



## 5-70.1 General

Ancillary structures include sign bridges, overhead sign supports, traffic signal monotube/pole (pole types 9, 10, 12, and 13), and high mast lighting pole (HML) structures. High strength structural steel bolts and Direct Tension Indicator (DTI) in ancillary structures need to conform to the same bolting requirements used for steel bridges and the requirements of [standard spec 641.2.2](#) and [standard spec 657.2.2.6](#). Anchor rods need to conform to department tensioning procedures enumerated in department form [DT2321](#). Other bolts and fasteners used in ancillary structures should conform to manufacturer specifications as detailed in the shop drawings.

The standard detail drawings for various traffic signal monotube/poles indicate which bolts need to conform to [standard spec 657.3.3.2](#). Sign bridges and overhead sign supports need to conform to [standard spec 641.3.3](#), [standard spec 641.3.3](#) and [standard spec 641.3.4](#).

Field staff need to know bolting quality control procedures used for erecting ancillary structures. It is recommended that contractors and department field personnel annually attend a department sponsored class called "Ancillary Structures: Anchor rods and Structural Bolting" presented by the Bureau of Structures. This class provides current requirements and best practices to be followed.

Good quality assurance on the installation and bolting of ancillary structures is particularly important because:

- Ancillary structures generally have structural connections with a small number of bolts (minimum of 4). This lack of redundancy is critical. Limited redundancy can lead to rapid and potentially catastrophic failures making each bolt connection much more critical. Testing ensures proper installation, reducing the risk of a structure falling on the roadway.
- Ancillary structures are subjected to high cycles of wind load, subjecting bolts to high stress ranges if not installed properly. The combination of high cycle loading and high stress ranges is a recipe for fatigue failure.
- When improper installation practices are used in the bolting process, such failures as nuts and bolts losing lubrication, collecting grit, rust, or other deteriorations, affect their ability to perform as designed in the finished structure and can lead to failures.

Quality is a two part process. This process involves quality control (QC) performed by the contractor and quality assurance (QA) performed by the department representative. The inspection checklist [attachment 1](#) provides QC checks the contractor needs to perform during construction; the department QA representative needs to double check to assure the contractor completed those steps. Ancillary structure installation and inspection should be discussed at the preconstruction conference. After installation the engineer should contact the region's maintenance or traffic operations unit to set up a structural inspection by the department or a third party. If possible, inspections should be scheduled to occur while the contractor is still on the job. If the inspection reveals a nonconforming installation or material, the contractor is responsible to correct the problem. The engineer should not make full payment for ancillary structures before structural inspections and all required corrective actions are completed. If the corrective action is re-inspected by the third party inspector, consult with the construction oversight engineer in the Bureau of Project Development associated with your region to determine if a deduct in the final payment for the third party re-inspection is applicable.

## 5-70.2 High Strength Bolts, Nuts, and Washers

Follow the requirements detailed in [CMM 5-20.5](#). Access to a calibrated Skidmore-Wilhelm device and torque wrench to establish torque/tension relationships is necessary. Federal requirements for Rotational Capacity testing must be followed. The contractor is responsible for ensuring certification of compliance from the supplier in addition to performing pre-installation test in accordance to the procedure enumerated in department form [DT2322](#).

The department requires the contractor to re-lubricate all high strength structural steel bolts. Re-lubrication makes it very unlikely that bolts will fail to develop their requisite tension at required torque levels. Proper lubrication also provides lower torque required to install bolts and promotes less strain on equipment. Most importantly, re-lubrication helps ensure that bolted components perform as designed in the finished structure.

Re-lubricating is relatively inexpensive because most ancillary structures contain a small number of high strength structural steel bolts. Beeswax and even toilet bowl ring waxes work well as lubricants. There are also commercially available products specifically designed for this purpose:

- Johnson Wax "Jon-cote 639"

- MacDermid "Torque'n Tension Control Fluid"
- Johnson's #140 Stik-Wax

If re-lubricated bolts fail to reach installation torques above the torque tension relationship listed on form [DT2322](#) Table 4, they must be rejected and new bolts used. Bolts must not be incorporated into the work if their condition has deteriorated after testing and before installation.

### 5-70.3 Assembly

#### 5-70.3.1 General

Ancillary structures that require A325 bolts must be fit-up with the faying surfaces and free of rust, loose mill scale, dirt, oil, and grease. Connections should be reasonably flat so that when the bolts are tensioned, the bolts draw the faying surfaces together into intimate contact around each bolt. If intimate contact cannot be made, call the Bureau of Structures, Metals and Fabrication Inspection Unit at (608) 266-8487 to determine the required course of action. Any other connection alignment issues or unique problems with fasteners should be documented and kept in the permanent project file.

Connections that are made with bolts other than A325 bolts, such as u-bolts, must be installed following a written procedure from the manufacturer. The written procedure should be kept in the permanent project file. Hardware and other fasteners that are used on the structure must conform to the drawings and instruction from the manufacturer.

The contractor should have a system to organize and segregate different bolting assemblies. Check to see if:

- Did the supplier pre-assemble each bolt/nut/washer assembly before shipping to ensure parts are the same rotational capacity (rocap) lot number? Having the nuts, bolts, and washers pre-assembled help ensure good fit and show the ability to run the nut down the bolt.
- Is there a certified report of test or analysis for each type of assembly showing the results of the supplier's rotational-capacity testing?
- Did the bolt/nut/washer assemblies get shipped in sealed and labeled container? For example, the contractor could use sealed containers that are stored out of the weather that has permanent labeling showing size and rocap lot number on the container.
- Has the contractor provided the required number of additional bolt/nut/washer assemblies to be used for pre-installation and department testing?

High Strength bolts are to be tensioned using DTI's. Follow the installation procedure listed in the department form [DT2322](#).

#### 5-70.3.2 Rotational Capacity Testing

Rotational capacity (rocap) testing is to be performed by the supplier on A325 bolt grades used on projects. The contractor needs to provide documentation for each rocap lot before installation. Field rocap testing is not required.

#### 5-70.3.3 Pre-installation Test and Torque Testing

The pre-installation test and torque determination are required to determine the effective installation of the bolt to a satisfactory tension. [DT2322](#) contains the procedure necessary to perform these tests. It is imperative that the department representative witness the pre-installation procedure. The department representative is required to sign the [DT2322](#), certifying proper testing was performed.

Complete contact of the indicators on the DTI is required to determine the torque applied to the assembly. Oversized washers (hole is significantly larger than the bolt shaft) are not allowed in the assembly because the DTI may not have full contact with the washer face.

### 5-70.4 Anchor Rods

#### 5-70.4.1 Anchor Rod Installation

Anchor rods on ancillary structures are important connections and strict adherence to installation requirements need to be followed in order to reduce risk to the motoring public. Installation of anchor rods requires consideration of several steps, including:

- Installing anchors at the correct elevation so the bottom of the leveling nut is no more than one diameter above the top of the concrete foundation. This allows for adequate adjustment for leveling the structure.
- Spacing of the anchor rods should be done with templates as shown on the contract plans and shop drawings.
- Anchor rods should be galvanized as required in the contract specifications.
- Anchor rods should be color coded to indicate their grade:

- Blue for F1554 Grade 36
- Yellow for F1554 Grade 55
- Red for F1554 Grade 105
- Base plate bolt holes of the structures should match so that no bending of the anchors or cutting of the base plate is required. If a hole does not line up, call the Bureau of Structures (BOS), Metals and Fabrication Inspection Unit at (608) 266-8487 for further action that may be required. Any discrepancy of a misaligned bolt, bolt holes, or remedial action taken, should be documented and put in the permanent project file.
- Protect anchor rod threads above the top of the foundation level from concrete splash

#### **5-70.4.2 Anchor Rod Tensioning Procedures**

Anchor rods are generally grade 55 and as such are not to be tightened like a friction bolt. Anchor rods should be tensioned by the contractor and documented according to the anchor rod tensioning form [DT2321](#). Lubrication with beeswax must be performed in all cases before tensioning. Installing any grade anchor rod other than grade 55 should be discussed with the BOS/Metals and Fabrication Inspection Unit before installation. A copy of the [DT2321](#) must be kept in the permanent project file ensuring the following ancillary structures have been addressed:

- Each sign bridge or sign support installed under [standard spec 641](#).
- Each type 9, 10, 12, and 13 structure installed under [standard spec 657](#).
- Each high mast lighting structure installed under [standard spec 660](#).
- Any moment or double nut type base plate connection.

Once a structure is leveled and top nuts and leveling nuts are in intimate contact with the base plate, the top and leveling nuts need to be snugged per Table 1 of form [DT2321](#). The nuts are rotated as required, depending on the diameter and the corresponding rotation listed on the form. For large anchors, 2-inches and over, a hydraulic tensioner may be necessary to obtain the required rotation. With the potential of base plates being warped, the leveling nuts should be checked after tensioning. It is imperative the department representative be present at this testing to witness the procedure. The department representative is required to sign the [DT2321](#), certifying proper procedures were followed.

#### **5-70.5 Construction Inspection Checklists**

The Bureau of Structures has developed a construction inspection checklist, [Attachment 1](#), for ancillary structures providing standard spec references for field staff to review before both installation and inspection. The checklist also enumerates additional things to watch for when erecting ancillary structures.

#### **List of Attachments**

[Attachment 1](#)                      Construction Inspection Checklist for Ancillary Structures