PREFACE

This document is intended to provide an introduction to aid students in the design of cold-formed steel members and is therefore limited in scope. The document addresses the design for a C-shaped cross section as a flexural member and a compression member. Connection design is limited to primarily a discussion of screw connections. The scope was selected to provide coverage of the high volume application of cold-formed steel in light-framed construction. This document is intended to serve only as an education tool. Final design must be based on the *North American Specification for the Design of Cold-Formed Steel Structural Members* [*Specification*].

This document includes excerpts from the *North American Specification for the Design of Cold-Formed Steel Structural Members* and materials taken from the Commentary on the *North American Specification for the Design of Cold-Formed Steel Structural Members*, as well as additional explanatory language. The commentary and explanatory language is identified by a vertical black line along the right margin.

INTRODUCTION

Cold-formed steel members are an economic solution for many construction applications in buildings. The sections are cold-formed from steel sheets, strips, plates or flat bars by using roll-forming, press brake, or bending machines. Cold-formed steel members have several advantages over other materials: (1) light members can be manufactured for relatively light loads and/or short spans, (2) unusual cross sections and configurations, resulting in favorable strength to weight ratios, (3) ease of prefabrication and mass production, (4) non-shrinking and non-creeping at ambient temperatures, (5) termite and rot proof, (6) non-combustible, and (7) recyclable.

Because cold-formed steel members are thin, the width-to-thickness ratios are large, especially compared to hot-rolled steel shapes. Therefore the cold-formed members are much more susceptible to local buckling. The thin member's elements (flange, web, lip, etc) may buckle locally before reaching yield stresses when the member is subject to compressive, flexural, shear, or bearing loads.

Local buckling is a major consideration in design of cold-formed steel members; this design must provide a good safety margin against local instabilities. Chapter B of the AISI *Specification* contains design requirements for width-to-thickness ratios as well as design equations for determining effective widths of stiffened, partially stiffened, and unstiffened elements. Chapter C of the *Specification* contains the design provisions for member design and Chapter E contains the connection design provisions.

LIMITATIONS

This document provides an introduction or overview to the design of cold-formed steel members and is therefore limited in scope. The document addresses the design for a C-shaped cross section as a flexural member and a compression member. Connection design is limited to primarily a discussion of screw connections. The scope was selected to provide coverage of the high volume application of cold-formed steel in light-steel framing applications.

Flexural member design is limited to members having full or adequate lateral support. Such members are commonly used as floor joists wherein the sub-floor sheathing provides lateral bracing to resist lateral-torsional buckling. Lateral-torsional buckling is a prevalent failure mode for a singly-symmetric section such as a C-shaped section. When sheathing is not attached to the compression flange, design must consider the provisions of Section C3.1.2 of the *Specification*.

Compression member design is limited to a discussion of discretely braced members. Thus, design when sheathing is attached and used as the brace member is outside the scope of this document. For guidance on sheathing braced design see the AISI *Standard for Cold-Formed Steel Framing – Wall Stud Design*.

This document is intended to serve only as an education tool. Final design must be based on the *Specification,* which includes the following topical contents:

A. General Provisions
B. Elements
C. Members
D. Structural Assemblies and Systems
E. Connections and Joints
F. Tests for Special Cases
G. Design for Fatigue Loading
H. Appendix 1: Direct Strength Method
I. Country Specific Appendices

REFERENCE DOCUMENTS

For more in-depth discussion of cold-formed steel design the reader is referred to the following documents:

1. AISI S100-07, *North American Specification for the Design of Cold-Formed Steel Members*, 2007 edition, American Iron and Steel Institute
2. AISI S100-07-C, *Commentary on North American Specification for the Design of Cold-Formed Steel Members*, 2007 edition, American Iron and Steel Institute
3. AISI Manual on *Cold-Formed Steel Design*, 2002 edition, American Iron and Steel Institute
4. AISI S200-07, *Standard for Cold-Formed Steel Framing – General Provisions*, 2007 edition, American Iron and Steel Institute
5. AISI S200-07, *Standard for Cold-Formed Steel Framing – Floor and Roof System Design*, 2007 edition, American Iron and Steel Institute
6. AISI S211-07, *Standard for Cold-Formed Steel Framing – Wall Stud Design*, 2007 edition, American Iron and Steel Institute
7. AISI S213-07, *Standard for Cold-Formed Steel Framing – Lateral Design*, 2007 edition, American Iron and Steel Institute
8. AISI S212, *Standard for Cold-Formed Steel Framing – Header Design*, 2007 edition, American Iron and Steel Institute
9. AISI S214-07, *Standard for Cold-Formed Steel Framing – Truss Design*, 2007 edition, American Iron and Steel Institute
10. AISI 230-07, *Standard for Cold-Formed Steel Framing – Prescriptive Method for One and Two Family Dwellings*, 2007 edition, American Iron and Steel Institute
11. Yu, W.W., *Cold-Formed Steel Design*, 3rd edition, John Wiley & Sons, 2000

SOFTWARE

For software the following are available at no cost to the student:
CFS light: www.rsgsoftware.com
AISIWIN: www.clarksteel.com

ADDITIONAL INFORMATION

Additional design information for cold-formed steel members and assemblies may be found at the following:

1. Center for Cold-Formed Steel Structures, www.ccfssonline.org
2. Cold-Formed Steel Engineers Institute, www.cfsei.org
3. American Iron and Steel Institute, www.steel.org
4. Steel Framing Alliance, www.steelframingalliance.com
5. Steel Stud Manufacturers Association, www.ssma.com
6. Metal Building Manufacturers Association, www.mbma.com
7. Steel Deck Institute, www.sdi.org
8. Metal Construction Association, www.mca1.org
9. Rack Manufacturers Institute, www.mhia.org

SYMBOLS AND DEFINITIONS

b	=	Effective design width of compression element
b_d	=	Effective width for deflection calculation
b_e	=	Effective width
b_o	=	Out-to-Out width of compression flange
b_1, b_2	=	Effective widths
D	=	Overall depth of the lip
d_s	=	Reduced effective width of stiffener. It is to be used in computing overall effective section properties
d'_s	=	Effective width of stiffener
E	=	Modulus of Elasticity of Steel, 29,500ksi (203,000MPa or 2,070,000kg/cm^2)
F_{cr}	=	Plate elastic buckling stress
F_y	=	Yield point used for design, not to exceed specified yield point
f	=	Stress in compression element computed on basis of effective design width
f_d	=	Computed compressive stress in the given element. Calculations are based on effective section at load for which deflections are determined
f_{d1}, f_{d2}	=	Computed stresses based on effective section at load for which deflections are determined.
f_{d3}	=	Computed stress in edge stiffener based on effective section at load for which deflections are determined.
f_1, f_2	=	Web or edge stiffener stresses
h_o	=	Out-to-out depth of web
I_a	=	Adequate moment of inertia of stiffener of each element will behave as a stiffened element.
I_s	=	Moment of inertia of full section of stiffener about its own centroidal axis parallel to element to be stiffened. The round corner between stiffener and element to be stiffened shall not be considered = $(d^3 t \sin^2\theta)/12$ for the stiffener
k	=	Plate buckling coefficient
S	=	$1.28\sqrt{E/f}$
t	=	Base steel thickness of any element or section
w	=	Flat width of element exclusive radii

λ, λ_c	=	Slenderness factors
μ	=	Poisson's ratio for steel = 0.30
ρ	=	Reduction factor
ψ	=	$\left\|f_2/f_1\right\|$

GENERAL TERMS

The following general terms used in cold-formed steel-framed construction are taken from Reference 4:

Base Metal Thickness. The thickness of bare steel exclusive of all coatings.

Bracing. Structural elements that are installed to provide restraint or support (or both) to other framing members so that the complete assembly forms a stable structure.

Cold-Formed Sheet Steel. Sheet steel or strip steel that is manufactured by (1) press braking blanks sheared from sheets or cut length of coils or plates, or by (2) continuous roll forming of cold- or hot-rolled coils of sheet steel; both forming operations are performed at ambient room temperature, that is, without any addition of heat such as would be required for hot forming.

C-Shape. A cold-formed steel shape used for structural and non-structural framing members consisting of a *web*, two (2) *flanges* and two (2) *lips* (*edge stiffeners*). (See Fig. A2-1)

Edge Stiffener. That part of a *C-shape* framing member that extends from the *flange* as a stiffening element that extends perpendicular to the *flange*. (See Fig. 1)

Flange. That portion of the *C-shape* framing member or *track* that is perpendicular to the *web*. (See Fig. 1)

Lip. See *edge stiffener*.

Mil. A unit of measurement equal to 1/1000 inch.

Punchout. A hole made during the manufacturing process in the *web* of a steel framing member.

Rim Track. A horizontal *structural member* that is connected to the end of a *floor joist*.

Roof Rafter. A horizontal or sloped, structural framing member that supports roof loads.

Shear Wall. A wall assembly designed to resist lateral forces from wind or seismic loads acting parallel to the plane of the wall.

Structural Member. A *floor joist*, *rim track*, *structural stud*, wall *track* in a structural wall, *ceiling joist*, *roof rafter*, *header*, or other member that is designed or intended to carry loads.

Structural Stud. A *stud* in an exterior wall or an interior *stud* which supports superimposed vertical loads and which may transfer lateral loads, including full-height wall *studs*, *king studs*, *jack studs* and *cripple studs*.

Stud. A vertical framing member in a wall system or assembly.

Track. A framing member consisting of only a *web* and two (2) *flanges*. *Track web* depth measurements are taken to the inside of the *flanges*.

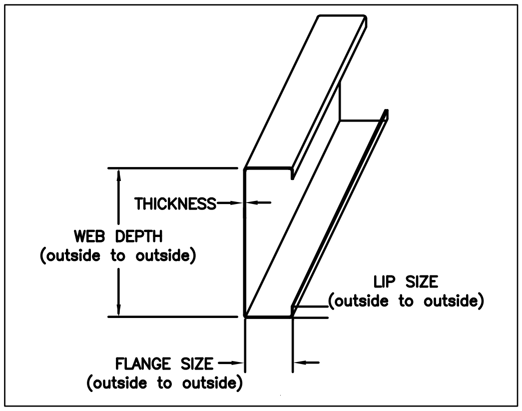

Figure 1 C-Shape