

# HIGH STRENGTH BOLTING

By  
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There is a lot of confusion in our industry about high strength bolting. Why is that? Is it because there are two steel grades, ASTM A325 and ASTM A490, each with their own specific issues? Is it because there are black bolts, weathering-steel bolts and galvanized steel bolts, each with their own specific issues? Is it because there are four approved methods of installing fully tensioned bolts? Is it because some jobs are now specified as "Snug", and that is not a fully tensioned bolt, but "snug" is a part of each of the four approved installation methods for high strength bolts? I submit to you that it is all of the above.

The torque-tension relationship is tenuous at best, but using a torque wrench is the only practical way of trying to measure the adequacy of a bolt installation. The jargon of the industry does not help. Everyone wants to "torque" bolts, or they want to "rattle them up." With high strength bolts you must tension the bolt in order to provide the clamping force that holds the plies of steel together. We would be better off if we would all start using the term tensioning bolts rather than torquing bolts.

What does fully tensioned really mean? It means that the bolt is tensioned to meet the minimum required tension as specified in the Research Council on Structural Connections (RCSC). It also means that the bolt assembly (bolt, nut and washer) must be verified as being capable of attaining that minimum required tension. How do you do this? Every company that installs fully tensioned bolts should have access to a bolt tension measuring device. You can buy one, rent one or borrow one, but you must have one. You must test three bolt assemblies from each bolt/nut lot combination following the instructions in the RCSC specification for the installation method being used. They are not all the same - another source of confusion. This process is called the pre-installation verification of the bolt assembly. You will hear, or should hear this term, pre-installation verification, often.

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The most common tension measuring device is a Skidmore-Wilhelm Device commonly called a Skidmore. It is a simple hydraulic load cell with a dial gauge that reads tension in pounds or kips (1,000 pounds). Some of the gauges are marked with the minimum tension for each of the common diameters and grades of bolts. Unfortunately due to the load cell pick-up capabilities, in order to reach the minimum required tension, you must read on the dial gauge a tension that is 5% higher than the minimum required tension. As you can see the answer to the question in paragraph one is not only all of the above, but also all of the below.

Snug tight bolts do not need pre-installation verification nor do they need an impact wrench for installation. Snug is defined as the amount of tension provided by an ironworker using a spud wrench and exerting his or her full force to rotate the nut or bolt head. If you use an impact wrench it means it is snug after two or three impacts. After the sound of the spinning nut turns to blows, just count three blows, and the bolt will be snug tight by specification. Now even with snug tight bolts, the plies of connecting material must be in intimate contact in the area surrounding the bolt and bolt hole.

Before you fully tension a bolt, it must first be snug as described above. Then the four approved installation methods come into play. These are turn-of-the-nut, tension control bolts, commonly called TC bolts or Twist-Off bolts (they are often called something else when the spline breaks off before you have snugged the bolt, or if you happen to step on a spline that has been left carelessly on the beam flange), Direct Tension Indicators (dti) also called load indicating washers (liw), and controlled torque bolts. Do not take my comments about TC bolts as having a negative bias. Like a lot of things, if they are used properly in the right places, they are very cost effective. The fourth method is hardly used now because there are so many variables that affect the process and you may have to do pre-installation verification several times a day.

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Along with the confusion, or perhaps because of the confusion, many myths have sprouted about the installation of bolts. Here are a few of them:

- ✚ You are not calibrating the wrench when you do pre-installation verification of the bolt assemblies. You are making sure that the assemblies will indeed attain the minimum required tension providing the installation rules are followed properly. This is also a good time and place to be sure that the workers know how to tension a bolt.
- ✚ With the turn-of-the-nut method there is no such thing as a timing method. Forget one thousand and one, one thousand and two ... The only way to use this method is to have the nut or bolt head turned the proper amount of turns.
- ✚ The proper amount of turns is specified in the RCSC specification. It is not to be determined by the amount of turns it takes to reach the minimum required tension. If the RCSC says 1/3 turn, that means 1/3 turn. Mark the bolt/nut/steel or the bolt head/steel to show that you have turned the element 1/3 or mark the impact wrench socket so that you can observe the 1/3 turn.
- ✚ Don't have your workers turn the nut 1/2 turn so that you are sure that they will at least make 1/3 turn. Don't have the workers use 1/2 turn on shop painted surfaces because the compression of the paint will relax the tension in the bolt. Remember, if the specification say 1/3 turn, use 1/3 turn.

If you read the RCSC specification carefully you do not have to yank the bolts with a torque wrench to inspect them. You may be stuck with that requirement by project specifications and all DOT work, but it really need not be done. However, don't take a clicker torque wrench, set it for a specific torque like 300 ft.-lbs., and send it out to the field. This is a no-no. You must use the pre-installation verification process to

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measure torque or use the arbitration torque in the RCSC specification. In addition the clicker further distorts the torque-tension relationship.

The best thing to do is obtain a copy of the current RCSC specification. There is a copy in your AISC Manual, but the specification is revised more often than the manual. It is a free download from <http://www.boltcouncil.org>. Read it, understand it, and train your workers in the right way to perform high strength bolting. Some outside inspectors may make up the rules as they go along, but if you know the right way; your life will be a lot easier. Stop perpetuating the myths. If you work at it, the confusion will go away.◆