
HIGH-STRENGTH STRUCTURAL BOLTING INSPECTION: 2022 CBC

Disciplines: Structural

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Division of the State Architect (DSA) documents referenced within this publication are available on the [DSA Forms](#) or [DSA Publications](#) webpages.

PURPOSE

This Interpretation of Regulations (IR) clarifies the responsibilities of special inspectors when performing high-strength bolting special inspection on construction projects under DSA's jurisdiction.

SCOPE

This IR is applicable to both shop and field structural bolting activities utilizing ASTM F3125 fasteners. At the design professional's discretion, as noted on the DSA-approved construction documents, the requirements of this IR shall apply to other high-strength fastener assemblies specified in *IR 17-8: Sampling and Testing of High-Strength Structural Bolts, Nuts and Washers*.

BACKGROUND

The California Building Code (CBC) requires sampling and testing of high-strength structural bolts (HSB) and either periodic or continuous special inspection of high-strength structural bolting operations. Refer to IR 17-8 for material identification, sampling and testing requirements of high-strength structural bolts, nuts and washers. Special inspection of the installation and tightening of all HSBs shall be conducted in accordance with CBC, applicable reference standards (e.g., Specification for Structural Joints Using High-Strength Bolts by the Research Council on Structural Connections [RCSC], American Institute of Steel Construction (AISC) 360, AISC 341, etc.) and the requirements of this IR. In accordance with *IR A-8: Project Inspector and Assistant Inspector Duties and Performance*, the project inspector shall coordinate scheduling with the bolting special inspector or Laboratory of Record (LOR), as applicable, to ensure special inspections and required reports of fastener components occurs.

1. QUALIFICATIONS

Special inspectors conducting high-strength structural bolting special inspection shall meet the following minimum requirements:

- 1.1 Hold valid certification identified in CBC Section 1705A.2.6.
- 1.2 Meet the minimum age and experience requirements specified in the California Administrative Code (CAC) Section 4-335(f).
- 1.3 Possess knowledge of the special inspection and reporting requirements of CAC Section 4-335, HSB requirements of CBC, and applicable reference standards.

2. INSPECTION DUTIES FOR ALL HSB INSTALLATION TECHNIQUES

Review and understand the applicable portions of the DSA-approved construction documents (e.g., plans, specifications, addenda, construction change documents, etc.). Accepted shop drawings, erection drawings, referenced codes and standards must also be reviewed and understood. (Note that shop/erection drawings are NOT DSA-approved documents and shall NOT be used as a basis for acceptance.)

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- 2.1** Review manufacturer's Material Test Report (MTR) for conformance with documents listed in Section 2.1 above.
- 2.2** Conduct material identification and verify the sampling for testing for all high-strength fastener assemblies and components as required by CBC and IR 17-8.
- 2.3** Verify that all fastener components are kept in protected storage (i.e., in suitable closed containers, in a protected shelter) when not in use, protected from contamination, moisture and weather to ensure the fastener components are maintained as close as possible to the as-manufactured condition until installed. Only the number of fasteners required for one shift of work shall be removed from protected storage at a time. At the end of the shift, unused fasteners shall be returned to protected storage. Fastener components shall also be controlled so that used, rejected, or unidentified materials are not incorporated in the work.
- 2.4** Visually inspect the surface conditions and markings (when applicable) of the bolts, nuts and washers. Identify and report as non-conforming any fastener components installed having visible defects (e.g., quench cracks, forging cracks, head-burst, etc.) exceeding limits specified in ASTM F788.
- 2.5** Verify that all applicable bolt installation procedures and manufacturer's instructions are available on the project site and that they are current and accurate.
- 2.6** Verify that all bolt installers are familiar with the requirements and are able to install bolts in accordance with the accepted procedures.
- 2.7** Inspect the condition of bolted joints prior to assembly as follows:
- 2.8** Verify bolt hole is the proper type (standard, short slotted, etc.) and size.
- 2.8.1** Check the condition of the bolt holes. For example, verify holes to receive bolts have no unfair reaming, unapproved flame cutting or slotting.
- 2.8.2** Check for appropriate bolt diameter, shank lengths (e.g., threads included or excluded at the faying surface as specified in the DSA-approved construction documents), and fastener component installation sequence (e.g., washers are installed on applicable side(s) of plies and in proper sequence with other components, etc.).
- 2.8.3** Verify the faying surfaces are properly prepared.
- 2.9** Verify that all required bolts have been installed.
- 2.10** Verify that all bolts have been tightened in a systematic manner, to bring the joint into a snug-tight condition, beginning at the most rigid part of the connection and progressing to the free edges. Several tightening cycles may be needed to bring plies into firm contact.
- 2.11** Mark completed joints that have been inspected and accepted with a distinguishing mark. The mark shall include: LOR's initials, inspector's initials, inspection date and acceptance status of the joint.

3. ADDITIONAL REQUIREMENTS FOR CONNECTIONS THAT REQUIRE PRETENSIONING

All requirements of Section 2 above shall apply in addition to the following:

- 3.1** Inspect pretensioning operations to verify the proper application of the bolting procedures and conformance with the DSA-approved documents and applicable reference standards.
- 3.2** Verify that faying surface requirements are met for all slip-critical joints.
- 3.3** Observe and document the pre-installation verification (PIV) for each fastener assembly lot prior to the use of that assembly lot being installed in the work. PIV shall be performed at the start of work. For calibrated wrench pretensioning, PIV shall be performed daily for the calibration of installation wrenches. Verify and document that the bolt tension calibrator (e.g., Skidmore-Wilhelm) used for this testing is currently calibrated and in good working order.

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3.4 Additional requirements apply to the following pretensioning methods per CBC Table 1705A.2.1:

3.4.1 Turn-of-Nut Method

- After all bolts have been brought to the snug-tight condition in accordance with Section 2.10 above, the face of the nut and the protruding bolt point shall be match-marked in the presence of the HSB special inspector.
- After match-marking, bolts shall be tightened by applying the specified amount of nut rotation. Bolts shall be tightened in a systematic manner beginning at the most rigid part of the connection and progressing systematically to the free edges. This final tightening operation shall be performed in the presence of the HSB special inspector.

3.4.2 Tension-Control Bolt Method (Twist-Off-Type)

- Hardened washers under the nut are always required when the tension-control pretensioning method is used.
- Tightening to the snug-tight condition and tightening to the final pretensioned condition (i.e., shearing the bolt shear groove) shall be accomplished in two separate tightening operations in the presence of the HSB special inspector. Each tightening operation shall be completed for all bolts in the connection before proceeding to the next tightening operation. Tightening shall always begin at the most rigid part of the connection and progress systematically to the free edges. If the shear groove of a bolt is sheared during the snug-tightening operation phase, that bolt shall be removed and replaced.
- Manufacturer-applied lubrication of tension-control bolts is essential to the reliable performance of these fasteners. Bolts that have been exposed to moisture, contaminants, or lubricants other than the factory coatings applied by the manufacturer shall not be used.

3.4.3 Calibrated Wrench Method

- Hardened washers under the element to be turned are always required when the calibrated wrench pretensioning method is used.
- At least once each working day, installation wrenches shall be calibrated on an acceptable, calibrated tension measuring device, such as a "Skidmore-Wilhelm," in the presence of the HSB special inspector.
- Wrenches shall be calibrated to provide a tension of 1.05 times the specified installation tension.
- Wrenches shall be calibrated with identical equipment, operator, compressor, hose length, bolts, nuts, washers, etc. as used in the production operation.
- Any time any component of the installation process is changed (operator, wrench, compressor, hose, fastener components, etc.) the calibration procedure shall be redone.
- Following initial tightening to the snug-tight condition the connection shall be tightened using the calibrated wrench beginning at the most rigid part of the connection and progressing systematically to the free edges until the torque for all bolts reaches the calibrated torque. Several tightening cycles may be needed.

3.4.4 Direct Tension Indicator (DTI) Method

- In addition to the requirements of Section 2.3 above, "direct tension indicators" shall be included in the bolt assemblies checked in the tension calibrating device. DTIs must meet the installed tolerances specified in Table 3 of ASTM F959.
- After all bolts in the joint have been brought to the snug-tight condition in accordance with Section 2.10 above, each bolt shall be tightened in a sequence beginning at the most rigid part of the connection and progressing to the free edges until the DTI arch-like protrusions are compressed to a gap of two times the job inspection gap. If any DTI is compressed to the

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job inspection gap prior to completing this step that DTI shall be replaced. Note that A325 bolts can be loosened and reinstalled *only once*, and A490 bolts may not be reinstalled. After all bolts are tightened so that the gap is twice the job inspection gap then bolts shall be tightened, starting at the most rigid part of the connection and progressing to the free edges, until the job inspection gap is obtained for all bolts.

4. GALVANIZED FASTENERS

Only ASTM F3125 Grade A325 designated high-strength bolts are permitted to be galvanized.

All galvanized high-strength bolts and nuts shall be shipped as an assembly together in the same container.

5. REUSE

The following bolt grades are **NOT** permitted to be reused:

- A490.
- A325 Galvanized.

6. REPORTING

The HSB special inspector shall provide detailed special inspection reports as described in Section 2 and 3 (when applicable) above, *IR 17-12: Special Inspection Reporting Requirements*, and CAC Section 4-335(f)4 to the project inspector and others indicated to receive such reports. A special inspection report template (form *DSA 250: Special Inspection Report*) is available on DSA's website. Any rejected HSBs or HSB installations that are not corrected shall be brought to the contractor's and project inspector's attention immediately.

6.1 Reports shall clearly describe the HSB installation process used and the inspection duties performed including all inspection listed above. Reports shall include a systematic list of accepted and rejected fastener components or joints. The HSB special inspector shall include his or her International Code Council Structural Steel and Bolting Special Inspector certification number on all reports.

7. FAILURE TO PERFORM

Failure to inspect the work in a professional and competent manner, report defective work, file all required reports in a truthful and timely manner, or fulfill any other duties defined by the code may result in withdrawal of the HSB special inspector's DSA acceptance and/or withdrawal of the LOR's DSA acceptance (reference CAC 4-335.1[c]). This includes but is not limited to withdrawal of acceptance or approval to work on any current or future projects under DSA jurisdiction.

REFERENCES:

2022 California Code of Regulations (CCR) Title 24
Part 2, California Building Code (CBC), Sections 1705A.2.1, 1705A.2.6, and Table 1705A.2.1

This IR is intended for use by DSA staff and by design professionals to promote statewide consistency for review and approval of plans and specifications as well as construction oversight of projects within the jurisdiction of DSA, which includes State of California public schools (K-12), community colleges and state-owned or state-leased essential services buildings. This IR indicates an acceptable method for achieving compliance with applicable codes and regulations, although other methods proposed by design professionals may be considered by DSA.

This IR is subject to revision at any time. Please check DSA's website for currently effective IRs. Only IRs listed on the webpage at www.dgs.ca.gov/dsa/publications at the time of project application submittal to DSA are considered applicable.