

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION  
DIVISION OF HIGHWAYS  
MATERIALS CONTROL, SOILS & TESTING DIVISION

MATERIALS PROCEDURE

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ANCILLARY STRUCTURE ANCHOR BOLT TIGHTENING

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**1. PURPOSE**

- 1.1 To establish equipment, procedure, documentation, and documentation transmittal requirements for the tightening of anchor bolt nuts associated with signing, signal, lighting, and intelligent transportation systems (ITS) related roadway ancillary structures.
- 1.1.1 This Materials Procedure is specifically focused on the procedure to be followed when tightening anchor bolt nuts and does not address all requirements and procedures pertaining to the installation of ancillary structures. Individual component pre-inspection and repair, structure pre-assembly, structure installation preparation, pre-application of protective coatings, overall installation procedure, and proper tightening of structural connection bolts are included as part of the Specifications.

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**2. MATERIALS AND EQUIPMENT**

- 2.1 The mandatory materials and equipment required to properly tighten the anchor bolts include lubricant, and a hydraulic fastener tightening wrench.
- 2.1.1 Beeswax or toilet ring wax may be used as lubricant.
- 2.1.2 Hydraulic wrenches and accompanying documentation are to meet the requirements herein.
- 2.1.2.1 The wrenches are to be capable of generating the necessary torque in order to tighten the anchor bolt nuts as described herein.
- 2.1.2.2 The hydraulic wrench consists of a wrench and a hydraulic power pack to power and operate the wrench.
- 2.1.2.3 Hydraulic wrenches are to have the wrench and the pressure or torque readout gauge associated with the power pack calibrated regularly. Prior to the tightening of any anchor bolt nuts, the project Engineer is to be provided with separate calibration certificates for the wrench and the gauge. The dates of the calibrations are to be one year or less prior to the date that the bolt tightening is performed. The certificates are to be from a calibration lab that is International Organization for Standardization (ISO) 17025 accredited, with the certificate indicating as such. The certificate for each is to display a serial number matching that shown on the wrench or gauge. If the gauge does

not provide readings directly in torque values, the calibration certificate is to be accompanied by calibration charts which equate gauge pressure readings to torque values. Example calibration certificates and charts are included as part of ATTACHMENT 1.

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**3. DOCUMENTATION**

- 3.1 The tightening of all anchor bolt nuts is to be documented using the form “WVDOH ANCILLARY STRUCTURE ANCHOR BOLT TIGHTENING RECORD” (documentation form) available at the [MCS&T DOH Webpage](#).<sup>1</sup> A sample of this form is provided in ATTACHMENT 2.

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**4. PROCEDURES**

- 4.1 Install the top nuts and washers and verify that the top nuts & washers, as well as the leveling nuts & washers, are all in firm contact with the base plate. Snug tighten the top nuts and leveling nuts utilizing the hydraulic wrench and the following procedure:
- 4.1.1 Use a permanent marker to indicate on the base plate the sequence of tightening to be followed. The sequence shall be a star pattern, examples of which are provided in Figures 1 and 2 below.
- 4.1.2 Snug tighten the top nuts to approximately 50% of the snug tightened condition torque values specified in Table 1 below following the star pattern.
- 4.1.3 Snug tighten the bottom nuts to approximately 50% of the snug tightened condition torque values specified in Table 1 below following the star pattern.
- 4.1.4 Snug tighten the top nuts to 100% of the snug tightened condition torque values specified in Table 1 below following the star pattern.
- 4.1.5 Snug tighten the bottom nuts to 100% of the snug tightened condition torque values specified in Table 1 below following the star pattern.

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<sup>1</sup> <https://transportation.wv.gov/highways/mcst/Pages/tbox.aspx>

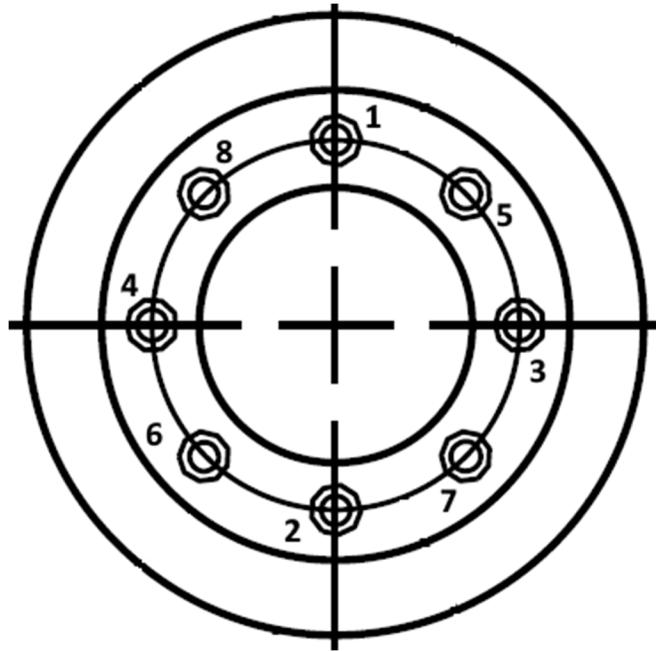


Figure 1 - Example nut tightening sequence for 8 bolt base plate.



Figure 2 - Snug tightening sequence numbering on base plate.

Diameter (in.)	Threads/inch	Snug Torque Value (ft-lbf)
1-1/4 (32 mm)	7 (3.629 Pitch in mm)	140 (190 Nm)
1-1/2 (38 mm)	6 (4.233 Pitch in mm)	240 (325 Nm)
1-3/4 (44 mm)	5 (5.080 Pitch in mm)	380 (515 Nm)
2 (51 mm)	4.5 (5.664 Pitch in mm)	570 (775 Nm)
2-1/4 (57 mm)	4.5 (5.664 Pitch in mm)	830 (1125 Nm)

Table 1 – Snug tightened torque values for ASTM F1554 Grade 55 Anchors (Contact Engineering Division for anchors outside those covered by this table).

- 4.2 After all nuts have been snug tightened and the necessity or unnecessary for repeating the snug tightening procedure with beveled washers has been determined and performed if required, snug tight condition reference marks are to be placed on the nut and base plate using a permanent marker to prepare for the full tightening procedure (see Figure 3 below). One reference mark is to be placed on the top of the nut at one of the corners. One reference mark is to be placed on the base plate such that this reference mark and the reference mark on top of the nut will be aligned when the nut is rotated one half of the amount specified in Section 4.3.1. An additional reference mark is to be placed on the base plate such that this reference mark and the reference mark on top of the nut will be aligned when the nut is rotated the complete amount specified in Section 4.3.1. All reference marks are to be placed such that they will remain visible when the tightening wrench is placed on the nut.

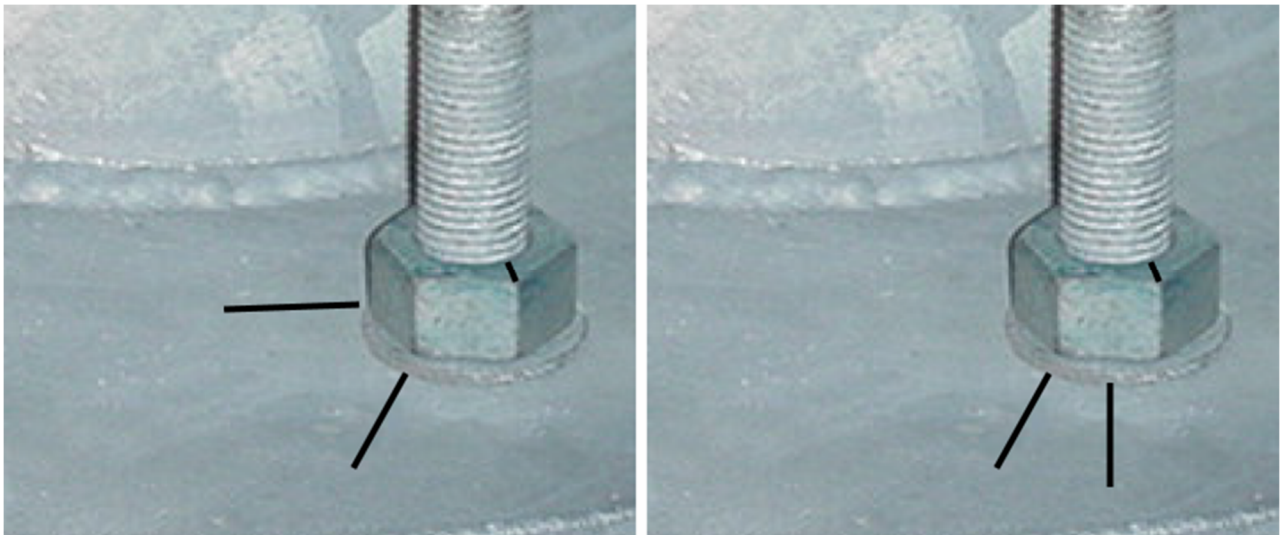


Figure 3 - Snug tight condition reference marks for bolts 1-1/2" (3.8 cm) diameter or less (left) and bolts greater than 1-1/2" diameter (3.8 cm) (right) .

- 4.3 Fully tighten the top nuts using the hydraulic wrench.
- 4.3.1 Full tightness of each nut is achieved by rotating the nut a prescribed number of flats beyond the reference position. Rotation is to be 1/3 (2 flats) beyond the reference

- position for bolts 1-1/2-inches (3.8 cm) in diameter or less. Rotation is to be 1/6 (1 flat) beyond the reference position for bolts greater than-1-1/2 inches (3.8 cm) in diameter.
- 4.3.2 Tightening is to proceed from nut to nut in the same star pattern that was used for the snug tightening procedure and is to be achieved over two cycles. Using a structure with 2-inch (5.1cm) anchor bolts as an example, each nut is to be tightened ½ flat. Each nut is to then be tightened an additional ½ flat.
- 4.4 Upon completion of the tightening of all nuts, a verification torque (Tv) is to be applied to each nut using the same hydraulic wrench and power pack that was used to tighten the nuts. The required verification torque is to be based on Table 2 below. The applied torque is not to exceed this value.

Diameter (in.)	Threads/inch	Tv Value (ft-lbf)
1-1/4 (32 mm)	7 (3.6 Pitch in mm)	550 (745 Nm)
1-1/2 (38 mm)	6 (4.2 Pitch in mm)	950 (1290 Nm)
1-3/4 (44 mm)	5 (5.1 Pitch in mm)	1500 (2035 Nm)
2 (51 mm)	4.5 (5.7 Pitch in mm)	2250 (3050 Nm)
2-1/4 (57 mm)	4.5 (5.7 Pitch in mm)	3290 (4460 Nm)

Table 2 – Verification torque values for ASTM F 1554 Grade 55 Anchors (Contact Traffic Engineering Division for anchors outside those covered by this table).

- If the gauge associated with the power pack does not provide a torque readout, the pressure readout required to achieve the verification torque is to be determined from the power pack calibration charts.
- 4.4.1 The documentation form is to be marked where indicated to indicate that a torque value of at least that provided in Table 2 would be required to further tighten the nuts. If the nuts further tighten prior to achieving the verification torque, the Traffic Engineering Division is to be notified of this issue.
- 4.5 At least 48-hours after the tightening and verification torque procedures are completed, and after all attachments (signs, lighting, etc.) have been installed on the structure, a torque equal to 110% of the Tv torque is to be applied to each nut using the same hydraulic wrench and power pack that was used to tighten the nuts. The 110% Tv torque is to be based on Table 3. The applied torque is not to exceed this value.

Diameter (in.)	Threads/inch	110% Tv Value (ft-lbf)
1-1/4 (32 mm)	7 (3.6 Pitch in mm)	605 (880 Nm)
1-1/2 (38 mm)	6 (4.2 Pitch in mm)	1045 (1410 Nm)
1-3/4 (44 mm)	5 (5.1 Pitch in mm)	1650 (2235 Nm)
2 (51 mm)	4.5 (5.7 Pitch in mm)	2475 (3355 Nm)
2-1/4 (57 mm)	4.5 (5.7 Pitch in mm)	3619 (4905 Nm)

Table 3 – 110% Verification torque values for ASTM F1554 Grade 55 Anchors (contact Traffic Engineering Division for anchors outside those covered by this table)

- If the gauge associated with the power pack does not provide a torque readout, the pressure readout required to achieve a torque of 110% Tv is to be determined from the power pack calibration charts.
- 4.5.1 The documentation form is to be marked where indicated to indicate that a torque value of at least that provided in Table 3 would be required to further tighten the nuts. If the nuts further tighten prior to achieving the 110% Tv torque, the Traffic Engineering Division is to be notified of this issue.

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**5. DOCUMENTATION TRANSMITTAL**

- 5.1 Upon completion of all procedures described herein and the documentation form being completed in its entirety, the Engineer is to transmit an electronic copy of the documentation form to the email address [DOH.OS.AnchorNutTightening@wv.gov](mailto:DOH.OS.AnchorNutTightening@wv.gov), which is established by the Traffic Engineering Division for this purpose. Prior to transmittal, the calibration certificates for the wrench and power pack pressure or torque readout gauge, as well as the calibration charts for the gauge, should be attached to the documentation form and included with the submittal. The subject line of the email should be named using the following format: D(*District Number*)-(*Contract ID Number*)-(*Sign, Signal, Lighting, or ITS*) Structure (*Structure Number as indicated on the project Plans*). Examples of this would be D4-2016000994-Sign Structure 6 and D7-2006001093-Lighting Structure HML1. An example of all documents that should be included as part of a complete transmittal is attached as ATTACHMENT 1.

**Michael Mance** Digitally signed by Michael  
Mance  
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Michael A. Mance, P.E.  
Interim Director  
Materials Control, Soils & Testing Division

MP 658.05.06 Steward – Traffic Certification Section  
MM:W  
ATTACHMENTS







Base Plate 4 Diagram
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Full Tightness Gauge Pressure and Torque Values								
	1	2	3	4	5	6	7	8
PSI								
foot-lbs								

Mark Each Box to Indicate Application of Tv did not Result in Further Turning of Nut								
	1	2	3	4	5	6	7	8
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Mark Each Box to Indicate Application of 1.10Tv did not Result in Further Turning of Nut								
	1	2	3	4	5	6	7	8
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

\_\_\_\_\_  
 Date of Tightening

\_\_\_\_\_  
 Date of Application of 1.10Tv

\_\_\_\_\_  
 Installation Contractor

\_\_\_\_\_  
 Bolt Tightening WVDOH Rep. (Print)

\_\_\_\_\_  
 Contractor Rep. (Print)

\_\_\_\_\_  
 Application of 1.10Tv WVDOH Rep. (Print)

\_\_\_\_\_  
 Contractor Rep. (Signature)

\_\_\_\_\_  
 WVDOH Project Engineer (Prin



ATTACHMENT 2

Base Plate 2 Diagram								
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Full Tightness Gauge Pressure and Torque Values								
	1	2	3	4	5	6	7	8
PSI								
foot-lbs								

Mark Each Box to Indicate Application of Tv did not Result in Further Turning of Nut								
	1	2	3	4	5	6	7	8

Mark Each Box to Indicate Application of 1.10Tv did not Result in Further Turning of Nut								
	1	2	3	4	5	6	7	8

Base Plate 3 Diagram								
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Full Tightness Gauge Pressure and Torque Values								
	1	2	3	4	5	6	7	8
PSI								
foot-lbs								

Mark Each Box to Indicate Application of Tv did not Result in Further Turning of Nut								
	1	2	3	4	5	6	7	8

Mark Each Box to Indicate Application of 1.10Tv did not Result in Further Turning of Nut								
	1	2	3	4	5	6	7	8

Sample Form

ATTACHMENT 2

Base Plate 4 Diagram

Full Tightness Gauge Pressure and Torque Values								
	1	2	3	4	5	6	7	8
PSI								
foot-lbs								

Mark Each Box to Indicate Application of Tv did not Result in Further Turning of Nut								
	1	2	3	4	5	6	7	8

Mark Each Box to Indicate Application of 1.10Tv did not Result in Further Turning of Nut								
	1	2	3	4	5	6	7	8

Date of Tightening	Date of Application of 1.10Tv
Installation Contractor	Bolt Tightening WVDOH Rep. (Print)
Contractor Rep. (Print)	Application of 1.10Tv WVDOH Rep. (Print)
Contractor Rep. (Signature)	WVDOH Project Engineer (Print)

Sample Form