Chapter 8

STEEL STRUCTURE DESIGN REQUIREMENTS

8.1 REFERENCE DOCUMENTS: The design, construction, and quality of steel *components* that resist *seismic forces* shall conform to the requirements of the references listed in this section except as modified by the requirements of this chapter.

AISC LRFD	American Institute of Steel Construction (AISC), *Load and Resistance Factor Design Specification for Structural Steel Buildings (LRFD),* December 1993.
AISC ASD	American Institute of Steel Construction (AISC), *Allowable Stress Design and Plastic Design Specification for Structural Steel Buildings (ASD),* June 1, 1989.
AISC Seismic	American Institute of Steel Construction (AISC)., *Seismic Provisions for Structural Steel Buildings* (1997), Part I, including Supplement No. 2 (November 2000).
AISI	American Iron and Steel Institute (AISI), *Specification for the Design of Cold-Formed Steel Structural Members,* 1996.
ANSI/ASCE 8-90	American Society of Civil Engineers, *Specification for the Design of Cold--formed Stainless Steel Structural Members,* ANSI/ASCE 8-90, 1990.
SJI	Steel Joist Institute, *Standard Specification, Load Tables and Weight Tables for Steel Joists and Joist Girders,* 1994.
ASCE 19	American Society of Civil Engineers (ASCE), *Structural Applications for Steel Cables for Buildings,* ASCE 19, 1995.

8.2 SEISMIC REQUIREMENTS FOR STEEL STRUCTURES: The design of steel *structures* to resist *seismic forces* shall be in accordance with Sec. 8.3 or 8.4 for the appropriate *Seismic Design Category*.

8.3 SEISMIC DESIGN CATEGORIES A, B, and C: Steel *structures* assigned to *Seismic Design Categories* A, B, and C shall be of any construction permitted by the references in Sec. 8.1. An *R* factor as set forth in Table 5.2.2 for the appropriate steel system is permitted when the *structure* is designed and detailed in accordance with the requirements of AISC Seismic, Part I, or Sec. 8.6 for light framed cold-formed steel wall systems. Systems not detailed in accordance with the above shall use the *R* factor in Table 5.2.2 designated for "steel systems not detailed for seismic."

8.4 SEISMIC DESIGN CATEGORIES D, E, AND F: Steel *structures* assigned to *Seismic Design Categories* D, E, and F shall be designed and detailed in accordance with AISC Seismic,

except as modified by other provisions in this section. Light framed cold-formed steel wall systems shall be designed and detailed in accordance with Sec. 8.6.

8.4.1 Modifications to AISC Seismic:

8.4.1.1: Revise Sec. 7.3b as follows: After the words "Charpy V-Notch toughness of 20 ft-lbs at 0° F, as determined by AWS classification or manufacturer certification" add the following: "For structures in which the steel frame is normally enclosed and maintained at a temperature of 50°F or higher, critical welded joints in seismic-force-resisting systems, including CJP welds of beam flanges to column flanges, CJP welds of shear tabs and beam webs to column flanges, column splices, and similar joints shall be made with weld filler metal capable of producing welds with minimum Charpy V-Notch toughness of 40 ft-lbs at 70°F and 20 ft-lbs at -20°F, under a range of welding conditions in accordance with FEMA 353, *Recommended Specifications and Quality Assurance Guidelines for Moment Resisting Steel Frames for Seismic Applications*. For structures with service temperatures lower than 50°F, the Charpy V-notch toughness shall be a minimum of 40 ft-lbs at 20° F above the lowest anticipated service temperature."

8.4.1.2: Revise Sec. 9.2c and 10.2b.3 as follows: After the words "in the opposite sense on each end of the beam" add the words "segment between the plastic hinge points." Delete the words "The required shear strength need not exceed the shear resulting from load combination 4-1."

8.4.1.3: Revise Sec. 11.2a1 by adding the following exception:

> **Exception:** Where weld access holes are provided, they shall conform to Figure X.

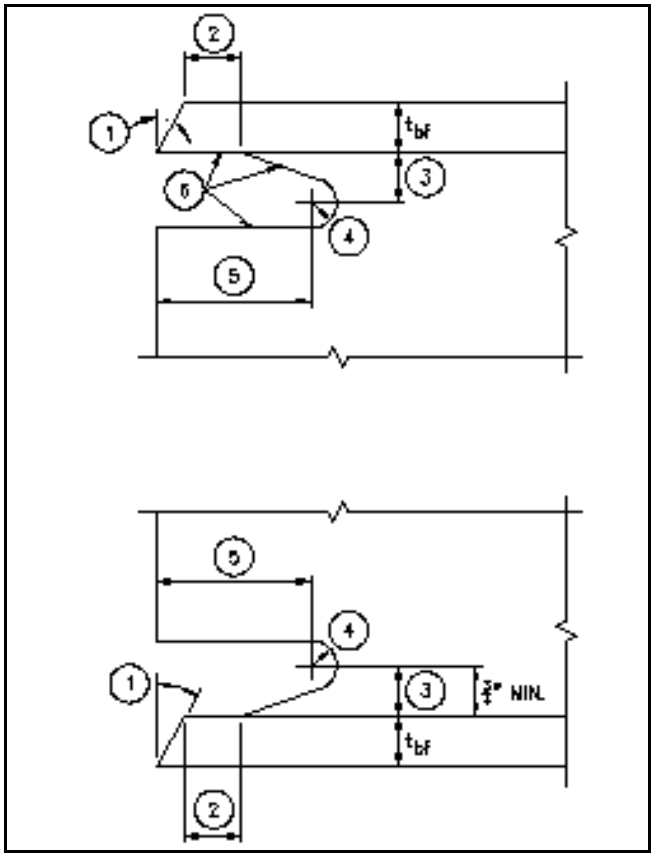

FIGURE X Legend: (1) bevel as required by AWS D1.1for selected groove weld procedure; (2) larger t_{bf} or 1/2 inch; (3) t_{bf} to t_{bf} with a 3/4 inch minimum; (4) 3/8 inch minimum radius; (5) 3 t_{bf} , (6) surfaces to 500 microinches roughness.

8.5 COLD-FORMED STEEL SEISMIC REQUIREMENTS: The design of cold-formed carbon or low-alloy steel members to resist seismic loads shall be in accordance with the requirements of AISI and the design of cold-formed stainless steel structural l to resist seismic loads shall be in accordance with the requirements of ANSI/ASCE 8-90, except as modified by this section. The reference to section and paragraph numbers are to those of the particular specification modified.

8.5.1 Modifications to AISI: Revise Sec. A5.1.3 of AISI as follows:

> "**A4.4 Wind or Earthquake Loads** Where load combinations specified by the applicable code include wind loads, the resulting forces are permitted to be multiplied by 0.75. Seismic load combinations shall be as determined by these provisions."

8.5.2 Modifications to ANSI/ASCE 8-90: Modify Sec. 1.5.2 of ANSI/ASCE 8-90 by substituting a load factor of 1.0 in place of 1.5 for nominal earthquake load.

8.6 LIGHT-FRAMED WALLS: When required by the requirements in Sec. 8.3 or 8.4, cold-formed steel stud *walls* designed in accordance with AISI and ANSI/ASCE 8-90 shall also comply with the requirements of this section.

8.6.1 Boundary Members: All boundary members, chords, and collectors shall be designed to transmit the specified induced axial forces.

8.6.2 Connections: Connections for diagonal bracing members, top chord splices, boundary members, and collectors shall have a *design strength* equal to or greater than the *nominal* tensile *strength* of the members being connected or Ω_0 times the design *seismic force*. The pull-out resistance of screws shall not be used to resist *seismic forces*.

8.6.3 Braced Bay Members: In stud systems where the lateral forces are resisted by braced frames, the vertical and diagonal members in braced bays shall be anchored such that the bottom tracks are not required to resist uplift forces by bending of the track or track web. Both flanges of studs shall be braced to prevent lateral torsional buckling. In vertical *diaphragm* systems, the vertical boundary members shall be anchored so the bottom track is not required to resist uplift forces by bending of the track web.

8.6.4 Diagonal Braces: Provision shall be made for pretensioning or other methods of installation of tension-only bracing to guard against loose diagonal straps.

8.6.5 Shear Walls: Nominal shear values for *wall* sheathing materials are given in Table 8.6.5. Design shear values shall be determined by multiplying the nominal values therein by a ϕ factor of 0.55. In *structures* over one *story* in height, the assemblies in Table 8.6.5 shall not be used to resist horizontal loads contributed by forces imposed by masonry or concrete construction.

Panel thicknesses shown in Table 8.6.5 shall be considered to be minimums. No panels less than 24 inches wide shall be used. Plywood or oriented strand board (OSB) structural panels shall be of a type that is manufactured using exterior glue. Framing members, blocking, or strapping shall be provided at the edges of all sheets. Fasteners along the edges in *shear panels* shall be placed not less than 3/8 in. (9.5 mm) in from panel edges. Screws shall be of sufficient length to ensure penetration into the steel stud by at least two full diameter threads.

The height to length ratio of *wall* systems listed in Table 8.6.5 shall not exceed 2:1.

Perimeter members at openings shall be provided and shall be detailed to distribute the shearing stresses. Wood sheathing shall not be used to splice these members.

Wall studs and track shall have a minimum uncoated base thickness of not less than 0.033 in. (0.84 mm) and shall not have an uncoated base metal thickness greater than 0.048 in. (1.22 mm). Panel end studs and their uplift anchorage shall have the *design strength* to resist the forces determined by the seismic loads determined by Eq. 2.2.6-3 and Eq. 2.2.6-4.

TABLE 8.6.5 Nominal Shear Values for Seismic Forces for Shear Walls Framed with Cold-Formed Steel Studs (in pounds per foot)[a, b]

Assembly Description	Fastener Spacing at Panel Edges [c] (inches)	Framing Spacing (inches o.c.)

	6	**4**	**3**	**2**	
15/32 rated Structural I sheathing (4-ply) plywood one side [d]	780	990	1465	1625	24
7/16 in. oriented strand board one side [d]	700	915	1275	1700	24

NOTE: For fastener and framing spacing, multiply inches by 25.4 to obtain metric mm.

[a] Nominal shear values shall be multiplied by the appropriate strength reduction factor ϕ to determine *design strength* as set forth in Sec. 8.6.5.

[b] Studs shall be a minimum 1-5/8 in. by 3-1/2 in. with a 3/8-in. return lip. Track shall be a minimum 1-1/4 in. by 3-1/2 in. Both studs and track shall have a minimum uncoated base metal thickness of 0.033 in. and shall be ASTM A446 Grade A (or ASTM A653 SQ Grade 33 [new designation]). Framing screws shall be No. 8 x 5/8 in. wafer head self-drilling. Plywood and OSB screws shall be a minimum No. 8 x 1 in. bugle head. Where horizontal straps are used to provide blocking, they shall be a minimum 1-1/2 in. wide and of the same material and thickness as the stud and track.

[c] Screws in the field of the panel shall be installed 12 in. o.c. unless otherwise shown.

[d] Both flanges of the studs shall be braced in accordance with Sec. 8.6.3.

8.7 SEISMIC REQUIREMENTS FOR STEEL DECK DIAPHRAGMS: Steel deck *diaphragms* shall be made from materials conforming to the requirements of AISI and ANSI/ASCE 8-90. *Nominal strengths* shall be determined in accordance with approved analytical procedures or with test procedures prepared by a *registered design professional* experienced in testing of cold-formed steel assemblies and approved by the authority having jurisdiction. *Design strengths* shall be determined by multiplying the *nominal strength* by a resistance factor, ϕ, equal to 0.60 for mechanically connected *diaphragms* and equal to 0.50 for welded *diaphragms*. The steel deck installation for the *structure*, including fasteners, shall comply with the test assembly arrangement. Quality standards established for the nominal strength test shall be the minimum standards required for the steel deck installation, including fasteners.

8.8 STEEL CABLES: The *design strength* of steel cables shall be determined by the requirements of ASCE 19 except as modified by the *Provisions*. Sec. 5d of ASCE 19 shall be modified by substituting $1.5(T_4)$ where T_4 is the net tension in cable due to *dead load*, prestress, *live load*, and seismic load. A load factor of 1.1 shall be applied to the prestress force to be added to the load combination of Sec. 3.1.2 of ASCE 19.