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## North American Standard for Cold-Formed Steel Framing -- Nonstructural Members, 2015 Edition

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AISI S220-15



**American  
Iron and Steel  
Institute**

# **AISI STANDARD**

## **North American Standard for Cold-Formed Steel Framing – Nonstructural Members**

2015 Edition



AISI S220-15



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## **North American Standard for Cold-Formed Steel Framing — Nonstructural Members**

2015 Edition

## DISCLAIMER

The material contained herein has been developed by the American Iron and Steel Institute (AISI) Committee on Framing Standards. The Committee has made a diligent effort to present accurate, reliable, and useful information on cold-formed steel framing design and installation. The Committee acknowledges and is grateful for the contributions of the numerous researchers, engineers, and others who have contributed to the body of knowledge on the subject. Specific references are included in the *Commentary*.

With anticipated improvements in understanding of the behavior of cold-formed steel framing and the continuing development of new technology, this material will become dated. It is anticipated that AISI will publish updates of this material as new information becomes available, but this cannot be guaranteed.

The materials set forth herein are for general purposes only. They are not a substitute for competent professional advice. Application of this information to a specific project should be reviewed by a design professional. Indeed, in many jurisdictions, such review is required by law. Anyone making use of the information set forth herein does so at their own risk and assumes any and all liability arising therefrom.

1<sup>st</sup> Printing – December 2015

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## PREFACE

The American Iron and Steel Institute Committee on Framing Standards has developed AISI S220, *North American Standard for Cold-Formed Steel Framing – Nonstructural Members*, to address requirements for construction with *nonstructural members* made from cold-formed steel. This Standard is intended for adoption and use in the United States, Canada and Mexico.

This Standard provides an integrated treatment of Allowable Strength Design (ASD), Load and Resistance Factor Design (LRFD), and Limit States Design (LSD). This is accomplished by including the appropriate resistance factors ( $\phi$ ) for use with LRFD and LSD, and the appropriate factors of safety ( $\Omega$ ) for use with ASD. It should be noted that LSD is limited to Canada and LRFD and ASD are limited to Mexico and the United States.

The following major revisions were made in the 2015 edition:

- (1) Performance requirements for screw penetration were added in Section A6.6.
- (2) Referenced documents in Section A7 were updated.
- (3) Errata in Section B1(b) was fixed; i.e., “using  $\beta_o = 1.6$ ” was added.
- (4) Testing requirements were expanded in Section F1 to reference the new AISI S916 Test Standard, when required to determine the strength and stiffness of composite nonstructural interior partition wall assemblies.
- (5) Testing requirements were added in Section F2 to reference the new AISI S915 Test Standard, when required to determine the strength and deformation behavior of bridging connectors.
- (6) Testing requirements for screw penetration were added in Section F3, and the test method was added in Appendix 1.

The Committee acknowledges and is grateful for the contributions of the numerous engineers, researchers, producers and others who have contributed to the body of knowledge on the subjects. The Committee wishes to also express its appreciation for the support of the Canadian Sheet Steel Building Institute.

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## NORTH AMERICAN STANDARD FOR COLD-FORMED STEEL FRAMING – NONSTRUCTURAL MEMBERS

### A. GENERAL

#### A1 Scope

The design and installation of *cold-formed steel nonstructural members* in buildings shall be in accordance with the provisions of this Standard.

This Standard applies to *nonstructural members* that comply with the following:

- 1) Member is in a steel-framed system that is limited to a transverse (out-of-plane) load of not more than 10 lb/ft<sup>2</sup> (0.48 kPa) in the U.S. and Mexico and 0.50 kPa in Canada.

**Exception:** Pressurized air plenums, ceilings and elevator shaft enclosures are permitted to have a load of not more than 15 lb/ft<sup>2</sup> (0.72 kPa).

- 2) Member is in a steel-framed system that is limited to a superimposed axial load, exclusive of sheathing materials, of not more than 100 lb/ft (1.46 kN/m).
- 3) Member is limited to a superimposed axial load of not more than 200 lbs (0.89 kN).

**In Canada:** Members in walls acting as guards, as defined in the *National Building Code of Canada* (NBCC), shall be considered *structural members*.

This Standard does not preclude the use of other materials, assemblies, structures, or designs not meeting the criteria herein when the other materials, assemblies, structures, or designs demonstrate equivalent performance for the intended use of those specified in this Standard. Where there is a conflict between this Standard and other reference documents, the requirements contained within this Standard shall govern.

This Standard includes Sections A through F inclusive.

#### A2 Definitions

In this Standard, “shall” is used to express a mandatory requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the Standard. Provisions described as “permitted” are optional, and the election to use such provisions is at the discretion of the *registered design professional*.

Where the following terms appear in this Standard in italics, such terms shall have meaning as defined herein or AISI S100 [CSA S136]. Terms included in square brackets are specific to *LSD* terminology. Where a country is indicated in square brackets following the definition, the definition shall apply only in the country indicated. Terms not defined in Section A2 shall have the ordinary accepted meaning in the context for which they are intended.

*Applicable Building Code.* The building code under which the building is designed.

*Approved.* Approved by the authority having jurisdiction or *design professional*.

*Base Steel Thickness.* The thickness of bare steel exclusive of all coatings.

*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.

*Cold-Formed Steel.* See *Cold-Formed Sheet Steel*.

*C-Shape.* A *cold-formed steel* shape used for structural and *nonstructural members* consisting of a

*web*, two (2) *flanges* and two (2) *lips* (edge stiffeners).

*Design Load*. Applied load determined in accordance with either *LRFD load combinations* or *ASD load combinations*, whichever is applicable. [USA and Mexico]

*Design Professional*. An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the state, province or territory in which the project is to be constructed.

*Designation Thickness*. The minimum *base steel thickness* expressed in *mils* and rounded to a whole number.

*Factored Load*. Product of a *specified load* and appropriate load factor. [Canada]

*Flange*. For a *C-shape*, *U-shape* or *track*, that portion of the framing member that is perpendicular to the *web*. For a *furring channel*, that portion of the framing member that connects the *webs*.

*Header*. A horizontal *structural member* used over floor, roof or wall openings to transfer loads around the opening to supporting *structural members*.

*Light-Frame Construction*. Construction where the vertical and horizontal structural elements are primarily formed by a system of repetitive *cold-formed steel* or wood framing members.

*Joist*. A *structural member* primarily used in floor and ceiling framing.

*Nonstructural Member*. A member in a steel-framed system that is not a part of the gravity load-resisting system, lateral force-resisting system or building envelope.

*Structural Member*. A member that resists *design loads* [*factored loads*], as required by the *applicable building code*, except when defined as a *nonstructural member*.

*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*.

*Web*. That portion of a framing member that connects the *flanges*.

### **A3 Loads and Load Combinations**

Steel-framed systems utilizing *nonstructural members* shall be designed in accordance with the *applicable building code*. In the absence of an *applicable building code*, the loads, forces, and combinations of loads shall be in accordance with accepted engineering practice for the geographical area under consideration as specified by the applicable sections of *Minimum Design Loads for Buildings and Other Structures* (ASCE 7) in the United States and Mexico, and the *National Building Code of Canada* (NBCC) in Canada.

### **A4 Material**

*Nonstructural members* utilized in *cold-formed steel* framed construction shall be cold-formed to shape from sheet steel complying with the requirements of ASTM A1003/A1003M Type NS.

*In Canada*: Alternatively, *nonstructural members* shall be cold-formed to shape from sheet steel in compliance with the requirements of ASTM A653 Type SS or ASTM A792 Type SS.

### **A5 Corrosion Protection**

**A5.1** *Nonstructural members* utilized in *cold-formed steel* framed construction shall have a protective coating conforming to ASTM A653/A653M G40 minimum or shall have a protective coating with an equivalent corrosion resistance.

*In Canada*: *Nonstructural members* shall have a metallic coating of G40 [Z120] complying with the requirements of ASTM A653/A653M, or AZ50 [AZM150] complying with the requirements of ASTM A792/A792M.

**A5.2** Additional corrosion protection shall not be required on edges of metallic-coated steel framing members, shop or field cut, punched or drilled.

**A5.3** Framing members shall be located within the building envelope and shielded from direct contact with moisture from the ground or the outdoor climate.

**A5.4** Dissimilar metals shall not be used in direct contact with *cold-formed steel* framing members unless *approved* for that application.

**A5.5** *Cold-formed steel* framing members shall not be embedded in concrete unless *approved* for that application.

**A5.6** Fasteners shall have a corrosion-resistant treatment, or be manufactured from material not susceptible to corrosion.

## **A6 Products**

### **A6.1 Base Steel Thickness**

In no case shall the minimum *base steel thickness* be less than 95% of the *design thickness*.

### **A6.2 Minimum Flange Width**

For *C-shape* members intended to receive sheathing, the minimum *flange* width shall be 1-1/4 inch (31.8 mm). For *track*, the minimum *flange* width shall be 1 inch (25.4 mm).

### **A6.3 Product Designator**

References to *nonstructural members* shall use a four-part product designator that identifies the size (both *web* depth and *flange* width), style, and thickness. The standard designator as described (i.e., based on U.S. Customary units) shall be used for either U.S. Customary or SI Metric units. The product designator shall consist of the following sequential codes:

A three- or four-digit numeral indicating member *web* depth in 1/100 inch. A letter indicating:

S = *Stud* or *joist* framing member which has *lips*

T = *Track* section

U = Channel or *stud* framing section which does not have *lips*

F = Furring channels

L = Angle or *L-header*

A three-digit numeral indicating *flange* width in 1/100 inch, followed by a dash, and a two- or three-digit numeral indicating *designation thickness*.

### **A6.4 Manufacturing Tolerances**

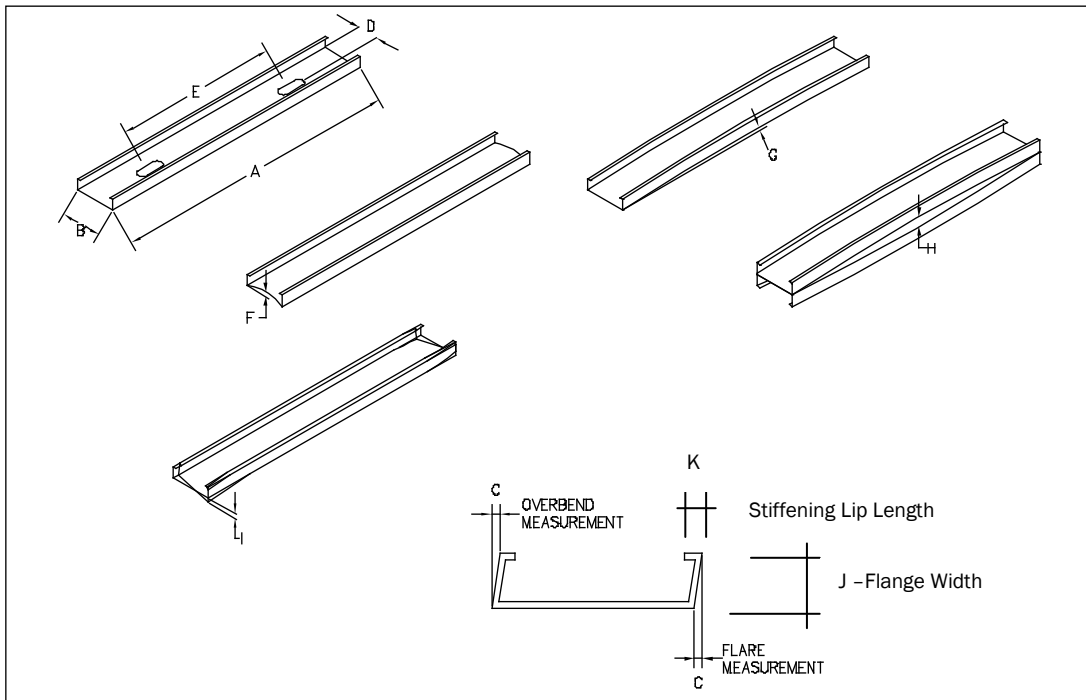
*Nonstructural members* utilized in *cold-formed steel* framed construction shall comply with the manufacturing tolerances listed in Table A6-1.

**Table A6-1  
Manufacturing Tolerances for Nonstructural Members**

Dimension <sup>1</sup>	Item Checked	Studs, in. (mm)	Tracks, in. (mm)
A	Length	+1/8 (3.18)	+ 1(25.40)
		-1/4 (6.35)	-1/4 (6.35)
B <sup>2</sup>	Web Depth	+1/32 (0.79)	+1/8 (3.18)
		-1/32 (0.79)	-0 (0)
C	Flare	+1/16 (1.59)	+0 (0)
	Overbend	-1/16 (1.59)	-3/16 (4.76)
D	Hole Center Width	+1/8 (3.18)	NA
		-1/8 (3.18)	NA
E	Hole Center Length	+1/4 (6.35)	NA
		-1/4 (6.35)	NA
F	Crown	+1/8 (3.18)	+ 1/8 (3.18)
		-1/8 (3.18)	- 1/8 (3.18)
G	Camber	1/32 per ft (2.6 per m)	1/32 per ft (2.6 per m)
		1/2 max (12.7)	1/2 max (12.7)
H	Bow	1/32 per ft (2.6 per m)	1/32 per ft (2.6 per m)
		1/2 max (12.7)	1/2 max (12.7)
I	Twist	1/32 per ft (2.6 per m)	1/32 per ft (2.6 per m)
		1/2 max (12.7)	1/2 max (12.7)
J	Flange Width	+1/8 (3.18)	+1/2 (12.7)
		-1/16 (1.59)	-1/16 (1.59)
K	Stiffening Lip Length	+1/8 (3.18)	NA
		-1/32 (0.79)	

<sup>1</sup> All measurements shall be taken not less than 1 ft (305 mm) from the end.

<sup>2</sup> Outside dimension for *stud*; inside for *track*.



**Figure A6-1 Manufacturing Tolerances for Nonstructural Members**

## A6.5 Product Identification

Framing members used in *cold-formed steel* framed construction shall be identified in accordance with the requirements of this section.

### A6.5.1 Identification of Groups of Like Members

Groups of like members shall be marked with a label or an attached tag. Marking shall include the roll-former's identification (name, logo, or initials), length, quantity, and roll-former's member designator including member depth, flange size, minimum steel thickness in mils or inches exclusive of protective coating, and the designation "NS".

### A6.5.2 Identification of Individual Framing Members

In addition to the marking referenced in A6.5.1, individual framing members shall have a legible label, stencil, or embossment at a maximum distance of 96 in. (2440 mm) on center, on the member, with the following minimum information:

- (1) The rollformer's identification (i.e., name, logo, or initials).
- (2) The minimum steel thickness, in mils or inches, exclusive of protective coating.
- (3) The minimum yield strength in kips per square inch (megapascals) if other than 33 ksi (230 MPa).
- (4) The protective coating type and weight, if other than as specified in Section A5.1.
- (5) The designation "NS".

*In Canada:* In addition to the marking referenced in Section A6.5.1, individual framing members shall have a legible label, stencil, or embossment at a maximum distance of 96 in. (2440 mm) on centre, on the member, with the following minimum information:

- (1) The manufacturer's identification (name, logo, or initials); and
- (2) The minimum steel thickness (in mils, inches or millimeters) exclusive of protective coatings.

## A6.6 Performance Requirements

When tested in accordance with the screw penetration test requirements of Section F3 of this Standard, *nonstructural members* shall be capable of pulling the head of the screw below the surface of the gypsum board in 2 seconds or less without screw spin out.

## A7 Referenced Documents

The following documents or portions thereof are referenced in this Standard and shall be considered part of the requirements of this document.

1. AISI S100-12, *North American Specification for the Design of Cold-Formed Steel Structural Members*, 2012 Edition, American Iron and Steel Institute, Washington, DC.
2. AISI S915-15, *Test Standard for Through-The-Web Punchout Cold-Formed Steel Wall Stud Bridging Connectors*, 2015 Edition, American Iron and Steel Institute, Washington, DC.
3. AISI S916-15, *Test Standard for Cold-Formed Steel Framing – Nonstructural Interior Partition Walls With Gypsum Board*, 2015 Edition, American Iron and Steel Institute, Washington, DC.
4. ASCE 7-10 Including Supplement No. 1, *Minimum Design Loads for Buildings and Other Structures*, American Society of Civil Engineers, Reston, VA.
5. ASTM A653/A653M-13, *Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron*



- Alloy-Coated (Galvannealed) by the Hot-Dip Process*, ASTM International, West Conshohocken, PA.
6. ASTM A792/A792M-10, *Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process*, ASTM International, West Conshohocken, PA.
  7. ASTM A1003/A1003M-15, *Standard Specification for Sheet Steel, Carbon, Metallic and Non-Metallic Coated for Cold-Formed Framing Members*, ASTM International, West Conshohocken, PA.
  8. ASTM C475/C475M-15, *Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board*, ASTM International, West Conshohocken, PA.
  9. ASTM C754-15, *Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products*, ASTM International, West Conshohocken, PA.
  10. ASTM C954-15, *Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness*, ASTM International, West Conshohocken, PA.
  11. ASTM C1002-14, *Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs*, ASTM International, West Conshohocken, PA.
  12. ASTM C1396/C1396M-14a, *Standard Specification for Gypsum Board*, ASTM International, West Conshohocken, PA.
  13. ASTM C1513-13, *Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections*, ASTM International, West Conshohocken, PA.
  14. CAN/CSA S136-12, *North American Specification for the Design of Cold-Formed Steel Structural Members*, 2012 Edition, Canadian Standards Association, Mississauga, Ontario, Canada.
  15. NBCC 2010, *National Building Code of Canada*, 2010 Edition, National Research Council of Canada, Ottawa, Ontario, Canada.

## B. DESIGN

Strength [resistance] and/or stiffness determinations for *nonstructural members* shall be in accordance with Chapter B and the requirements of AISI S100 [CSA S136] where specifically referenced herein.

### B1 Member Design

*Nonstructural members* shall be designed either on the basis of Non-Composite Assembly Design or Composite Assembly Design.

(a) Non-Composite Assembly Design—Assemblies using a non-composite assembly design approach shall be designed neglecting the composite-action contribution of the attached sheathings and based on either:

(i) Chapters A through E of AISI S100 [CSA S136] with:

$$\Omega_N = 0.9 \Omega$$

$$\phi_N = 1.1 \phi$$

where

$\Omega$  = Safety factor per relevant section of AISI S100 [CSA S136]

$\phi$  = Resistance factor per relevant section of AISI S100 [CSA S136]

(ii) Chapter F of AISI S100 [CSA S136] with:

$$\beta_o = 1.6 \text{ for LRFD}$$

$$= 1.82 \text{ for LSD}$$

where

$\beta_o$  = Target Reliability Index in accordance with Section F1.1(b) of AISI S100 [CSA S136]

$\Omega$  = Safety factor per Section F1.2 of AISI S100 [CSA S136]

$\phi$  = Resistance factor per Section F1.1(b) of AISI S100 [CSA S136]

If Section A1.2(c) of AISI S100 [CSA S136] is utilized, then supplementary tests are permitted to be performed and Chapter F of AISI S100 [CSA S136] is permitted to be employed for determination of  $\Omega$  or  $\phi$ , with  $P_m$  replaced by  $P_{\text{test}}/P_{\text{compute}}$  and  $\beta_o$  in accordance with the provisions above.

In the use of AISI S100 [CSA S136] Chapter F, the professional factor,  $P$ , shall be the test-to-predicted ratio where the prediction is that of the rational engineering analysis method selected,  $P_m$  is the mean of  $P$  and  $V_P$ , the coefficient of variation of  $P$ . At least three tests shall be conducted.

(b) Composite Assembly Design – Assemblies using a composite assembly design approach shall be designed based on the tests undertaken and evaluated using  $\beta_o = 1.6$  for LRFD and  $\beta_o = 1.82$  for LSD in accordance with Section F1 of this Standard.

### B2 Member Condition

Framing members shall be as specified by an *approved* design or *approved* design standard. The members shall be in good condition. Damaged members shall be replaced or repaired in accordance with an *approved* design or *approved* design standard.

#### B2.1 Web Holes

Holes in *webs* of framing members shall be in conformance with an *approved* design or an *approved* design standard. *Webs* with holes not conforming to the above shall be reinforced or

patched in accordance with an *approved* design or *approved* design standard.

### **B2.2 Cutting and Patching**

All cutting of framing members shall be accomplished by sawing, abrasive cutting, shearing, plasma cutting or other *approved* methods.

### **B3 Connection Design**

Connections shall be designed in accordance with AISI S100 [CSA S136] or tested in accordance with Section F1 of AISI S100 [CSA S136], and the requirements of Chapter D of this Standard.

### **B4 Bracing**

Bracing, when required, shall be designed in accordance with AISI S100 [CSA S136] or tested in accordance with Section F1 of AISI S100 [CSA S136].

### **B5 Serviceability**

Serviceability limits shall be chosen based on the intended functions of the assembly, and shall be evaluated using load and load combinations in accordance with Section A3 of this Standard.

**C. INSTALLATION**

Installation of *nonstructural members* shall be in accordance with ASTM C754.

## **D. CONNECTIONS**

### **D1 Screw Connections**

#### **D1.1 Steel-to-Steel Screws**

Screw fasteners for steel-to-steel connections shall be in compliance with ASTM C1513 or an *approved* design or *approved* design standard. Use of a larger than specified screw size is permitted if the installation is in accordance with the minimum spacing and edge distance requirements of Section D1.4 of this Standard.

#### **D1.2 Installation**

Screw fasteners shall extend through the steel connection a minimum of three (3) exposed threads. Screw fasteners shall penetrate individual components of connections without causing permanent separation between components.

#### **D1.3 Stripped Screws**

Stripped screw fasteners in direct tension shall be considered ineffective. Stripped screw fasteners in shear shall only be considered effective when the number of stripped screw fasteners considered effective does not exceed 25% of the total number of screw fasteners considered effective in the connection.

#### **D1.4 Spacing and Edge Distance**

For screw fasteners in steel-to-steel connections to be considered fully effective, the minimum center-to-center spacing and edge distance shall be 3 times the nominal diameter; except where the edge is parallel to the direction of the applied force, the minimum edge distance of screw fasteners shall be 1.5 times the nominal diameter. Where the minimum center-to-center spacing is 2 times the nominal diameter, screw fasteners shall be considered 80 percent effective.

#### **D1.5 Gypsum Board**

Gypsum board shall be attached to *cold-formed steel* framing in accordance with the *applicable building code* or an *approved* design standard. Screw fasteners for gypsum board to steel connections shall be in compliance with ASTM C954, ASTM C1002, or ASTM C1513, as applicable, with a bugle head style.

### **D2 Other Connections**

#### **D2.1 Other Connectors**

Other types of connections shall be designed, fabricated and installed in accordance with the design requirements as set forth by an *approved* design or *approved* design standard, and the fastener manufacturer's requirements.

#### **D2.2 Connection to Other Materials**

Fasteners used to connect *cold-formed steel* framing to wood, masonry, concrete or other steel components shall be designed and installed in accordance with the *applicable building code*, an *approved* design or *approved* design standard.

## **E. MISCELLANEOUS**

### **E1 Utilities**

#### **E1.1 Holes**

Holes shall comply with the requirements specified in Section B2.1. Penetrations of floor, wall and ceiling/roof assemblies which are required to have a fire resistance rating shall be protected in accordance with the *applicable building code* or in accordance with the requirements as stipulated by the authority having jurisdiction.

#### **E1.2 Plumbing**

All piping shall be provided with an isolative non-corrosive system to prevent galvanic action or abrasion between framing members and piping.

#### **E1.3 Electrical**

Wiring not enclosed in metal conduit shall be separated from the framing members by non-conductive non-corrosive grommets or by other *approved* means.

### **E2 Insulation**

#### **E2.1 Mineral Fiber Insulation**

Mineral fiber insulation (e.g., rock wool, glass fiber, etc.) for installation within cavities of framing members shall be full-width type insulation and shall be installed in accordance with the requirements as set forth by the *applicable building code* and insulation manufacturer. Compression of the insulation shall be permitted to occur at the open side of the *C-shaped* framing member.

#### **E2.2 Other Insulation**

Other types of insulation (e.g., foams, loose fill, etc.) for installation within cavities of framing members shall be installed in accordance with the *applicable building code* and insulation manufacturer's requirements. The width of insulation shall be dimensionally compatible with the *cold-formed steel* framing.

## **F. TESTING**

### **F1 Composite Assemblies**

Tests of composite assemblies, when required by Section B1 of this Standard, shall be in accordance with AISI S916, or other *approved* test methods with the calibration in accordance with Section F1 of AISI S100 [CSA S136]. The tests shall be conducted under the supervision of a *design professional*.

### **F2 Bridging Connectors**

Tests of bridging connectors, when required to determine the strength and deformation behavior of bridging connectors for *cold-formed steel wall stud* bracing for *nonstructural members* in *light-frame construction*, shall be in accordance with AISI S915, or other *approved* test methods with the calibration in accordance with Section F1 of AISI S100 [CSA S136]. The tests shall be conducted under the supervision of a *design professional*.

### **F3 Screw Penetration**

Tests of screw penetration, when required to demonstrate the capability of a *nonstructural member* to pull the head of the screw below the surface of the gypsum board in 2 seconds or less without screw spin out, shall be in accordance with Appendix 1.

## APPENDIX 1, SCREW PENETRATION TEST

This test is used to determine the screw penetration performance of steel members.

### 1.1 Test Requirements

**1.1.1** A steel member has met the requirements of this test if the screw penetrated the steel member and the head of the screw is pulled below the surface of the gypsum board in 2 seconds or less without spin out.

**1.1.2** The steel member has failed to meet the requirements of this test if the screw did not penetrate the steel or the head of the screw was not pulled below the surface of the gypsum board in 2 seconds or less, or the screw has spun out.

### 1.2 Test Apparatus

**1.2.1** The test apparatus shall conform to the following:

- (a) Power-driven drill screw gun capable of 4000 rpm (free spindle speed), equipped with a depth-sensitive nosepiece, and supplied with a screw driving bit to fit the screw used in the test.
- (b) Stopwatch capable of being read to the nearest 0.1 second.

### 1.3 Test Specimens

**1.3.1** Materials shall conform to the following:

- (a) Gypsum board complying with ASTM C1396 Type X and is 5/8 in. (15.9 mm) thick.
- (b) Screws complying with ASTM C1002 Type S and are minimum 1 in. (25.4 mm) long.
- (c) Paper joint tape complying with ASTM C475.

**1.3.2** One *C-shape* member or furring channel member shall be selected from each bundle or package. No more than 10 members shall be selected from any one shipment for testing.

**1.3.3** Each member to be tested shall be cut into test specimens not less than 18 in. (460 mm) long.

**1.3.4** The gypsum wallboard, 6-in. (150-mm) square, shall be cut not less than 12 in. (305 mm) from the edge or end of the gypsum wallboard.

**1.3.5** The paper joint tape shall be 2-in. (50-mm) square.

### 1.4 Test Procedure

**1.4.1** Each test shall include one member, one (1) gypsum wallboard and four (4) pieces of paper joint tapes, and shall be assembled on a rigid, flat surface as shown in Figure 1-1 for *C-shape* members or Figure 1-2 for furring channels.

**1.4.2** Prior to performing the test, several screws shall be driven without the paper joint tape to set the depth of the nosepiece on the screw gun, allowing the screws to be driven below the surface of the wallboard without breaking the gypsum wallboard face paper.

**1.4.3** Using the screw gun, screws shall be driven through the paper joint tape, while applying a force (dead weight plus applied force) of 30 lbf (112.2 N). Screws shall be driven until the nosepiece of the screw gun has stopped, the screw is seated or the screw spins out.

**1.4.4** It shall be recorded whether the screw has spun out or if it exceeds 2 seconds to seat the screw in the gypsum wallboard.



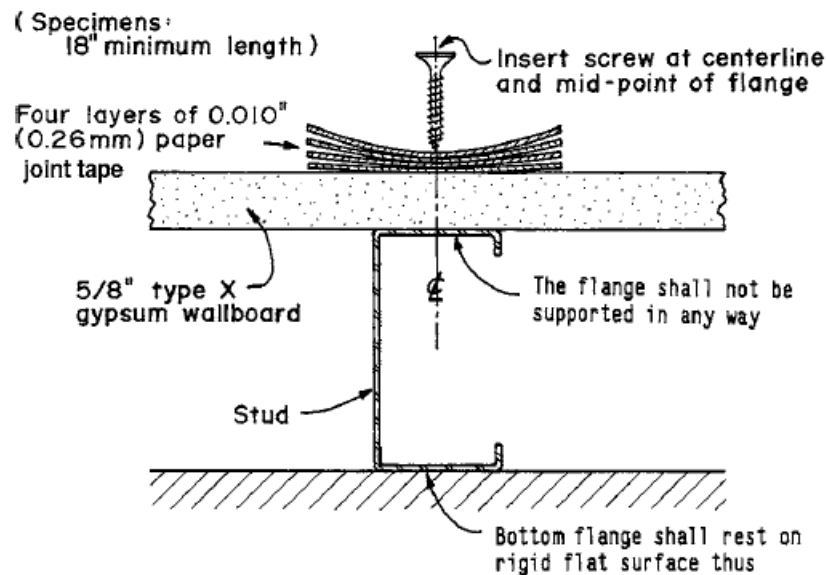


Figure 1-1 – Testing of C-Shape Members

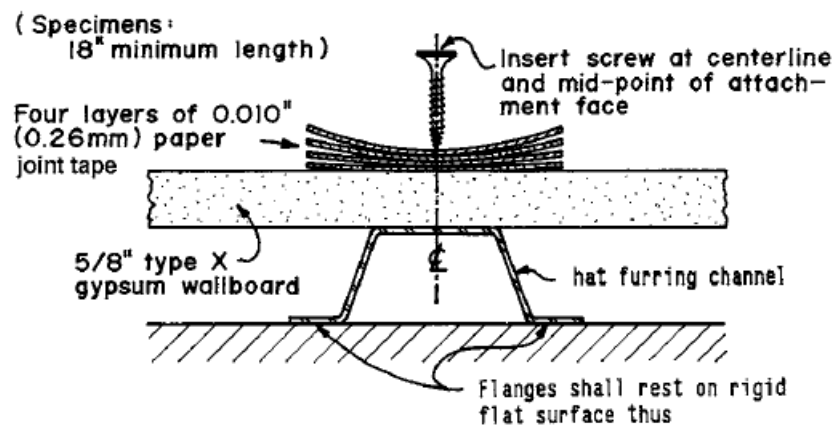


Figure 1-2 – Testing of Furring Channels

## 1.5 Number of Tests and Retests

**1.5.1** A sampling consisting of five specimens shall be tested.

**1.5.2** If not more than one of the test specimens fails to meet the requirements, as indicated in 1.1.1, the sample has met the requirements of this test.

**1.5.3** If two of the five test specimens fail to meet the requirements, two additional test specimens shall be chosen for retesting. If either of the two additional test specimens fails, the sample has failed to meet the requirements of this test.

**1.5.4** If three or more of the five test specimens fail to meet the requirements, the sample failed to meet the requirements of this test.

## 1.6 Report

**1.6.1** For each specimen tested, the report shall indicate whether the screw has spun out or

if it has exceeded 2 seconds to seat the screw in the gypsum wallboard.

**1.6.2** The test report shall indicate the total number of specimens tested and the number of specimens meeting the requirements of this test.



# **AISI STANDARD**

**Commentary on the  
North American Standard for  
Cold-Formed Steel Framing –  
Nonstructural Members**

2015 Edition

## DISCLAIMER

The material contained herein has been developed by the American Iron and Steel Institute (AISI) Committee on Framing Standards. The Committee has made a diligent effort to present accurate, reliable, and useful information on cold-formed steel framing design and installation. The Committee acknowledges and is grateful for the contributions of the numerous researchers, engineers, and others who have contributed to the body of knowledge on the subject. Specific references are included in this *Commentary*.

With anticipated improvements in understanding of the behavior of cold-formed steel framing and the continuing development of new technology, this material will become dated. It is anticipated that AISI will publish updates of this material as new information becomes available, but this cannot be guaranteed.

The materials set forth herein are for general purposes only. They are not a substitute for competent professional advice. Application of this information to a specific project should be reviewed by a design professional. Indeed, in many jurisdictions, such review is required by law. Anyone making use of the information set forth herein does so at their own risk and assumes any and all liability arising therefrom.

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## **PREFACE**

This *Commentary* is intended to facilitate the use and provide an understanding of the background of AISI S220, *North American Standard for Cold-Formed Steel Framing – Nonstructural Members*. The *Commentary* illustrates the substance and limitations of the various provisions of the Standard.

In the *Commentary*, sections, equations, figures, and tables are identified by the same notation as used in the Standard. Words that are italicized are defined in the Standard. Terms included in square brackets are specific to LSD terminology.

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## COMMENTARY ON THE NORTH AMERICAN STANDARD FOR COLD-FORMED STEEL FRAMING — NONSTRUCTURAL MEMBERS

### A. GENERAL

#### A1 Scope

AISI S220 (AISI, 2015) was first developed in 2011 to help clearly delineate and eliminate confusion between the requirements for *cold-formed steel structural members* and *nonstructural members*. As such, provisions formerly in AISI S200 (AISI, 2012b) for material, corrosion protection, base steel thickness, product designators, manufacturing tolerances, product identification, member design, member condition, installation, connections, and miscellaneous for *nonstructural members* were moved to AISI S220. However, use of the more stringent requirements for *structural members* that are in AISI S200 for *nonstructural members* should be permitted, since these should demonstrate equivalent performance for the intended use of those specified in this Standard.

AISI S220 is based on the premise that the consequence of failure for a *nonstructural member* is less than for a *structural member* and, consequently, permits a lower reliability for *nonstructural members*.

Section A2 of AISI S220 defines *nonstructural members* as members in a steel-framed system that are not a part of the gravity load-resisting system, primary lateral force-resisting system or building envelope. Section A1 of AISI S220 defines the applicability of the Standard based on transverse (out-of-plane) and superimposed axial loads. Examples of *nonstructural members* include, but are not limited to, studs in interior non-load bearing walls and furring members.

*In Canada:* Walls acting as “guards” are defined as walls where the floor elevation on one side of a wall, including a wall around a shaft, is more than 600 mm higher than the floor or ground on the other side.

AISI S220 provides design methods for cases where the composition and configuration of *cold-formed steel nonstructural members* is such that calculation of strength [resistance] and/or stiffness cannot be made in accordance with the design rules in AISI S100 [CSA S136] (AISI, 2012a; CSA, 2012). In order to afford a consistent range of design options, AISI S220 is also applicable to those cases where the composition and configuration of *cold-formed steel nonstructural members* is such that calculation of strength [resistance] and/or stiffness could be made in accordance with the design rules in AISI S100 [CSA S136].

#### A3 Loads and Load Combinations

Currently, ASCE 7 (ASCE, 2010) has no geographical-based information on Mexico. Therefore, users with projects in Mexico should work with the appropriate authority having jurisdiction to determine appropriate loads and load combinations that are consistent with the assumptions and rationale used by ASCE 7.

#### A6 Products

In 2015, performance requirements for screw penetration, based on similar requirements in ASTM C645 (ASTM, 2013a), were added for evaluating the *nonstructural members'* ability to pull the head of a screw below the surface of gypsum wallboard.

**A6.4 Products**

In 2015, manufacturing tolerances for stiffening *lip* length and *flange* width were added.

## B. DESIGN

Because of the diverse forms in which *cold-formed steel nonstructural members* can be used (e.g., rolled-in web stiffeners, embossments, etc.), it is not possible to cover all compositions and configurations by the design rules in AISI S100 [CSA S136]. AISI S220 provides methods for such cases. AISI S220 also provides alternative methods that are permitted even for those cases where the composition and configuration of *cold-formed steel nonstructural members* is such that calculation of strength [resistance] and/or stiffness could be made in accordance with the design rules in AISI S100 [CSA S136].

### B1 Member Design

AISI S220 permits the design of wall *studs* to be based on either a Non-Composite Assembly Design or a Composite Assembly Design.

In the case of Non-Composite Assembly Design, AISI S220 prescribes adjustments to the target reliability index, safety factor and resistance factor per AISI S100 [CSA S136] due to the reduced consequence of failure inherent in such systems that are lightly loaded and not a part of the gravity load-resisting system, lateral force-resisting system or building envelope. AISI S100 [CSA S136] establishes that where members do not meet the requirements for calculation in AISI S100 [CSA S136], performance may be established from one of two methods: Section A1.2(a) using tests, or Section A1.2(b) using rational engineering analysis.

Traditional ASD practice for composite interior partition wall *studs* have employed  $\Omega = 1.5$ ; consequently, AISI S220 prescribes a 10 percent reduction on the traditional safety factor of 1.67 for flexural members. This equates to a 10 percent increase in the resistance factor when using LRFD or LSD.

For acceptable levels of variability (i.e., reasonably low  $V_p$ ) this corresponds to a  $\beta_o = 1.6$  for LRFD and  $\beta_o = 1.82$  for LSD (with  $M_m = 1.10$ ,  $V_m = 0.10$ ,  $F_m = 1.00$  and  $V_F = 0.05$ ). The  $\beta_o$  value for LSD in Section B.1(a)(ii) will give the same reliability as ASD when the design is based on Section F1 of S100 [CSA S136]. Note, for this lower level of reliability,  $\phi$  calculated per *Specification* Equation F1.1-2 may be greater than 1.0. A  $\phi$  greater than 1.0 (just like a  $\phi$  less than 1.0) simply reflects the necessary change in the nominal strength [resistance] such that the target reliability is achieved.

Calibration of  $\beta_o$  to past practice reflects that for composite interior partition wall *studs* and other *nonstructural members*, the consequence of failure is less severe than for other *structural members*. In the case of Composite Assembly Design, AISI S220 prescribes testing due to the lack of rational engineering analysis methods based upon appropriate theory and related test data. The  $\beta_o$  value for LSD in Section B.1(b) for composite assemblies is taken from Section F1.1(a), Appendix B of S100 [CSA S136] and will give the same reliability as ASD when the design is based on testing.

### B5 Serviceability

The ICC *International Building Code* (ICC, 2015) and *NFPA 5000: Building Construction and Safety Code* (NFPA, 2015) set forth deflection limits for use in the United States and Mexico. Likewise, the *User's Guide - NBC 2010 Structural Commentaries (Part 4, of Division B)* (NRC, 2010) sets forth deflection limits for use in Canada.

### C. INSTALLATION

AISI S220 requires that the installation of *nonstructural members* be in accordance with ASTM C754 (ASTM, 2011a). ASTM C754 covers the minimum requirements for the installation of interior nonstructural steel framing and furring members designed to receive screw-attached gypsum panel products. However, as stated in ASTM C754, details of construction for a specific assembly to achieve a required fire resistance need to be obtained from reports of fire-resistance tests, engineering evaluations, or listings from recognized fire testing laboratories.

ASTM C754 includes provisions for the installation of *studs*, runners (e.g., *track*), rigid furring channels, and grid suspension systems. For *stud* installation, ASTM C754 provides typical framing spacing, heights and connection requirements as well as special requirements for studs located adjacent to door and window frames, partition intersections and corners. The Standard cautions that where conditions require that a partition be constructed with compensation for vertical structural movement, the gap between the end of a stud and the adjacent runner must be designed by an architect or engineer.

ASTM C754 does not address specific design conditions for members supporting interior openings, which present point loads and moments that may still allow the *stud* to meet the gravity load criteria for a *nonstructural member*, but which should be considered in design. ASTM C754 also does not address design conditions for loads imposed by such items as shelving, cabinets, fixtures or grab bars that might be attached to the wall.

## **D. CONNECTIONS**

### **D1 Screw Connections**

The Standard requires that screw fasteners for gypsum board to steel connections be in compliance with ASTM C954 (ASTM, 2011b), ASTM C1002 (ASTM, 2013b) or ASTM C1513 (ASTM, 2013c), as applicable, with a bugle head style. ASTM C954 is for fastening to steel having a thickness from 0.033 inches (0.84 mm) to 0.112 inches (2.84 mm). ASTM C1002 is for fastening to steel with a thickness less than 0.033 inches (0.84 mm). ASTM C1513 is for fastening to steel with a thickness not greater than 0.118 inches (2.997 mm).

## **F. TESTING**

### **F1 Composite Assemblies**

For *cold-formed steel nonstructural members* in interior non-load bearing wall assemblies, AISI S916, *Test Standard for Cold-Formed Steel Framing – Nonstructural Interior Partitions* (AISI, 2015b) is an *approved* test method. AISI S916 is applicable to nonstructural interior partition wall assemblies for structures subjected to uniform static pressure loads up to 15 pounds per square foot (720 Pa), framed with *cold-formed steel nonstructural members*, and sheathed on one or both sides with gypsum board panel products.

Alternatively, ICC-ES AC86, *Acceptance Criteria for Cold-Formed Steel Framing Members – Interior Nonload-Bearing Wall Assemblies* (ICC-ES, 2010), is generally an *approved* test method.

### **F2 Bridging Connectors**

For *nonstructural members in light-frame construction*, AISI S915, *Test Standard for Bridging Connectors as Cold-Formed Steel Wall Stud Bracing* (AISI, 2015a) is an *approved* test method to determine the strength and deformation behavior of bridging connectors. AISI S915 is applicable to bridging connectors attached to a *cold-formed steel wall stud* and the bridging member by mechanical fastening.

### **F3 Screw Penetration**

In 2015, a screw penetration test method, based on procedures in ASTM C645 (ASTM, 2013a), was added for evaluating the *nonstructural members'* ability to pull the head of a screw below the surface of gypsum wallboard. Many variables affect screw installation performance in the field. The correlation of screw penetration testing results with screw installation performance in the field has not been determined.

## REFERENCES

- (AISI, 2011), *North American Standard for Cold-Formed Steel Framing – Nonstructural Member Design*, AISI 220-11, American Iron and Steel Institute, Washington, D.C., 2011.
- (AISI, 2012a), *North American Specification for the Design of Cold-Formed Steel Structural Members*, AISI S100-12, American Iron and Steel Institute, Washington, DC, 2012.
- (AISI, 2012b), *North American Standard for Cold-Formed Steel Framing – General Provisions*, AISI S200-12, American Iron and Steel Institute, Washington, DC, 2012.
- (AISI, 2015a), *Test Standard for Bridging Connectors as Cold-Formed Steel Wall Stud Bracing*, AISI S915-15, American Iron and Steel Institute, Washington, D.C., 2015.
- (AISI, 2015b), *Test Standard for Cold-Formed Steel Framing – Nonstructural Interior Partitions*, AISI S916, American Iron and Steel Institute, Washington, D.C., 2015.
- (ASCE, 2010), *Minimum Design Loads for Buildings and Other Structures*, ASCE 7-10, American Society of Civil Engineers, Reston, VA, 2010.
- (ASTM, 2011a), *Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products*, ASTM C754-09a, ASTM International, West Conshohocken, PA, 2011.
- (ASTM, 2011b), *Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness*, ASTM C954-10, ASTM International, West Conshohocken, PA, 2011.
- (ASTM, 2013a), *Standard Specification for Nonstructural Steel Framing Members*, ASTM C645-13, ASTM International, West Conshohocken, PA, 2013.
- (ASTM, 2013b), *Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs*, ASTM C1002-13, ASTM International, West Conshohocken, PA, 2013.
- (ASTM, 2013c), *Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections*, ASTM C1513-10, ASTM International, West Conshohocken, PA, 2013.
- (CSA, 2012), *North American Specification for the Design of Cold-Formed Steel Structural Members*, CAN/CSA-S136-12, Canadian Standards Association, Mississauga, Ontario, Canada, 2012.
- (ICC, 2015), *International Building Code*, International Code Council, Falls Church, VA, 2015.
- (ICC-ES, 2010), *Acceptance Criteria for Cold-Formed Steel Framing Members - Interior Nonload-Bearing Wall Assemblies*, ICC-ES AC86, ICC Evaluation Service, Whittier, CA, 2010.
- (NFPA, 2015), *NFPA 5000: Building Construction and Safety Code*, National Fire Protection Association, Quincy, MA, 2015.
- (NRC, 2010), *User's Guide – NBC 2005 Structural Commentaries (Part 4, of Division B)*, National Research Council of Canada, Ottawa, Ontario, Canada, 2010.



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