Steel Interchange is an open forum for *Modern Steel Construction* readers 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.

The opinions expressed in *Steel Interchange* do not necessarily represent an official position of the American Institute of Steel Construction, Inc. and have not been reviewed. It is recognized that the design of structures is within the scope and expertise of a competent licensed structural engineer, architect or other licensed professional for the application of principles to a particular structure.

If you have a question or problem that your fellow readers might help you to 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:

Steel SolutionsCenter
One East Wacker Dr., Suite 3100
Chicago, IL 60601
tel: 312.670.2400
fax: 312.423.4651
solutions@aisc.org

BOLTED CONNECTION DESIGN

Is it accurate to state that specifying a connection as slip-critical will increase the strength of that connection?

Karl Lankenau
Dormitory Authority of the State of New York
Albany, NY

Generally no. Making a joint slip-critical just means it will have a predictable resistance to slip in the service range. The ultimate strength of the connection is identical whether we make it slip-critical or not because it will have slipped into bearing prior to reaching its ultimate strength. This is correct when comparing bearing and slip-critical joints with the same number of bolts and geometry.

If the constant is the force to be transferred and the comparison is between the number of bolts required for bearing and the number required for slip resistance (i.e., joints with different numbers of bolts), then the SC joint will in most cases have more bolts and a higher ultimate strength. However, this higher strength is attained only at ultimate —after slip has occurred.

So if slip resistance is truly a necessary design criterion, the slip-critical joint has no additional design strength beyond that of a similarly and properly designed bearing joint.

Charles Carter, S.E., P.E.
American Institute of Steel Construction
Chicago, IL

BOTTOM FLANGE PLATE

I heard that AISC has information for designing composite beams with a cover plate on the bottom flange. Please let me know how I could obtain this information.

Question sent to AISC's Steel Solutions Center

Please refer to AISC Design Guide No. 5, *Low- and Medium-Rise Steel Buildings*. Although this design guide is much more general in nature than the subject question, it contains a brief section and an ASD/LRFD example in the Appendix for determining the design strength of a composite beam with a bottom flange plate.

If you do not have this particular design guide, it can be ordered by calling our Publications Department at 800.644.2400 or online at www.aisc.org/bookstore.html.

Sergio Zoruba, Ph.D.
American Institute of Steel Construction
Chicago, IL

BOLT ORIENTATION

Often we hear that bolts should be installed pointing downward (with the heads on top) to prevent them from falling off if the nut got loose and slipped. Is there any code or steel installer manual or any written reference that supports, recommends or mandates this practice?

Question sent to AISC's Steel Solutions Center

If bolts are installed properly, the nut should not loosen, regardless of the bolt orientation during installation. There are no provisions that would require that a bolt be inserted one way or the other in terms of vertical orientation. It is really up to the preference of the erector. One line of thought is that the bolt is dropped into the hole head-up so it does not fall out, as this lessens the amount of work required in maintaining the bolt in-place (if inserted from the bottom-up, then the bolt must be held before it is fastened.) Yet, on the other hand, some erectors might prefer to have the nut on top since the equipment used to turn the nut may be significantly heavier than the wrench used to hold the head in place.

Of course, there may be times when one orientation may be preferred to another for accessibility, entering and tightening clearances. Additionally, orientation of the bolt becomes very important if the bolt threads are designed to be excluded from the shear plane since the ply thickness adjacent to the nut must be properly sized to achieve the X-condition.

The following is a related frequently-asked question from www.aisc.org/faq.html:

What can be done to prevent the nut from loosening?
In general, when properly installed, the high-strength bolt-nut assembly will not loosen. When snug-tight bolts are used, the loading will be such that loosening of a nut will not occur. When fully tensioned bolts are required, as for slip-critical connections subjected to vibratory or fatigue

loading, the installed tension and the attendant friction on the threads will prevent the nut from loosening.

Keith Mueller, Ph.D.
American Institute of Steel Construction
Chicago, IL

GUSSET PLATE BUCKLING

My question is regarding compression buckling of gusset plate attached to a beam and column. For example, if my brace is in compression, how do I check the *KL/r* for the effective section of the gusset plate?

Question sent to AISC's Steel Solutions Center

There are guidelines pertaining to gusset plate buckling in the 3rd edition LRFD *Manual*. For instance, the effective length factor *K* can be 0.5 if the gusset plate is supported on two edges. If it is supported on one edge, a *K* of 1.2 would be more appropriate (see page 13-32).

With respect to the effective length, it is usually conservative to take the perpendicular distance of the Whitmore section's spread end to the interior corner of the gusset plate. Alternatively, there is a method discussed in the new manual that uses the average of three distances to determine the effective length of the gusset plate.

The radius of gyration is determined by taking the square root of *I/A* about the weak-axis of the gusset plate. The term pertaining to the width of the plate is cancelled in the calculation, as it is used in both the numerator and denominator. This is handy, as a tapered gusset plate does not complicate the calculation for *r*. Tables 3-36 and 3-50 in the 1999 LRFD *Specification* can be used to determine the design critical stress of the gusset plate for various *KL/r* values.

Sergio Zoruba, Ph.D.
American Institute of Steel Construction
Chicago, IL

MASONRY SHELF ANGLES

Question reprinted from www.aisc.org/faq.html

How is a masonry shelf-angle designed?

A paper by Tide and Krogstad (referenced below) notes:

Factors such as deformation of lower courses of masonry during construction and the rigidity of masonry walls after the mortar begins to set cause shelf angles to be loaded by a combination of uniform and concentrated loads acting near the back edge of the masonry. Restraint provided by friction and the masonry ties reduces torsional forces and deflection and provides lateral support for the shelf angles.

A design procedure that accounts for these factors can be found in "Economical Design of Shelf Angles," by R. H. R. Tide and N. V. Krogstad (1993, *Proceedings of the Symposium on Masonry: Design and Construction, Problems and Repair*, STP 1180, American Society for Testing and Materials (ASTM), Philadelphia, PA.)

Answer reprinted from www.aisc.org/faq.html

NEW QUESTION

LACING COLUMN DESIGN

Please provide any additional sources of information relative to AISC *Specification* section E4 (ASD *Manual*, 9th ed., pages 5-43 and 5-44) covering the proportioning of lacing members to resist a 2% shear stress.

Additional references with discussions, the history of its origin, derivation and/or examples of the proper application of this specification would be greatly appreciated.

W. H. Parker
Derrick Engineering

NEW AISC WEB SITE LAUNCHED

Big changes have taken place at AISC's web site, www.aisc.org. During the week of April 22, AISC launched a completely redesigned site that's faster, easier to navigate and packed with new features:

- **Steel Availability List.** The online list is now fully searchable and truly "live"—the steel mills maintain the database of shape availability themselves.
- ***Engineering Journal* Articles.** Members may download individual *Engineering Journal* articles for free. Non-members may download articles for fee of $10 per article.
- **Steel Solutions Center.** Visitors can now easily browse for information by topic (i.e. bolts, seismic design, parking structures) and find all that AISC has to offer. Many documents are available in the easy-to-use (and easy-to-print) Adobe Acrobat .pdf file format.