If you've ever asked yourself "Why?" about something related to structural steel design or construction, *Modern Steel*'s monthly Steel Interchange is for you! Send your questions or comments to **solutions@aisc.org**.

steel interchange

Composite versus Non-composite Beams

I have recently noticed engineers specifying headed stud anchors for shorter span and infill beams, which have sufficient strength when designed as non-composite. I thought that shear studs are only useful when designing longer-span beams and/or girders. Are there advantages to providing shear studs for shorter span and infill beams?

The use of studs on steel beams to develop composite members can be advantageous to the beam design regardless of the beam span or the building occupancy type, unless the beams are very short. The use of shear connectors and composite beams in commercial building designs has become the norm for steel construction for the last few decades; it's not a recent change in practice.

Some beams, including short ones, also may have studs because they collect the loads from the diaphragm and deliver them to the lateral framing system.

Sometimes, even if the non-composite beam has sufficient strength, the use of shear connectors to make the member composite can provide significant additional stiffness and allow the floor system to perform better from a deflection perspective. I have worked on industrial projects where I elected to design the beams non-composite due to the abundance of floor penetrations but still provided shear connectors to take advantage of the additional stiffness wherever possible.

There are almost always multiple ways a structure can be designed and sometimes one way may be just as good as another. Nuances of the design or criteria may not be apparent to someone other than the original designer. You might ask the engineer who designed the structure about it the next time you see it. You might learn why, or he or she might learn a better way from you.

Susan Burmeister, P.E.

Alternate Fastener Grades

I have a project where ½-in.-diameter ASTM A490 bolts have been specified for slip-critical connections. I have been told that these bolts are not produced. Is it possible to substitute grade-8 bolts for the A490 bolts? If it is possible, can you provide any guidance on the use of grade-8 bolts in structural applications?

The AISC *Specification* recognizes that engineers will sometimes need to use materials not specifically approved by the *Specification* in their designs. Though not directly addressing fasteners, the Commentary to Section A3 of the *Specification* states: "There are hundreds of steel materials and products. This *Specification* lists those products/materials that are commonly useful to structural engineers and those that have a history of satisfactory performance. Other materials may be suitable for specific applications, but the evaluation of those materials is the responsibility of the engineer specifying them." Evaluation of alternative bolts and fasteners is the responsibility of the engineer specifying them.

Since the *Specification* does not directly address your condition, you'll have to use your own judgment. The *Specification* does address the use of bolts larger than those permitted by ASTM A325 and A490. These provisions might be used as a guide relative to your condition. Section J3.1 states: "When ASTM A354 Grade BC, A354 Grade BD or A449 bolts and threaded rods are used in slip-critical connections, the bolt geometry including the thread pitch, thread length, head and nut(s) shall be equal to or (if larger in diameter) proportional to that required by the RCSC *Specification*. Installation shall comply with all applicable requirements of the RCSC *Specification* with modifications as required for the increased diameter and/or length to provide the design pretension."

Therefore, there is some precedent for using bolts outside the range permitted under A325 and A490. It seems A354 Grade BD bolts are readily available in ½ in. in diameter. This would be a more common substitution for structural applications. A354 is also specifically addressed in the *Specification*, though only for larger, not smaller, diameters. A354 allows the bolt geometry including the thread pitch, thread length, head and nut(s) to be specified so as to be equal to or proportional to that required by the RCSC *Specification*.

Larry S. Muir, P.E.

There are Many Ways to Pretension a Bolt—but Only Use One at a Time

When installing twist-off-type tension-control (TC) bolts, must the torque and rotation be monitored? Should bolts rotated beyond the rotations listed in Table 8.2 of the RCSC *Specification* be rejected and replaced? Is there a maximum permitted torque for TC bolts?

The answer to all of your questions is "No."

The RCSC *Specification* provides the following pretensioning methods:

- Turn-of-nut pretensioning
- Calibrated wrench pretensioning
- Twist-off-type tension-control bolt pretensioning
- Direct tension indicator (DTI) pretensioning

Each method can be used to achieve the required pretension in the joint. Turn-of-nut installation involves applying a specified rotation beyond snug-tight. Calibrated wrench installation involves the determination and application of a torque. TC bolt installation relies on a specially configured bolt and wrench. DTIs involve depressing indicators on a specially made washer.

Some people subscribe to the "more is better" concept—in the case of bolt pretensioning believing that if one criterion is good then requiring multiple criteria must better ensure proper pretensioning. This is not consistent with the intent of the RCSC *Specification* and rather than ensuring proper pretension has been achieved, this practice will likely result in confusion or worse.

The idea that our methods are so exacting that the spline on the TC bolt will break just as the DTI washer flattens and the calibrated wrench shuts off at a specified rotation is unrealistic. While it may be possible to continue turning a bolt past one indicator and then force another indicator in the series, this does not mean the installation is superior. In fact, some installation methods are clearly incompatible.

The fact that the RCSC *Specification* does not provide a maximum installation torque and rotation is not a cause for rejection in the TC bolt pretensioning method.

Carlo Lini, P.E.

Engineer in Training

I recently received my degree in civil engineering and am working for an engineering consulting company. I am being asked to solve design problems the likes of which we never saw in school. I have found the AISC *Manual*, Design Guides and online videos quite helpful. However, sometimes I find I do not fully understand the decisions that are being made or the concepts being applied and am simply plugging values into equations. Up to this point, I have assumed that there is only one correct approach to a given problem and only one acceptable solution. As my work progresses, I am discovering this may not be true. How do I know whether a given approach is suitable to a given situation?

First, I am glad you have found these resources to be helpful. You have listed a number of different sources of information, and it is important to understand the intent of each. The August 2013 issue of *Modern Steel Construction* contained an article entitled "Says Who" that provides an informal overview of the various sources (you can find it in the Archives section at www.modernsteel.com).

The online videos you refer to are typically recorded sessions from NASCC: The Steel Conference and can be treated as proceedings. The information provided reflects the opinions of the presenters, who are selected based on their knowledge and expertise, so the information provided is sound. However, engineering involves judgment. Often, presenters will address specific conditions and apply analysis and design methods that the presenters feel are applicable to the conditions they are envisioning. Deciding whether another condition is similar to the one presented involves the application of engineering knowledge and judgment. Both AISC and the presenters intend engineers to exercise their own judgment.

As an engineer in training just beginning your career, you are not permitted to practice engineering independently. All states require qualifying engineering experience under the supervision of a professional engineer before one can become a professional engineer (or a structural engineer in some states). Ultimately, it is the engineer of record (EOR) who is responsible for the design and the assumptions made in the course of the work. In other words the design must reflect the experience and judgment of the engineer of record, not that of AISC or the presenters—or even you. Your supervisor should be keeping up with the assumptions you are making and the design procedures you are employing. You should reciprocate by actively informing your supervisor of your decisions.

As for your question on whether a given approach is suitable to a given situation, the EOR must be satisfied based upon his or her judgment. Note that practice is limited to areas in which the engineer is competent, and so engineers must self-regulate. As you gain experience and knowledge, you will likely be better prepared to make such decisions. In the meantime, you should pass all of your assumptions through your supervisors and let the EOR make the decisions.

Larry S. Muir, P.E.

The complete collection of Steel Interchange questions and answers is available online. Find questions and answers related to just about any topic by using our full-text search capability. Visit Steel Interchange online at **www.modernsteel.com**.

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Steel Interchange is a forum to exchange useful and practical professional ideas and information on all phases of steel building and bridge construction. Opinions and suggestions are welcome on any subject covered in this magazine.

If you have a question or problem that your fellow readers might help you solve, please forward it to us. At the same time, feel free to respond to any of the questions that you have read here. Contact Steel Interchange via AISC's Steel Solutions Center:

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