

INSTALLATION AND INSPECTION OF HIGH STRENGTH BOLTS

High strength bolts are an important element of a steel frame structure; the installation procedures are often misunderstood. Some of the misunderstandings are caused by general "rules of thumb" and methods used in the past. Some are due to a misunderstanding of the principles of connections using high strength bolts and the responsibility of the contractor to assure the specified bolt tension is achieved.

If slip critical connections are specified, the connections are required to be fully pretensioned in accordance with Table 4 of the "Specification for Structural Joints Using ASTM A325 or A490 Bolts" chapter found in the AISC Manual of Steel Construction Allowable Stress Design – Ninth Edition.

The Contractor or Erector must use a bolt tension measuring device such as the Skidmore-Willhelm portable bolt-tension calibrator shown in Figure 1. The Inspector verifies that the device has been calibrated within one year and observes the wrench calibration procedure performed by the Contractor each day. The Inspector also monitors the installation of bolts to determine that all plies of connected material have been drawn together and that the selected procedure is properly used to tighten all bolts. The tension required is 5 percent in excess of the minimum tension specified in Table 4 mentioned above. The torque (ft. lbs.) required to produce this tension (lbs) is then used on the work connections. Wrenches are recalibrated each day and whenever significant differences are observed between the surface conditions of the bolt threads or washers being tensioned and the previously tested sample assembly.



Figure 1

The building code does not recognize standard torque loads determined from tables or from formulas which are assumed to relate torque to tension. In the past we have been queried as to what torque is required for a 1-inch diameter ASTM A325 bolt. This question indicates a misunderstanding of what happens during bolt tensioning. The principle is that the bolt is stretched (tensioned) by tightening the nut against the surface of a hardened washer. The tension induced in the bolt then compresses the plies of the connection. The correct question should have been; what tension is required for a 1-inch diameter ASTM A325 bolt, and how do we know when we have achieved this tension. This must be determined each day by gathering a representative sample of not less than three bolts for each diameter, length and grade of bolt being installed in the connections. The average torque load required to achieve an excess of five percent of the specified tension as measured in the bolt tension measuring device should be used.

Since tension is achieved by turning the nut, it is appropriate to consider that the amount of tension necessary can be determined by the foot-pounds of turning effort. This is true and determined each day with each bolt diameter, length and grade. However, a problem arises if the Erector attempts to generalize the procedure and assume that, since it took him 280 foot pounds of torque to bring the 1-inch diameter ASTM A325 bolt at the last job to the correct tension that the same torque will work at the current job. The reason we cannot rely on our previously determined torque to achieve the same tension on each project relates to the many factors that interfere with a consistent torque to achieve the required tension. When a nut is tightened, we are overcoming a combination of frictional forces. These forces include the tension in the bolt, the friction between the nut thread and bolt thread and the friction between the nut surface in contact with the washer. Some threads are more lubricated than others and we cannot know how much torque will be required to defeat the friction we feel turning the nut to achieve the required connection bolt tension. Studies have shown as much as a forty percent variance in required torque to achieve the same tension depending on the thread lubrication, the cleanliness of the nut and bolt as well as the surface conditions of the nut and washer.

Whether you are using a calibrated wrench, the turn of nut method, tension shear bolts, or load indicating washers, the Erector is required to provide the means, methods and equipment for achieving the specified pretension each day.

It is the Inspector's responsibility to: assure that the bolt-tension measuring device has been calibrated annually, observe the Erectors wrench calibration procedures and to monitor the installation of bolts (assuring that the faying surfaces are clean and free of spatter, all plies of connected material have been drawn together and that the selected procedure is properly used to tighten all bolts).

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