

MEDFORD FABRICATION

PROCEDURE NO.: SP 205

TITLE: Installation Procedure for
High Strength Bolts

DATE: September 20, 2002

REVISION: 0

ORIGINATOR: RW & RB

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PURPOSE:

The purpose of this procedure is to outline the installation procedure for high strength bolts.

SCOPE:

The following protocol is for the installation of high-strength bolts used in structural steel connections that require either pretension (tightened) fasteners or non-pretension (snug tight only) fasteners.

RESPONSIBILITIES:

The General Manager, Quality Manager, Engineering Manager and Vice President of Sales are responsible for adhering to the procedure portion of this procedure.

REFERENCES:

Specification for Structural Joints Using ASTM A325 or A490 Bolts, June 23, 2000, American Institute of Steel Construction, Inc., One East Wacker Drive, Suite 3100, Chicago, IL 60601-2001, 312-670-2400

Structural Bolting Handbook, 2001, Steel Structures Technology Center, Inc., 24110 Meadow Brook Road, Suite 104, Novi, MI 48375-3406, 248-893-0132

EXHIBITS:

PROCEDURE:

Introduction

The "turn-of-nut" method shall be the bolt installation procedure used by Medford Fabrication for pretension bolts. Methods are presented for two conditions:

- *snug-tight only,
- *pretension to the minimum required pretension

Design, use and installation is governed by the American Institute of Steel Construction (AISC) Specification for Structural Steel Buildings, either ASD or LRFD, and the Research Council on Structural Connections (RCSC) Specification for Structural Joints Using ASTM A325 and A490 Bolts. Additional information for special applications may be drawn from the Structural Bolting Handbook, published by the Steel Structures Technology Center (SSTC)

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Materials

Bolts, nuts and washers shall be purchased from domestic manufacturers with full manufacturer's certifications in accordance with the ASTM specifications. It is not necessary to repeat any physical testing of the fastener products to verify the manufacturer's test results. The manufacturer and lot numbers of the fasteners used shall be recorded. Preferably, fasteners shall be ordered in sufficient quantities so that the same lot may be used for each diameter, length and grade required. A common lot may be used for nuts and washers for a given diameter and grade.

Nuts shall be ASTM A563 grade DH or DH3, or ASTM A194 grade 2H. Alternatively, ASTM A563 nuts of grades C, C3 and D, or ASTM A194 grade 2, may be used provided the hardness as tested is at least 89 HRB or 180 Brinell. This is necessary to minimize the risk of nut thread strip-ping when performing testing in the bolt calibrator.

All fasteners are to be stored by lot in closed containers, kept clean and dry. Black (uncoated fasteners) shall be oily to the touch. Do not lubricate any individual fasteners unless the entire lot is lubricated in the same manner. If lubricated, the fastener assembly must have the Pre-Installation Testing and Calibration testing, as described below, performed prior to use.

Joint Design and Tightening

Bolt lengths shall be selected so that the bolt end is at least flush with the outer face of the nut after installation.

Joints will preferably be configured so that the fastener assembly will be tightened by turning the nut rather than turning the bolt head. The bolt head must be held when turning the nut, and vice versa.

For testing purposes and torque measurement consistency, even though not required by RCSC for all cases, hardened steel ASTM F436 washers shall be used beneath the turned element.

For joint behavior that is dependent upon slip resistance (a slip-critical joint), the joint should be tensioned to the minimum required pretension. For joints in direct tension, the joints may be tightened to either the minimum required pretension, or tensioned using standard approved shop and field practices, which will generally provide tensions higher than the minimum required pretension. For joints where bolt tension would not affect the behavior of the joint, the snug-tight only condition should be used.

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Pre-Installation Testing and Calibration

The following procedures are to establish benchmark values for certain tightening operations and to verify the suitability of the fastener assembly. The AASHTO/FHWA Rotational Capacity Test Procedure has been adapted for use in this section. For further details on the original AASHTO/FHWA test procedure, see SSTC pages 72-76.

Prior to installation in the test joint, five bolts, nuts and washers of each diameter, length and grade of the lots to be used in the test shall be subjected to pre-installation testing in a Skidmore-Wilhelm bolt tension calibrator or similar device. Each assembly shall be placed in the calibrator, oriented in the same manner so that the element turned (bolt head or nut) in the calibrator is also the element turned in the test joint. The washer used as a part of the assembly shall be placed directly below the turned element. Additional flat washers or plates shall be used to provide approximately two threads of stick out beyond the face of the nut prior to tightening. For long bolts, several washers in a stack may provide questionable calibration results, and therefore solid steel plates or stacks of flat plates are recommended for assemblies requiring more than one inch of stacked washers.

The assembly shall then be tightened by hand with a spud wrench or similar hand wrench. Do not exceed the required pretension. Upon completion of snugging, match mark the end of the bolt, face of the nut, and face of the calibrator with a single straight line.

Tighten the assembly until the assembly reaches the required pretension as provided in AISC Table J3.7, as provided below.

Bolt Diameter	A325 Bolt	A490 Bolt
1/2"	12	15
5/8"	19	24
3/4"	28	35
7/8"	39	49
1"	51	64
1-1/8"	56	80
1-1/4"	71	102
1-3/8"	85	121
1-1/2"	103	148

Using a manual torque wrench with a dial-type torque indicator, measure the torque at this condition by applying the torque wrench in the tightening direction, placing the wrench into motion adequate to provide approximately 5° additional rotation. Record his torque value in a logbook. The torque must not exceed the torque, measured in foot-pounds, per the following table. If the torque exceeds this amount, then the fastener assembly is considered poorly lubricated and should not be used until lubricated and retested.

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Bolt Diameter	A325 Bolt	A490 Bolt
1/2"	150	180
5/8"	290	360
3/4"	500	630
7/8"	820	1030
1"	1230	1540
1-1/8"	1500	2160
1-1/4"	2140	3060
1-3/8"	2810	3990
1-1/2"	3690	5320

Further turn the nut until the required turn for pretension is provided in accordance with RCSC T-1, as provided below. Bolt length is measured from the underside of the bolt head to the end of the bolt. Record the bolt tension as measured in the bolt calibrator. Measure and record the torque at this tension using the same steps as in the previous paragraph.

SSTC Table T-1

Bolt Length	Rotation
up to and including 4 diameters	1/3 turn
over 4 but not exceeding 8 diameters	1/2 turn
over 8 but not exceeding 12 diameters	2/3 turn

Further tighten the assembly until a total of twice the number of turns required by RCSC Table T-1 has been provided, as stated in the following table:

Bolt Length	Rotation
up to and including 4 diameters	2/3 turn
over 4 but not exceeding 8 diameters	1 turn
over 8 but not exceeding 12 diameters	1-1/3 turn

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Record the bolt tension. The tension at this point should not be less than 15% higher than the minimum required pretension, as provided per the table below.

Bolt Diameter	A325 Bolt	A490 Bolt
1/2"	14	17
5/8"	22	28
3/4"	32	40
7/8"	45	56
1"	59	74
1-1/8"	64	92
1-1/4"	82	117
1-3/8"	98	139
1-1/2"	118	170

Remove the assembly from the Skidmore. Visually inspect the bolt threads and nut threads for any visual indications of stripping.

Should a specific combination of bolt lot, nut lot and washer lot be changed, the above Pre-Installation Testing Procedure shall be repeated for the new combination of lots.

Short Bolts

For bolts too short to fit into a Model M or Model L Skidmore-Wilhelm bolt calibration device, the use of the Model MS Skidmore-Wilhelm is recommended. Alternatively, the use of "calibrated" direct tension indicators (dti's) is permitted to verify minimum required bolt tension values. For calibration of dti's, see SSTC page 17. Calibrated dti's may not be used to establish or verify turn-of-nut procedures. Alternative methods must be used for turn-of-nut verification, or the dti installation procedure as described in SSTC page 30 or 31 may be used in lieu of turn-of-nut tightening.

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Inspection Procedures Prior to Installation

Inspect the materials to verify that they are readily identifiable, have proper markings, and have proper documentation in accordance with the project specifications. Ensure the storage methods for each fastener lot are kept separate and identifiable. Keep galvanized fastener assemblies together as one unit as shipped by the supplier. All fasteners should be adequately lubricated and any black hardware that is dry or rusty should be cleaned, relubricated and retested if necessary.

Tightening a Joint to the Snug Tight Condition

The snug tight condition is defined as "the tightness achieved with the full effort of a worker with an ordinary spud wrench or a few hits of an impact wrench that brings the connected plies into firm contact."

The joint must have the steel in contact immediately around each bolthole. It is not necessary to have the steel in contact at outer edges of the joint, such as the edges of plates or the heels or toes of angles. For materials of 1-1/2 inches in thickness or more, it may not be possible to bring the joint into contact around the boltholes when there is severe misalignment of parts. In this case, impact wrenches must be used for snugging the joint and the steel must be brought into solid contact where possible.

Joints must be snugged in a systematic manner, starting from the most rigid part of the joint and proceeding toward the free edges, or from the part in contact toward the part of the joint not in contact

Pretension a Joint to the Minimum Required Pretension by turning the nut

Bring the joint to the snug tight condition as described above and inspect the joint to verify the snug condition has been achieved. Match mark each nut, bolt and steel surface in a straight line, going across a corner of the nut. One worker holds the bolt head still as a second worker turns the nut the required amount of turns given in SSTC Table T-1. Visually inspect the match marks to confirm the required number of turns has been applied.

Pretension a Joint to the Minimum Required Pretension by turning the bolt

Bring the joint to the snug tight condition as described above and inspect the joint to verify the snug condition has been achieved. Match mark each bolt head and steel surface in a straight line, going across a corner of the nut. Also, match mark a nut corner and the steel on the opposite side. One worker holds the nut still as a second worker turns the bolt the required amount of turns given in SSTC Table T-1. Visually inspect the match marks to confirm the required number of turns has been applied.

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Pretension Using Other Approved Shop and Field Practices

Although other pretension methods (calibrated wrench, twist-off bolts, alternative design fasteners, and direct tension indicators) are approved for use under RCSC Specification, the turn-of-nut method is the method anticipated to be the most commonly used for heavy structural connections in building applications, and therefore has been selected for this protocol. Other methods may be used with the approval of the Engineering Manager.