Arizona Residential Post-Tensioned Round Table
March 2007

Recommendations for Standards of Construction and Design #1

SPECIAL INSPECTION

The requirements for special inspection of concrete construction are provided in International Building Code 2003, Section 1704.4. Table 1704.4 lists 10 different inspection items for concrete construction. Six of the items (Numbers 1, 4, 5, 6, 8, and 10) could be applied to post-tensioned slabs on ground. The Arizona Residential Post-Tensioned Round Table makes the following recommendations for special inspection of residential post-tensioned slabs-on-ground.

1. Inspection of reinforcing steel, including pre-stressing tendons and placement shall occur prior to slab pour.

4. Verifying use of required design mix shall occur periodically.

5. At the time fresh concrete is sampled to fabricate specimens for strength tests, perform slump tests, and determine the temperature of the concrete.

6. Inspection of concrete placement for proper application and techniques shall occur for the full duration of concrete placement.

8. Verification of pre-stressing forces shall occur at the time of pre-stress application.

10. Prior to stressing of tendons in post-tensioned concrete, periodic verification of in-situ strength shall be performed per ACI 228.

The recommendations listed above satisfy the intent of the code.

Please see Appendix A, Recommendations for Standards of Construction and Design #1 for table 1704.4

1704.3.3.3 Continuous monitoring. Monitoring of bolt installation for pretensioning using the calibrated wrench method or the turn-of-nut method without matchmarking shall be performed on a continuous basis.

1704.4 Concrete construction. The special inspections and verifications for concrete construction shall be as required by this section and Table 1704.4.

Exception: Special inspections shall not be required for:

1. Isolated spread concrete footings of buildings three stories or less in height that are fully supported on earth or rock.
2. Continuous concrete footings supporting walls of buildings three stories or less in height that are fully supported on earth or rock where:
   2.1. The footings support walls of light frame construction;
   2.2. The footings are designed in accordance with Table 1805.4.2; or
   2.3. The structural design is based on a f'_c no greater than 2,500 pounds per square inch (psi) (17.2 Mpa).
3. Nonstructural concrete slabs supported directly on the ground, including prestressed slabs on grade, where the effective prestress in the concrete is less than 150 psi (1.03 Mpa).
4. Concrete foundation walls constructed in accordance with Table 1805.5(1), 1805.5(2), 1805.5(3) or 1805.5(4).
5. Concrete patios, driveways and sidewalks, on grade.

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.

TABLE 1704.4
REQUIRED VERIFICATION AND INSPECTION OF CONCRETE CONSTRUCTION

VERIFICATION AND INSPECTION	CONTINUOUS	PERIODIC	REFERENCED STANDARD[a]	IBC 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. At the time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	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. b. Grouting of bonded prestressing tendons in the seismic-force-resisting system.	 X X	—	 ACI 318: 18.20 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 posttensioned concrete and prior to removal of shores and forms from beams and structural slabs.	—	X	ACI 318: 6.2	1906.2

For SI: 1 inch = 25.4 mm.

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

Arizona Residential Post-Tensioned Round Table
March 2007

Recommendations for Standards of Construction and Design #2

EVALUATION AND ACCEPTANCE OF CONCRETE

The requirements for evaluation and acceptance of concrete are provided in Section 1905.6 of the 2003 International Building Code (IBC). There are no exceptions to these provisions. The Phoenix Post-Tensioned Round Table makes the following recommendations for evaluation and acceptance of concrete for residential post-tensioned slabs on ground.

Because of the large variations in slab thickness, slab size and scheduling of pours, the Arizona Residential Post-Tensioned Round Table recommends that cylinders be taken on every lot. This would satisfy the intent of the code and provide consistent documentation for the structural engineers and building officials.

It is recommended that a minimum of four cylinders be cast as a strength sampling for each lot. One cylinder for early strength testing, two cylinders to verify *f'c* (1905.2.4), and the fourth cylinder for a 56-day strength break if required.

Please see Appendix A, Recommendations for Standards of Construction and Design #2 for further information.

Code Reference: IBC 2003 Section 1905.6.2 Frequency of Testing

The frequency of conducting strength tests of concrete shall be as specified in Section 1905.6.2.1 through 1905.6.2.4

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 of concrete, nor less than once for each 5000 square feet of surface area for slabs or walls.

1905.6.2.2Minimum 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.

1905.2.3 Small Volume

When the total volume of a given class of concrete is less than 50 cubic yards strength tests are not required when evidence of satisfactory strength is submitted to and approved by the building official.

1905.2.4 Strength Test

A strength test shall be the average of the strength 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.*

The parameters stated in 1905.6.2.1 are very specific. We have observed that PT slabs vary in thickness from 6" to 10". For an average 1800 square foot house the concrete yardage could vary from 34 cubic yards for a 6" thick slab to 56 cubic yards for a 10" thick slab. In the larger home communities with an average 2500 square foot house, the range could be between 46-78 cubic yards. It is not uncommon to see houses on the same tract with different slab thicknesses as well as large variations in square footage. There are larger slabs that require over 120 cubic yards of concrete due to size and thickness.

The requirement states in 1905.6.2.1 that cylinders must be taken at least once a day, or every 150 yards or every 5000 square feet. Collecting all of the information to meet these three criteria with the wide variety of design specifications, variety of sizes of slabs in a given subdivision and the imprecise nature of pour schedules creates considerable tracking issues. It is the position of the Arizona Residential Post-Tension Round Table that cylinders are taken on every lot. This procedure ensures that a record of concrete strength is provided for each post-tensioned slab and satisfies the intent of the code.

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December 8, 2005

Mr. Brian Juedes, P.E., S.E., Architect
Felten Group, Inc.
3602 East Greenway Road
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Phoenix, AZ 85032

RE: Sections 101.2, 1704.1, 1704.4, 1905.1 and 1905.6 of the ICC International Building Code/2003

Dear Mr. Juedes:

On December 6, 2005 we received your fax transmittal of December 5th concerning special inspections along with the evaluation and acceptance criteria for concrete construction. Our answers to your letter are contained herein and are based on the above referenced code sections.

We understand your situation involves a residential reinforced concrete slab-on-grade that has been designed and post-tensioned for the expansive soils located below the building. You are specifically asking whether special inspections are required for this concrete construction. The answer is Yes.

Special inspections are required by the code for those large complex projects involving structural materials with highly detailed critical connections. The adequacy of structural members, materials and components along with the construction work needed to assemble those items must be carefully inspected to verify compliance with not only the building code but also its referenced standards. Exception No. 3 of Section 1704.4 exempts special inspections for nonstructural concrete slabs poured directly onto grade such as driveways, patios, basement slabs, floor slabs, etc. since the uniformly distributed live loads are transferred directly into the underlying soils. In your specific situation, a post-tensioned concrete floor slab designed and constructed to resist the uplift forces of expansive soils is no longer a nonstructural component and must be specially inspected.

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You have also asked whether concrete construction is still subject to the evaluation and acceptance criteria of Section 1905.6 even if it is exempt from the special inspection requirements of Section 1704.4. The answer is Yes. The provisions of Section 1905 provide methods for testing concrete and criteria for its evaluation and acceptance based on strength requirements. There are no exceptions to these provisions listed directly in Section 1905.6.

As an important side note, both your letter and recent phone conversation with our Mr. Allan Bilka indicated this slab was for a residential project. Please keep in mind that all detached single-family houses, detached simple duplexes and townhouses are required to be regulated and constructed in accordance with the ICC International Residential Code.

We hope this answers your letter in full. If you have any further questions, please call. These opinions are based on the information which you have provided. We have made no independent effort to verify the accuracy of your submitted information nor have we conducted a review beyond the scope of your questions. As this interpretation is only advisory, please consult with the authority having jurisdiction, the building official.

Very truly yours,

Gary L. Nelson, P.E.
Senior Staff Engineer

cc: Mr. Allan Bilka - ICC Chicago District Office

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March 27, 2006

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RE: Table 1704.4 of the 2003 International Building Code

Dear Mr. Juedes:

This letter is in response to your letter, dated February 9, 2006, faxed to this office.

Your question was: Table 1704.4 Item 5 indicates "continuous inspection" at the time fresh concrete is sampled..." does this mean the Special Inspector need only be on site when the concrete is sampled or should the Special Inspector be on site for the full duration of the concrete pour?

My answer is that the column under "continuous" is indicated here because test samples are to be taken at periodic points throughout the placement of the concrete. Therefore, an inspector must be available continuously to verify that this is being done. Please note that there are other inspections that will also require continuous presence during a concrete lift.

This opinion is based on the information which you have provided. We have made no independent effort to verify the accuracy of your submitted information nor have we conducted a review beyond the scope of your question. As this interpretation is only advisory, please consult with the authority having jurisdiction, the code official.

I hope this letter assists you. If you have any questions or comments, please do not hesitate to contact me.

Very truly yours,

David A. Bowman
Manager, Code Development

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