

## CODE APPLICATION NOTICE

**Subject:** Qualification, Design, and Use  
of Anchors Installed in Concrete

**FILE NO.:** 2-1912A.1  
**EFFECTIVE:** 07/01/08

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**CODE SECTION:** Section 1912A.1, 2007 California Building Code (CBC)

**1912A.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 *Section 1908A.1.47*, provided they are within the scope of Appendix D.

**Exception:** Where the basic concrete breakout strength in tension of a single anchor,  $N_b$ , is determined in accordance with Equation (D-7), the concrete breakout strength requirements of Section D.4.2.2 shall be considered satisfied by the design procedures of Sections D.5.2 and D.6.2 for anchors exceeding 2 inches (51 mm) in diameter or 25 inches (635 mm) tensile embedment depth.

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

### PURPOSE:

Section 1912A.1 requires an approval procedure to determine the design strength of anchors that are not within the scope of Appendix D of ACI 318 as amended by the 2007 CBC. This CAN establishes the OSHPD approved procedure and requirements for the qualification, design, and use of anchors that are within and are not within the scope of Appendix D of ACI 318. Anchors that are not within the scope of Appendix D of ACI 318 include screw anchors, specialty inserts, chemical/adhesive anchors, and power actuated fasteners.

See CAN 2-1916A.8 for field testing of post-installed anchors.

### INTERPRETATION:

#### 1.0 Procedure and Requirements

#### 1.1 Design Strength of Mechanical Anchors

Design strength of mechanical anchors determined in accordance with ICC Evaluation Services, Inc. (ICC-ES) AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements (edition citing 2006 IBC as a reference standard) satisfies the requirements of Section 1912A.1, 2007 CBC. For the purpose of AC193, mechanical anchors include screw anchors, displacement controlled anchors, torque controlled anchors, and undercut anchors. The use of specific mechanical anchors shall be

limited to the same configuration as tested in accordance with AC193, unless otherwise approved by OSHPD.

Installation of mechanical anchors in concrete where cracking is likely to occur over the service life of the anchor shall be based on qualification tests in cracked concrete. Installation of mechanical anchors at the underside of the beam/slab shall be based on tests on cracked concrete.

**Exceptions:**

- a. Mechanical anchors installed in the compression region of the beam/slab, when the design engineer provides dimensions and details to confirm anchor placement.
- b. Mechanical anchors installed in the high flute (rib) of the metal deck in a concrete on metal deck assembly.
- c. Mechanical anchors installed with sufficient embedment so the load-transfer zone is above the neutral axis of the beam or slab, except when the slab is intended to serve as a diaphragm for transferring earthquake forces to other lateral load resisting elements.

Installation of mechanical anchors subjected to wind or seismic forces shall be based on a seismic qualification test in concrete.

All mechanical anchors shall have an identification number or letter at the head, observable after installation, which indicates the length of the anchor installed.

Specialty inserts, including cast-in-place specialty inserts, tested in accordance with AC193 shall be considered to satisfy the requirements of Section 1912A.1, 2007 CBC. Sensitivity tests, which are unique to post-installed anchors and have no effect on cast-in-place specialty insert capacities, need not be performed to qualify cast-in-place inserts.

**1.1.1 Power Actuated Fasteners**

Power actuated fasteners shall be qualified on the basis of ICC-ES AC70, Acceptance Criteria for Fasteners Power-Driven into Concrete, Steel and Masonry Elements (edition citing 2006 IBC as a reference standard). Power actuated fasteners shall not be used where they are prohibited by ICC-ES AC70, unless specifically permitted by this CAN.

Section 13.4.5 of ASCE 7-05 does not permit power actuated fasteners for seismic tension load applications. Power actuated fasteners shall not be used to carry seismic tension loads (except for vertical seismic load produced by self-weight of the components supported as provided in the paragraph below) or in cracked concrete unless approved for such loading by OSHPD. Power actuated fasteners may be permitted for interior conditions subject to gravity loads. Allowable loads in tension, shear, or tension and shear combinations shall

not exceed the smaller of: 1) 100 pounds or 2) loads provided in the relevant ICC-ES Report (ESR) using ICC-ES AC70.

Design loads shall be increased for vertical seismic load effect in accordance with Section 12.4.2.2 of ASCE 7-05 and total loads shall be increased by a factor of 1.3 in accordance with Section 13.4.2 of ASCE 7-05, for anchors embedded in concrete. Power actuated fasteners may be used for interior non-shear wall partitions and seismic shear, when they are specifically listed for service in resisting lateral loads in areas subject to earthquakes. See limitations in Section 3 of this CAN, Anchorage Design Limitations.

**Exception:** Power actuated fasteners shall not be used to anchor exterior cladding or curtain wall systems.

### 1.1.2 Installation of Mechanical Equipment

Expansion anchors for non-vibration isolated mechanical equipment rated over 10 hp are not permitted by Section 13.6.5.5 of ASCE 7-05. Anchors installed in overhead conditions for non-vibration isolated equipment with reciprocating or rotating mechanisms shall be undercut anchors.

### 1.1.3 Other Anchors

Attachments into concrete utilizing non-expanding or cast iron inserts shall require prior approval by OSHPD. Internally threaded shell-type anchors/displacement-controlled anchors (drop-ins, etc.) shall not be permitted at the underside of beam/slab.

Use of screw anchors shall be limited to dry interior conditions. Screw anchors shall not be permitted at the underside of beam/slab. Re-use of screw anchors or screw anchor holes shall not be permitted. Assessment of screw anchors that are set with an impact wrench shall include the reliability tests described in Section 8.8.2.2.3 of AC193 (anchors qualified for re-tightening).

## 1.2 Design Strength of Chemical/Adhesive Anchors

Design strength of chemical/adhesive anchors determined in accordance with ICC-ES AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements (edition citing 2006 IBC as a reference standard) satisfies the requirements of Section 1912A.1, 2007 CBC. Use of specific anchors shall be limited to the same configuration as tested in accordance with AC308, unless otherwise approved by OSHPD. The long term durability, stability, and temperature sensitivity of chemical/adhesive anchors shall be considered as required by AC308.

Chemical/adhesive anchors do not include the use of surface bonding applications, such as the base of support pedestals used in access floor systems.

Core bits may be used to drill holes for chemical/adhesive anchors when permitted by ICC-ESR for the specific anchor system.

Installation of anchors in concrete where cracking is likely to occur over the service life of the anchor shall be based on qualification test in cracked concrete. The use of chemical/adhesive anchors in overhead applications or applications with sustained (continuous) tension load that can lead to creep is not allowed.

Installation of anchors subjected to wind or seismic forces shall be based on seismic qualification test on cracked concrete.

Chemical/adhesive anchors should be installed in only interior conditioned spaces.

**Exceptions:**

- a. Where chemical/adhesive anchors are used as shear dowels at the perimeter of an existing opening (slab or wall) to be filled with concrete, or are being used to connect new concrete elements to existing concrete elements, they may be installed in exterior locations with prior approval by OSHPD.
- b. When chemical/adhesive anchors are tested in accordance with AC308 and approved in an ICC-ESR, they shall be permitted for the tested conditions.

If chemical/adhesive anchors are exposed to fire, all chemical/adhesive anchors in the affected area should be inspected and evaluated by a qualified person to ensure that their load carrying capability has not been compromised.

**1.2.1 Structural Applications**

Where chemical/adhesive anchors are used for structural applications, such as dowels between new and existing concrete, the anchor shall be installed in a manner such that the ultimate tensile capacity of the steel element can be reliably developed, i.e., the anchor capacity is controlled by the ultimate strength of the steel element.

**Exception:** Chemical/adhesive anchors that cannot develop the tensile capacity of the steel element may be used to transfer forces, provided that the loads on the anchor are amplified by the system overstrength factor ( $\Omega_0$ ) in Table 12.2-1 of ASCE 7-05 or where unreduced forces are used in accordance with ASCE 41-06 for existing hospital buildings.

When chemical/adhesive anchors are used to resist tensile forces in structural applications, the minimum depth of embedment shall be greater than or equal to the development length ( $l_d$ ) determined in Section 12.1 of ACI 318 for a cast in place reinforcing bar of the same diameter and grade, unless it can be shown by calculation, or testing approved by OSHPD, that the anchor spacing and edge distance is sufficient to develop the tensile strength of the anchor in a lesser depth of embedment.

## **2.0 Installation**

### **2.1 Procedure**

All anchors shall be installed in accordance with the requirements of the ICC-ESR for the specific anchor, or as required by the manufacturer. If the concrete cracks during installation of the anchor, the anchor shall be removed or abandoned. Where post installed mechanical anchors are used in a standoff configuration (i.e., where the attachment is separated from the concrete in which the anchor is installed), a nut and washer shall be provided at the concrete surface to facilitate setting of the anchor and to transmit axial compression loads into the concrete. Axial compression loads shall not be carried by the mechanical anchor body or anchor rod into the concrete.

### **2.2 Holes for Post-Installed Anchors**

All holes for post-installed anchors shall be drilled, cleaned, and prepared in accordance with manufacturer's recommendations or the applicable ICC-ESR. All debris shall be removed by in-hole brushing combined with vacuum or oil-free compressed air. Jetting holes with water is not permitted. When an anchor does not set properly or fails a tension test, the drilled hole may not be reused. Abandoned holes shall be filled with non-shrink grout. The minimum spacing between an abandoned hole and a drilled hole used for a post-installed anchor shall not be less than 1-1/2 anchor diameters unless otherwise approved by OSHPD.

### **2.3 Application of Torque**

Where the manufacturer's installation instructions or applicable ICC-ESR specify the application of an installation torque, the specified torque shall be applied with a calibrated torque wrench. The specified installation torque shall not be exceeded. Prior to the application of torque, the anchor threads shall be protected from damage. Supplemental lubricants shall not be applied to the threads.

Torque-controlled expansion anchors and torque-controlled chemical/adhesive anchors are anchors that require the application of torque to set the anchor and produce expansion forces in the concrete. Following attainment of 10% of the specified torque, 100% of the specified torque shall be reached within seven (7) or fewer complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor shall be removed or abandoned. Torque-controlled expansion anchors shall not be used in a manner that requires loosening of the nut following the application of the installation torque unless otherwise approved by OSHPD.

### **2.4 Embedment, Spacing, and Edge Distance**

All anchors shall meet the minimum embedment, edge distance, spacing, and slab thickness criteria established by the relevant ICC-ESR.

Edge distance shall be a minimum of ten (10) bolt diameters from the free edge of the slab; and center-to-center spacing shall be a minimum of twelve (12) bolt diameters, unless data is submitted indicating full anchor tension and shear capacity at a closer

distance. If the edge distance is less than ten (10) diameters and the load is directed toward the free edge, the shear capacity shall be reduced in accordance with Appendix D of ACI 318.

Minimum edge distance for power-driven fasteners shall be the value give in ASTM E 1190 or the relevant ICC-ESR, whichever is larger.

Post-installed anchors shall be installed to comply with the minimum slab thickness requirements established by the manufacturer's technical guide for the specified anchor, provided sufficient test data is provided to support the installation.

When installing expansion-type anchors through the low flutes of metal decking into concrete, the anchors shall be placed as close to the center of the flute width as practicable, to avoid the deck seam or as provided in the relevant ICC-ESR. The deck must be a minimum 20 ga. thickness in accordance with Section 2209A.3 of the 2007 CBC and the flute width must meet or exceed the value set forth in the relevant ICC-ESR for the anchor or as otherwise tested, but not less than four (4) inches. The minimum effective depth of embedment shall be as noted in the ICC-ESR for the anchor.

### 3.0 Anchorage Design Limitations

For consistency with the requirements of Section D.3.3.3 of ACI 318-05, only 75% of the design strength shall be considered as available strength for structures located in Seismic Design Categories D, E, and F. Requirements of Section 13.4.2 of ASCE 7-05 shall apply for nonstructural component anchorage, which require anchor design forces for concrete to be increased by a factor of 1.3 and  $R_p$  limited to 1.5, except as provided in Section 13.4.2 of ASCE 7-05. All internally threaded expansion anchors (e.g. drop-ins, etc) and screw anchors shall be considered to have brittle failure and shall have their  $R_p$  limited to 1.5 in accordance with Section 13.4.2 of ASCE 7-05. Anchors shall also satisfy the requirements of Section 1908A.1.47 of the 2007 CBC, where applicable.

<u>Original Signed</u>	<u>07/01/08</u>
John D. Gillengerten	Date