

Guidelines for the Qualification of Structural Bolting Inspectors

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AMERICAN ASSOCIATION
OF STATE HIGHWAY AND
TRANSPORTATION OFFICIALS
AASHTO



AASHTO/NSBA Steel Bridge Collaboration

American Association of State Highway and
Transportation Officials
National Steel Bridge Alliance

Preface

This document presents guidelines developed by the AASHTO/NSBA Steel Bridge Collaboration. The primary goal of the Collaboration is to achieve steel bridge design and construction of the highest quality and value through standardization of the design, fabrication, and erection processes. Each document represents the consensus of a diverse group of professionals.

It is desired that Owners adopt and support Collaboration guidelines in their entirety to facilitate the achievement of standardization. It is understood, however, that local statutes or preferences may prevent full adoption of the guidelines recommended herein. In such cases, Owners may adopt these guidelines with the exceptions they feel are necessary.

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Introduction

These guidelines have been developed by the AASHTO/NSBA Steel Bridge Collaboration to define essential factors involved in structural bolting and the qualification of personnel inspecting and monitoring those operations.

This document should be a guide in developing individual training and qualification programs. The recommended elements listed in the Body of Knowledge in Section 5 should be modified to meet specific needs.

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Section 1 References

The following industry standards and specifications should be used in the development of a compliant qualification and certification program:

- AASHTO/NSBA Steel Bridge Collaboration S2.1, *Steel Bridge Fabrication Guide Specification*
- AISC, Manual of Steel Construction
- Research Council on Structural Connection (RCSC) Specification for Structural Joints – Using High-Strength Bolts
- ASTM Standard Specifications as they apply to structural bolting: A449, A563, F436, F959, and F3125.
- FHWA-SA-91-031, *High-Strength Bolts for Bridges* (Disclaimer: this document could serve as a basis for training, but be forewarned that it is archived, not updated, and in some cases obsolete).

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Section 2 Functions

2.1—Capabilities

A qualified Structural Bolting Inspector should be able to perform bolting inspections, supervise one or more inspectors, prepare inspection procedures, conduct audits of field bolting conditions and methods, and ensure that bolting operations conform to project requirements and applicable standards.

The Inspector should be able to identify deficiencies in structural bolting, verify rotational capacity testing, and observe pre-installation testing.

2.2—Duties

Although the Inspector's duties are defined by each organization, a Structural Bolting Inspector should be able to perform at least the following duties:

2.2.1—Interpret drawings and other documents.

2.2.2—Interpret and accept rotational capacity (ROCAP) test reports, material test reports (MTRs), and manufacturers' certificates of compliance.

2.2.3—Verify fastener assemblies for correct components, material type, grade, and coating; verify bolt head markings and manufacturer and supplier marks, nut markings, and structural and DTI washer markings, supported by proper documentation.

2.2.4—Verify proper storage conditions.

2.2.5—Verify proper coating (if required), lubrication, and surface condition of bolts, nuts, and washers.

2.2.6—Identify the requirements for washers and ensure adherence.

2.2.7—Verify snug-tight conditions prior to final pretensioning.

2.2.8—Witness performance of pre-installation verification and verify reference marks on components and material before final pretensioning.

2.2.9—Verify the suitability and calibration of equipment used to perform structural bolting activities.

2.2.10—Verify that the knowledge of personnel supervising or performing bolting applications is adequate.

2.2.11—Determine whether bolts may be reused (i.e., loosened and retightened).

2.2.12—Determine and verify required minimum fastener pretension.

2.2.13—Prepare clear, concise reports and verify that pertinent records are maintained.

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Section 3 Training/Experience Requirements

3.1—Recommendations

The Structural Bolting Inspector should:

3.1.1—be a high school graduate, or hold a state-approved high school equivalency diploma.

3.1.2—possess at least one year of experience in structural steel bridge fabrication, erection, and/or inspection, and be directly involved with structural bolting operations.

3.2—Structured Training

Training and qualification required by this document may be considered satisfied if the candidate Inspector provides documentation for successfully completing a minimum of eight hours of training offered by an organization or individual recognized by the Owner. Such documentation should include evidence of satisfying the requirements listed in Section 5.

3.3—Experience Credit

Structural Bolting Inspectors not meeting the above experience guidelines should work under the supervision of a qualified Structural Bolting Inspector until such time as the appropriate experience and training is gained.

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Section 4 Qualification

4.1—Requirements

The requirements for qualifying a Structural Bolting Inspector under this Guide are as follows:

4.1.1—The Inspector should pass a written test of no less than 50 multiple choice and/or True/False questions with a minimum of 70 percent correct, proving a general understanding of the Body of Knowledge specified in Section 5.

4.1.2—The Inspector should demonstrate hands-on proficiency by completing or directing the completion of rotational capacity testing and pre-installation verification testing using a tension calibration device in the presence of an individual qualified in accordance with this Guide.

4.1.3—The Inspector should remain qualified under this Guide, provided that he or she documents ongoing employment involving structural bolting operations and performing inspection duties at least once every six months.

4.2—Documentation

The employer of the Inspector should maintain training records (including dates and curricula), completed examinations, evidence of initial demonstrated proficiency, qualification certificates issued, and documentation of inspections performed, including dates, testing, and types of assemblies.

Qualification certificates should contain the following information:

4.2.1—name of the Inspector

4.2.2—statement indicating satisfactory completion of training

4.2.3—statement indicating that the Inspector’s qualification is in accordance with this Guide or an acceptable industry standard

4.2.4—signature of party responsible for maintaining

4.2.5—qualification date of qualification

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Section 5

Body of Knowledge

5.1—Bolted Connection Overview

This section delineates code requirements and proper methods for using bolted joints that the Inspector should understand and enforce. The Inspector should also understand the installation and inspection requirements for various types of high-strength bolted joints.

5.1.1—Joint Types

The types of bolted joints commonly used in bridge and highway construction.

5.1.1.1—Slip-Critical

The definition, load transfer method, surface and bolt requirements, typical usage, installation, and inspection of slip-critical joints.

5.1.1.2—Snug Tightened

The definition, installation requirements, and inspection of snug-tightened joints.

5.1.1.3—Pretensioned

The definition, installation requirements, and inspection of pre-tensioned joints.

5.1.2—Load Transfer

The difference between various load transfer mechanisms for high-strength bolted joints.

5.1.2.1—Shear/Bearing

Bolts subjected to direct shear at bearing connections in bolted splices.

5.1.2.2—Direct Tension

Effects of direct tension on connections for hangers, prying action, etc.

5.1.2.3—Friction

The types of surface conditions required to obtain proper slip coefficients.

5.1.3—Bolt Holes and Slots

The acceptance/rejection quality standards for standard bolt holes, oversized holes, and short and long slotted holes including dimensions, reaming, multi-ply alignment, out-of-round, and quality (tears, burrs, etc.). The acceptance/rejection criteria for bolt spacing and edge distance.

5.1.4—Snug Tightening

The definitions of “snug tight” for both rotational capacity testing and installation. Proper systematic tightening to bring an entire assembly to the snug-tight condition.

5.1.5—Bolt Pretension

The principles and methods to tighten bolts in pretensioned and slip-critical joints.

5.2—Bolting Materials and Usage

Know, understand, and be able to properly identify the bolting materials required for a project, ensure the materials’ quality upon receipt and after storage, and select the proper materials and methods for installation.

5.2.1—Bolts

5.2.1.1—Bolt Types

The differences between various types of bolts (heavy hex head, twist-off type, etc.).

5.2.1.2—Material Grades

The differences and common uses for each grade and type of structural bolt (A354, A449, F3125 Grades A325, A490, F1852, and F2280 with Types 1 and 3), including restricted uses and conditions.

5.2.1.3—Markings, Dimensions, etc.

The significance of head markings on structural bolts as well as common bolt dimensions and terminology.

5.2.2—Nuts

5.2.2.1—Materials, Markings, Dimensions, etc.

The significance of markings on structural grade nuts as well as common nut dimensions and terminology.

5.2.2.2—Suitability with Bolts

The acceptable combinations of nuts and bolts for structural bolting applications (see ASTM A563 Table X1.1), and the qualification of bolt–nut assemblies.

5.2.3—Washers

5.2.3.1—Material, Dimensions, etc.

The standard materials and sizes of hardened steel washers for structural applications (see F436), and plate or beveled washers for slots or sloping surfaces.

5.2.3.2—Connection Requirements

The correct usage of hardened steel washers in applications with standard, slotted, and oversized holes.

5.2.4—Washer-Type Direct Tension Indicators (DTI)

5.2.4.1—Material, Dimensions, etc.

The configuration, interpretation, and sizes of washer-type direct tension indicators used with high-strength bolts (see ASTM F959).

5.2.4.2—Connection Requirements

The correct installation and verification of washer-type direct tension indicators, including hardened washer requirements based on the turned element, and placement for standard, slotted, and oversized holes.

5.2.5—Bolt Length/Grip

The correct bolt length for given applications, identify stripping, excessive stick-out, and bottoming-out of nuts.

5.2.6—Reuse of Bolts

The situations in which bolts that have been pretensioned may be reused (black vs. coated grades, see ASTM A3125 Grades A325 and A490) and how to check for suitability for reuse.

5.2.7—Storage

Proper job site storage and protection

5.2.7.1—Job Site/Shop Storage

Proper lot segregation and storage procedures and identify and isolate defective items.

5.2.7.2—Lubrication

Proper lubrication of nuts and bolts (black as well as galvanized) and the proper methods and materials used for re-lubrication.

5.2.7.3—Bolted Splices

The requirements for the use of alignment (drift) pins for splice alignment prior to snug tightening and final tensioning.

5.3—Inspection

Know and understand the specific inspection requirements as they apply to the following listed installation methods.

5.3.1—Prior to Installation

Identification of fasteners (type, grade, etc.), proper storage and lubrication, and proper pre-installation verification for the installation method used, including frequency of testing and determination of installation torque if required.

5.3.2—Rotational Capacity (ROCAP) Testing

Requirements for rotational capacity testing (frequency, number of specimens, procedure, required results, long vs. short bolts, etc.).

5.3.3—Snug Tight

Definition of snug tight and systematic tightening, proper snug-tightening procedures and results, how to identify a snug-tightened condition and verify this condition prior to pretensioning.

5.4—Installation Methods

This section includes items to be verified or observed for specific common fastener installation techniques.

For all methods, understand preinstallation verification, proper snug-tightening methods and sequences, use of correct lengths and sizes of fasteners, correct wrench operation, and use of torque verification if required.

5.4.1—Turn-of-Nut Installation

All critical aspects of the turn-of-nut installation technique, including match-marking requirements and required number of turns for the bolts used.

5.4.2—Twist-Off-Type Tension-Control Bolts

All aspects of the installation technique for twist-off-type tension-control bolts, including the required condition of the twist-off splines after snugging and after installation. (Torsion is the mechanism that governs twist-off, but it is related to fastener tension by test results.)

5.4.3—Washer-Type Direct Tension Indicators (DTI)

The installation of high-strength bolts using washer-type direct tension indicators.

5.4.3.1—Pre-Installation Verification

Determination of job inspection gap through preinstallation verification, unless gap is specified; thread check after preinstallation verification test.

5.4.3.2—Snugging

Use of feeler gauge to assess conformance to gap requirements (number of refusals) after snugging.

5.4.3.3—Joint Pretensioning

Use of a feeler gauge or self-indicating features, as permitted, to determine proper bolt pretension based on number of refusals and some visible gap (no “dead flat” washers).

5.4.4—Calibrated Wrench Installation

The installation of high-strength bolts using a calibrated torque wrench, including determination of installation torque, frequency of wrench calibration, and proper setting of wrench for achieving installation torque.

5.5—Time Management

It is not possible to closely monitor multiple bolting crews. Be aware of crew schedules and tell-tale indications of good or bad crew technique to determine how often to check each operation for efficient inspection.

5.6—Arbitration of Disputes

Be familiar with the correct procedures for arbitrating disputes (see the RCSC section on Arbitration).

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