
High Strength Bolt Assemblies with Direct Tension Indicator Verification

SC T 135

1. Scope

Testing verifies assemblies' results furnished by the manufacturer or distributor.

2. Referenced Documents

2.1 ASTM Standards

- A 325 Specification for High-Strength Bolts for Structural Steel Joints
- A 563 Specification for Carbon and Alloy Steel Nuts
- F 436 Specification for Hardened Steel Washers
- F 606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets
- F 959 Specification for Compressible-Washer Type Direct Tension Indicators for Use with Structural Fasteners

2.2 SCDOT Standards

Current Edition of South Carolina Department of Transportation Specifications for Highway Construction

3. Apparatus

- 3.1 Skidmore-Wilhelm Calibrator
- 3.2 Torque Wrench
- 3.3 Tapered Leaf Thickness Gauge 0.005 inch
- 3.4 Wrench for Bolt Head
- 3.5 Markers
- 3.6 Rockwell Hardness Tester
- 3.7 Coating Thickness Gauge
- 3.8 Charts for length to size installation and test requirements for tension and torque readings
- 3.9 Mill Test Reports
- 3.10 Manufacturer certified test report or distributor certified test report

4. Test Specimens

- 4.1 Three assemblies of each combination of materials including bolt production lot, nut lot, washer lot, DTI lot and for each length of bolts.
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5. Procedure

- 5.1 Each possible combination will have a rotational-capacity lot (RCL #) number and will be given a lab number which will be the rotational-capacity lot number and markings shown on report sheet.
- 5.2 Each lot number will have the chemical properties recorded from the mill test and the results checked for conformance to specifications.
- 5.3 Each RCL # will be identified and recorded for the bolt, nut, flat washer and DTI, including manufacturer, heat, lot grade or type, surface hardener, core hardens, proof load, and tension strength where required per certification. Checked for conformance to the specifications, as well as all following results.
- 5.4 Check zinc coating with an average reading for three tests on each piece.
- 5.5 Measure body diameter of bolt and nut to thousandths of an inch.
- 5.6 Measure minor thread diameter of the nut to a thousandths of an inch.
- 5.7 Measure major thread diameter of the bolt to a thousandths of an inch.
- 5.8 Measure head height of the bolt to a thousandths of an inch.
- 5.9 Measure the Rockwell Hardness "C" of the bolt, nut, flat washer surface and the core of the flat washer.
- 5.10 Assemble the bolt, nut, and washer in the calibrator and tension to 10% of the specified proof load.
- 5.11 Mark nut and tighten to installation tension for proof load and record tension and torque for later use.
- 5.12 Complete tightening nut:

240° for bolt lengths ≤ 4 diameter (d)
360° for bolt lengths > 4 d and ≤ 8 d
480° for bolt lengths > 8 d and ≤ 12 d

Record torque and tension and check to see if the tension meets the specification of 1.15 times required minimum installation tension.

- 5.13 Inspect threads for damage.
- 5.14 Indicate if lubrication was satisfactory.
- 5.15 Set up system with new materials with added DTI against the head of the bolt.
- 5.16 Tighten nut to 1.05 times the proof load with another wrench on bolt head to prevent rotation of the head against the DTI which can be taken from table below.

Bolt Tension (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
M164 (A325)	13	20	29	41	54	59	75	89	108
M253 (A490)	NA	NA	37	51	67	84	107	127	NA

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- 5.17 Determine and record the number of spaces between the protrusion on the DTI that a 0.005 in. thickness gage is refused. The total number of spaces in the various sizes and grade of DTI's is shown below.

Number of Spaces

Bolt Dia (in)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
M164 (A325)	4	4	5	5	6	6	7	7	8
M253 (A490)	NA	NA	6	6	7	7	8	8	NA

- 5.18 The number of spaces which the 0.0005 in. gage is refused should not exceed the number given in the table below. If the number of spaces exceeds the number in the table, the DTI fails the verification test.

Verification Criteria

Number of spaces in washer	4	5	6	7	8
Maximum number of spaces gage is refused	1	2	2	3	3

- 5.19 Tighten bolt until the 0.005 in. gage is refused at all spaces but a visible gap exists and record compression strength.
- 5.20 Calculate 95% of tension from 5.11.
- 5.21 Remove the fastener from the calibrator and turn the nut on the threads of the bolt by hand through the full length of the threads.
- 5.22 DTI is satisfactory if the compressive strength of the DTI is between strengths from 5.16 and 5.20 and nut goes full length in 5.21.

6. Calculations

$$45 \text{ Kips} \times 0.95 = 42.8 \text{ Kips}$$

$$45 \text{ Kips} \times 1.05 = 47.3 \text{ Kips}$$

7. Report

Test results are reported on Lab Form 947. Data and calculations are recorded on worksheet 947W.
