Overview of Changes to 2007 AISI Specification

Design of Cold-Formed Steel Structural Members

By Roger LaBoube, Ph.D., P.E. and Helen Chen, Ph.D., P.E.

The *North American Specification for the Design of Cold-Formed Steel Structural Members*, as its name implies, is intended for use thoughout North American, that is Canada, Mexico, and the United States. The 2007 edition of the Specification will soon be issued by the American Iron and Steel Institute (AISI) and the Canadian Standards Association (CSA).

As with the 1996 and 2001 Specification editions, the 2007 edition provides an integrated treatment of Allowable Strength (ASD), and Load and Resistance Factor Design (LRFD) for the United States. Since the 2001 specification, Limit States Design (LSD) for Canada has also been included.

Although there are numerous editorial changes to the 2007 Specification, this article focuses on major technical changes to the document. Some of the editorial changes are the result of the efforts of AISI and AISC to promote common terminology by issuing the 2007 edition of the AISC and AISI *Standard Definitions for Use in the Design of Steel Structures*.

More economical designs may be achieved by use of ASTM A1039, which was adopted as a steel grade for use by the Specification. ASTM A1039 is a higher strength steel, but unlike other high strength steels, for example A653 Grade 80 steel, ASTM A1039 has a chemistry that enables acceptable ductility.

New to the Specification are provisions that enable evaluation of the effective width for unstiffened elements and edge stiffeners with stress gradient. Previously, the effective width was conservatively determined assuming a uniformly distributed compression stress. This new design provision will result in more accurate assessment of the buckling performance of an unstiffened compression element.

Cold-formed steel members are often singly-symmetric sections, and thus may be subject to combined bending and torsion. The 2007 Specification contains design provisions that enable the evaluation of the structural performance of a cold-formed steel member subject to this combined loading.

It has been recognized that cold-formed steel members may be subject to distortional buckling. Distortional buckling is an instability that may occur in members with edge stiffened flanges, such as C- and Z-sections. *Figures 1* and *2* illustrates the various buckling modes for a flexural member and the fact that distortional buckling is characterized by instability of the entire compression flange, as the flange along with the edge stiffener rotates about the junction of the compression flange and the web. However, until the 2007 edition, the Specification has been silent on the evaluation of the structural performance of members subject to distortional buckling. These new distortional buckling provisions for both flexural members and compression members may likely be one of the more significant changes to the 2007 Specification. The Specification provides explicit equations for distortional buckling strengths for C- and Z- section members, and rational methods for arbitrary sections.

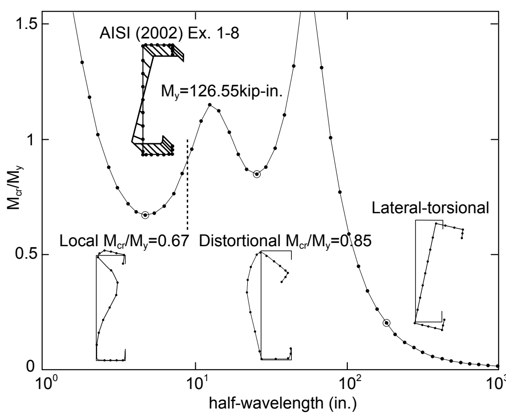

Figure 1: Buckling Modes for a Z-section.

Chapter D, titled *Structural Assemblies and Systems*, has experienced significant editorial as well as substantive technical changes. Editorial changes include Section D4, *Light Frame Construction*, which now references the ANSI approved standards developed by the AISI Committee on Framing Standards for the design of cold-formed steel framing. These framing standards recognize the growing use of cold-formed steel framing in both residential and commercial construction. Also, Section D6, *Metal Roof and Wall Systems*, was created to house the provisions for assemblies that are typically applicable to metal building design.

A substantive technical change to Section D includes new provisions for determining the required brace strength and stiffness for an axially loaded compression member. The design provision is given as follows:

The required brace strength to restrain lateral translation at a brace point for an individual compression member is given as:

$P_{br},1 = 0.01P_n$

The required brace stiffness to restrain lateral translation at a brace point for an individual compression member is calculated:

$$\beta_{br,1} = \frac{2[4 - (2/n)]P_n}{L_b}$$

where

P_n = Axial compression strength of the member to be braced.

$P_{br},1$ = Required nominal brace strength for a single compression member.

P_n = Nominal axial compression strength of a single compression member.

$\beta_{br},1$ = Required brace stiffness for a single compression member.

n = Number of equally spaced intermediate brace locations.

L_b = Distance between braces on one compression member.

These requirements for brace strength and stiffness for a single compression member are similar to the provisions in the AISC *Specification for Structural Steel Buildings* for compression member nodal bracing. The above requirements for brace stiffness for a single compression member are also similar to the AISC provisions, with the exception that 2(4-(2/n)) instead of 8 is used as the multiplier for the brace stiffness. AISC assumes n equals infinity. For the calculation of brace strength and stiffness, the nominal axial strength of the member, P_n, is used rather than the required strength, because the equations for the member strength assume the brace enables the development of the full member strength.

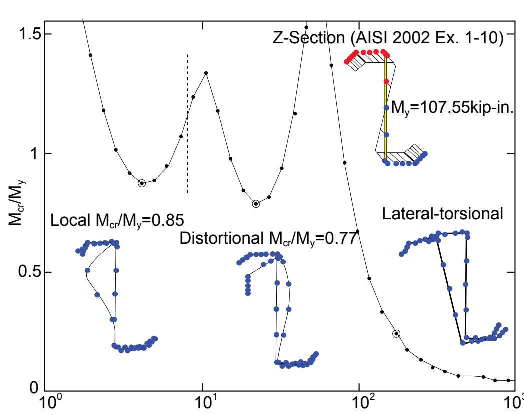

Figure 2: Buckling Modes for a C-section.

Previous editions of the Specification contained requirements for evaluating the anchorage force of a metal roof system utilizing C- or Z-purlins. In the 2007 Specification, Section D6 contains new design equations for assessing the required anchorage force for purlin roof systems under gravity load when the top flange is attached to either a through-fastened or standing seam roof panel.

Connection design has also been enhanced by the addition of design provisions for the determination of the shear strength of welded sheet-to-sheet connections. Also, an interaction equation for combined shear and pull-over for screw connections appears in the 2007 Specification.

Two appendices are included in the 2007 Specification. Appendix 1, titled *Direct Strength Design for Cold-Formed Steel Structural Members*, is an alternative approach for determining the strength and stiffness of cold-formed steel beams and columns. The determination of member strength and stiffness are accomplished with the aid of a finite strip or finite element elastic buckling analysis. The long standing effective width approach is not required when the Direct Strength Method is used. The Direct Strength Method provides a new rational approach for determining the member strengths of cold-formed members with an unconventional cross section.

Appendix 2 empowers engineers to perform a second-order analysis as an alternative method for evaluating the second-order effect in a cold-formed steel member subject to combined bending and axial compression.

The *Commentary on the 2007 North American Specification for the Design of Cold-Formed Steel Structural Members* contains a more detailed discussion of the design provisions. Also, the Commentary provides a comprehensive bibliography for the background of the Specification provisions. For a more complete compilation of the changes to the 2007 *North American Specification for the Design of Cold-Formed Steel Structural Members* refer to Wei-Wen Yu Center for Cold-Formed Steel Structures' Technical Bulletin Vol. 16, No. 2, Fall 2007 (**www.umr.edu/~ccfss**).▪

Helen Chen, Ph. D., P.E. is a senior structural engineer and the secretary of AISI Committee on Specifications for the Design of Cold-Formed Steel Structural Members.

Roger LaBoube, Ph. D., P.E., is a distinguished teaching professor of Civil Engineering and Director of the Wei-Wen Yu Center for Cold-Formed Steel Structures, University of Missouri-Rolla, Rolla, MO. Dr. LaBoube is an active member of AISI Committee on Specifications and Committee on Framing Standards.