

1 **PROPOSAL 6-4 (2009)**
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5 **SCOPE: Part 1, Sec. 14.1, Chapter 23**
 6 **Part 2, Commentary for Sec. 14.1**
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 8
 9

10 **PROPOSAL FOR CHANGE:**

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

12 Add a new line, #C12 in Table 12.2-1 for “Cold-formed Steel – Special Bolted Moment Frame”
 13 as follows:
 14
 15
 16

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 ^b	14.1	3.5	NA ^a	2.93.0	35	35	35	35	35

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

19 ^b Cold-formed steel – special bolted moment frames shall be limited to one-story no greater than 35 feet in
 20 height in accordance with AISI S110.

21
 22 **Revise Part 1, Section 14.1 of the 2009 Provisions as follows:**
 23

24 **14.1 STEEL**

25 Structures, including foundations, constructed of steel to resist seismic loads shall be designed
 26 and detailed in accordance with this standard including the reference documents and additional
 27 requirements provided in this section.
 28

29 **14.1.1 Reference Documents.** The design, construction, and quality of steel components that
 30 resist seismic forces shall conform to the applicable requirements of

- 31 1. AISC 360
- 32 2. AISC 341
- 33 3. AISI NAS
- 34 4. AISI S110
- 35 5. AISI-GP
- 36 ~~6~~5. AISI-PM
- 37 ~~7~~6. AISI Lateral
- 38 ~~8~~7. AISI WSD
- 39 ~~9~~8. ASCE 19
- 40 ~~10~~9. ASCE 8
- 41 ~~11~~40. SJI Tables

1 **14.1.2 Seismic Design Categories B and C.** Steel structures assigned to Seismic Design
 2 Category B or C shall be of any construction permitted by the reference documents in Section
 3 14.1.1. An *R* factor as set forth in Table 12.2-1 is permitted where the structure is designed and
 4 detailed in accordance with the requirements of AISC 341 for structural steel buildings, AISI
 5 S110 for cold-formed steel construction, and AISI Lateral for light-framed cold-formed steel
 6 construction. Systems not detailed in accordance with AISC 341, AISI S110, or AISI Lateral
 7 shall use the *R* factor designated for “Structural steel systems not specifically detailed for seismic
 8 resistance” in Table 12.2-1.

10 **14.1.3 Seismic Design Categories D through F.** Steel structures assigned to Seismic Design
 11 Category D, E, or F shall be designed and detailed in accordance with AISC 341 for structural
 12 steel, AISI S110 for cold-formed steel construction, or AISI Lateral for light-framed cold-formed
 13 steel construction.

15 **14.1.4 Cold-Formed Steel.** The design of cold-formed carbon or low-alloy steel to resist seismic
 16 loads shall be in accordance with the requirements of AISI NAS, AISI S110 and the design of
 17 cold-formed stainless steel structural members to resist seismic loads shall be in accordance with
 18 the requirements of ASCE 8.

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

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

Nonbuilding Structure Type	Detailing Requirements	R	Ω_o	C_a	Structural System and Height Limits (ft)				
					Seismic Design Category				
					A&B	C	D	E	F
<u>Cold Formed Steel – Special Bolted Moment Frame</u>	<u>AISI S110</u>	<u>3.5</u>	<u>NA^a</u>	<u>2.0</u>	<u>35</u>	<u>35</u>	<u>35</u>	<u>35</u>	<u>35</u>

26 ^a – The seismic load effect with overstrength, E_m , shall be based on the expected strength determined in
 27 accordance with AISI S110.

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

33 **AISI**
 34 **American Iron and Steel Institute**
 35 **1140 Connecticut Avenue**
 36 **Suite 705**
 37 **Washington, DC 20036**

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

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

2
3 **(Please note: Modifications shown are to the Commentary TS6**
4 **submitted on 07/20/06 and only reflect the changes needed to be in**
5 **agreement with Part 1 of this proposal.)**

6
7 **C14.1 STEEL**

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

10
11 **C14.1.1 Reference Documents.**

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

15
16 **C14.1.2 Seismic Design Categories B and C.**

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

25
26 **C14.1.3 Seismic Design Categories D through F.**

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

31
32 **C14.1.4 Cold-Formed Steel.**

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

37
38 ~~Both~~ Each documents ~~have~~ has specific limits of applicability. AISI NAS applies to the design of
39 structural members that are cold-formed to shape from carbon or low-alloy steel sheet, strip, plate
40 or bar not more than one-inch in thickness. [AISI NAS: A1.1] ~~Whereas~~ Building on the
41 requirements of AISI NAS, AISI S110 has additional special seismic design provisions for a
42 newly designated seismic force resisting system entitled “cold-formed steel – special bolted
43 moment frame (CFS-SBMF)”. Finally, ASCE 8 governs the design of structural members that are
44 cold-formed to shape from annealed and cold-rolled sheet, strip, plate, or flat bar stainless steels.
45 [ASCE 8: 1.1.1] ~~Both~~ All three documents focus on load-carrying members in buildings;
46 however, allowances are made for applications in nonbuilding structures, if dynamic effects are
47 appropriately considered.

1 Within each document, AISI N95 and ASCE 8, there are requirements on the general provisions
2 for the applicable types of steel; design of elements, members, structural assemblies, connections
3 and joints; and mandatory testing. In addition, AISI N95 contains a chapter on the design of
4 cold-formed steel structural members and connections undergoing cyclic loading. Both standards
5 contain extensive commentaries for the benefit of the user.

6
7 The first edition of AISI S110 (2007) focuses on design requirements for cold-formed steel –
8 special bolted moment frames (CFS-SBMF) systems only. Based upon research (Uang and Sato,
9 2007) at UCSD, this system is intended to withstand inelastic deformations through friction and
10 bearing at the frame’s beam-to-column bolted connections, with beams and columns sized
11 accordingly. Currently, CFS-SBMF systems are limited to one-story structures, no greater than
12 35 feet in height. It is anticipated that later editions of this standard will be expanded in scope
13 through research on additional types of cold-formed steel seismic force resisting systems. Like
14 the other two documents listed in this section, this document contains an extensive commentary
15 to aid the user in the design and construction of CFS-SBMF systems.

18 REASON FOR PROPOSAL:

19
20 This proposal introduces the first edition of AISI S110, *Standard For Seismic Design Of Cold-*
21 *Formed Steel Structural Systems – Special Bolted Moment Frames*, which is based upon research
22 conducted at UCSD (2007). Specifically, the document focuses on providing design provisions
23 for a newly defined seismic force resisting system entitled “Cold-formed Steel – Special Bolted
24 Moment Frame” or CFS-SBMFs. This type of system is expected to experience substantial
25 inelastic deformation during significant seismic events. It is intended that most of the inelastic
26 deformation will take place at the bolted connections, due to slip and bearing. In order to develop
27 the designated mechanism, requirements based on the capacity design principles are provided for
28 the design of the beams, columns and associated connections. Additionally, the document has
29 specific requirements for the determination of story drift and the application of quality assurance
30 and quality control procedures.

31
32 In Appendix 1, AISI S110 makes initial recommendations for the seismic design coefficients of
33 the CFS-SBMF system. The Response Modification Coefficient, R , is set at 3.5. Cyclic testing
34 has shown that CFS-SBMFs have very large ductility capacity and significant hardening. This
35 contribution due to system reduction together with engineering judgment and system testing
36 appears to justify an R -value of 3.5 in a qualitative sense. However, it is intended that $R = 3.5$ be
37 used for a preliminary design. Once preliminary member sizes are determined, Section E of AISI
38 S110 provides a procedure that allows the designer to calculate the expected maximum seismic
39 forces and story drift in the system. In other words, the most significant feature of AISI S110,
40 Section E is that it is based on a calibrated, reliable physical model, and that $R = 3.5$ is only used
41 for preliminary sizing.

42
43 For this particular system, no system overstrength factor is provided. Instead, it is intended that
44 the seismic load effect with overstrength, E_m , be based upon the expected strength computed in
45 accordance with AISI S110, Section D.1.2.3. The derivation of the deflection amplification
46 factor, C_d , can be found in the AISI S110 Commentary, Section D1.3. Finally, the height
47 limitation of 35 feet for all SDCs is based on practical use only and not from any limits
48 on the CFS-SBMF system strength.