Removing the Guesswork

Cold-Formed Steel Framing Design

By Roger A. LaBoube and Jay W. Larson

How many times have you or a colleague lamented that "Cold-formed steel design is complex and not clearly defined"?

Well, in 1997, the AISI Construction Marketing Committee responded to this common complaint by authorizing the formation of the Committee on Framing Standards (COFS). This was done due to the increased interest in cold-formed steel for residential and light commercial framing, and the sense that there were a number of design issues that were not being adequately addressed for this emerging market.

The COFS established as its mission: "To eliminate regulatory barriers and increase the reliability and cost competitiveness of cold-formed steel framing in residential and light commercial building construction through improved design and installation standards." The committee also established as its primary objective: "To develop and maintain consensus standards for cold-formed steel framing, manufactured from carbon or low alloy flat rolled steel, that describe reliable and economical design and installation practices for compliance with building code requirements."

The COFS organized itself under the same ANSI-approved operating procedures that govern the proven AISI Committee on Specifications. These procedures provide for balance between producer, user and general interest categories; voting, including the resolution of negatives; public review, interpretations and appeals. Numerous task groups have been added under various subcommittees; however, the main committee always maintains control of all decisions through the balloting process.

By no means has the COFS completed its mission. It continues to improve the existing standards and develop new standards and design support documents. An article in the February issue of STRUCTURE® magazine introduced the design standards for cold-formed steel trusses and headers, as well as the general provisions. This article introduces the remainder of the series, which includes wall stud and lateral load design, as well as a new industry Code of Standard Practice document developed by the COFS.

Wall Stud Design

The *Standard for Cold-Formed Steel Framing – Wall Stud Design* addresses general requirements, loading, design and installation of cold-formed steel wall studs. It addresses certain items not presently covered by the AISI Specification, including load combinations specific to wall studs; a new, more rational approach for sheathing braced design; and methodologies for evaluating stud-to-track connections and deflection track connections. (Note: The sheathing braced design provisions in Section D4.1 of the 2001 edition of the AISI Specification were eliminated in the 2004 Supplement to the Specification.)

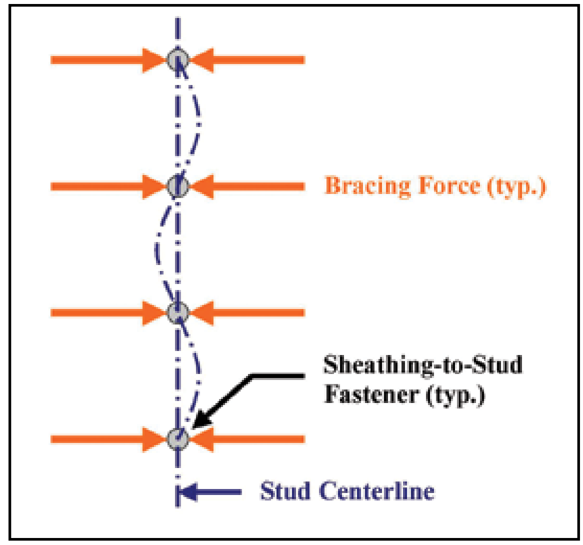

Figure 1: Sheathing Braced Design Rational Analysis Assumptions

Included in the wall stud design standard is a requirement that when sheathing braced design is used, the wall stud shall be evaluated without the sheathing bracing for the dead loads and loads that may occur during construction or in the event that the sheathing has been removed or has accidentally become ineffective. The load combination is taken from ASCE 7-02 for special event loading conditions.

Sheathing braced design in the wall stud design standard is based on rational analysis assuming that the sheathing braces the stud at the location of each sheathing-to-stud fastener location (*Figure 1*). Axial load in the stud is limited, therefore, by the capacity of the sheathing or sheathing-to-wall stud connection (*Table 1*).

Provisions are provided for the stud-to-track connection, and recognize that when the track thickness is equal to or greater than the stud thickness, an increase in web crippling strength can be realized. This increased strength is attributed to the favorable synergistic effect of the stud-to-track assembly (*Figure 2*). The provisions are based on research conducted at the University of Waterloo and the University of Missouri-Rolla. If the track thickness is less than the stud thickness, a design equation is provided to assess the shear punch-through capacity of the track.

In curtain wall applications, the wall stud bears on a track flange and the strength of this connection relies solely on the strength of the track flange. The wall stud standard contains design provisions for a single deflection track application.

Figure 2: Stud-to-Track Assembly After Testing to Ultimate Capacity

Sheathing	Screw Size	Ultimate Load (per Screw)	Allowable Load (per screw)
½ inch	No. 6	0.117 kips (0.516 kN)	0.058 kips (0.258 kN)
½ inch	No. 8	0.134 kips (0.596 kN)	0.067 kips (0.298 kN)
⅝ inch	No. 6	0.136 kips (0.605 kN)	0.068 kips (0.302 kN)
⅝ inch	No. 8	0.156 kips (0.694 kN)	0.078 kips (0.347 kN)

Table 1: Maximum Axial Load Limited by Gypsum Sheathing-to-Wall Stud Connection Capacity

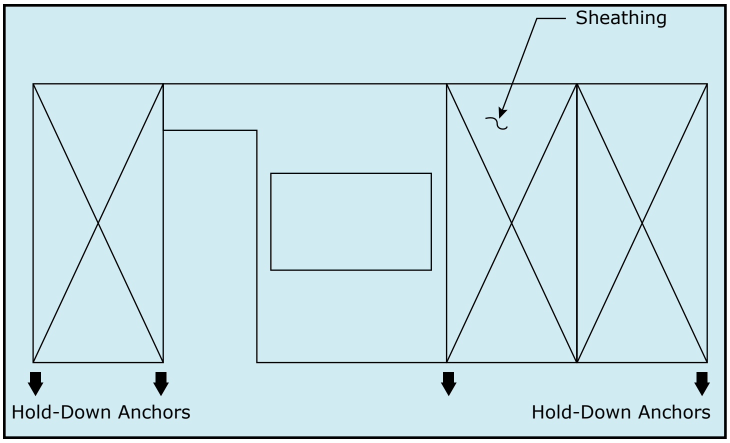

Figure 3: Typical Type I Shear Wall

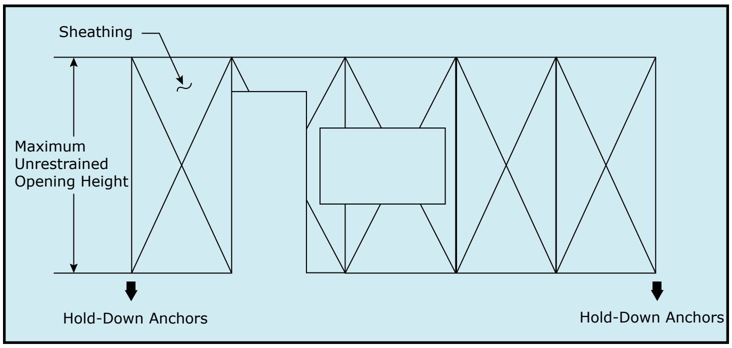

Figure 4:Typical Type II Shear Wall

Lateral Design

The Standard for Cold-Formed Steel Framing – Lateral Design addresses general and design requirements for walls and diaphragms that provide lateral support to a building structure. This standard addresses design requirements for shear walls (Type I or segmented and Type II or perforated), diagonal strap bracing (that is part of a structural wall), wall anchorage and diaphragms. Previously, these requirements were scattered among various building code provisions, design guides, technical notes and research reports. The intent of this standard is to pull them together into one document that is recognized by the codes. A companion Commentary has also been developed to help provide further technical substantiation of the provisions.

Figure 5: AISI Code of Standard Practice


Figure 6: Field Modification of Cold-Formed Steel Structural Framing

The requirements for Type I shear walls (*Figure 3*) in the Lateral Design standard were based on studies by Serrette at the University of Santa Clara. This series of investigations included reverse cyclic and monotonic loading and led to the development of the design values and details for plywood, oriented strand board, and gypsum wallboard lightweight shear wall assemblies.

The requirements for Type II shear walls (*Figure 4*), also known as perforated shear walls, in the Lateral Design standard were based on recognized provisions for wood systems. Research has demonstrated that the design procedure is as valid for steel framed systems as for all wood systems.

Also included in the Lateral Design standard are new provisions for estimating the deflection of Type I shear walls. This method considers the bending, overturning, shear and inelastic effects and is based on a recent study at the University of Santa Clara.

Design values for diaphragms with wood sheathing were also developed as was the methodology for determining the design deflection of diaphragms, which was based on a comparison of the equations used for wood frame shear walls and diaphragms, coupled with similarities in the performance of cold-formed steel and wood frame shear walls.

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Code of Standard Practice

The COFS developed of an industry *Standard for Cold-Formed Steel Framing – Code of Standard Practice* in 2005 (*Figure 5*). This standard covers general requirements, classification of materials, contract documents, installation drawings, materials, installation, quality control, and contractual relations. The standard also addresses responsibility for design, fabrication and installation, as well as responsibilities related to field modifications (*Figure 6*) and damage (*Figure 7*).

This document was reviewed by several peer committees within the industry. It defines and sets forth accepted norms of good practice for fabrication and installation of cold-formed steel structural framing. It is not intended to conflict with or supersede any legal building regulations, but serves to supplement and amplify such laws and is intended to be used unless there are differing instructions in the contract documents. This document was patterned after the other industry documents, but was tailored to the needs of cold-formed steel structural framing industry.

Figure 7: Field Damaged Cold-Formed Steel Trusses

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Conclusions

The American Iron and Steel Institute has effectively leveraged its experience and expertise in standards development to support the growing needs of the cold-formed steel framing industry.

The COFS documents are available from the American Iron & Steel Institute (**www.steel.org**) and the Steel Framing Alliance (**www.steelframingalliance.com**).▪

Acknowledgements

The members of the committee, subcommittees and task groups responsible for bringing these standards to fruition are to be commended for their time and effort. It is through the participation of representatives from steel producers, fabricators, users, educators, researchers, and building code officials in this consensus process that such progress is made. The partner organizations, Steel Framing Alliance, Steel Stud Manufacturers Association, Canadian Sheet Steel Building Institute and Wei-Wen Yu Center for Cold Formed Steel Structures, are to be thanked for their active participation.

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