

## CHAPTER 7 CAST-IN-PLACE CONCRETE

### SICC-701 GENERAL

**SICC-701.1 Scope.** The requirements of this chapter and NCSBC-1704.4 shall apply when construction includes cast-in-place concrete as listed in SICCC-302.3.

### SICC-702 FABRICATION AND ERECTION DOCUMENTS

**SICC -702.1 Review and approval.** The cast-in-place concrete fabrication and erection documents, including concrete mix designs, shall be submitted for review and approval to the **SER** prior to concrete construction and/or formwork erection, as appropriate. The **GC** shall provide **SER**-approved fabrication and erection documents for use by the **SIER** to conduct special inspections during construction.

**SICC-702.2 SER review and approval.** Each fabrication and erection document shall bear the review and approval stamp of the **SER** and be properly signed and dated. Prior to concrete construction and/or formwork erection, as appropriate, the fabrication and erection documents listed below shall be reviewed and approved by the **SER**:

- Non-prestressed mild steel reinforcement.
- Prestressing steel to be post-tensioned.
- Concrete mix designs, including any accelerators or other admixtures, for each class of concrete to be used.

### SICC-703 INSPECTIONS

**SICC-703.1 Special inspections.** The **SIER** shall perform special inspections in accordance with this chapter, NCSBC-1704.4 and NCSBC-Table 1704.4. NCSBC -Table 1704.4 Item 2, *Reinforcing steel welding* requires continuous or periodic inspection, depending upon the use of the reinforcing steel. (see SICCC-604.2 and NCSBC -Table 1704.3 Item 5b).

**NCSBC-1704.4.1 Materials.** In the absence of sufficient data or documentation providing evidence of conformance to quality standards for materials in Chapter 3 of ACI 318, the building official shall require testing of materials in accordance with the appropriate standards and criteria for the material in Chapter 3 of ACI 318. Weldability of reinforcement, except that which conforms to ASTM A 706, shall be determined in accordance with the requirements of Section 1903.5.2.

**NCSBC-TABLE 1704.4**  
**REQUIRED VERIFICATION AND INSPECTION OF CONCRETE CONSTRUCTION**

VERIFICATION AND INSPECTION	CONTINUOUS	PERIODIC	REFERENCED STANDARD <sup>a</sup>	NCSBC REFERENCE
1. Inspection of reinforcing steel, including prestressing tendons, and placement.	—	X	ACI 318: 3.5, 7.1-7.7	1903.5, 1907.1,1907.7 1914.4
2. Inspection of reinforcing steel welding in accordance with Table 1704.3, Item 5B.	—	—	AWS D1.4 ACI 318: 3.5.2	1903.5.2
3. Inspect bolts to be installed in concrete prior to and during placement of concrete where allowable loads have been increased.	X	—	—	1912.5
4. Verifying use of required design mix.	—	X	ACI 318: Ch. 4, 5.2-5.4	1904, 1905.2-1905.4 1914.2,1914.3
5. Sampling fresh concrete and performing slump, air content and determining the temperature of fresh concrete at the time of making specimens for strength tests.	X	—	ASTM C 172 ASTM C 31 ACI 318: 5.6, 5.8	1905.6, 1914.10
6. Inspection of concrete and shotcrete placement for proper application techniques.	X	—	ACI 318: 5.9, 5.10	1905.9, 1905.10, 1914.6,1914.7 1914.8
7. Inspection for maintenance of specified curing temperature and techniques.	—	X	ACI 318: 5.11-5.13	1905.11, 1905.13, 1914.9
8. Inspection of prestressed concrete:				
a. Application of prestressing forces.	X	—	ACI 318: 18.20	—
b. Grouting of bonded prestressing tendons in the seismic-force-resisting system.	X	—	ACI 318: 18.18.4	
9. Erection of precast concrete members.	—	X	ACI 318: Ch. 16	—
10. Verification of in-situ concrete strength, prior to stressing of tendons in post tensioned concrete and prior to removal of shores and forms from beams and structural slabs.	—	X	ACI 318: 6.2	1906.2

a. Where applicable, see also Section 1707.1, Special inspection for seismic resistance.

### SICC-703.2 Particular Elements.

**a. Concrete formwork.** The **SIER** shall verify that the formwork materials, cleanliness, size, and installation conform to approved formwork fabrication and erection documents, prior to placement of concrete.

**b. Reinforcing steel.** The **SIER** shall verify that reinforcing steel is in compliance with County approved construction documents and SER approved fabrication and erection documents, including welding of reinforcement of the structural seismic-force-resisting system.

**c. Tendons to be post-tensioned.** The **SIER** shall verify that tendons to be post-tensioned are in compliance with County approved construction documents and SER approved fabrication and erection documents, including full-time monitoring of grouting, consolidation and reconsolidation of bonded

prestressing tendons. Inspections shall include tendon size and strength, chair height, tendon profile, tendon snaking elimination, horizontal ties between chairs and condition of sheathing.

**d. Stressing of tendons.** The **SIER** shall verify that tendon stressing operations are in compliance with project specifications. Stressing of tendons shall not start before the specified minimum strength of field-cured test cylinders has been achieved and verified by the **SIER** and approved by the **SER**. Continuous monitoring of stressing of tendons is required. Elongation records shall be made and checked against project specifications. Tendon failures or tendon elongations not in compliance with project specifications shall be rejected and the **SER** shall make recommendations in writing for remedial actions.

**e. Concrete.** The **SIER** shall verify use of proper concrete design mix, monitor placement of concrete, and perform inspections and testing listed in NCSBC-Table 1704.4. Continuous monitoring shall be required at the point of discharge from trucks / batch plant, and at the point of deposit / consolidation of concrete. Verify that water added at the site does not exceed that allowed by the mix design.

**f. Weldability of reinforcement.** If steel reinforcement other than ASTM A 706 is to be welded, the **SIER** shall verify that the weldability of the reinforcement has been determined in accordance with NCSBC -1903.5.2.

**g. Welding of reinforcement.** Special inspection of welding of reinforcement is required in accordance with **both** NCSBC -Table 1704.4 Item 2 **and** NCSBC -Table 1704.3 Item 5B. Continuous monitoring of welding of reinforcing steel shall be provided where required by NCSBC -Table 1704.3 Item 5B.

## SICC-704 TESTING

**Concrete shall be tested in accordance with NCSBC-1905.6 and this section.**

**NCSBC-1905.6 Evaluation and acceptance of concrete.** The criteria for evaluation and acceptance of concrete shall be as specified in Sections 1905.6.2 through 1905.6.5.5.

**NCSBC-1905.6.1 Qualified technicians.** Concrete shall be tested in accordance with the requirements in Sections 1905.6.2 through 1905.6.5. Qualified field testing technicians shall perform tests on fresh concrete at the job site, prepare specimens required for curing under field conditions, prepare specimens required for testing in the laboratory, and record the temperature of the fresh concrete when preparing specimens for strength tests. Qualified laboratory technicians shall perform all required laboratory tests.

**NCSBC-1905.6.2 Frequency of testing.** The frequency of conducting strength tests of concrete shall be as specified in Sections 1905.6.2.1 through 1905.6.2.4.

**NCSBC-1905.6.2.1 Minimum frequency.** Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 150 cubic yards (115 m<sup>3</sup>) of concrete, nor less than once for each 5,000 square feet (465 m<sup>2</sup>) of surface area for slabs or walls.

**NCSBC-1905.6.2.2 Minimum number.** On a given project, if the total volume of concrete is such that the frequency of testing required by Section 1905.6.2.1 would provide less than five strength tests for a given class of concrete, tests shall be made from at least five randomly selected batches or from each batch if fewer than five batches are used.

**NCSBC-1905.6.2.3 Small volume.** When the total volume of a given class of concrete is less than 50 cubic yards (38 m<sup>3</sup>), strength tests are not required when evidence of satisfactory strength is

submitted to and approved by the building official.

**NCSBC-1905.6.2.4 Strength test.** A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at the test age designated for the determination of  $f'_c$ .

**NCSBC-1905.6.3 Laboratory-cured specimens.** Laboratory-cured specimens shall comply with the provisions of Sections 1905.6.3.1 through 1905.6.3.4.

**NCSBC-1905.6.3.1 Sampling.** Samples for strength tests shall be taken in accordance with ASTM C 172.

**NCSBC-1905.6.3.2 Cylinders.** Cylinders for strength tests shall be molded and laboratory cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39.

**NCSBC-1905.6.3.3 Acceptance of results.** The strength level of an individual class of concrete shall be considered satisfactory if both of the following requirements are met:

1. Every arithmetic average of any three consecutive strength tests equals or exceeds  $f'_c$ .
2. No individual strength test (average of two cylinders) falls below  $f'_c$  by more than 500 psi (3.45 MPa).

**NCSBC-1905.6.3.4 Correction.** If either of the requirements of Section 1905.6.3.3 are not met, steps shall be taken to increase the average of subsequent strength test results. The requirements of Section 1905.6.5 shall be observed if the requirement of Section 1905.6.3.3, Item 2 is not met.

**NCSBC-1905.6.4 Field-cured specimens.** Field-cured specimens shall comply with the provisions of Sections 1905.6.4.1 through 1905.6.4.4.

**NCSBC-1905.6.4.1 When required.** Where required by the building official, the results of strength tests of cylinders cured under field conditions shall be provided.

**NCSBC-1905.6.4.2 Curing.** Field-cured cylinders shall be cured under field conditions in accordance with ASTM C 31.

**NCSBC-1905.6.4.3 Sampling.** Field-cured test cylinders shall be molded at the same time and from the same samples as laboratory-cured test cylinders.

**NCSBC-1905.6.4.4 Correction.** Procedures for protecting and curing concrete shall be improved when the strength of field-cured cylinders at the test age designated for determination of  $f'_c$  is less than 85 percent of that of companion laboratory-cured cylinders. The 85 percent limitation shall not apply if the field-cured strength exceeds  $f'_c$  by more than 500 psi (3.45 MPa).

**NCSBC-1905.6.5 Low-strength test results.** The investigation of low-strength test results shall be in accordance with the provisions of Sections 1905.6.5.1 through 1905.6.5.5.

**NCSBC-1905.6.5.1 Precaution.** If any strength test (see Section 1905.6.2.4) of laboratory-cured cylinders falls below the specified value of  $f'_c$  by more than 500 psi (3.45 MPa) (see Section 1905.6.3.3, Item 2), or if tests of field-cured cylinders indicate deficiencies in protection and curing (see Section 1905.6.4.4), steps shall be taken to assure that the load-carrying capacity of the structure is not jeopardized.

**NCSBC-1905.6.5.2 Core tests.** If the likelihood of low-strength concrete is confirmed and calculations indicate that load-carrying capacity is significantly reduced, tests of cores drilled from

the area in question in accordance with ASTM C 42 is permitted. In such cases, three cores shall be taken for each strength test more than 500 psi (3.45 MPa) below the specified value of  $f'_c$ .

**NCSBC-1905.6.5.3 Condition of cores.** If concrete in the structure will be dry under service conditions, cores shall be air dried at temperatures between 60°F (16°C) and 80°F (27°C) and relative humidity less than 60 percent for seven days before testing and shall be tested dry. If concrete in the structure will be more than superficially wet under service conditions, cores shall be immersed in water for at least 40 hours and be tested wet.

**NCSBC-1905.6.5.4 Test results.** Concrete in an area represented by core test shall be considered structurally adequate if the average of three cores is equal to at least 85 percent of  $f'_c$  and if no single core is less than 75 percent of  $f'_c$ . Additional testing of cores extracted from locations represented by erratic core strength results is permitted.

**NCSBC-1905.6.5.5 Strength evaluation.** If the criteria of Section 1905.6.5.4 are not met and if the structural adequacy remains in doubt, the building official is permitted to order a strength evaluation in accordance with ACI 318, Chapter 20, for the questionable portion of the structure, take other appropriate action.

**SICC-704.1 Testing required.** Material tests for concrete properties and strength, for determining the compressive strength of concrete, prior to removal of concrete formwork and shoring, reshoring, stressing post-tensioning tendons, loading of vertical building elements, erection of structural steel, and for verifying adequacy of concrete protection and curing methods during cold weather, shall comply with the following:

**a. Frequency of testing.** Samples for strength tests of each class (concrete mix design) shall be taken in accordance with NCSBC-1905.6.2. Concrete samples for test cylinders shall be taken in accordance with ASTM C 172. Additional test cylinders for strength tests shall be cast if required by the **AR**, **SER**, or County approved documents. Additional cylinders to be field-cured shall be required to evaluate strengths of concrete prior to removal of shores and concrete formwork, prior to stressing of post-tensioning tendons, loading of vertical building elements, erection of structural steel, and adequacy of concrete curing and protection methods during cold weather concreting conditions.

**b. Laboratory-cured cylinders.** Cylinders for strength tests shall comply with this section and NCSBC-1905.6.3. Cylinders for strength tests shall be cast, stored, transported and laboratory-cured in accordance with ASTM C 31. Tests shall be in accordance with ASTM C 39.

**c. Field-cured cylinders.** Field-cured cylinders, to evaluate strengths of concrete prior to removal of concrete formwork and shoring, reshoring, prior to stressing post-tensioning tendons, and to determine adequacy of curing and protection of concrete during cold weather, shall comply with this section and NCSBC-1905.6.4. Field-cured cylinders shall be cured as closely as possible to the location of placement of the concrete pour they represent, and be exposed as nearly as possible to the same temperature and moisture environment, in accordance with ACI 318 and ASTM C 31. Tests shall be in accordance with ASTM C 39.

Cylinders may be fabricated on the ground or on the slab, and moved to the curing location no more than 30 minutes after fabrication. If fabricated on the ground, cylinders shall be placed in a temporary open storage location, protected by no more than insulated blankets, remain undisturbed for a minimum of 16 hours but no more than 24 hours after molding, and then be relocated into or on the structure as closely as is practicable to the concrete they represent. If molded on the slab, cylinders shall be placed into or on the structure as closely as is practicable to the concrete they represent immediately after molding.

Equivalency may be achieved by storing uncapped cylinders on or immediately adjacent to the structural concrete placement as soon as practical after casting (and until six hours or less prior to testing), and

subjecting them to the same temperature and moisture loss controls as the structure itself. Test cylinders shall be protected from cold weather and cured in the same manner as the concrete they represent. Under no circumstances shall field-cured cylinders be subjected to a curing environment that is better than the concrete they represent, such as placement within a temperature and/or humidity controlled container.

**SICC-704.2 Low-strength concrete test results.** Investigation of low-strength concrete shall be in accordance with NCSBC-1905.6.5 and this section. The following procedures shall apply when test results do not comply with the acceptance criteria of ACI 318 for concrete strength.

**a. Submittal of data and recommendations to CCBSD.** The **SIER** shall submit to **CCBSD** a copy of any records pertaining to under-strength concrete, with written recommendations of the **SER**.

### **SICC-705 COMPLETION OF CAST-IN-PLACE CONCRETE CONSTRUCTION**

Upon completion of cast-in-place concrete construction, the **SIER** shall submit a completion letter to **CCBSD**. The **SIER** shall also indicate the date of completion on the final report of special inspections for all cast in place concrete.

## Cast-in-Place Concrete (CASE Guidelines)

Item	Scope
1. Mix Design	<i>Review concrete batch tickets and verify compliance with approved mix design. Verify that water added at the site does not exceed that allowed by the mix design.</i>
2. Material Certification	
3. Reinforcement Installation	<i>Inspect size, spacing, cover, positioning and grade of reinforcing steel. Verify that reinforcing bars are free of form oil or other deleterious materials. Inspect bar laps and mechanical splices. Verify that bars are adequately tied and supported on chairs or bolsters</i>
4. Post-Tensioning Operations	<i>Inspect placement, stressing, grouting and protection of post-tensioning tendons. Verify that tendons are correctly positioned, supported, tied and wrapped. Record tendon elongations.</i>
5. Welding of Reinforcing	<i>Visually inspect all reinforcing steel welds. Verify weldability of reinforcing steel. Inspect preheating of steel when required.</i>
6. Anchor Rods	<i>Inspect size, positioning and embedment of anchor rods. Inspect concrete placement and consolidation around anchors.</i>
7. Concrete Placement	<i>Inspect placement of concrete. Verify that concrete conveyance and depositing avoids segregation or contamination. Verify that concrete is properly consolidated.</i>
8. Sampling and Testing of Concrete	<i>Test concrete compressive strength (ASTM C31 &amp; C39), slump (ASTM C143), air-content (ASTM C231 or C173) and temperature (ASTM C1064).</i>
9. Curing and Protection	<i>Inspect curing, cold weather protection and hot weather protection procedures.</i>
10. Other:	

### COLD WEATHER CONCRETE SLAB TEMPERATURE LOG

PLACEMENT DATE:		PROJECT _____ PERMIT # _____						
		DESCRIPTION OF POUR _____						
FINISH TIME:		Station #1	Station #2	Station #3	Station #4	Air Temp Und Slab	Ambient Air Temp	Remarks
DAY 1	12 am							
	4 am							
	8 am							
	12 pm							
	4 pm							
	8 pm							
DAY 2	12 am							
	4 am							
	8 am							
	12 pm							
	4 pm							
	8 pm							
DAY 3	12 am							
	4 am							
	8 am							
	12 pm							
	4 pm							
	8 pm							
DAY 4	12 am							
	4 am							
	8 am							
	12 pm							
	4 pm							
	8 pm							
<p>1) Maintain data for 72 hours after finish of placement.                  2) Number of temperature monitoring stations may be increased as needed.                  3) Stations shall be located near the outer edges.</p>								