

steelwise

WHAT IS SNUG, ANYWAY?

BY CHARLES J. CARTER, SE, PE, PHD,
AND THOMAS J. SCHLAFLY

The answer is simple,
though not necessarily brief.

THE RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC) addresses three types of bolted joints: snug-tightened, pretensioned and slip-critical.

These joints are defined in the RCSC *Specification for Structural Joints Using High-Strength Bolts*, which is a free download at www.boltcouncil.org. Supporting information also is available in the *Guide to Design Criteria for Bolted and Riveted Joints*, 2nd Edition (also free as a download from RCSC). RCSC defines these joint types and provides guidance for their use. Nonetheless, there remains some confusion about what snug-tightening is.

The formal definition of a snug-tightened joint is given by RCSC as:

A joint in which the bolts have been installed in accordance with Section 8.1. The snug tightened condition is the tightness that is attained with a few impacts of an impact wrench or the full effort of an ironworker using an ordinary spud wrench to bring the plies into firm contact.

The intent is to provide for great simplicity, but perhaps definitions can get in the way. Breaking it all down, here is what snug-tight means.

Snug-tightened installation is all that's needed for the majority of joints. See the sidebar for cases where pretensioned or slip-critical joints are required. Those specific cases have special needs that are clear and definable. All other cases are basic statically loaded joints for which snug-tightening is all that's needed to prevent loosening of a joint.

Where Did Snug-Tight come from?

There was a time before snug-tightening existed and all bolts required pretensioned installation. When bolts were introduced, rivet manufacturers succeeded in forcing the most conservative installation requirements to be applied across the board. In the early 1980s, Bob Disque and Ted Winneberger—steel industry legends from AISC and W&W Steel, respectively—collaborated to lead an effort to free most bolts from decades of conservatism. The snug-tight concept was born and included in the 1985 RCSC *Specification*.

Snug means bringing the connected plies into firm contact. RCSC defines firm contact as the condition that exists on a faying surface when the plies are solidly seated against each other. Note that this does not mean the plies must be in continuous contact. It only means that further tightening of a bolt should not loosen an adjacent bolt. When a joint is solidly seated, any further tightening of a bolt will simply add some reasonably consistent amount of installed tension in the bolt.

We don't care how much installed tension there is. The whole point of a snug-tightened joint is that we do not need to concern ourselves with how much installed tension is present in the bolts. Small joints with flat mating faces on the plies generally will have less installed tension than larger joints with curved or wavy mating faces. If the bolt tightening is used to compress gaps in the joint, some bolts may reach—and even exceed—the minimum pretension for pretensioned and slip-critical joints. This is acceptable! Above all, we do not require measurement of the installed tension in the bolts.

Note also that twist-off-type tension-control bolts can be used in snug-tightened joints, even if the splined ends are severed during installation.

Every bolted joint installation starts with snug-tightening. When you specify a snug-tightened joint, installation starts and ends with the requirements in Section 8.1. When you specify a pretensioned joint or a slip-critical joint, installation starts with the same requirements. Thereafter, the pretension is induced—i.e., snug-tightening is the starting condition for



Charles J. Carter (carter@aisc.org) is a vice president and chief structural engineer and **Tom Schlafly** (schlaflly@aisc.org) is director of research, both with AISC.

turn-of-nut, calibrated wrench, twist-off type tension-control bolt, and direct-tension-indicator washer pretensioning.

All joint types use the same bolts, but names have changed. Snug-tightened, pretensioned and slip-critical joints all use the same bolts; (same for N, X, and SC, too!). We are used to calling them ASTM A325 and A490. You also likely know that the twist-off-type tension-control bolt assembly equivalents are called ASTM F1852 and F2280. You also need to know that there is a new umbrella specification for all of these called ASTM F3125 and it replaces all of the previously separate standards.

This new umbrella standard is constructed in an intuitive and familiar manner. It ties the new to the old in a very direct and unmistakable way because the previously separate products are identified as grades A325, A490, F1852 and F2280. This is an easy adaptation that will not trip you up as the transition occurs in the marketplace. This was covered in the November 2015 article “Six into One” (available at www.modernsteel.com).

Additionally, ASTM F3125 appears in AISC 360-16, the next revision of the *AISC Specification*. Happy snugging! ■

When do I need more than a Snug-Tightened Joint?

Pretensioned

A pretensioned joint is a joint that transmits shear and/or tensile loads in which the bolts have been installed to provide a pretension in the installed bolt. Bolts can be pretensioned using turn-of-nut, calibrated wrench, twist-off-type tension-control bolt or direct-tension-indicator washer methods.

Section 4.2 in the *RCSC Specification* requires pretensioned joints in the following applications:

1. Joints in which fastener pretension is required in the specification or code that invokes the *RCSC Specification*
2. Joints that are subject to significant load reversal
3. Joints that are subject to fatigue load with no reversal of the loading direction
4. Joints with ASTM A325 or F1852 bolts that are subject to tensile fatigue
5. Joints with ASTM A490 or F2280 bolts that are subject to tension or combined shear and tension, with or without fatigue

Section J1.10 in AISC 360 requires that joints be pretensioned in the following circumstances:

1. Column splices in buildings with high ratios of height to width
2. Connections of members that provide bracing to columns in tall buildings
3. Various connections in buildings with cranes over 5-ton capacity
4. Connections for supports of running machinery and other sources of impact or stress reversal

These joints do not need the controlled faying surfaces associated with slip-critical connections.

Slip-Critical

A slip-critical joint is a joint that transmits shear loads or shear loads in combination with tensile loads in which the bolts have been installed to provide a pretension in the installed bolt (clamping force on the faying surfaces), and with faying surfaces that have been prepared to provide a calculable resistance against slip.

Section 4.3 in the *RCSC Specification* requires slip-critical joints in the following applications involving shear or combined shear and tension:

1. Joints that are subject to fatigue load with reversal of the loading direction
2. Joints that utilize oversized holes
3. Joints that utilize slotted holes, except those with applied load approximately normal (within 80 to 100 degrees) to the direction of the long dimension of the slot
4. Joints in which slip at the faying surfaces would be detrimental to the performance of the structure

Requirements in AISC 360 are essentially similar.

