WACEL

Structural Concrete/ Masonry Inspector

Study Guide

July 2002

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Scope:

A technician who has been certified at both the WACEL Concrete Level I and Concrete Level II and who has attained the prerequisite experience is eligible for certification as a Structural Concrete/Masonry Inspector.

This is the highest level of certification in concrete and masonry sponsored by WACEL. It presupposes a relatively advanced knowledge of basic concrete and masonry construction. This basis of knowledge includes materials behavior, plan reading, formwork, reinforcing steel and testing.

Concrete I introduced the entry-level technician to the basics of concrete as a construction material. It also concentrated on the more common quality control tests that may be required.

Concrete II expanded this information with basic plan reading; proper placement of reinforcing-steel; concrete placement, consolidation, and curing; and basic structural masonry. More significantly, however, Concrete II starts to expose the technician to many of the publications that significantly contribute to their required knowledge as mid-level inspectors. These documents include applicable publications of the ASTM, ACI, NCMA, CRSI and the PCA. The careful integration of these industry standards with approved drawings and specifications was stressed.

Candidates for certification as Structural Concrete/Masonry Inspectors expands the previously acquired body of knowledge even further. A much broader understanding of concrete as a construction material is expected and a wider range of structural masonry topics are required. A knowledge of the BOCA ’96 and the IBC requirements for the inspection of structural masonry is also expected.

In addition, two specialty topics are introduced. They are post-tensioned concrete and tilt-up concrete construction. In both instances, inspection of these items should generally be limited to certified Structural Concrete/Masonry Inspectors. Industry publications from the PTI and the TCA are also introduced.

Building on a philosophy introduced as part of Concrete II certification, a much greater reliance is placed on a knowledge of and the proper use of industry- approved reference documents. Structural Concrete/Masonry 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.

Examination:

The Structural Concrete/Masonry Examination is based on the following references. It will be 3 hours in length and is an open-book examination. A grade of 80 percent or better is required for passing. A calculator is authorized.

All of the required references listed below can be used during the examination as long as they contain no marks, tabbing, or highlighting. The addition references are listed for the purpose of a more expanded background; their content is usually well addressed in the essential references.

No notes or working sheets may be removed from the examination area.

References:

Building Codes (required):

A. Chapter 17, "Structural Tests and Inspections", The BOCA National Building Code/1996.
B. Chapter 17, "Structural Tests and Special Inspections", 2000 International Building Code.

Advanced Concrete Topics (required):

A. "Design and Control of Concrete Mixtures", Portland Cement Association, 14th Edition, 2002.
B. "Concrete Inspection Handbook", Portland Cement Association, 2d Edition, 2000.
C. "Manual of Standard Practice", Concrete Reinforcing Steel Institute, MSP-1-01, March 2001.

Advanced Concrete Topics (additional):

A. ASTM C94, "Specifications for Ready Mixed Concrete".
B. ACI 305, "Hot Weather Concreting".
C. ACI 306, "Cold Weather Concreting".
D. ACI 308, "Standard Practice for Curing Concrete".
E. ACI 309, "Standard Practice for Consolidation of Concrete".
F. ACI 318, "Building Code Requirements for Structural Concrete".

Post-tensioning (required):

A. "Instructional Manual for Training and Certification of Field Personnel for Unbonded Post-Tensioning," Post-Tensioning Institute, April 1999
B. "Field Procedures Manual for Unbonded Single Strand Tendons," 3rd Edition, Post-Tensioning Institute, October 2000.

Post-tensioning (additional):

A. "Post-Tensioning Manual," Post-Tensioning Institute, 5th edition, 1990

B. "Specification for Unbonded Single Strand Tendons", Post-Tensioning Institute, July 1993.
C. "Field Procedures Manual for Unbonded Single Strand Tendons – Slide Lecture #5", Post-Tensioning Institute, 1989
D. ACI 423.3R, "Recommendations for Concrete Members Prestressed with Unbonded Tendons"

Advanced Structural Masonry (required):

A. ACI 530/ASCE 5/TMS 402, "Building Code Requirements for Masonry Structures".
B. ACI 530.1/ASCE 6/TMS 602, "Specifications for Masonry Structures".
C. Publication TR 156, "Inspection of Concrete Masonry Construction, National Concrete Masonry Association".
D. ASTM C 109, "Compressive Strength of Hydraulic Cement Mortar".
E. ASTM C 270, "Mortar for Unit Masonry".
F. ASTM C 780, "Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry".
G ASTM C 1019, "Sampling and Testing Grout".
H. ASTM C 1314, "Constructing and Testing Masonry Prism Used to Determine Compliance with Specified Compressive Strength of Masonry".

Advanced Structural Masonry (additional):

A. ASTM C 143, "Slump of Portland Cement Concrete".
B. ASTM C 67, Sampling and Testing Brick and Structural Clay Tile.
C. ASTM C 90, Load Bearing Concrete Masonry Units.
D. ASTM C 140, Sampling and Testing Concrete Masonry Units.
E. ASTM C 216, Standard Specifications for Facing Brick.
F. ASTM C 476, Standard Specifications for Grout for Masonry.
G. ASTM C 1064, "Temperature of Freshly Mixed Concrete".
H. Hot & Cold Weather Masonry Construction, Masonry Industry Council, January 1999.

Tilt-up Construction (required):

A. "Guideline Specifications for Section 03470 – Tilt-up Concrete", Tilt-up Concrete Association (TCA).

Tilt-up Construction (additional):

B. ACI 551-R, "Tilt-up Concrete Structures".

Learning Objectives: (see WACEL Skills Matrix for Concrete Inspectors).

I. Can perform post-tensioned concrete inspections.

   A. Understands the purposes of, the advantages of, and the more common uses of post-tensioned concrete.

B. Understands the general terms used in post-tensioning operations.
C. Is familiar with post-tensioning drawings, symbols, notes and abbreviations, and basic components.
D. Is able to extract the necessary information from the approved plans and shop drawings and subsequently fill out the post-tensioning forms correctly.
E. Knows how to inspect the proper placement of tendons and related accessories and reinforcing elements prior to the placement of concrete.
F. Understands the proper techniques of concrete placement, consolidation and curing as it relates to post-tensioning.
G. Is familiar with the dangers associated with stressing operations.
H. Is knowledgeable of how to properly monitor and document stressing operations.
I. Understands the need for turning in of complete and proper elongation reports in a timely fashion.
J. Is aware of common jobsite troubleshooting problems and corrective procedures.

II. Can inspect complex reinforced masonry above the basic level.
A. Knows the different types and designations of masonry mortar including differences between laboratory – designed mortar and field – mixed mortar.
B. Is familiar with the architectural and structural drawings and requirements that cover the specifics of structural masonry to include block/brick type bond pattern, reinforcing, control joints, weep holes and the like.
C. Demonstrates a knowledge of how to determine if the materials and components for structural masonry are in accordance with contract documents.
D. Has a detailed understanding of masonry placement requirements to include reinforcing steel and other embedded components, mortar thicknesses and tolerances, and requirements of grouting operations.
E. Knows the techniques and requirements for observing the proper proportioning of mortar and grout and for taking mortar cubes or cylinders, grout prisms and masonry prisms.
F. Understand the storage and handling differences among mortar cubes, grout prisms and masonry prisms.
G. Is familiar with the primary code and industry documents that influence the testing and inspection of structural masonry to include BOCA, IBC, ACI 530, ACI 530.1 and TR 156 (NCMA).

III. Can perform observations, inspections and testing for tilt-up concrete structures.

A. Using approved design drawings and approved shop drawings, can monitor tilt-up formwork for proper openings and dimensions within allowable tolerances.

B. Using approved design drawings for structural reinforcement and approved shop drawings for reinforcement needed for erection and lifting, can inspect all reinforcing steel, embedded items, and lifting hardware for proper size, placement, and positioning.

C. From approved construction documents, can determine the full range of tests and observations that must be accomplished for the concrete being used.

1. Approved mix design to include maximum water-cement ratio, air entrainment, authorized and/or prohibited admixtures, and limits on addition of job site water.
2. Testing parameters to include slump, unit weight, temperature, batch-to-placement time and air content.
3. Can determine the quantity and type of strength specimens (as well as curing environment) to be taken for both erection and acceptance.
4. Knows how to identify and resolve issues when testing requirements appear to be incomplete or inconsistent.

D. Monitors proper placement and consolidation of concrete as presented in ACI 309, "Standard Practice for Consolidation of Concrete".

E. Can properly monitor curing of tilt-up panels as required by project specifications, ACI 305, "Hot Weather Concreting"; ACI 306, "Cold Weather Concreting"; and ACI 308, "Standard Practice for Curing Concrete.

F. If required by contract specifications and/or building code requirements, ensure proper temporary bracing is installed and maintained as depicted in approved shop drawings. Monitors and documents compliance with approved removal criteria.

IV. Understands Advance Topics for Concrete as a Construction Material.

A. Understands the advantages of low water-cement ratios for a concrete mix.

B. Knows what is meant by the workability of concrete and is familiar with the various factors that can influence it.

C. Is familiar with how concrete gains strength (hydration) and the curing conditions that can impact strength gain.

D. Knows the fundamentals of the following characteristics of concrete to include the factors that influence each of them:

1. Density.
2. Permeability and water-tightness.
3. Abrasion resistance.
4. Volume stability and crack control.
5. Freeze-thaw resistance.
6. Alkali-silica reactivity (ASR).
7. Chloride resistance and steel corrosion.
8. Chemical resistance.

E. Understands the various strength tests that can be accomplished or hardened concrete (compressive strength, flexural strength, direct tensile strength, splitting tensile strength, and shear strength) and their relationships.

F. Has a basic understanding of the mineral components of Portland Cement and how Portland Cement is manufactured.

G. Knows the different types of Portland Cement (types I, IA, II, IIA, III, IIIA, IV and V) and has a basic understanding of the characteristics of each.

H. Has a working knowledge of blended hydraulic cements, modified portland cements, and special cements.

I. Can discuss the basic physical properties of cement to include particle size and fineness, setting time, early stiffening, and compressive strength.

J. Can discuss the sources, properties, and advantages/disadvantages of mineral admixtures or "supplementary cementitious materials" such as fly ash; ground granulated blast furnace slab (GGBFS), silica fume and natural pozzolans..

K. Is familiar with the various types and sources of aggregates for concrete and a general description of acceptability.

L. Is knowledgeable of the basic characteristics of aggregates for concrete including grading, partical shape and surface texture.

M. Knows the general effects of air entrainment on concrete properties with particular emphasis on freez-thaw resistance, deicer-scaling resistance, compressive and flexural strength, absorption and permeability, bleeding, sulfate resistance, workability, and finishability.

N. Understands the more-common factors that can affect air content including cement content, coarse and fire aggregate, mixing water and slump, vibration, concrete temperature, supplementary cementitious materials, admixtures and mixing action.

O. Knows the types of tests that are available to measure the air content of a concrete mixtures as well as the advantages and limitations of each.

P. Can discuss the general categories and properties of chemical admixtures that can be added to a concrete mix.

Q. Understands the basic concepts for the batching, mixing, transportation, and handling of concrete with particular emphasis on the requirements of ASTM C 94, “Specifications for Ready-mixed Concrete”.

R. Understands the generally accepted practices governing the proper placement of concrete in various situations as presented by the American Concrete Institute (ACI) and the Portland Cement Association (PCA)..

S. Knows all aspects of the consolidation of concrete by vibration to include how it works, types of vibrators, techniques for the proper use of vibrators, consequences of improper vibration, and indications of adequate vibration.

T. Has a detailed knowledge of how to properly cure concrete.

U. Is familiar with the precautions and techniques of both hot-weather and cold-weather concreting.

V. Can discuss the various destructive and non-destructive control tests to determine the quality and durability of concrete. Such tests are in addition to those required of a Concrete I Technician.

W. Is familiar with the characteristics of special types of concrete with particular emphasis on lightweight concrete, no-slump concrete, high-density concrete, and shotcrete.