IF YOU'VE EVER ASKED YOURSELF "WHY?" about something related to structural steel design or construction, *Modern Steel Construction*'s monthly Steel Interchange column is for you! Send your questions or comments to solutions@aisc.org.

Weak Axis Bending

I have an H-shape in bending about the weak axis. Chapter F, Section F2 of the AISC manual notes, "Lateral bracing is not required for members loaded through the shear center about their weak axis, or for members of equal strength about both axes." Do we still need to consider the lateral torsional buckling effect if the beam is bent about the weaker axis? Based on my understanding, lateral bracing prevents torsion and lateral deflection only. What is the exact relation between "lateral bracing to prevent torsion" and "lateral bracing to prevent lateral torsional buckling"?

Lateral-torsional buckling is a combination of lateral movement and twisting that can occur when a beam is not stiff in the lateral direction. But when a beam is bent about its weak axis, it can't move laterally because it is stronger in that direction, and the lateral effects cannot overcome that. Thus, lateral-torsional buckling does not apply for a member that is bent about its weak axis.

Section 6.3 of Appendix 6 in the 2005 AISC specification (a free download at **www.aisc.org/2005spec**) discusses how to brace beams to resist lateral-torsional buckling. Lateral-torsional buckling can be restrained by a torsional brace or a lateral brace. That is, the brace can either prevent twist or lateral displacement of the compression flange relative to the tension flange. Most details provide some combination of these restraint mechanisms.

Amanuel Gebremeskel, P.E.

Design Forces

A fabricator has recommended providing member end forces (for beams) and axial member forces (for braces) for economical connection design. What are "transfer forces" with regard to connection design, and how does one calculate these? What is the rationalization as to why member end forces acting transverse to the longitudinal axis (in the weak axis direction) are ignored in connection design?

Transfer forces are forces that occur across a joint where multiple members attach to the joint. An example would be in a frame with braces connected on opposite sides of a column. Some of the axial forces in the braces are transferred into the beams and column, while some go from one brace into the other brace. In the analysis, the joint was treated as a node, but the forces must have a path through the various connections in the real structure to get from brace to brace.

As for your second question, the AISC specification does not define what forces can be ignored or not. That decision needs to be made by the responsible design professional based on the particular project details. In many cases the horizontal forces perpendicular to the longitudinal axis for a beam that has an attached slab are assumed to be taken by a slab diaphragm.

Kurt Gustafson, S.E., P.E.

R = 3

I understand that there is a provision that will allow me to not design steel connections per the AISC *Seismic Provisions* if I use an *R* value of 3. Can you tell me where I can find this information?

The governing building code or model code typically addresses which *R* values require compliance with the AISC *Seismic Provisions* and which ones do not. For instance, as per ASCE 7, for low and moderate seismic risk areas (Seismic Design Category C and below), you are correct that structures can be designed per item H in ASCE 7-05 Table 12.2-1, which covers steel systems not specifically detailed for seismic resistance. This option allows for the use of *R* = 3 with normal detailing, an option that is covered in detail in Part 2 of the *Seismic Design Manual*. In high seismic risk areas (Seismic Design Category D and above), however, all steel building structures must utilize one of the other systems provided in ASCE 7-05 Table 12.2-1 and comply with the corresponding requirements of the AISC *Seismic Provisions*.

The 2005 AISC *Seismic Provisions* can be found at **www.aisc.org/2005seimic**.

Amanuel Gebremeskel, P.E.

Steel Availability and Fabricator Listings

Could you suggest a resource where I can obtain mill pricing on structural shapes and information on availability? Could you also suggest a resource where I can obtain list of domestic steel distributors and major fabricators?

It is very important for structural engineers and architects to have a current understanding of the market for structural steel both in terms of price and availability. Mill pricing and the current rolling schedule for wide-flange products is available on the web sites of each of the major wide-flange producers (see **www.aisc.org/availablity** for a list of producer web sites). However, this information only provides a partial picture of the market for structural steel. Approximately 70% of all structural steel flows through local service centers that carry a significant stock of commonly used wide-flange, HSS, and miscellaneous sections. In addition, the designer should keep in mind that the mill price of the structural steel typically represents less than one-third of the erected cost of the steel. The best resources for determining what sections are stocked locally for immediate delivery and pricing trends in your area are local steel fabricators and steel service centers who are active in the market on a daily basis. AISC member fabricators can be found in your area by visiting the "Find a Company/Person" area of the **www.aisc.org** web site. A list of member service centers is available at **www.aisc.org/servicecenter**. If you need assistance locating a member mill, service center, or fabricator, please give the AISC Steel Solutions Center a call at 866.ASK.AISC (866.275.2472).

John P. Cross, P.E.
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steel interchange

Bending Radius

What is the minimum allowable bend radius for 1½-in.- and 1¾-in.-diameter bars in ASTM A572 Grade 50? When hot bending is required, are there code provisions for the temperature required?

Suggested minimum inside radii for cold bending steel material of various groups and thicknesses are given in Appendix X4 of ASTM A6. There is also guidance given based upon thickness and steel grade in AISC manual Table 10-12 (page 10-160 in the 13th edition). It suggests that the minimum radius for cold bending should be twice the diameter for the sizes you mention. For hot bending, temperature limitations for cambering, curving, and straightening of steel are discussed in Section M2.1 of the AISC specification (a free download at **www.aisc.org/2005spec**).

Kurt Gustafson, S.E., P.E.

Shape Availability

I was informed by my engineering team that a W24×160 beam is commercially available. Can you tell me by whom such a beam is being produced?

This shape is not currently produced in the U.S. It is possible that your engineering team is working with outdated information, as there has not been such a shape designation in the U.S. since the early 1970s.

There is a W24×162 in the current ASTM A6 standard. You can find the producers of this shape on the AISC steel availability link at **www.aisc.org/availability**. At that link, you will find four mills that roll this particular product, as well as contact information for these mills. You will also find contact information for many steel service centers from which the shape can be obtained.

Kurt Gustafson, S.E., P.E.

Historic Steel Specifications

I remember seeing a download that shows the historical steel specifications used in industry—for example, what years ASTM A7 steel was used. Can you help?

AISC's Design Guide 15 is probably the document you are looking for. You will find it at **www.aisc.org/epubs**.

You may also want to download an article that appeared in the February 2007 issue of *Modern Steel Construction* titled "Evaluation of Existing Structures." Back issues of MSC can be accessed via the "Archive" link at **www.modernsteel.com**.

Kurt Gustafson, S.E., P.E.

BF in Table 3-2

Table 3-2 in the 13th edition manual has a column showing value of *BF*; however, the symbol list does not include the term *BF*. General Nomenclature (Index) indicates that *BF* is factor that can be used to calculate the flexural strength for unbraced length L_b between L_p and L_r. How is that done? Table 3-2 also lists M_{rx}. How was this calculated?

The *BF* listed in Table 3-2 is a simplification of Equation F2-2 of the AISC specification to account for the slope of the straight line between L_p and L_r. In numerical terms it represents $(M_p - M_r)/(L_r - L_p)$.

M_r is the moment capacity of the beam as it enters the elastic buckling range on the curve. Essentially, it is the moment capacity of the beam when the unbraced length is L_r and is calculated using Equation F2-6. Equations F2-3 and F2-4 are used to calculate the value of M_r.

Kurt Gustafson, S.E., P.E.

Unbraced Tee in Flexure

Does the limit state of yielding apply to an unbraced tee flexural member with stem in tension? The compression flange is non-compact.

Yes. The AISC specification (a free download at **www.aisc.org/2005spec**) contains a section for the design of tees loaded in the plane of symmetry, and Section F9.1 provides for a yield check. Also, Section F9.2 provides for the lateral-torsional buckling (LTB) limit states, and Section 9.3 provides for the flange local buckling limit states; the later includes checks for non-compact and slender flanges.

Amanuel Gebremeskel, 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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