3-hours (3.5-hours if the on-line version is used) to complete this open-book examination. A overall grade of 75 percent is required for passing with at least 70 percent on the plan reading questions. A basic, non-recording calculator should be used for the test.

All of the required references listed below should be brought to the examination by the candidate, and the reference materials shall contain no marks, tabbing, or highlighting. The additional references are listed for the purpose of a more expanded background; their content is usually well addressed in the essential references.

Mobile telephones and smart watches or devices cannot be brought into the examination area, and photo identification will be checked for each examination candidate. No notes or working sheets may be removed from the examination area.

Required References:

Building Code:

- A. Chapter 17, "Structural Tests and Special Inspections," 2018 International Building Code.

Advanced Concrete Topics (required):

- A. "Design and Control of Concrete Mixtures", Portland Cement Association, 17th Edition, 2021.

Post-tensioning:

- A. "Instructional Manual for Training and Certification of Field Personnel for Unbonded Post-Tensioning," Post-Tensioning Institute, 3rd Edition, C30.1-03, reprinted 2008.

- B. "Field Procedures Manual for Unbonded Single Strand Tendons," 3rd Edition, Post-Tensioning Institute, M10.3-16.

Tilt-up Construction:

- A. "Tilt-Up Concrete Construction Guide," ACI 551.1R-14.
- B. TCA's Guide Specifications, 2018 Revision v1.

Additional References (optional):

The following additional references are listed to provide more in-depth information on selected topics. Their use in assisting candidates in preparing for this examination is recommended. Use of these optional publications during the examination is permitted but not necessary.

- A. "Manual of Standard Practice," Concrete Reinforcing Steel Institute, 29th Edition.
- B. ASTM C94-22a, "Specifications for Ready Mixed Concrete."
- C. ACI 301-20, "Specifications for Concrete Construction."
- D. ACI 305R-20, "Guide To Hot Weather Concreting."
- E. ACI 306R-16, "Guide to Cold Weather Concreting."
- F. ACI 308R-16 "Guide to Curing Concrete."
- G. ACI 309R-05, "Guide for Consolidation of Concrete."
- H. ACI 318-19, "Building Code Requirements for Structural Concrete."

Learning Objectives:

- I. Can perform unbonded, post-tensioned concrete inspections.
 - A. Understands the purposes, the advantages, and the more common uses of unbonded, post-tensioned concrete.
 - B. Is aware of the differences between pre-tensioned and post-tensioned concrete.
 - C. Understands the general terms used in post-tensioning operations.
 - D. Is familiar with post-tensioning drawings, symbols, notes and abbreviations, and basic components.
 - E. Is able to extract the necessary information from the approved plans and shop drawings and subsequently fill out the post-tensioning forms correctly.

- F. Knows how to inspect the proper placement of tendons and related accessories and reinforcing elements prior to the placement of concrete.
 - G. Understands the proper techniques of concrete placement, consolidation and curing as it relates to post-tensioning.
 - H. Is familiar with the dangers associated with stressing operations.
 - I. Is knowledgeable of how to properly monitor and document stressing operations to include proper calibration of the required equipment.
 - J. Understands the need for submitting complete and proper elongation reports in a timely fashion.
 - K. Is aware of common jobsite troubleshooting problems and corrective procedures.
 - L. Understands the purposes and the special handling requirements for encapsulated post-tensioning systems.
- II. Can perform observations, inspections and testing for tilt-up concrete structures.
- A. Is highly familiar with the Tilt-up Concrete Association's "Guide Specifications," and can compare and contrast the TCA's recommendations to a specific project's requirements.
 - B. Using the ACI's Publication "Tilt-up Concrete Construction Guide" (ACI 551.1R-14), is aware of the general considerations of tilt-up concrete construction.
 - C. Using approved design drawings and approved shop drawings, can monitor tilt-up formwork for proper openings and dimensions within allowable tolerances.
 - D. Using approved design drawings for structural reinforcement and approved shop drawings, placing drawings, and erection plans for reinforcement needed for erection and lifting, can inspect all reinforcing steel, embedded items, and lifting and bracing hardware for proper size, placement, and positioning. Note: Plan reading questions based on a MeadowBurke Erection Plan.
 - E. Can monitor and evaluate the specific testing requirements that a tilt-up project requires prior to the erection of panels.

III. Understands advanced topics for concrete as a construction material.

All questions that support this Learning Objective are based on the Portland Cement Association publication “Design and Control of Concrete Mixtures.” Individuals taking the Structural Concrete Special Inspector examination need to be familiar with this publication. Particular emphasis will be given to Chapters 1-4, 6, 8, 9, 15.

A. Introduction to Concrete:

1. Knows the range of materials and processes that contribute to mixing, placing, and curing of quality concrete.
2. Understands the development of Abrams’ Law (compressive strength vs. water-cement ratio correlation) and the range of advantages in reducing the water content of concrete mixtures.
3. Appreciates the need to modify concrete mix designs to optimize performance under a variety of loads and adapt to different environments.
4. Has a basic knowledge of the historical use of concrete and the development of the current concrete industry.

B. Portland, Blended, and Other Hydraulic Cements:

1. Has a basic understanding of the manufacturing process for Portland cement.
2. Knows the six basic types of Portland cement (Type I, Type II, Type II (MH), Type III, Type IV, and Type V).
3. Has a basic understanding of the range of specialty cements that may be encountered to address specific requirements.

C. Supplementary Cementitious Materials:

1. Understands the use of Supplementary Cementitious Materials (SCMs) and can discuss the more-common SCMs that may be encountered.
2. Knows the impact on fresh properties of the more common SCMs on concrete to include workability, bleeding, setting time, and heat of hydration.

D. Mixing Water for Concrete:

1. Knows the various potential sources of mixing water for concrete and the limitations if any – for use.
2. Is aware of the constraints that govern when using seawater as mixing water for concrete, if authorized.

F. Chemical Admixtures for Concrete:

1. Has an understanding of the wide variety of chemical admixtures that can be used to modify the properties of concrete, mortar, or grout in the plastic state, the hardened state or both.
2. Is aware of the changes that air entrainment can impart on fresh or hardened concrete.
3. Knows the advantages of using water-reducing admixtures in fluid concrete.
4. Understands the advantages and limitations of using chemical accelerators or calcium chloride (CaCl_2) to achieve increased compressive strength at an early age.

F. Reinforcement:

1. Knows why reinforcement is often used in concrete structures and components.
2. Is familiar with the typical grades (yield strengths) of steel reinforcements used in concrete construction.
3. Knows what type of steel reinforcement is typically specified if weldability is important.
4. Understands the inch-pound systems of sizing steel reinforcing bars.
5. Knows the various types of “specialty” reinforcing bars that may be specified to increase corrosion protection.

G. Properties of Concrete:

1. Can list the more common characteristics that can be used to discuss freshly mixed or hardened concrete.
2. Understand the range of factors that can influence the workability of a concrete mixture.
3. Knows how air entrainment affects the properties of a concrete mixture.
4. Is knowledgeable of the factors that define the durability of concrete and some of the deterioration mechanisms that can reduce the long-term durability of hardened concrete.

H. Placing and Finishing Concrete:

1. Knows the planning and communications actions recommended by the Portland Cement Association to assist in executing successful concrete projects.
2. Knows some of the potential problems that can be encountered when placing concrete on ground.
3. Is familiar with the range of moisture problems that can be encountered when placing slabs on ground.
4. Knows the considerations that should be addressed when using Self-Consolidating Concrete (SCC).
5. Is knowledgeable of the more-common tools and methods for the consolidation of fresh concrete.
6. Is familiar with the use of isolation joints, contraction joints, and construction joints that may be used or specified in concrete construction.
7. Can list some curing, protection, and formwork considerations addressed by the Portland Cement Association (PCA).

IV. Special Inspection Program.

- A. Has an overall knowledge of the Special Inspection Program as outlined in Chapters 2 and 17 of the *International Building Code*.

- B. Understands the difference between periodic and continuous inspections.
- C. Knows the specific cast-in-place inspection requirements of the International Building Code.
 - 1. Inspection of reinforcing steel and prestressing tendons.
 - 2. Inspection of bolts and anchors placed prior to concrete placement, during concrete placement, and in hardened concrete.
 - 3. Verifying use of required mix designs.
 - 4. Inspecting formwork for shape, locations, and dimensions.
 - 5. Providing specified quality control tests when sampled.
 - 6. Monitoring proper curing temperatures and techniques.
- D. Is aware of the purpose, the submission requirements, and the general content of a Statement of Special Inspections.
- E. Is aware of who the Special Inspectors must be employed by and who must approve their qualifications.
- F. Knows when Special Inspections are required.
- G. Knows what “Fabricated Items” are.
- H. Is aware of the reporting and notification requirements of the Special Inspection Program.