

**STATE OF OHIO
DEPARTMENT OF TRANSPORTATION**

SUPPLEMENT 1080

**REQUIREMENTS FOR HIGH-STRENGTH STEEL
BOLTS, NUTS AND WASHERS (711.09)**

April 19, 2002

High strength steel bolts, nuts and washers shall conform to the requirements of this supplement, in addition to 513.20 and 711.09.

A.

- A1. All AASHTO M 164/ASTM A 325 (AASHTO M 164M/ASTM A 325M) high strength bolts, nuts and washers shall be furnished in accordance with the appropriate AASHTO Materials Specification as amended and revised herein.

Additional requirements for field or shop installation of AASHTO M 164/ASTM A 325 (AASHTO M 164M/ASTM A 325M) high strength bolts are also included. These additional requirements supplement the requirements in Item 513 of the Construction and Material Specifications.

B. Specifications

- B1. All bolts shall meet the requirements of AASHTO M 164/ASTM A 325 (AASHTO M 164M/ASTM A 325M) and these revisions.
- B2. All nuts shall meet the requirements of AASHTO M 291/ASTM A 563 (AASHTO M 292M/ASTM A 194M or AASHTO M 291M/ASTM A 563M) as applicable and these revisions.
- B3. All washers shall meet the requirements of AASHTO M 293/ASTM F 436 (AASHTO M 293M/ASTM F 436M) and these revisions.

C. Manufacturing

C1. Bolts

1. Hardness of bolts with diameters M16 through M36 (½ inch thru 1 inch) shall be within the range specified below:

| Bolt Size, in. | Hardness Number | | | |
|-----------------|-------------------|-------|------------|------|
| | Vickers (Brinell) | | Rockwell C | |
| | Min. | Max. | Min. | Max. |
| M16 thru M36 | 264 | 327 | 24 | 33 |
| (½ thru 1 inch) | (248) | (311) | (24) | (33) |

C2. Nuts.

1. Nuts, hot-dip galvanized or mechanically zinc coated, shall be heat treated Grade 10S AASHTO M 219M/ASTM A 563M (Grade DH or DH3, AASHTO M 291/ASTM A 563, or Grade 2H, AASHTO M 292/ASTM A 194).
2. Plain (ungalvanized) nuts shall be AASHTO M 291M/ASTM A 563M Grades 8S & 8S3 with a minimum Rockwell hardness of 89 HRB (AASHTO M 291/ASTM A 563, Grades C, D, DH, DH3 or C3, or AASHTO M 292/ASTM A 194 Grade 2 or 2H with a minimum hardness of 89 HRB).
3. Nuts that are to be galvanized shall be tapped oversize the minimum amount required for proper assembly. The amount of overlap in the nut shall be such that the nut will assemble freely on the bolt in the coated condition and shall meet the mechanical requirements of AASHTO M 291M/ASTM A 563M (AASHTO M 291/ASTM A 563) and the rotational-capacity test herein. The overlapping requirements of AASHTO M 291M/ASTM A 563M Paragraph 7.8 (AASHTO M 291/ASTM A 563 Paragraph 7.4) shall be considered maximum values instead of minimum, as currently shown.
4. Galvanized nuts shall be lubricated with a lubricant containing a dye of any color that contrasts with the color of the galvanizing.

C3. Marking

1. All bolts, nuts and washers shall be marked in accordance with the appropriate AASHTO/ASTM Specifications.

D. Testing

D1. Bolts

1. Proof load tests (ASTM F 606 Method 1) are required. Minimum frequency of tests shall be as specified in AASHTO M 164M/ASTM A 325M Paragraph 10.2.4 (AASHTO M 164/ASTM A 325 Paragraph 9.5.1).
2. Wedge tests on full size bolts (ASTM F 606 Paragraph 3.5) are required. If bolts are to be galvanized, tests shall be performed after galvanizing. Minimum frequency of tests shall be as specified in AASHTO M 164M/ASTM A 325M Paragraphs 7.4 and 10.2.4 (AASHTO M 164/ASTM A 325 Paragraph 9.5.1).
3. If galvanized bolts are supplied, the thickness of the zinc coating shall be measured. Measurements shall be taken on the wrench flats or top of the bolt head.

D2. Nuts

1. Proof load tests (ASTM F 606 Paragraph 4.2) are required. Minimum frequency of tests shall be as specified in AASHTO M

291M/ASTM A 563M, Paragraph 9.3 (AASHTO M 291/ASTM A 563, Paragraph 9.3, or AASHTO M 292/ASTM A 914, Paragraph 7.1.2.1). If nuts are to be galvanized, tests shall be performed after galvanizing, overtapping and lubricating.

2. If galvanized nuts are supplied, the thickness of the zinc coating shall be measured. Measurements shall be taken on the wrench flats.

D3. Washers

1. If galvanized washers are supplied, hardness testing shall be performed after galvanizing. (Coating shall be removed prior to taking hardness measurements.)
2. If galvanized washers are supplied, the thickness of the zinc coating shall be measured.

D4. Assemblies

1. Rotational-capacity tests are required and shall be performed on all black or galvanized (after galvanizing) bolt, nut and washers assemblies. The Contractor is responsible for assuring the rotational-capacity testing is performed by either the manufacturer or distributor prior to shipping. Washers are required as part of the test even though they may not be required as part of the installation procedure.

The following shall apply:

- a. Except as modified herein, the rotational-capacity test shall be performed in accordance with the requirements of AASHTO M 164M/ASTM A 325M (AASHTO M 164/ASTM A 325).
- b. Each combination of bolt production lot, nut lot and washer lot shall be tested as an assembly. Where washers are not required by the installation procedures, they need not be included in the lot identification.
- c. A rotational-capacity lot number shall be assigned to each combination of lots tested.
- d. The minimum frequency of testing shall be two assemblies per rotational-capacity lot.
- e. The bolt, nut and washer assembly shall be assembled in a Skidmore-Wilhelm Calibrator or in an acceptable equivalent device (Note - this requirement supersedes the current AASHTO M 164M/ASTM A 325M (AASHTO M 164/ASTM A 325) requirement that the test be performed in a steel joint.) For bolts which are too short to be assembled in the Skidmore-Wilhelm Calibrator, See Section D4.1i.

- f. The minimum rotation, from a snug tight condition (10% of the specified proof load), shall be:

240 degrees ($\frac{2}{3}$ turn) for bolt lengths less than or equal to 4 diameters.
 360 degrees (1 turn) for bolt lengths greater than 4 diameters and less than or equal to 8 diameters
 480 degrees ($1\frac{1}{3}$ turn) for bolt lengths greater than 8 diameters.

- g. The tension reached at the above rotation shall be equal to or greater than 1.15 times the required installation tension. The installation tension and the tension for the turn test are shown below:

METRIC

| Diameter (mm) | M16 | M20 | M22 | M24 | M27 | M30 | M36 |
|--------------------------------|-----|-----|-----|-----|-----|-----|-----|
| Req. Installation Tension (kN) | 91 | 142 | 176 | 205 | 267 | 326 | 475 |
| Turn Test Tension (kN) | 105 | 163 | 202 | 236 | 307 | 375 | 546 |

ENGLISH

| Diameter (in.) | $\frac{1}{2}$ | $\frac{5}{8}$ | $\frac{3}{4}$ | $\frac{7}{8}$ | 1 | $1\frac{1}{8}$ | $1\frac{1}{4}$ | $1\frac{3}{8}$ | $1\frac{1}{2}$ |
|----------------------------------|---------------|---------------|---------------|---------------|----|----------------|----------------|----------------|----------------|
| Req. Installation Tension (kips) | 12 | 19 | 28 | 39 | 51 | 56 | 71 | 85 | 103 |
| Turn Test Tension (kips) | 14 | 22 | 32 | 45 | 59 | 64 | 82 | 98 | 118 |

- h. After the required installation tension listed above has been exceeded, one reading of tension and torque shall be taken and recorded. The torque value shall conform to the following:

Torque less than or equal to 0.25 PD

METRIC

Torque = measured torque (N-m)

P = measured bolt tension (N)

D = bolt diameter (mm)

ENGLISH

Torque = measured torque (foot-pounds)

P = measured bolt tension (pounds)

D = bolt diameter (feet)

- i. Bolts that are too short to test in a Skidmore-Wilhelm Calibrator may be tested in a steel joint. The tension requirement of Section D4.lg need not apply. The maximum torque requirement of Section D4.lh shall be computed using a value of P equal to the turn test tension shown in the table in Section D4.lg.

D5. Reporting

1. The results of all tests (including the one for zinc coating thickness) required herein and in the appropriate AASHTO specifications shall be recorded in the appropriate document.
2. The location where tests are performed and the date of tests shall be reported in the appropriate document.

D6. Witnessing

1. The tests need not be witnessed by an inspection agency; however, the Contractor's manufacturer or distributor performing the tests, shall certify that the results recorded are accurate.

E. Documentation

E1. Mill Test Report(s) (MTR's)

1. MTR's shall be furnished for all mill steel used in the manufacture of the bolts, nuts, or washers.
2. MTR's shall indicate the place where the material was melted and manufactured.

E2. Manufacturer Certified Test Report(s) (MCTR's)

1. The manufacturer of the bolts, nuts and washers shall furnish test reports (MCTR's) for the items furnished.
2. Each MCTR shall show the relevant information required in accordance with Section D.
3. The manufacturer performing the rotational-capacity test shall include on the MCTR.
 - a. The lot number of each of the items tested.
 - b. The rotational-capacity lot number as required in Section D4.lc.
 - c. The results of the tests required in Section D4.
 - d. The pertinent information required in Section D5.2.
 - e. A statement that MCTR's for the items are in conformance with this specification and the appropriate AASHTO specifications.
 - f. The location where the bolt assembly components were manufactured.

E3. Distributor Certified Test Report(s) (DCTR's)

1. The DCTR shall include MCTR's for the various bolt assembly components.
2. The rotational-capacity test may be performed by a distributor (in lieu of a manufacturer) and reported on the DCTR.
3. The DCTR shall show the results of the tests required in Section D4.
4. The DCTR shall also show the pertinent information required in Section D5.2.
5. The DCTR shall show the rotational-capacity lot number as required in Section D4.lc.
6. The DCTR shall certify that the MCTR's are in conformance with this specification and the appropriate AASHTO specifications.

F. Shipping

- F1. Bolts, nuts and washers (if required) from each rotational-capacity lot shall be shipped in the same container. If there is only one production lot number for each size of nut and washer, the nuts and washers may be shipped in separate containers. Each container shall be permanently marked with the rotational-capacity lot number such that identification will be possible at any stage prior to installation.
- F2. The appropriate MTR, MCTR or DCTR shall be supplied to Engineer after the Contractor has verified the material tests meet the requirements of this specification.

G. Installation

- G1. Bolts shall be installed in accordance with CMS 513.20 During installation particular care shall be exercised so that the snug tight condition as defined in CMS 513.20 is achieved.
- G2. If the rotational-capacity test, described in Section D4, has been performed by the Contractor's manufacturer or distributor; the delivered bolts nuts and washers are in lot marked un-opened containers, and when opened the bolts, nuts and washers comply with G4, no additional rotational-capacity lot tests are required prior to the start of bolt installation. Hardened steel washers are required as part of the test although they may not be required in the actual installation procedures.

If fasteners were delivered with certifications but no rotational capacity testing as described in D4, the Contractor may choose to either perform the rotational capacity tests at the project or return the fasteners for rotational testing. If testing is performed on the project and the fastener lots are identifiable, the tests should be run for each combination of bolt, nut and washer. If no fastener lots are identifiable, field site lots of 100 bolts nuts and washers shall be designated and tested.

Fasteners without certifications and rotational capacity testing are not acceptable.

- G3. A Skidmore-Wilhelm Calibrator or an acceptable equivalent tension measuring device shall be required at each job site during erection. Testing shall be performed to assure compliance with the installation test procedures required in CMS 513.20.
- G4. Lubrication
1. Galvanized nuts shall be checked to verify that a visible lubricant is on the threads.
Black bolts shall be “oily” to the touch when delivered and installed.
 2. Weathered or rusted ASTM A 325M (ASTM A 325) Type 1 and Type 2 bolt, nut and washer assemblies shall not be used.