Delaware Valley Association of Structural Engineers Seminar

Inspection Requirements For Anchors in Concrete in Accordance With ACI 318-11 and the 2012 IBC

January 14, 2015

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Director of Codes and Standards for Hilti North America

Topics
• Special inspection
• 2009/2012 IBC inspection requirements
• ACI 318-11 inspection requirements
• Proof-loading
• Certified adhesive anchor installers
• ICC-ES supplemental inspection requirements
• General Notes sheet/specifications
• Q&A
Topics

• Special inspection
  • 2009/2012 IBC inspection requirements
  • ACI 318-11 inspection requirements
  • Proof-loading
  • Certified adhesive anchor installers
  • ICC-ES supplemental inspection requirements
  • General Notes sheet/specifications
  • Q&A

What is special inspection?

1. It is NOT structural observation

**STRUCTURAL OBSERVATION.** The visual observation of the structural system by a registered design professional for general conformance to the approved construction documents. Structural observation does not include or waive the responsibility for the inspection required by Section 110, 1704 or other sections of this code.

2009 IBC
What is special inspection?

2. It is defined in the code.

SPECIAL INSPECTION. Inspection as herein required of the materials, installation, fabrication, erection or placement of components and connections requiring special expertise to ensure compliance with approved construction documents and referenced standards (see Section 1704).

2009 IBC

What is special inspection?

2. It is defined in the code.

SECTION 1704
SPECIAL INSPECTIONS

1704.1 General. Where application is made for construction as described in this section, the owner or the registered design professional in responsible charge acting as the owner’s agent shall employ one or more approved agencies to perform inspections during construction on the types of work listed under Section 1704. These inspections are in addition to the inspections identified in Section 110.

The special inspector shall be a qualified person who shall demonstrate competence, to the satisfaction of the building official, for the inspection of the particular type of construction or operation requiring special inspection.

2009 IBC
What is special inspection?

4. It can only be performed by a approved inspector NOT employed or retained by the contractor.

1703.1.1 Independence. An approved agency shall be objective, competent and independent from the contractor responsible for the work being inspected. The agency shall also disclose possible conflicts of interest so that objectivity can be confirmed.

2009 IBC

Continuous or periodic?

SPECIAL INSPECTION, CONTINUOUS. The full-time observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed.

SPECIAL INSPECTION, PERIODIC. The part-time or intermittent observation of work requiring special inspection by an approved special inspector who is present in the area where the work has been or is being performed and at the completion of the work.

2009 IBC

Continuous inspection is often viewed as uninterrupted observation of the work in progress.
Continuous or periodic?

SPECIAL INSPECTION. Inspection of construction requiring the expertise of an approved special inspector in order to ensure compliance with this code and the approved construction documents.

Continuous special inspection. Special inspection by the special inspector who is present when and where the work to be inspected is being performed.

Periodic special inspection. Special inspection by the special inspector who is intermittently present where the work to be inspected has been or is being performed.

2012 IBC

The definitions changed materially in the 2012 IBC.

Where is it called out?

The submission of a special inspection schedule is a mandatory part of the permit process.
Where is it called out?

The submission of a special inspection schedule is a part of the permit process.

Special inspection forms

Jurisdictions develop their own requirements for how this information is to be submitted.
Special inspection forms

Jurisdictions develop their own requirements for how this information is to be submitted.

| Jurisdiction | Requirements | Concrete | Steel | Wood | Other | Periodic
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>City of Richmond</td>
<td>Field inspection prior to and during pouring</td>
<td>x</td>
<td>1046</td>
<td>A1101</td>
<td>5055.14</td>
<td></td>
</tr>
<tr>
<td>City of Philadelphia</td>
<td>Field inspection prior to and during pouring</td>
<td>x</td>
<td>1046</td>
<td>A1101</td>
<td>5055.14</td>
<td></td>
</tr>
</tbody>
</table>

excerpted from City of Richmond, Schedule of Chapter 17 Inspections

www.hilti.com

Special inspection forms

Jurisdictions develop their own requirements for how this information is to be submitted.

<table>
<thead>
<tr>
<th>Verification and Inspection Item</th>
<th>Required</th>
<th>Continuous</th>
<th>Periodic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fabrication of structural load-bearing members and assemblies (1746.3)</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Fabrication of Pre-Cast Concrete (1996.5.1)</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Fabrication process of prefabricated wood structural elements and assemblies (1746.6 and 2999)</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Steel</td>
<td>Welding</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>(1746.3, and Table 1746.3)</td>
<td>Dyeing</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Wild Fire Materials</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Steel Frame Joint Details</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>High Strength Bolts, Nuts, and Washers</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Reinforcing Steel</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Concrete</td>
<td>Reinforcing Steel</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>(1746.4, and Table 1746.4)</td>
<td>Formwork</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Pre-cast Concrete Elements</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Post-tension Concrete</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Stucco Application</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Pre-stress Concrete</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Post-tension Concrete</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

excerpted from City of Philadelphia, Statement of Special Inspections Schedule

www.hilti.com
**Topics**

- Special inspection
- 2009/2012 IBC inspection requirements
- ACI 318-11 inspection requirements
- Proof-loading
- Certified adhesive anchor installers
- ICC-ES supplemental inspection requirements
- General Notes sheet/specifications
- Q&A

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**In the beginning...**

“...Where special inspection is provided values may be increased 100 percent.”

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**1976 Uniform Building Code**

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**TABLE NO. 26-G—ALLOWABLE SHEAR AND TENSION ON BOLTS**

(In Pounds)

<table>
<thead>
<tr>
<th>DIAMETER (in inches)</th>
<th>MINIMUM EMBEDMENT (in inches)</th>
<th>SHEAR MINIMUM CONCRETE STRENGTH (in psi)</th>
<th>TENSION MINIMUM CONCRETE STRENGTH (in psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8</td>
<td>2</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>1/2</td>
<td>3</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>5/8</td>
<td>4</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>3/4</td>
<td>4</td>
<td>1375</td>
<td>1375</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>1470</td>
<td>1470</td>
</tr>
<tr>
<td>7/8</td>
<td>6</td>
<td>1790</td>
<td>1790</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>2075</td>
<td>2075</td>
</tr>
<tr>
<td>1 1/4</td>
<td>8</td>
<td>2350</td>
<td>2350</td>
</tr>
<tr>
<td>1 1/4</td>
<td>9</td>
<td>2650</td>
<td>2650</td>
</tr>
</tbody>
</table>

**NOTES:** Values shown are for work without special inspection. Where special inspection is provided values may be increased 100 percent.

Values are for natural stone aggregate concrete and bolts of at least A307 quality. Bolts shall have a standard bolt head or an equal deformity in the embedded portion.

Values are based upon a bolt spacing of 12 diameters with a minimum edge distance of 6 diameters. Such spacing and edge distance may be reduced 50 percent with an equal reduction in value. Use linear interpolation for intermediate spacings and edge margins.

*An additional 2 inches of embedments shall be provided for anchor bolts located in the top of columns for buildings located in Seismic Zones 2, 3 and 4.
Note that as recently as the 2006 code, inspection was only for cast-in anchors and then only if you were using increased allowable loads for design (i.e., using a FS of 4 instead of 8!). Per the code inspection was not required for post-installed anchors or for anchors designed using strength design provisions, e.g., of ACI 318.

This was corrected in the 2009 IBC through the addition of a new entry for “anchors installed in hardened concrete”. However, note that continuous inspection for cast in anchors was still required, even for strength design, whereas post-installed anchors required only periodic.
In the 2012 IBC, both cast-in and post-installed anchors require periodic inspection, unless otherwise noted as per footnote b.

Footnote b.

“b. Specific requirements for special inspection shall be included in the research report for the anchor issued by an approved source in accordance with ACI 355.2 or other qualification procedures. Where specific requirements are not provided, special inspection requirements shall be specified by the registered design professional and shall be approved by the building official prior to the commencement of the work.”

Sources of additional inspection requirements for anchors:

- ACI 318 code (2011 and later)
- ACI 355.4
- Evaluation reports (i.e., ESRs)
Summary of special inspection requirements

<table>
<thead>
<tr>
<th>Anchor design</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2006 IBC</td>
</tr>
<tr>
<td>CAST-IN ASD FS = 8</td>
<td>NOT REQUIRED</td>
</tr>
<tr>
<td>CAST-IN ASD FS = 4</td>
<td>CONTINUOUS</td>
</tr>
<tr>
<td>CAST-IN STRENGTH DESIGN (e.g., ACI 318 Appendix D)</td>
<td>NOT REQUIRED</td>
</tr>
<tr>
<td>POST-INSTALLED</td>
<td>NOT REQUIRED</td>
</tr>
<tr>
<td>POST-INSTALLED ADHESIVE QUALIFIED AT A LOWER LEVEL</td>
<td>ADHESIVE ANCHORS NOT INCLUDED</td>
</tr>
<tr>
<td>POST-INSTALLED ADHESIVE FOR SUSTAINED TENSION OVERHEAD TO HORIZONTAL</td>
<td>ADHESIVE ANCHORS NOT INCLUDED</td>
</tr>
</tbody>
</table>

ACI 318-11 and the 2012 IBC

The concrete chapter of the 2012 International Building Code®, Chapter 10, references ACI 318-11 Building Code Requirements for Structural Concrete, the standard for concrete design and construction. This chapter continues to include a small number of modifications to ACI 318. These modifications are based on ACI 318-08, which was the referenced standard for concrete in the 2009 IBC. This makes the 2012 IBC consistent with the 2011 edition of the ACI 318 standard.

The purpose of this article is to identify three significant proposed changes, approved for the 2012 Code Development Cycle, which resolve the inconsistencies in the 2012 IBC. These approved changes address requirements for concrete and steel and anchors in concrete. The code changes are S2011-13, S546-12, and S595-11. These changes are being brought to the attention of designers and adopting agencies to assist in considering the provisions of the 2012 IBC with those of ACI 318-11. Jurisdictions that have not adopted the 2012 IBC can make the follow-
If you do work in structures assigned to SDC C, D, E or F, you should be aware of this issue.

I highly recommend obtaining the article by Dr. Ghosh or contacting him directly at: skghoshinc@gmail.com
2015 IBC

1909.1 Scope. The provisions of this section shall govern the strength design of anchors installed in concrete for purposes of transmitting structural loads from one connected element to the other. Headed bolts, headed studs and hooked (J- or L-) bolts cast in concrete and expansion anchors and undercut anchors installed in hardened concrete shall be designed in accordance with Appendix D of ACI 318 as modified by Sections 1905.1.9 and 1905.1.10; provided they are within the scope of Appendix D.

The strength design of anchors that are not within the scope of Appendix D of ACI 318, and as amended in Sections 1905.1.9 and 1905.1.10, shall be in accordance with an approved procedure.

Reason: Requirements for the design and installation of adhesive anchors was included in ACI 318-11. Requirements for continuous inspection were added for adhesive anchors installed horizontally or in upward inclined orientations with sustained loads.

S213–12

Table 1705.3, 1908.1, 1908.2, Table 1908.2, 1908.3, 1908.4, 1908.5

Proponent: Matthew Serenca, P.E., American Concrete Institute (ACI)

Revise as follows:

<p>| TABLE 1705.3 |
| REQUIRED VERIFICATION AND INSPECTION OF CONCRETE CONSTRUCTION |</p>
<table>
<thead>
<tr>
<th>VERIFICATION AND INSPECTION</th>
<th>CONTINUOUS</th>
<th>PERIODIC</th>
<th>REFERENCED STANDARD</th>
<th>IBC REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Inspection of anchors cast in concrete where allowable loads have been increased or where strength design is used</td>
<td>—</td>
<td>X</td>
<td>ACI 318 8.1.3, 21.2.8</td>
<td>1908.5, 1909.1</td>
</tr>
</tbody>
</table>

(Entries of Table not shown remain unchanged)
2015 IBC

Delete without substitution:

SECTION 1908. ANCHORAGE TO CONCRETE—ALLOWABLE STRESS DESIGN

1908.1 Scope. The provisions of this section shall govern the allowable stress design of headed studs and headed stud anchors cast in normal-weight concrete for purposes of transmitting structural loads from one connected element to the other. These provisions do not apply to anchors installed in hardened concrete or where load combinations include earthquake loads or effects. The bearing area of headed anchors shall be not less than one and one-half times the shank area. Where strength design is used, or where load combinations include earthquake loads or effects, the design strength of anchors shall be determined in accordance with Section 1909: Bolts shall conform to ASTM A 307 or an approved equivalent.

1908.2 Allowable service load. The allowable service load for headed anchors in shear or tension shall be as indicated in Table 1908.2. Where anchors are subject to combined shear and tension, the following relationship shall be satisfied:

\[
(P_t + P_v) S_3 = (P_t + P_v) S_3 \leq 1 \text{ (Equation 19-1)}
\]

where:

- \( P_t \) = Applied tension service load, pounds (N).
- \( P_v \) = Allowable tension service load from Table 1908.2, pounds (N).
- \( S_3 \) = Allowable shear service load, pounds (N).
- \( S_3 \) = Allowable shear service load from Table 1908.2, pounds (N).

2015 IBC

TABLE 1908.3

<table>
<thead>
<tr>
<th>BOLT DIAMETER</th>
<th>MINIMUM EMBEDMENT</th>
<th>EDGE DISTANCE</th>
<th>SPACING (inches)</th>
<th>MINIMUM CONCRETE STRENGTH (psi)</th>
<th>TENSION S3</th>
<th>SHEAR S3</th>
<th>TENSION S3</th>
<th>SHEAR S3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8</td>
<td>3</td>
<td>1-1/2</td>
<td>3</td>
<td>200</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>1/2</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>500</td>
<td>1,250</td>
<td>1,250</td>
<td>1,250</td>
<td>1,250</td>
</tr>
<tr>
<td>3/4</td>
<td>6</td>
<td>5-1/2</td>
<td>9</td>
<td>2,125</td>
<td>1,875</td>
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<td>5/4</td>
<td>10-1/2</td>
<td>7-1/2</td>
<td>9</td>
<td>2,825</td>
<td>2,575</td>
<td>2,575</td>
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<td>2,575</td>
</tr>
<tr>
<td>7/8</td>
<td>12</td>
<td>9-1/2</td>
<td>9</td>
<td>3,600</td>
<td>3,250</td>
<td>3,250</td>
<td>3,250</td>
<td>3,250</td>
</tr>
<tr>
<td>1-1/8</td>
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<td>10-1/2</td>
<td>9</td>
<td>4,400</td>
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<td>11-1/2</td>
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<td>4,800</td>
<td>4,800</td>
<td>4,800</td>
<td>4,800</td>
</tr>
</tbody>
</table>

1908.3 Required edge distance and spacing. The allowable service loads in tension and shear specified in Table 1908.2 are for the edge distance and spacing specified. The edge distance and spacing are permitted to be reduced to 0.70 percent of the values specified with an equal reduction in allowable service load. Where edge distance and spacing are reduced less than 90 percent, the allowable service load shall be determined by linear interpolation.

1908.4 Increase in allowable load. Increase of the values in Table 1908.2 by one-third is permitted where the provisions of Section 1900.3.2 permit an increase in allowable stress for wind loading.

1908.5 Increase for special inspection. Where special inspection as provided for the installation of anchors, a 100-per cent increase in the allowable tension loads of Table 1908.2 is permitted. No increase in shear value is permitted.

References: This proposal removes allowable stress design for anchoring to concrete. This approach to anchor design is not consistent with the standards published by AASHTO or ACI.
Topics

- Special inspection
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ACI 318-11

- The 2011 edition of ACI 318 introduced adhesive anchors into the code.
- This was prompted by the 2006 failure of adhesive anchors securing the ceiling of the I-90 connector tunnel in Boston.
- The primary concern was for anchors installed overhead and resisting sustained tension loads (e.g., gravity loads).
ACI 318-11

The ACI code addresses this issue in several ways:

1. ALL adhesive anchor systems must be qualified to resist sustained tension loads. (D.2.3)
2. Adhesive anchors to be installed overhead must be qualified for overhead and horizontal installation. (D.3.4)
3. Adhesive anchors subject to sustained tension are subjected to a special design check using reduced bond values. (D.4.1.2)
4. Adhesive anchors installed overhead and subject to sustained tension must be installed by certified adhesive anchor installers (D.9.2.2/D.9.2.3) and must be installed under continuous special inspection. (D.9.2.4)

ACI 355.4-11

- Continuous special inspection for adhesive anchors may also be triggered by the manner in which they are assessed under the ACI standard ACI 355.4 Qualification of Post-Installed Adhesive Anchors in Concrete (ACI 355.4) and Commentary. In such cases, proof loading is also required.

### Threshold values for anchors subject to periodic special inspection only

<table>
<thead>
<tr>
<th>Anchor category</th>
<th>$f_{lux}$ for selected reliability tests</th>
<th>Reliability test numbers according to Table 5.1, Table 5.2, or Table 5.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$0.95$</td>
<td>$0.80$</td>
</tr>
<tr>
<td>2</td>
<td>$0.80$</td>
<td>$0.75$</td>
</tr>
<tr>
<td>3</td>
<td>$0.75$</td>
<td>$0.75$</td>
</tr>
</tbody>
</table>

†Periodic special inspections

### Threshold values for anchors subject to continuous special inspection and proof loading

<table>
<thead>
<tr>
<th>Anchor category</th>
<th>$f_{lux}$ for selected reliability tests</th>
<th>Reliability test numbers according to Table 5.1, Table 5.2, or Table 5.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$0.80$</td>
<td>$0.75$</td>
</tr>
<tr>
<td>2</td>
<td>$0.70$</td>
<td>$0.65$</td>
</tr>
<tr>
<td>3</td>
<td>$0.65$</td>
<td>$0.65$</td>
</tr>
</tbody>
</table>

†Continuous special inspection and no proof loading program

‡Optimal tests, refer to Table 10.3 for permissible combinations.

§Test 25 may be omitted.

×Threshold of less exact tests is permitted in specific cases: for example, if the desired category is fulfilled with the results of Tests 26, 27, and 28, then Tests 25, 29, and 26 may be omitted.
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Proof loading

- Proof loading of anchors has been practiced in the western U.S. for many years as a means of ensuring enhanced quality control for structures resisting earthquakes.
- There are no widely recognized standards for proof loading.
- Proof loading was implemented in the construction of the Big Dig ceiling system but the proof loads were quite low (125% of the allowable design load) and the response to anchor failures (as many as 16% of the anchors tested prior to the start of construction failed to resist the proof load) was inadequate.
- Best practice has been summarized in a document issued by the Concrete Anchor Manufacturers Association.
Proof loading components

1. Proof loads should be established at a level that stresses the anchor within the elastic range and does not damage the anchor if it is not defective. Typical practice in California (OSHPD) is to require proof loads up to 50% of the permissible bond strength or 80% of anchor yield, whichever is less.

2. A representative number of anchors should be tested, depending on the criticality of the installation. OSHPD typically requires that 50% of all anchors be tested. Rates for non-hospital work range from 10% to 25%.

3. The consequences of any anchor failing the proof load test should be appropriately severe. Typical language requires that the sample rate increase to 100% if any anchor fails the proof load.

4. Proof loads should be applied with a confined test set up.

5. Proof load specs should include permissible anchor deflection at proof load, if any. (“No visible movement.”)

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Certified installers

- The requirement for certified installers comes from the ACI code.
- It is intended to improve the knowledge base of construction personnel involved in the installation of adhesive anchors.
- ACI, in conjunction with CRSI, has developed a certification program for adhesive anchor installers.
- This certification program is comprised of a written exam and a hands-on “practice” exam.
- The exam was developed largely on the basis of Hilti’s experience with training of installers of adhesive anchor systems.
- There is a growing concern that there is/will be a deficit of certified installers.
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Evaluation Service Reports

- Inspection requirements for post-installed anchors are given in the Evaluation Service Reports issued by ICC-ES.
- These requirements are typically a summary of requirements found in other sections of the IBC and ACI codes, but may also include requirements or clarifying language not stated in those documents.

4.3 Special Inspection:

Periodic special inspection must be performed where required in accordance with Sections 1704.4 and 1704.15 of the 2009 IBC or Section 1704.13 of the 2006 IBC and this report. The special inspector must be on the jobite during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, adhesive identification and expiration date, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, concrete thickness, anchor embedment, tightening torque and adherence to the manufacturer’s printed installation instructions.

The special inspector must verify the initial installations of each type and size of adhesive anchor by construction personnel on site. Subsequent installations of the same anchor type and size by the same construction personnel are permitted to be performed in the absence of the special inspector. Any change in the anchor product being installed or the personnel performing the installation must require an initial inspection. For ongoing installations over an extended period, the special inspector must make regular inspections to confirm correct handling and installation of the product.

Continuous special inspection of adhesive anchors installed in horizontal or upward inclined orientations to resist sustained tension loads shall be performed in accordance with ACI 318 Section 9.2.4.

Under the IBC, additional requirements as set forth in Sections 1702 and 1706 must be observed, where applicable.
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General notes and specifications

- Correctly referencing quality control requirements for anchors in the construction documents can greatly enhance construction quality and prevent change orders.
General notes

Basic requirements for anchoring are often placed on the S1 sheet.

1.0 DRILLED-IN ANCHORS

1.1 GENERAL

A. Drill holes with rotary impact hammer drills using carbide-tipped bits or core drills using diamond core bits. Drill bits shall be of diameters as specified by the anchor manufacturer. Unless otherwise shown on the Drawings, all holes shall be drilled perpendicular to the concrete surface.

B. Cored Holes. Where anchors are to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer.

C. Embedded Items. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in coring or drilling to avoid damaging existing reinforcing or embedded items. Notify the Engineer if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and telecommunications conduit, and gas lines.

D. Basic Material Strength. Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

Proof load requirements are often stated in the General Notes.

E. Testing

1. [10%] [25%] _____ of each type and size of drilled-in anchor shall be proof loaded by the independent testing laboratory. Adhesive anchors and capsule anchors shall not be torque tested unless otherwise directed by the Engineer. If [any] [more than 10%] _____ of the tested anchors fail to achieve the specified torque or proof load within the limits as defined on the Drawings, all anchors of the same diameter and type as the failed anchor shall be tested, unless otherwise instructed by the Engineer.

2. Torque shall be applied with a calibrated torque wrench.

Specimen Note: Other limits on displacement may be appropriate, depending on the magnitude of the proof load and the requirements of the application.

3. Proof loads shall be applied with a calibrated hydraulic ram. Displacement of adhesive anchors at proof load shall not exceed D/10, where D is the nominal anchor diameter.

F. Remove and replace mis-placed or malfunctioning anchors. Fill empty anchor holes and patch failed anchor locations with high-strength nonshrink, nonmetallic grout. Anchors that fail to meet proof load shall be replaced.
General notes

It is useful to emphasize that the manufacturers printed instructions (MPII) should be followed. This is also stressed in the anchor installer training.

1.2 CARTRIDGE INJECTION ADHESIVE ANCHORS AND DOWELS

A. Materials – provide anchors of size and type shown
   2. Reinforcing dowels shall be A615 or A706 Grade 60.

B. Installation
   1. Perform installation in accordance with manufacturer’s printed installation instructions.
   2. Drill holes with a carbide bit and rotary-percussive drill and prepare holes in accordance with manufacturer’s printed installation instructions.
   3. Assemble injection tools and inject adhesive in accordance with manufacturer’s printed installation instructions, using piston plug assembly for horizontal and overhead installations.
   4. Sufficient adhesive shall be injected in the hole to ensure that the annular gap is filled to the surface upon bar installation. Remove excess adhesive from the surface. For dowels installed overhead, shim or otherwise support bars during adhesive gel time to prevent downward movement of bar.
   5. Observe manufacturer’s printed installation instructions with respect to installation temperatures.

General notes

Proof loads are often shown in tabular form:

**Specifier Note:** Proof loading of adhesive anchors is intended to catch significant installation problems, such as partial or complete failure to cure. It is not intended to check the design capacity of the anchorage. The proof loads provided in the following tables are based on the lesser of 50% of the minimum ultimate bond strength in 2 ksi concrete or 80% of the bar yield (A36 threaded rod and Grade 50 rebars).

7. Unless otherwise shown on the drawings, minimum anchor embedment and proof load shall be as follows.

**Specifier Note:** The data shown here are for illustration purposes only.

<table>
<thead>
<tr>
<th>ANCHOR DIAMETER</th>
<th>MINIMUM ANCHOR EMBEDMENT</th>
</tr>
</thead>
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<tr>
<td>INCHES</td>
<td>MM</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>3-1/2</td>
</tr>
<tr>
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</tr>
<tr>
<td>1-1/4&quot;</td>
<td>12</td>
</tr>
</tbody>
</table>
Specifications

Anchor specifications are usually found in 03 15 00 Concrete Accessories

SECTION 03 15 00
CONCRETE ACCESSORIES

Specifier Note: This specification is intended to address the use of anchors for safety-related applications, such as structural connections, earthquake bracing, guard rails, mechanical and electrical equipment support, piping and ductwork support and bracing, scaffolding and facade connections, or rebar doweling. Light-duty anchors are not included.

PART 1 – GENERAL

1.01 SUMMARY

Specifier Note: If cast-in anchors are not used, delete reference here and in Sections 2.02 and 3.01.

A. Section Includes: Cast-in and drilled in anchors for concrete.

Specifications

Installer training and certification is addressed under Quality Assurance.

1.03 QUALITY ASSURANCE

A. Installer Qualifications:

1. Drilled-in anchors shall be installed by a [contractor] [installer] with at least [three] [five] years of experience performing similar installations.

2. Where indicated, adhesive anchors shall be installed by an installer having a valid ACI/CRSI Adhesive Anchor Installer Certification or equivalent.

B. Installer Training: Conduct a thorough training with the manufacturer or the manufacturer’s representative for the [contractor] [installer] on the project. Training to consist of a review of the complete installation process for drilled-in anchors, to include but not limited to:

1. hole drilling procedure
2. hole preparation & cleaning technique
3. adhesive injection technique & dispenser training / maintenance
4. rebar dowel preparation and installation
5. proof loading/torquing
Specifications

Requirements on anchor installation are found under Execution.

PART 3 – EXECUTION
3.01 INSTALLATION

A. Cast-In-Place Bolts: Use templates to locate bolts accurately and securely in formwork.
B. Drilled-In Anchors:

Specifier Note: Verify if restrictions exist on the type of drilling equipment to be used for the project.

1. Drill holes with rotary impact hammer drills using [carbide-tipped bits, hollow drill bit system], [core drills using diamond core bits]. Drill bits shall be of diameters as specified by the anchor manufacturer. Unless otherwise shown on the Drawings, all holes shall be drilled perpendicular to the concrete surface.
   a. Cored Holes: Where anchors are permitted to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer. Properly clean cored hole per manufacturer’s instructions.
   b. Embedded Items: Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in boring or drilling to avoid damaging existing reinforcing or embedded items. Notify the Engineer if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and telecommunications conduit, and gas lines.
   c. Base Material Strength: Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

2. Perform anchor installation in accordance with manufacturer instructions.

Topics

• Special inspection
• 2009/2012 IBC inspection requirements
• ACI 318-11 inspection requirements
• Proof-loading
• Certified adhesive anchor installers
• ICC-ES supplemental inspection requirements
• General Notes sheet/specifications
• Q&A
For discussion

1. Do you use adhesive anchors for safety-related structural applications?
2. Do you specify adhesive anchors with confidence?
3. Do you agree with the requirement for certified installers?
4. Would you require certification for all critical installations or just those mandated by the code?
5. How can the certification program be improved?