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Flexural Strength of a Box Section

When calculating S_e for a box section with slender flanges, should the full S_x of each web be included?

No. You will need to account for the change in location of the centroid due to the reduced effective width of the compression flange. The first step is to compute the effective width of the flange based on the requirements of AISC *Specification* Section F7. Then, the moment of inertia can be computed based upon the parts of the section that are still effective (the tension flange, both webs, and the effective part of the compression flange). Based upon the centroid of that section, the effective section modulus can be computed.

Brad Davis, S.E., Ph.D.

Double-Angle Connections

Can you please provide some recommendations on whether or not to use double-angle connections, bolted to a beam and welded to an HSS column when the connection is subject to axial tension?

I would not use a double-angle connection bolted to the beam web and welded to the face of an HSS column when a specified axial force is present. For shear loading, this type of connection is given in 14th Edition AISC *Steel Construction Manual* Table 10-2, Case II. The weld is referred to as Weld B.

In the industry, this is called a "knife connection" because the angles are shop welded to the HSS and the beam is "knifed" down between them during erection. This connection should be used for shear only. Not only is the fillet root put in tension under axial load, but the angle legs are subjected to bending. This bending will accentuate the tensile stress on the fillet root. AWS D1.1 2006, paragraph 2.8.1.1 addresses a similar situation that occurs in lap joints.

A single-plate shear connection can be used for this case. This would be a specifically designed connection for shear and tension using the principles of structural mechanics. The HSS would be checked per Chapter K of the AISC *Specification*.

Bill Thornton, P.E., Ph.D.

Joists in SMF Protected Zone

We are designing a building with special moment frames as the seismic force resisting system. Are open-web joists allowed to bear on the beam in the protected zone?

AISC *Seismic Provisions* Section 7.4 prohibits attachments within the protected zone unless they are specifically allowed by ANSI/AISC 358, *Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications*, for the connection being used. AISC 358 does not currently have a prequalified connection that allows a joist attachment within the protected zone. Thus, the joist can bear in this area, but cannot be positively connected—the practical result is that a joist cannot be placed within the protected zone.

Larry S. Muir, P.E.

Workable Gage

The AISC *Steel Construction Manual* Table 1-1 lists the workable gage for a W14×145 as 3-7½-3. These large W14 sections are the only members in this table that have the gage listed as such. Can you please explain this gage designation?

Those particular W14 sections with a large flange width can typically fit four rows of bolts across the width of the flange instead of the two rows typical to other shapes. Thus the 7½-in. gage width is centered on the web and then it is 3 in. to the next row of bolts on either side.

Erin Criste, LEED GA

AESS and Stiffener Corner Clips

Does AISC *Code of Standard Practice* Section 10.2.4 regarding AESS fabrication tolerances apply to stiffener clips at the radius on a wide flange?

AISC *Code of Standard Practice* Section 10.2.4 states, "All copes, miters and cuts in surfaces that are exposed to view shall be made with uniform gaps of ⅛ in. [3 mm] if shown as open joints, or in reasonable contact if shown without gap."

Corners of stiffeners usually are clipped diagonally or blocked in rectangular fashion with a radius at the corner of the rectangle. This is not a code requirement for non-seismic conditions, rather it is typical practice. AISC does not recommend eliminating corner clips in stiffeners in these cases. For seismic conditions where AWS D1.8 applies, it is a code requirement that certain stiffeners be blocked or clipped. AISC *Code* Section 10.2.4 was not intended to override other specification requirements, thus it does not apply to stiffeners subject to the requirements of D1.8.

Heath Mitchell, S.E., P.E.

Detailing for Steel Construction

Does AISC's *Detailing for Steel Construction*, 3rd Edition, have connection design examples similar to those contained in the 1st Edition?

Detailing for Steel Construction, 3rd Edition, contains example connection details and drawings for illustration purposes. It also has an appendix illustrating basic principles and discusses such topics as tension members and trusses. It is important to note that the 3rd Edition does not contain capacity tables or detailed connection design examples for simple connections.

Capacity tables and detailed connection design examples for simple connections are included in Part 10 of the 14th Edition AISC *Steel Construction Manual* and the companion AISC *Design Examples*. The design examples are available as a free download at **www.aisc.org/designexamples**.

Erin Criste, LEED GA

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OCBF Unbalanced Load

In a two-story "X" type OCBF, must the beam and braces above resist the unbalanced forces as specified in AISC 341 Section 14.3(1)?

The Commentary to AISC 341-05 Section 14.3 refers to the Commentary to Section 13.4a (on SCBF) for additional information. This latter commentary states, "The adverse effect of this unbalanced load can be mitigated by using… an X-configuration over two-story modules…" It is stating that the adverse effect on the beam can be mitigated, not eliminated, by using the two-story X configuration.

A load path still needs to be provided for the unbalanced load. The idea is that the braces above are able to support the unbalanced load on the beam due to brace yielding below. For some cases the two-story X configuration can eliminate the unbalanced load on the beam. However, brace sizes and slopes above and below the joint can have an impact on the degree to which the unbalanced force is redistributed. A free-body diagram of the joint can help determine the proportion of the unbalanced load that is taken by the beam and the brace above. Additionally, the connection needs to be designed to transfer the unbalanced load across the beam from the lower to the upper brace.

Heath Mitchell, S.E., P.E.

Multiple Washers

Is there a maximum number of washers that can be used in a high-strength bolted connection?

Neither the RCSC *Bolt Specification* nor the AISC *Specification* prohibit the use of multiple washers. Multiple washers are sometimes used to ensure the threads excluded condition. This is referred to in the Commentary to RCSC *Specification* Section 2.3, which states:

> "If necessary, the next increment of bolt length can be specified with ASTM F436 washers in sufficient number to both exclude the threads from the shear plane and ensure that the assembly can be installed with adequate threads included in the *grip* for proper installation."

Larry S. Muir, P.E.

Long-Slotted Holes

In a slip critical connection, can one member have long slots parallel to the direction of the load and the other have long slots perpendicular to the load?

According to the 2010 AISC *Specification* Section J3.2, long-slotted holes are permitted in only one of the connected parts at an individual faying surface. Note that one of the reasons for this requirement is a concern related to ineffective pretensioning. This is explained in Section 8.3 of AISC *Steel Design Guide No. 17, High Strength Bolts—A Primer for Structural Engineers*, which is available as a free download for AISC members at www.aisc.org/epubs.

Brad Davis, S.E., Ph.D.

Protected Storage of Bolts

Section 2.2 of the 2009 RCSC *Specification* states that bolts cannot be used in the work that have become dirty or rusty and that these bolts must be qualified to Section 7. If individual bolts are cleaned and lubricated on an "as needed" schedule, do bolts need to be requalifed if they have already been qualifed in the as-received condition?

Section 2.2 of the RCSC *Specification* states, "Fastener components that accumulate rust or dirt shall not be incorporated into the work unless they are requalified as specified in Section 7."

The intent of the RCSC *Specification*, stated in the first sentence of Section 2.2, is that bolts should be, "protected from dirt and moisture in closed containers at the site of installation." If this is not done and the condition of the bolts has changed from the as-received condition, the bolts must be requalified. Assuming the condition of all the bolts has deteriorated in a uniform manner, the sampling required in Section 7 is sufficient. If the condition of the bolts is substantially varied, then the bolts must be requalified in accordance with the sampling requirements of Section 7 taking into account the various levels of deterioration.

In other words, bolts in similar condition should be treated the same. If the requalification requires relubrication, then all the bolts exposed to similar conditions should be relubricated. There is no way to establish "as needed" unless the bolts are requalified and then treated in the same manner.

It also should be noted that twist-off-type tension-control (TC) bolts cannot be relubricated in the field. Section 2.2 states, "ASTM F1852 and F2280 twist-off-type tension-control bolt assemblies and alternative-design fasteners that meet the requirements in Section 2.8 shall not be relubricated, except by the *manufacturer*."

Larry S. Muir, P.E.

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