specwise

A BEAM IS A BEAM

Designing members for flexure with the new AISC *Specification*.

BY LOUIS F. GESCHWINDNER, PE, PhD

BENDING MEMBERS are still bending members in the new AISC *Spec*.

Overall, the 2016 *AISC Specification*, ANSI/AISC 360-16, brings few changes to the design of the more commonly designed I-shaped bending members. These changes are intended to simplify provisions and improve both safety and economy. The most significant changes have to do with the provisions for tees and double angles in Section F9 and single angles in Section F10. Throughout Chapter F, the user may notice slight changes, as variables are defined in different locations from before, and some now have expanded definitions. In addition, clarifications have been provided where the committee felt they would be helpful.

I-Shaped Members

Design for bending is based on required strength not exceeding the available strength for the limit states of yielding, lateral-torsional buckling (also referred to as unbraced length) and local buckling (generally referred to as compact, noncompact or slender element members). This has not changed in over 50 years. Figure 1 illustrates how moment strength varies with unbraced length or width-to-thickness ratio (element slenderness) for I-shaped members and the majority of other members covered by the *Specification*.

When considering unbraced length, the variation of the moment diagram between braced points is an important factor that, when accounted for, can provide added available moment strength for the member. A clarification is provided for cantilevered beams, stating that at the support, the cantilevered member must be prevented from warping, and if the other end is free, then C_b = 1.0. For any other cantilever member bracing conditions, the Commentary discussion should be reviewed. And for other combinations of beams and loadings, extensive discussion is provided in the Commentary.

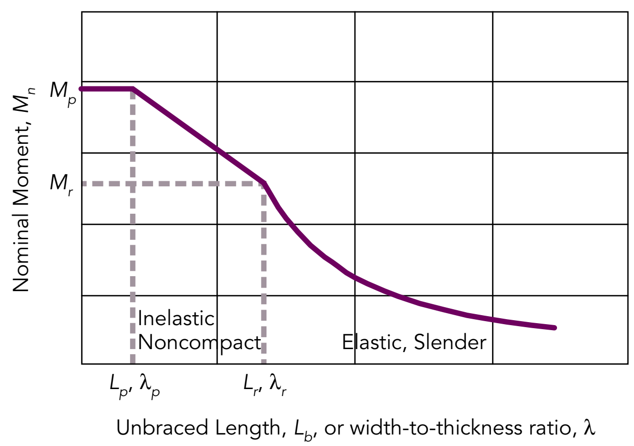
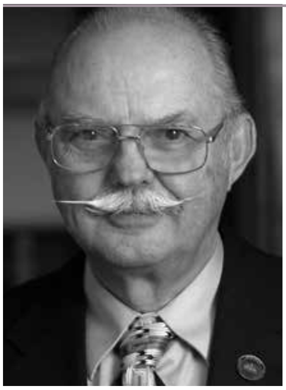


Figure 1. Moment strength vs. unbraced length or width-to-thickness ratio.

Box Sections

With the goal of clarifying how Chapter F applies to boxes built-up from plates, box sections have been defined as square or rectangular doubly symmetric members made with four plates welded together at the corners such that they behave as single members. Then, throughout the *Specification*, the term "box-shaped members" has been replaced with "box sections." The provisions for box sections in bending continue to be combined with those for square and rectangular hollow structural sections (HSS) and presented in Section F7.

Although there are no slender web HSS, it is possible that a box section may be designed with slender webs, thus provisions have been established for web local buckling of slender web box sections. In addition, provisions for lateral-torsional buckling of square and rectangular HSS and box sections have been added. These lateral-torsional buckling provisions will rarely limit the strength of these bending members.



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Tees and Double Angles

The requirements for tees and double angles have been revised to better reflect their behavioral similarities and differences. In addition, the provisions for single angles and double angles have been harmonized. Thus, as an example, the moment strength for the limit state of yielding for double angles with the legs in compression is now limited to 1.5 times the moment that just causes the extreme fiber to yield, M_y. This is the same as for single angles. It had previously been limited to M_y, the same as for tees. This difference is primarily due to the fact that there are insufficient test results to show that tees are capable of reaching this higher strength.

The provisions for lateral-torsional buckling of tees and double angles have been revised to look more like the behavior illustrated in Figure 1. The difference between members with the stem or web legs in tension and compression becomes apparent for tees buckling elastically with unbraced lengths beyond L_r, as seen in Figure 1. For double angles, the provisions require coordination with the requirements for single angles—again working to ensure that double- and single-angle bending members are treated similarly when appropriate.

Stem local buckling of tees was first introduced in ANSI/AISC 360-10, following many years of the Commentary stating that this limit state will not be critical. However, the conservative assumptions used in the development of those 2010 provisions proved to be far too conservative. Thus, the stem local buckling provisions for tees have been completely revised. They now take on a format similar to that shown in Figure 1 with a comparison between the 2010 and 2016 provisions shown in Figure 2.

Flange local buckling of tees remains unchanged for 2016 and follows the pattern shown in Figure 1. For double-angle members, both web leg and flange leg local buckling provisions refer the engineer to Section F10 for single angles.

Single Angles

The provisions for yielding of single-angle bending members remain unchanged, and the provisions for lateral-torsional buckling have been reorganized for a more reasonable arrangement of equations as shown in Figure 3. The equations cited are a function of the elastic lateral-torsional buckling moment of the single angle, which is a function of the axis of bending—geometric or principal. Overall, these provisions have been somewhat simplified.

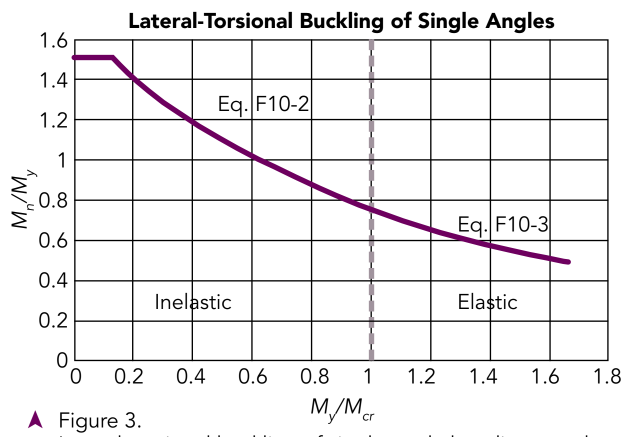

Figure 3.
Lateral-torsional buckling of single-angle bending members.

Local buckling of the angle leg depends on which leg is in compression. For geometric axis bending, the flange leg toe or the stem leg toe may be in compression—and for principal axis bending, one or both leg toes may be in compression. Recent changes in availability of large angles have introduced 10-in. and 12-in. leg angles. Figure 4 shows the variation of strength as a function of leg width-to-thickness ratio, with the most slender leg for each angle size noted.

The changes in Chapter F from ANSI/AISC 360-10 to 360-16 were deemed necessary by the Committee on Specifications to both clarify and simplify the provisions, and in the case of tees, to give a more economical design with an appropriate level of safety. The majority of bending member designs according to the 2016 *Specification* will be no different than those performed according to the 2010 *Specification*.

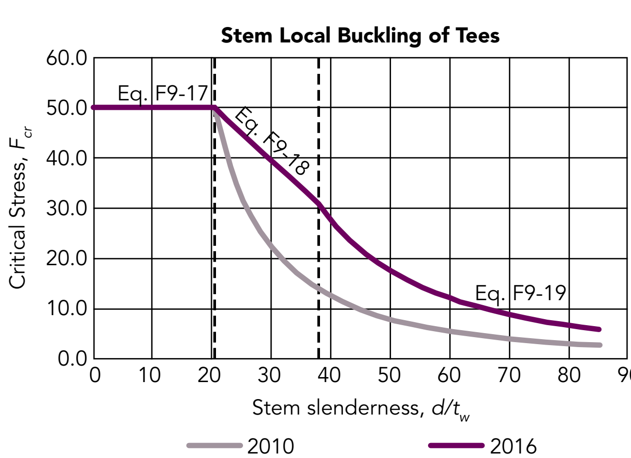

Figure 2. Comparison of stem local buckling provisions for ANSI/AISC 360-10 and 360-16

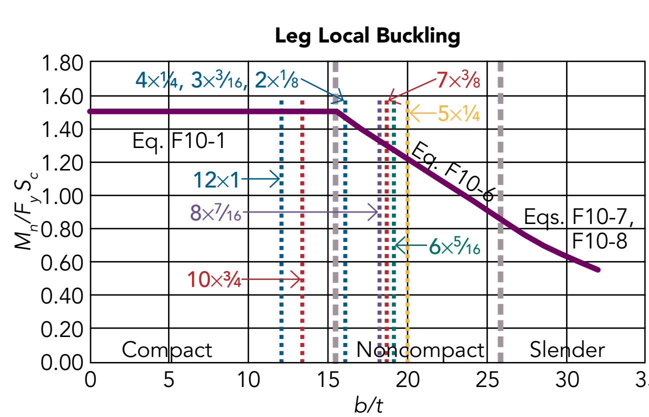

Figure 4. Maximum angle leg slenderness.