PROPOSAL 6-4 (2009)

SCOPE: Part 1, Sec. 14.1, Chapter 23
Part 2, Commentary for Sec. 14.1

PROPOSAL FOR CHANGE:

Revise Part 1, Table 12.2-1 of the 2009 *Provisions* as follows:

Add a new line, #C12 in Table 12.2-1 for "Cold-formed Steel – Special Bolted Moment Frame" as follows:

Seismic Force Resisting System	**ASCE 7 Section where Detailing Requirements are Specified**	**Response Modification Coefficient, R**	**System Overstrength Factor, Ω_o**	**Deflection Amplification Factor, C_d**	**Structural System Limitations and Building Height (ft) Limit**				
					Seismic Design Category				
					B	**C**	**D**	**E**	**F**
C12. Cold-Formed Steel – Special Bolted Moment Frame	14.1	3.5	NA[a]	2.9	35	35	35	35	35

[a] The seismic load effect with overstrength, E_m, shall be based on the expected strength determined in accordance with AISI S110.

Revise Part 1, Section 14.1 of the 2009 *Provisions* as follows:

14.1 STEEL

Structures, including foundations, constructed of steel to resist seismic loads shall be designed and detailed in accordance with this standard including the reference documents and additional requirements provided in this section.

14.1.1 Reference Documents. The design, construction, and quality of steel components that resist seismic forces shall conform to the applicable requirements of

1. AISC 360
2. AISC 341
3. AISI NAS
4. AISI S110
5. AISI-GP
6~~5~~. AISI-PM
7~~6~~. AISI Lateral
8~~7~~. AISI WSD
9~~8~~. ASCE 19
10~~9~~. ASCE 8
11~~10~~. SJI Tables

14.1.2 Seismic Design Categories B and C. Steel structures assigned to Seismic Design Category B or C shall be of any construction permitted by the reference documents in Section 14.1.1. An *R* factor as set forth in Table 12.2-1 is permitted where the structure is designed and detailed in accordance with the requirements of AISC 341 for structural steel buildings, AISI S110 for cold-formed steel construction, and AISI Lateral for light-framed cold-formed steel construction. Systems not detailed in accordance with AISC 341, AISI S110, or AISI Lateral shall use the *R* factor designated for “Structural steel systems not specifically detailed for seismic resistance” in Table 12.2-1.

14.1.3 Seismic Design Categories D through F. Steel structures assigned to Seismic Design Category D, E, or F shall be designed and detailed in accordance with AISC 341 for structural steel, AISI S110 for cold-formed steel construction, or AISI Lateral for light-framed cold-formed steel construction.

14.1.4 Cold-Formed Steel. The design of cold-formed carbon or low-alloy steel to resist seismic loads shall be in accordance with the requirements of AISI NAS, AISI S110 and the design of cold-formed stainless steel structural members to resist seismic loads shall be in accordance with the requirements of ASCE 8.

Revise Part 1, Table 15.4-1 of the 2009 *Provisions* as follows:

Add a new line in Table 15.4-1 for “Cold-formed Steel – Special Bolted Moment Frame” as follows:

Nonbuilding Structure Type	Detailing Requirements	R	Ω_o	C_d	Structural System and Height Limits (ft)				
					Seismic Design Category				
					A&B	C	D	E	F
Cold-Formed Steel – Special Bolted Moment Frame	AISI S110	3.5	NA[a]	2.9	35	35	35	35	35

[a] The seismic load effect with overstrength, E_m, shall be based on the expected strength determined in accordance with AISI S110.

Add the following document to Part 1, Chapter 23 of the 2009 *Provisions* as follows:

AISI
American Iron and Steel Institute
1140 Connecticut Avenue
Suite 705
Washington, DC 20036

ANSI/AISI S110
Sections 14.1.1, 14.1.2, 14.1.3, Table 12.2-1, Table 15.4-1
Standard For Seismic Design Of Cold-Formed Steel Structural Systems – Special Bolted Moment Frames

Part 2: Revise Part 2, Section 14.1 of the 2009 *Commentary* as follows*:*

(Please note: Modifications shown are to the Commentary TS6 submitted on 07/20/06 and only reflect the changes needed to be in agreement with Part 1 of this proposal.)

C14.1 STEEL

This general discussion invokes both the language of ASCE7 and the referenced standards for the design of steel structures for seismic resistance.

C14.1.1 Reference Documents.

This section lists a series of structural standards published by AISC, AISI, ASCE and SJI that are to be applied in the seismic design of steel members and connections in conjunction with the requirements of ASCE 7-05.

C14.1.2 Seismic Design Categories B and C.

In the lower Seismic Design Categories B and C, the Engineer is allowed a choice in the design of a steel lateral force resisting system. The first option is to design the structure to meet the design and detailing provisions required for structures in higher Seismic Design Categories, with the commensurate seismic design parameters (R, Cd and Omega-zero). The second option is to use a lower R factor of 3 (and higher resulting base shear) but not follow the seismic design and detailing provisions. The concept of this option is that the higher base shear force will compensate for the reduced ductility of the members and connections resulting in similar levels of performance in these lower Seismic Design Categories.

C14.1.3 Seismic Design Categories D through F.

In the higher Seismic Design Categories, the Engineer is not given a choice, but must follow the seismic design provisions of either AISC or AISI using the seismic design parameters specified for the chosen structural system. It is not considered appropriate to design structures without specific design for seismic response in these high seismic design categories.

C14.1.4 Cold-Formed Steel.

This section adopts ~~two~~ three standards by direct reference – AISI NAS, *North American Specification for the Design of Cold-Formed Steel Structural Members,* AISI S110, *Standard For Seismic Design Of Cold-Formed Steel Structural Systems – Special Bolted Moment Frames*, and ASCE 8, *Specification for the Design of Cold Formed Stainless Steel Structural Members.*

~~Both~~ Each document~~s have~~has specific limits of applicability. AISI NAS applies to the design of structural members that are cold-formed to shape from carbon or low-alloy steel sheet, strip, plate or bar not more than one-inch in thickness. **[AISI NAS:** A1.1] ~~Whereas~~Building on the requirements of AISI NAS, AISI S110 has additional special seismic design provisions for a newly designated seismic force resisting system entitled “cold-formed steel – special bolted moment frame (CFS-SBMF)”. Finally, ASCE 8 governs the design of structural members that are cold-formed to shape from annealed and cold-rolled sheet, strip, plate, or flat bar stainless steels. [**ASCE 8:** 1.1.1] ~~Both~~ All three documents focus on load-carrying members in buildings; however, allowances are made for applications in nonbuilding structures, if dynamic effects are appropriately considered.

Within ~~each document~~ AISI NAS and ASCE 8, there are requirements on the general provisions for the applicable types of steel; design of elements, members, structural assemblies, connections and joints; and mandatory testing. In addition, AISI NAS contains a chapter on the design of cold-formed steel structural members and connections undergoing cyclic loading. Both standards contain extensive commentaries for the benefit of the user.

The first edition of AISI S110 (2007) focuses on design requirements for cold-formed steel – special bolted moment frames (CFS-SBMF) systems only. Based upon research (Uang and Sato, 2007) at UCSD, this system is intended to withstand inelastic deformations through friction and bearing at the frame's bolted connections, with beams, columns, and beam-to-column connections sized accordingly. Currently, CFS-SBMF systems are limited to one-story structures, no greater than 35 feet in height. It is anticipated that later editions of this standard will be expanded in scope through research on additional types of cold-formed steel seismic force resisting systems. Like the other two documents listed in this section, this document contains an extensive commentary to aid the user in the design and construction of CFS-SBMF systems.

REASON FOR PROPOSAL:

This proposal introduces the first edition of AISI S110, *Standard For Seismic Design Of Cold-Formed Steel Structural Systems – Special Bolted Moment Frames*, which is based upon research conducted by Drs. Uang and Sato at UCSD (2007). Specifically, the document focuses on providing design provisions for a newly defined seismic force resisting system entitled "Cold-formed Steel – Special Bolted Moment Frame" or CFS-SBMFs. This type of system is expected to experience substantial inelastic deformation during significant seismic events. It is intended that most of the inelastic deformation will take place at the bolted connections, due to slip and bearing. In order to develop the designated mechanism, requirements based on the capacity design principles are provided for the design of the beams, columns and associated connections. Additionally, the document has specific requirements for the determination of story drift and the application of quality assurance and quality control procedures.

In Appendix 1, AISI S110 makes initial recommendations for the seismic design coefficients of the CFS-SBMF system. The Response Modification Coefficient, R, is set at 3.5. Cyclic testing has shown that CFS-SBMFs have very large ductility capacity and significant hardening. This contribution due to system reduction together with engineering judgment and system testing appears to justify an R-value of 3.5 in a qualitative sense. However, it is intended that R = 3.5 be used for preliminary design. Once preliminary member sizes are determined, Section E of AISI S110 provides a procedure that allows the designer to calculate the maximum seismic forces and story drift in the system. In other words, the most significant feature of AISI S110, Section E is that it is based on a calibrated, reliable physical model and R = 3.5 is only used for preliminary sizing.

For this particular system, no system overstrength factor has been established rather, it is intended that the seismic load effect with overstrength, E_m, be based upon the expected strength determined in accordance with AISI S110, Section D.1.2.3. The derivation of the deflection amplification factor, C_d, can be found in the AISI S110 Commentary, Section D1.3. Finally, the height limitation of 35 feet for all SDCs is based on practical use only and not from any limits on the CFS-SBMF system strength.

TS 6 VOTE:

YES = 5 *Yes with Reservations= 3* *No= 0* *Not Voting=0*

Comments for Yes w/ reservations votes are noted below.

I think that this system should be considered by the PUC. It would be good to have the system run through the ATC 63 procedure that is in draft form at this point in time (75% available and 90% soon to be completed) for verification as part of the process. (K. Swensson and J. Malley).

Is the 35’ story limit only indicated in the AISI Specification, or should it be shown here as well? (M. Cochrane)