product
expert series

TWISTS AND TURNS

The latest from the world of high-strength bolting.

BY ROBERT E. SHAW, JR., P.E.

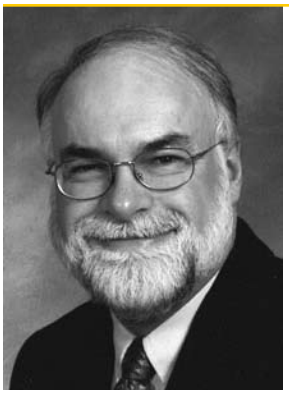
HIGH-STRENGTH BOLTS HAVE been used in steel structures since the early 1950s—and they've come a long way since then.

The first specification for high-strength bolting, issued in 1951 by the Research Council on Riveted and Bolted Structural Joints, totaled three pages and was titled *Specifications for Assembly of Structural Joints Using High Tensile Steel Bolts*. The latest version, issued in 2009, is closer to 100 pages and reflects the growing number of high-strength structural fasteners and related considerations with its new name: *Specification for Structural Joints Using High-Strength Bolts*. (In addition, the organization is now called the Research Council on Structural Connections.)

Coatings

A major addition to the 2009 version is the recognition of a relatively new coating system suitable for ASTM A490 bolts. The coating, produced by Metal Coatings International, is covered by ASTM F1136 *Zinc/Aluminum Corrosion Protective Coatings for Fasteners* and is known by the trade name of Dacromet. Guidance on the use of Dacromet-coated A490 bolts, nuts and washers is available on the RCSC website (**www.boltcouncil.org**) in the form of the *Bulletin on ASTM F1136/F1136M Zinc/Aluminum Coatings for use with ASTM A490/A490M Structural Fasteners*.

More recently, a second coating system has been approved by the ASTM F16 Fastener Committee and will be added to the ASTM A490 and A490M standards, hopefully in the next few months. Produced by Magni Industries, Inc., the coating, which combines an inorganic zinc-rich basecoat with an aluminum-rich topcoat that contains an integrated lubricant, is covered by ASTM F2833 *Corrosion Protective Fastener Coatings with Zinc Rich Base Coat and Aluminum Organic/Inorganic Type*. This newly approved coating, and perhaps other coating systems undergoing testing too, will be considered for inclusion in the next RCSC *Specification* (the release date of which will be decided soon).



Bob Shaw is president of the Steel Structures Technology Center, Inc., Howell, Mich. He is a member of the RCSC and the AISC Specifications Committees, and is author of the *Structural Bolting Handbook*. He can be reached at **rshaw@steelstructures.com**.

Direct-Tension Indicators

Applied Bolting Technology now has their Squirter direct-tension indicators (DTIs) recognized in Chapter 5 of the ASME standard B18.2.6-2010 *Fasteners for Use in Structural Applications*, identified as "silicone emitting type load indicator washers"; Squirter DTIs have flexible silicone embedded in the depressions under the protrusions, which squirts out of the grooves on the underside of the DTI when the bolt is pretensioned.

In addition, TurnaSure has developed the TurnAnut system, in which a TurnaSure DTI is integrally linked to an ASTM A563 DH nut as a single unit. The bolt is tightened until the gap is at or below 0.005 in. and can be completely flattened. It is currently available for ASTM A325 bolts in ¾-in. and ⅞-in. diameters, with a plan for 1-in. A325 bolts to be added later.

Installation Wrenches

A wide variety of electric installation wrenches are changing the way many bolts are installed. Once used only for twist-off type tension control bolts (ASTM F1852 and F2280), electric wrenches such as the Tone TN series are now available with control systems that enable the installer to set the wrench to apply a certain rotation; this is very useful for the turn-of-nut pretensioning method. Other electric wrenches such as the Tone SR series have a control system to enable the installer to set the wrench at a given torque—which is useful for the calibrated wrench method of pretensioning.

In addition, electric wrench capabilities have increased dramatically over the years, with torques up to 2,200 ft-lbs, enough to pretension a well-lubricated 1⅜-in. A325 or 1¼-in. A490 bolt. Additional capacity can be achieved through the use of torque multipliers. Hydraulic systems are also used for large diameter high-strength bolts, as

they often exceed the capacity of both electric wrenches and the typical air impact wrenches.

Calibration Devices

The Skidmore-Wilhelm Model MZ is becoming a favorite bolt tension calibrator for fabricators and erectors. In 2008, the MZ's housing was changed to aluminum, reducing the unit's weight to 21 lbs (plus face plate and bushing) compared to 46 lbs with the Model MS, which used a steel housing. The new bushing retaining system also eliminates the problem of failed shear pins when torques get high. The unit's capacity is 126 kips of bolt tension, adequate for 1¼-in. A490 bolts.

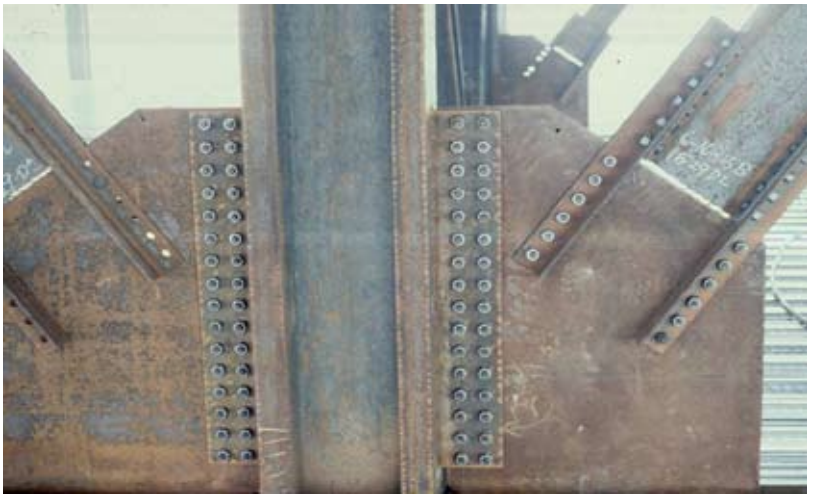
A Higher-Strength High-Strength Bolt

Research coordinated by the Steel Structures Technology Center is currently underway on bolts manufactured by the NS Bolten Company of Japan that could take high-strength bolting to a new level in North America. Known in Japan (where they have been used in buildings for more than a decade) as SHTBs (super-high-tension bolts), they have a 200-ksi minimum specified tensile strength—50 ksi stronger than the current A490 bolt—and use a unique patented combination of special steel, manufacturing, bolt design and thread design. Tests are being conducted on both heavy hex and twist-off type tension control bolts manufactured to 1-in., 1⅛-in. and 1¼-in. diameters to enable inclusion in future ASTM, AISC, CSA and other standards.

More to Come

The RCSC meets each June to discuss further improvements to its *Specification* (suggestions for clarification and improvement to the *Specification* are always welcome). Expect some modifications to the turn-of-nut tables, and perhaps some new coating systems, to be included in the next edition.

In addition, other, yet-to-be-reported research, with RCSC involvement, includes *Delayed Installation of ASTM F1852 Fasteners—2nd Phase* (Birkemoe, University of Toronto), *Effect of Material Characteristics and Surface Processing Variables on Hydrogen Embrittlement of Steel Fasteners* (Brahimi, IBECA Technologies Corp.), *Fatigue Resistance of High Strength Bolts in Tension* (Grondin, University of Alberta) and *The Effect of Fillers on Steel Girder Field Splice Performance* (Dusicka, Portland State University). Check **www.boltcouncil.org** for updates on these projects. MSC



A typical bolted brace connection.

Bolt Resource

The RCSC is a nonprofit, volunteer organization, comprised of over 85 leading experts in the fields of structural steel connection design, engineering, fabrication, erection and bolting. Its website, **www.boltcouncil.org**, offers free downloads of the latest three versions (2000, 2004 and 2009) of the RCSC *Specification*. Older versions can be downloaded from the AISC website, **www.aisc.org**, in the ePubs section under "Historical Standards."

The RCSC website is also the source for downloading multiple high-strength bolt-related documents, such as the *Guide to Design Criteria for Bolted and Riveted Joints*, 2nd Edition, by Kulak, Fisher and Struik, a valuable source document explaining the research behind many of the RCSC *Specification* provisions. Also available on the website are recent papers, such as *Evaluation of the Current Resistance Factors for Bolted Connection Strength* (Moore, Rassati and Swanson, University of Cincinnati), *Effects of Head Size on the Performance of Twist-Off Bolts* (Schnupp and Murray, Virginia Polytechnic Institute and State University), *Installation Characteristics of ASTM F1852 Twist-Off Type Tension Control Structural Bolt/Nut/Washer Assemblies* (Tan, Maleev and Birkemoe, University of Toronto) and *Qualification of Dacromet for Use with ASTM A490 High-Strength Structural Bolts* (Brahimi, IBECA Technologies Corp).

Super-high-tension bolts, which may see use in North America in the future.