



WACEL

STUDY GUIDE

**Reinforced Concrete
Special Inspector
(Concrete II)**

October 2022

Reinforced Concrete Special Inspector

Examination: The Reinforced Concrete Special Inspector examination is based on the references cited in this document. For in-person testing, the exam is 3 hours in length, is an open-book examination, and contains 75 questions (multiple choice). Online testing is 3.5 hours for the exam. An overall grade of 75 percent or greater with a minimum of 70 percent on the “plan reading” questions is required for certification. All of the required references can be used as long as there are no added markings. “Background” references are for information and training purposes.

Successful certification as a WACEL Level I Concrete Technician, or an approved equivalent, is a prerequisite to taking this examination. While the Concrete I certification focused on an introduction to concrete as a construction material, as well as the common field quality control tests, Reinforced Concrete Special Inspector introduces a much more extensive range of related topics. These topics include:

- A review of topics addressed in Concrete I.
- Building code and standard specifications requirements for reinforced concrete.
- A comprehensive knowledge of reinforcing steel.
- An introduction to formwork.
- Numerous areas covering the placing, consolidation, and the curing of concrete to include cold and hot weather concrete operations.
- A working knowledge of the International Building Code’s Special Inspection Program.
- An understanding of the proper inspection and observation of post-installed anchors.

As previously mentioned, the examination is open book. Candidates should be highly familiar with the required references listed below. Required references must be brought to the examination site by the candidate. The background references are excellent tools to assist both instructors and exam candidates. However, the use of the printed, background references during the examination is not recommended due to the large number of required references. Required references brought into the examinations can have no marking.

In addition, a significant number of the examination questions are based on actual project drawings related to the scope of this certification. Candidates should be capable of quickly and correctly extracting pertinent project information from such documents as structural drawings, reinforcing steel placing drawings, formwork shop drawings, and embed drawings. Questions based on extracting pertinent inspection and observation standards from an ICC Evaluation Report for post-installed anchors will also be considered as “Plan Reading” questions.

The listed, required references and a basic calculator (i.e., no printing or programming capabilities) are the only items that can be brought into the examination. Writing instruments and scratch paper will be provided; both must be turned in at completion of the examination. Cell phones are not allowed in the examination area, and photo identification is required.

Required References:

1. Chapters 2 and 17, "International Building Code," International Code Council, 2018.
2. ACI 305R-20, "Guide to Hot Weather Concreting." (Chapter 1-7).
3. ACI 306R-16, "Guide to Cold Weather Concreting." (Chapters 1-4, 6-8. & 10).
4. ACI 309R-05, Consolidation of Concrete. (Chapters 1-4, 7, & 18).
5. Chapter 26, ACI 318-19, "Building Code Requirements for Structural Concrete."
6. ACI 347R-14, "Guide to Formwork for Concrete" (Chapters 1, 2, 3, & 5).
7. CRSI "Field Inspection of Reinforcing Bars," Second Edition (2019).
8. "Special Inspection Guidelines for Post-Installed Anchors," Concrete Anchor Manufacturers' Association (CAMA), 2011.
9. ASTM C31-15a, "Making and Curing Concrete Test Specimens in the Field."
10. ASTM C94-21b, "Standard Specifications for Ready-Mixed Concrete."
11. ASTM C138-17a, "Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete."
12. ASTM C143-20, "Slump of Hydraulic-Cement Concrete."
13. ASTM C172-17, "Sampling Freshly Mixed Concrete."
14. ASTM C173-16, "Air Content of Freshly Mixed Concrete by the Volumetric Method."
15. ASTM C231-17a, "Air Content of Freshly Mixed Concrete by the Pressure Method."
16. ASTM C1064-17, "Temperature of Freshly Mixed Hydraulic-Cement Concrete."
17. ESR-3187 "HILTI HIT_HY 200 Adhesive Anchors and Post Installed Reinforcing Bar Connections in Concrete," Reissued March 2022.

Background References:

1. ACI 301-16, "Specifications for Structural Concrete."
2. ACI 302.1R-15, "Guide for Concrete Floor and Slab Construction."
3. CRSI "Manual of Standard Practice," 29th Edition (2019).
4. "Concrete Manual," International Code. (2015 IBC & ACI 318-14).
5. "Concrete Inspection Handbook," Portland Cement Association, Fourth Edition, 2005.
6. "Design and Control of Concrete Mixtures," Portland Cement Association, Seventeenth Edition.

Learning Objectives:

- I. Knowledge of Concrete I ASTMs. Can determine some of the detailed test requirements addressed in basic ASTMs introduced as part of Concrete I.
- II. Understands the specific concrete requirements for structural concrete addressed in Chapter 26 of ACI 318.
 - A. Knows what constitutes a valid set of 6"x12" or 4"x8" cylinders for the purposes of strength testing.
 - B. Knows the minimum frequency of strength testing required to comply with ACI 318 to include when smaller quantities of a given concrete mixture are placed on a project.
 - C. Understands reasons for and criteria for a maximum coarse aggregate size in a concrete mix.
 - D. Understands the placement criteria and requirements of concrete.
 - E. Is highly familiar with the differences between and the purposes of standard-cured and field-cured cylinders.
 - F. Knows the ACI 318 curing requirements for freshly placed concrete.
 - G. Can use the compressive strength results of field-cured cylinders to determine the adequacy of concrete curing and protective measures.
 - H. Understands the differences between and how to apply equilibrium density and fresh density when inspecting lightweight concrete.
- III. Knowledge of ASTM C94, "Standard Specifications for Ready-Mixed Concrete" with a particular emphasis on those items impacting inspections and observations.
 - A. Know the components of batch water.
 - B. Is aware of the differences between fresh density and equilibrium density when testing lightweight concrete.
 - C. Can address the requirement of drum revolutions to include after any water is added when dealing with ready-mixed concrete.
 - D. Knows the acceptable slump tolerances if they are not defined in project specifications.
 - E. Understands the meaning of "batch-to-placement time" and "as-placed" concrete placement and how they are applied to concrete testing and observations.
 - F. Understands the importance of completely checking all batch tickets.
 - G. Knows the standard testing and sampling interval.

- IV. Knows and can apply the background and practices that apply during hot weather concreting as discussed in ACI 305R.
 - A. Know the definition of and the conditions that can lead to hot weather concreting.
 - B. Is familiar with the potential problems and related in working with fresh concrete when hot weather conditions are present.
 - C. Can discuss the effects of hot weather on concrete properties.
 - D. Knows the variability of the factors that can affect the ambient conditions that influence the placement of concrete.
 - E. Knows the general requirements that are associated with the placement and curing of concrete during hot weather.
 - F. Is familiar with the planning and preparations associated with a hot weather placement.
 - G. Is aware of unique hot weather considerations for the curing and protection of fresh concrete.
 - H. Is highly familiar with the testing and inspection topics presented in ACI 305R.

- V. Knows the recommended requirements and precautions that are to be taken during cold weather concrete operations as delineated in ACI 306R.
 - A. Knows the definition of when cold weather provisions are in effect.
 - B. Has knowledge of the general areas that must be considered to satisfy the intended concrete service recommendations during cold weather operations.
 - C. Understands what is the “protection period.”
 - D. Knows principals and objectives of cold weather concreting.
 - E. Can determine the minimum, as-placed concrete temperature depending on section size.
 - F. If appropriate, is aware of the temperature monitoring and recording actions.
 - G. Is aware of the actions and precautions to be taken if heated enclosures are used.
 - H. Knows the general guidelines for when cold weather protection can be minimized or terminated.

- VI. Knows the purposes, the techniques, and the cautions involved when monitoring the proper consolidation of fluid concrete (ACI 309R).
 - A. Knows the potential defects of under consolidation of concrete and that under consolidation is much more common than over consolidation.
 - B. Knows some of the indicators that proper consolidation has been accomplished.

- C. Is aware of the conditions that let the inspector know that increased attention must be paid to the consolidation of concrete.
- VII. Understands the basic principles of and can perform visual inspection of reinforcing steel placement as addressed in Chapter 26 of ACI 318 and the CRSI's "Field Inspection of Reinforcing Bars."
- A. Understands the differences between and the applicability of design drawings and placing drawings to determine the complete and proper installation of reinforcing steel.
 - B. Demonstrate an ability to extract dimensions, placement and material requirements from drawings and supporting tables and sections.
 - C. Have a working knowledge of the proper placement of reinforcing steel and welded wire fabric to include size, type, proper identification and placement tolerances, lap splices, cover, condition, and field bending.
 - D. Understands the specific reinforcing steel requirements for structural concrete addressed in Chapter 26 of ACI 318.
 - E. Can determine requirements for the proper installation of anchor rods and dowel bars in foundation elements.
 - 1. Can confirm the proper quantity, size, configuration, and relative alignments of anchor rods and dowel bars.
 - 2. Can confirm the required depth of embedment and the specified end conditions of anchor rods and dowel bars.
 - 3. Can verify the proper projection above the top of the foundation for anchor rods and dowel bars. (Anchor rod lengths allow for subsequent, proper connection if structural steel or precast elements. Dowel bar length allows for subsequent required lap splices for concrete or reinforced masonry construction).
 - 4. Knows that although anchor rods are considered structural steel component, their inspection is typically accomplished by reinforced concrete inspectors prior to the placement of concrete.
- VIII. Has knowledge of proper handling and placement of corrosion-protected rebar.
- A. Knows the currently authorized types of corrosion protected reinforcing steel.
 - B. Knows the purpose and intent of coated bars or mesh to include the need for compatible supports and wires and specialized storage and handling requirements.
 - C. Awareness of the need for and how damage occurs to the protective coating and how proper repairs are accomplished.
 - D. Is aware of the major specialized issues for corrosion-protected reinforcing that should be addressed in project specifications.

- IX. Knows the technical requirements and the inspection criteria for the proper monitoring of the installation of post-installed concrete anchors.
 - A. Can confirm that the type of post-installed anchor being used is approved by the structural engineer of record.
 - B. Ensures that manufacturer's printed installation instructions (MPII) are available and are being used.
 - C. Can confirm that drilled holes are correct with respect to drill bit type, diameter, depth, and cleanliness.
 - D. Can verify edge distance and spacing requirements of the anchor being used.
 - E. For adhesive anchors, understands expiration dates, mixing requirements, and temperature limitations.
 - F. Understands the criticality of the inspector having and using the ICC ESR for the anchor being installed.
 - G. Understands the "Post-Installed Special Inspection Guidelines" as established by the Concrete Anchor Manufacturers' Association (CAMA).

- X. Can inspect basic vertical and horizontal formwork (ACI 347R).
 - A. Demonstrate a knowledge of the basic criteria for suitable formwork construction to include inspection requirements.
 - B. Know the principles and criteria for early formwork removal to include reshoring.

- XI. Has an overall knowledge of the Special Inspection Program as outlined in Chapter 17 of the International Building Code to include the specific concrete construction inspection requirements.
 - A. Understands the difference between periodic and continuous inspections.
 - B. Knows the specific concrete construction inspection requirements of the International Building Code.
 - C. Is aware of the purpose, the submission requirements, and the general content of a Schedule of Special Inspections.
 - D. Is aware of who the Special Inspectors must be employed by and who must approve their qualifications.
 - E. Knows when Special Inspections are required.
 - F. Knows what "Fabricated Items" are.
 - G. Is aware of the reporting and notification requirements of the Special Inspection Program.

- XII. Can interpret reinforced concrete plans, specifications, shop drawings and details for materials, dimensions, sizes and locations.

Can extract pertinent inspection and observation standards from an ICC-ES Evaluation Report for post-installed concrete anchors. ESR-3187 will be used as a sample.