

Recommend Approval: <u>Rayan S. Lewis Sr</u> <u>8/13/19</u> Team Leader Date <u>[Signature]</u> <u>8-13-19</u> Division Chief Date	Maryland Department of Transportation State Highway Administration Office of Materials Technology MARYLAND STANDARD METHOD OF TESTS	
Approved: <u>[Signature]</u> <u>08/16/2019</u> Director Date	ROTATIONAL CAPACITY FIELD TEST AND TURN OF THE NUT VERIFICATION TEST OF HIGH STRENGTH STEEL BOLTS	MSMT 710

SCOPE:

This procedure covers the Rotational Capacity Field Test and Turn of the Nut Verification test for high strength bolts used in structural steel members. This test method is used to confirm the suitability of the complete fastener assembly, including lubrication.

REFERENCE DOCUMENTS:

F3125 Standard Specification for High Strength Bolts, Steel and Alloy Steel Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric

EQUIPMENT:

1. Bolt tension measuring device (Skidmore-Wilhelm or equal) of the size required for the bolts to be tested.
2. Dial torque wrench and spud wrenches.
3. Spacers with holes 1/16 larger than bolt to be tested or nominal diameter washers.
4. Steel section to mount the tension measuring device.

PROCEDURE:

Each Test Method consists of Three Assembly Sets. An assembly set consists of a bolt of each diameter, length, grade and production lot with a nut of each diameter, grade and production lot, including any washers that will be used in the field. The Turn of the Nut Verification test uses the first 6 steps listed below and the Rotational Capacity Field Test method, when required, uses all 9 steps listed below.

1. Perform pre-installation testing for each fastener for each assembly lot to be used 24 hours prior to the start of work. Further testing may be required if the condition of the fasteners or the lubrication changes.
2. Measure the bolt length from the end of the bolt to the washer face at the bolt head to shank interface.
3. Install the bolt in the tension calibrator with the required spacers or washers so that it is flush with the nut to a maximum of three threads. This will typically provide three to five threads

within the grip (the distance between the bolt head and the inside face of the nut). This stick-out requirement applies during installation.

4. Tighten the fastener assembly using a spud wrench to the snug tight tensions listed below: (-0 / +2 kips)

Bolt Dia. (in.)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Initial Tension (kips) A-325	1	2	3	4	5	6	7	9	10
Initial Tension (kips) A-490	2	2	4	5	6	8	10	12	15

5. Match mark the bolt, nut and face plate of the calibrator.
6. Use the calibrated dial torque wrench to tighten the fastener assembly to at least the minimum installation tension listed below, then record the tension and torque. Read the torque while the nut is rotating. The torque value (T) from the test shall not exceed $T = .25 PD$. P= tension in pounds. D= Dia. (in.)/12 = bolt diameter in feet.

Bolt Dia. (in.)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Tension (kips) A-325	12	19	28	39	51	56	71	85	103
Tension (kips) A-490	15	24	35	49	64	80	102	121	148

7. Further tighten the bolt to the rotation listed below. Measure the rotation from the initial marking in step 5.

Bolt Length (from step 1)	4 x bolt dia. or less	Greater than 4 dia. but not more than 8	Greater than 8 dia.
Required Rotation	2/3	1	1 1/6

8. Record the tension at the completion of the rotation in Step 6. The tension shall equal or exceed 1.15 x the minimum installation tension. The minimum required tensions are listed below:

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

9. Loosen and remove the nut. There shall be no signs of thread shear failure, stripping or torsional failure. Use your fingers to turn the nut on the bolt threads to its position during the test. The nut does not need to run the full length of the threads. Nuts that cannot be turned with your fingers are considered to have thread failure.

FAILURES

The following constitute a failure of the rotational capacity test: Failure of any one of these items on either assembly constitutes a failure of the test

- a. Exceeding the maximum allowable torque in the torque/tension comparison.
- b. Failure to achieve the required rotation.
- c. Failure to achieve the required tension at the required rotation.
- d. Thread failure.

When a failure occurs, the subject lot of fasteners is rejected. The contractor is given the option to clean and re-lubricate as necessary and then retest the fastener assemblies.

REPORT

Complete the Rotational Capacity Field Test Turn of the Nut Verification Worksheet (page 4 of 5) and file in the onsite project file.

**ROTATIONAL CAPACITY FIELD TEST
AND TURN OF NUT VERIFICATION APPENDIX**

Table 1 Snug Tight Condition									
Bolt Dia. (in.)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Snug Tension (Kips) A325 Bolts	1-3	2-4	3-5	4-6	5-7	6-8	7-9	9-11	10-12
Snug Tension (Kips) A490 Bolts	2-4	3-5	4-6	5-7	7-9	8-10	11-13	13-15	15-17

Table 2 Minimum Tension For Rotation Capacity Test*									
Bolt Dia. (in.)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Tension (Kips) A325 Bolts	12 (13)	19 (20)	28 (29)	39 (41)	51 (54)	56 (59)	71 (75)	85 (89)	103 (108)
Tension (Kips) A490 Bolts	15 (16)	24 (25)	35 (37)	49 (51)	64 (67)	80 (84)	102 (107)	121 (127)	148 (155)

*Number in () = minimum Torque for Turn of Nut

Table 3 Full Rotation Tension Requirements									
Bolt Dia. (in.)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Tension (Kips) A325 Bolts	14	22	32	45	59	64	82	98	118
Tension (Kips) A490 Bolts	-	-	-	-	-	-	-	-	-

**ROTATIONAL CAPACITY FIELD TEST
AND TURN OF NUT VERIFICATION WORKSHEET**

Contract Number:	Date:
Contractor:	Bridge Number:
Erector:	SHA Representative:

RC Number:	Size	Lot Number	Manufacturer	ID Mark	Finish	
					Plain	Galv.
Bolt						
Nut						
Washer						

Skidmore Serial #	Calibration Date	Torque Wrench Manufacturer	Torque Wrench Serial Number	Calibration Date

All equipment must be calibrated within one year of use.

TEST REQUIREMENTS

Installation Turn of Nut Required			Snug Tight Requirements	Minimum RC Tension Required	Minimum Turn of Nut Tension	Maximum Degree of Rotation		
Circle One						Circle One		
≤4d	>4d-8d	>8d				≤4d	>4d-8d	>8d
1/3 120°	1/2 180°	1 360°				2/3 240°	1 360°	1 1/3 480°

TEST RESULTS

	Test 1	Test 2	Test 3	Pass	Fail
				(yes/no)	
Bolt, Nut, Washer (Oily To Touch)					
Tested Tension ¹					
Torque At Tested Tension ²					
Turn of Nut Tension Verification ³					
Maximum Degree of Rotation					
Tension At Full Rotation					
Visual Inspection of Bolt after Test					

¹ Test tension may exceed minimum tension requirements. See Table 1 in Appendix below.

² Torque value shall not exceed Chart 1. For bolts not listed use .25(test tension)(bolt diameter in feet)

³ Turn of nut tension must be equal to or greater than tension listed in Table 2 parentheses ().

Address questions or concerns related to the installation of High Strength Fasteners to the Office of Materials and Technology, Metals Team (443)572-5291.

Signature: _____