AISI S220-20

American Iron and Steel Institute

AISI STANDARD

North American Standard for Cold-Formed Steel Nonstructural Framing

2020 Edition

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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.

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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 Nonstructural Framing*, 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 (ϕ) for use with LRFD and LSD, and the appropriate factors of safety (Ω) 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 2020 edition:

1. The relevant provisions of AISI S201-17, *North American Standard for Cold-Formed Steel Framing – Product Data,* are incorporated into this Standard. AISI S201 will no longer be maintained.
2. Section A1.2.3 is added to define the governing standard if conflict exists between this Standard and the *applicable building code*.
3. Tracks with flange width designation of 150 are added to Table A5-4.
4. References in Section A7 are updated. Section references and notations are updated throughout the Standard to be consistent with AISI S100-16 (2020) w/S2-20.
5. Screw edge distance has been revised to 1.5 times nominal diameter in Section B3.1.2.1.
6. References to ASTM C951 and ASTM C1513 are removed from Section B3.1.3 since both standards are not applicable to the given provisions.

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 NONSTRUCTURAL FRAMING

A. GENERAL

A1 Scope and Applicability

A1.1 Scope

This Standard applies to the design and installation of *cold-formed steel nonstructural members* in buildings.

A1.2 Applicability

A1.2.1 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/ft² (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/ft² (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).

A1.2.2 In Canada, members in walls acting as guards, as defined in the *National Building Code of Canada* (NBCC), shall be considered *structural members*.

A1.2.3 This Standard shall govern over other standards, including those referenced in this Standard, in matters pertaining to elements falling within the scope of this Standard, as defined in Section A1.1. Where conflicts between this Standard and the *applicable building code* occur, the requirements of the *applicable building code* shall govern. In areas without an *applicable building code*, this Standard defines the minimum acceptable standards for elements falling within the scope of this Standard, as defined in Section A1.1.

A1.2.4 This Standard does not preclude the use of other *approved* materials, assemblies, structures, or designs of equivalent performance.

A1.2.5 This Standard includes Sections A through D inclusive, and Appendix 1.

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.

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.

Punchout. A hole made during the manufacturing process in the *web* of a steel framing member.

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 Material

A3.1 In the United States and Mexico, *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.

A3.2 In Canada, *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.

A4 Corrosion Protection

A4.1 Protective Coatings

A4.1.1 In the United States and Mexico, *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.

A4.1.2 In Canada, *nonstructural members* shall have a minimum metallic coating of G40 [Z120] complying with the requirements of ASTM A653/A653M, or AZ50 [AZM150] complying with the requirements of ASTM A792/A792M.

A4.2 Additional corrosion protection shall not be required on edges of metallic-coated steel framing members, shop or field cut, punched, or drilled.

A4.3 Framing members shall be located within the building envelope and shielded from direct contact with moisture from the ground or the outdoor climate.

A4.4 Dissimilar metals shall not be used in direct contact with *cold-formed steel* framing members unless *approved* for that application.

A4.5 *Cold-formed steel* framing members shall not be embedded in concrete unless *approved* for that application.

A4.6 Fasteners shall have a corrosion-resistant treatment or be manufactured from material not susceptible to corrosion.

A5 Products

A5.1 Base Steel Thickness

A5.1.1 In no case shall the minimum *base steel thickness* be less than 95% of the *design thickness*.

A5.1.2 In Canada, *nonstructural members* shall be manufactured from steel having a minimum *base steel thickness* of 0.0179 in. (0.455 mm). *Nonstructural members* that can show third-party testing in accordance with AISI S916 and conform to the limiting height tables in ASTM C754 need not meet the minimum steel thickness limitation.

A5.2 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).

A5.3 Product Designator

A four-part product designator that identifies the size (both *web* depth and *flange* width), type, and thickness shall be used for reference to *nonstructural members*. The product 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) A three- or four-digit numeral indicating member *web* depth in 1/100 inch.

(b) A letter indicating member type, in accordance with the following:

S = *C-shape* (commonly used as a *stud* 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*

(c) A three-digit numeral indicating *flange* width in 1/100 inch, followed by a dash.

(d) A two- or three-digit numeral indicating *design thickness*.

A5.4 Manufacturing Tolerances

Nonstructural members utilized in *cold-formed steel light-frame construction* shall comply with the manufacturing tolerances listed in Table A5-1, as illustrated in Figure A5-1. All measurements shall be taken not less than 1 ft (305 mm) from the end of the member.

Table A5-1
Manufacturing Tolerances for Nonstructural Members

Dimension[1]	Item Checked	C-shapes, in. (mm)	Tracks, in. (mm)
A	Length	+1/8 (3.18)	+ 1(25.40)
		-1/4 (6.35)	-1/4 (6.35)
B[2]	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)	

[1] All measurements shall be taken not less than 1 ft (305 mm) from the end.
[2] Outside dimension for *C-shape*; inside for *track*.

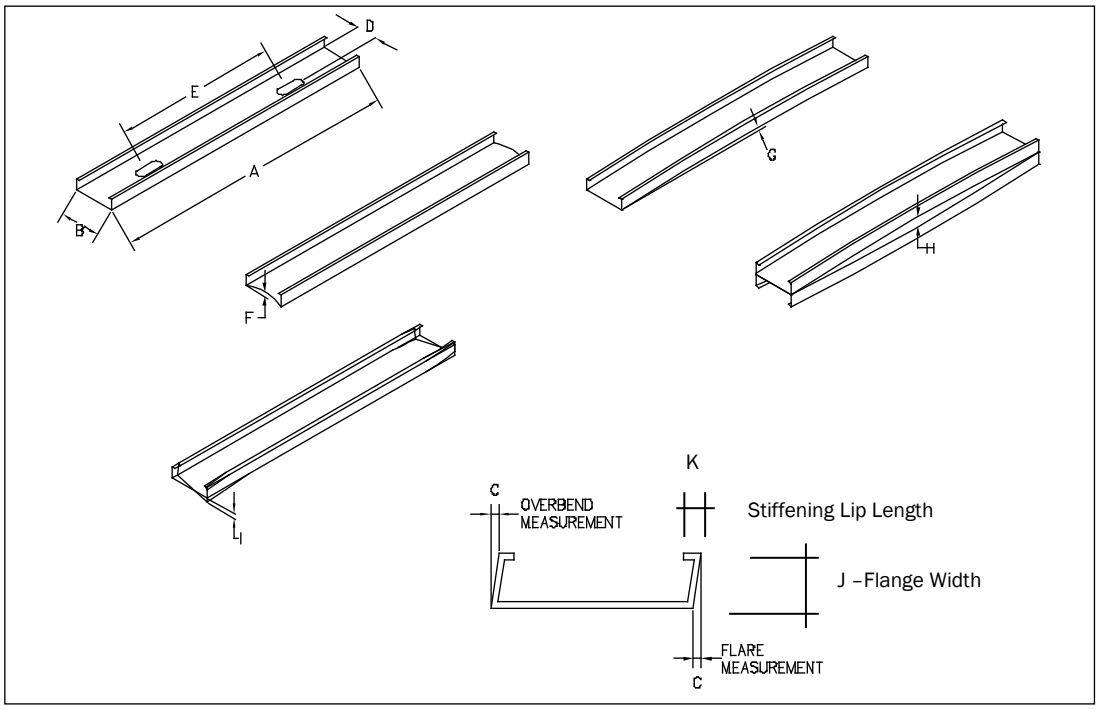

Figure A5-1 Manufacturing Tolerances for Nonstructural Members

A5.5 Product Identification

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

A5.5.1 Identification of Groups of Like Members

A5.5.1.1 In the United States and Mexico, 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".

A5.5.1.2 In Canada, the identification of groups of like members is at the discretion of the manufacturer.

A5.5.2 Identification of Individual Framing Members

A5.5.2.1 In the United States and Mexico, in addition to the marking referenced in A5.5.1.1, 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:

(a) The roll-former's identification (i.e., name, logo, or initials).
(b) The minimum steel thickness, in mils or inches, exclusive of protective coating.
(c) The minimum yield strength in kips per square inch (megapascals) if other than 33 ksi (230 MPa).
(d) The protective coating type and weight, if other than as specified in Section A4.1.

(e) The designation "NS".

A5.5.2.2 In Canada, in addition to the marking referenced in Section A5.5.1.2, 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:

(a) The manufacturer's identification (name, logo, or initials); and

(b) The minimum steel thickness (in mils, inches or millimeters) exclusive of protective coatings.

A5.6 Standard Shapes

Standard shapes for *nonstructural members*, as illustrated in Figure A5-2, are combinations of the basic dimensions listed in Tables A5-3 through A5-7, depending on the member type.

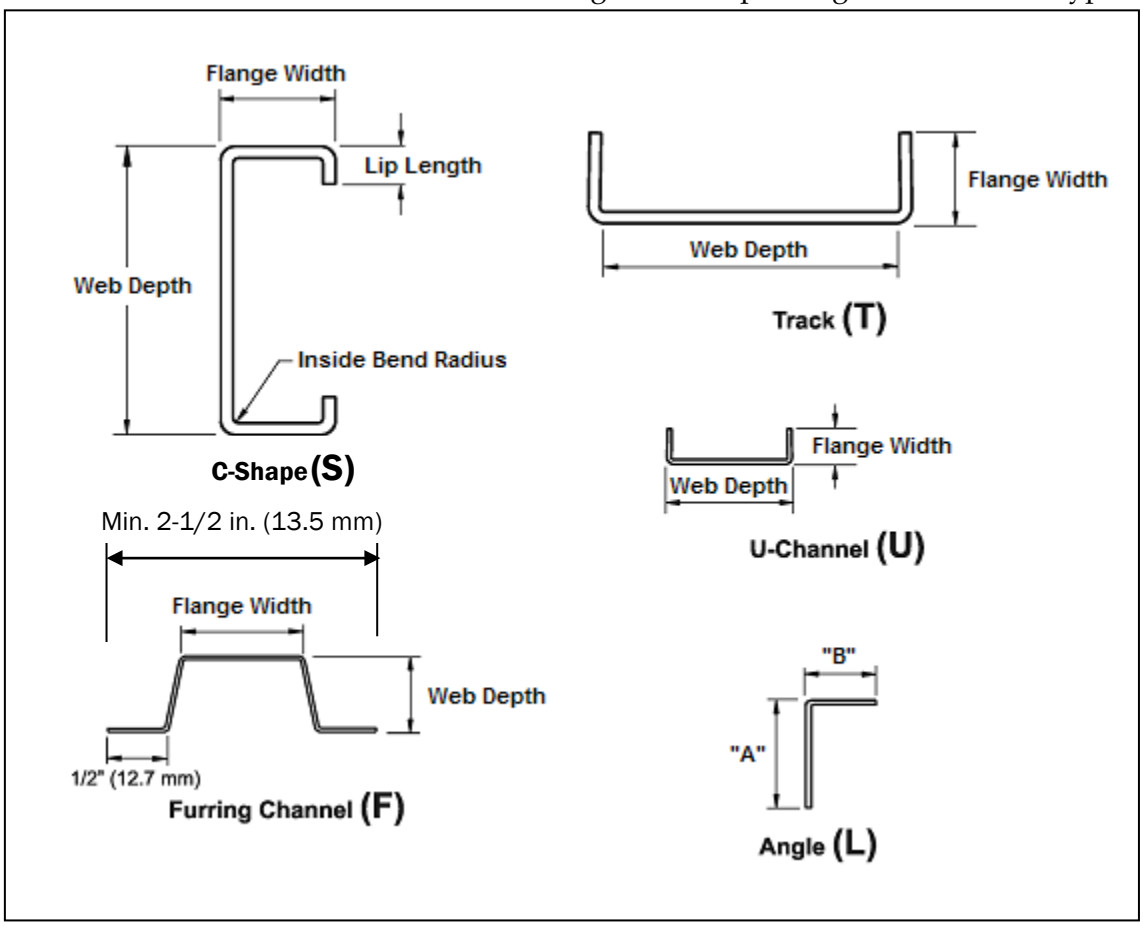

Figure A5-2 Standard Cold-Formed Steel Framing Member Types

Table A5-3
Standard Dimensions for C-Shapes (S)

Web Depth		
Depth Designation	Design Depth	
	(inch)	(mm)
162	1-5/8	41.3
250	2-1/2	63.5
362	3-5/8	92.1
400	4	102
600	6	152

Flange Width		
Width Designation	Design Width	
	(inch)	(mm)
125	1-1/4	31.8

Table A5-4
Standard Dimensions for Tracks (T)

Web Depth		
Depth Designation	Design Depth	
	(inch)	(mm)
162	1-5/8	41.3
250	2-1/2	63.5
362	3-5/8	92.1
400	4	102
600	6	152

Flange Width		
Width Designation	Design Width	
	(inch)	(mm)
125	1-1/4	31.8
150	1-1/2	38.1

Table A5-5
Standard Dimensions for U-Channels (U)

Web Depth		
Depth Designation	Design Depth	
	(inch)	(mm)
75	3/4	19.1
150	1-1/2	38.1
200	2	50.8
250	2-1/2	63.5

Flange Width		
Width Designation	Design Width	
	(inch)	(mm)
50	1/2	12.7
75	3/4	19.1

Note: Not all shapes are available in every standard thickness.

Table A5-6
Standard Dimensions for Furring Channels (F)

Web Depth		
Depth Designation	Design Depth	
	(inch)	(mm)
87	7/8	22.2
150	1-1/2	38.1

Flange Width		
Width Designation	Design Width	
	(inch)	(mm)
125	1-1/4	31.8

Note: Not all shapes are available in every standard thickness.

Table A5-7
Standard Dimensions for Angles (L)

"A" Flange Width		
Depth Designation	Design Depth	
	(inch)	(mm)
62	5/8	15.9
87	7/8	22.2
137	1-3/8	34.9
150	1-1/2	38.1
200	2	50.8
300	3	76.2

"B" Flange Width		
Width Designation	Design Width	
	(inch)	(mm)
62	5/8	15.9
87	7/8	22.2
137	1-3/8	34.9
150	1-1/2	38.1
200	2	50.8
300	3	76.2

Note: Not all shapes are available in every standard thickness.

A5.7 Inside Bend Radius

Unless specified otherwise in the manufacturer's literature, the size of the inside bend radius used for design shall comply with the requirements shown in Table A5-8.

Table A5-8
Standard Design Inside Bend Radius

Designation Thickness	Inside Bend Radius	
	(inch)	(mm)
18	0.0843	2.141
27	0.0796	2.022
30	0.0781	1.984

A5.8 Lip Length

Unless specified otherwise in the manufacturer's literature, the *lip* length on a *C-shape* shall be related to the *flange* width as listed in Table A5-9.

Table A5-9
Standard Design Lip Length for C-Shapes (S)

Flange Width Designation	Flange Width		Design Lip Length	
	(inch)	(mm)	(inch)	(mm)
125	1-1/4	31.8	3/16	4.8

A5.9 Punchouts

Unless specified otherwise by the manufacturer, factory punchouts (perforations) shall comply with the following conditions:

(1) *Punchouts* shall be spaced along the centerline of the *web* of the framing member;

(2) *Punchouts* shall have a center-to-center spacing of not less than 24 inches (610 mm);

(3) *Punchouts* shall have a width not greater than half the member depth or 2-1/2 inches (63.5 mm), whichever is less;

(4) *Punchouts* shall have a length not exceeding 4-1/2 inches (114 mm); and

(5) The distance from the center of the last *punchout* to the end of the member shall not be less than 12 inches (305 mm), unless otherwise specified.

Any configuration or combination of holes that fits within the *punchout* width and length limitations is permitted.

A6 Referenced Documents

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

1. American Iron and Steel Institute, Washington, DC

   AISI S100-16 (2020) w/S2-20, *North American Specification for the Design of Cold-Formed Steel Structural Members* with Supplement 2

   AISI S915-15, *Test Standard for Through-The-Web Punchout Cold-Formed Steel Wall Stud Bridging Connectors*

   AISI S916-15, *Test Standard for Cold-Formed Steel Framing – Nonstructural Interior Partition Walls With Gypsum Board*

2. American Society of Civil Engineers, Reston, VA

   ASCE 7-16, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*

3. ASTM International, West Conshohocken, PA

   ASTM A653/A653M-19a, *Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process*

   ASTM A792/A792M-10(2015), *Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process*

   ASTM A1003/A1003M-15, *Standard Specification for Sheet Steel, Carbon, Metallic and Non-Metallic Coated for Cold-Formed Framing Members*

   ASTM C475/C475M-17, *Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board*

   ASTM C754-18, *Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products*

   ASTM C1002–18, *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 C1396/C1396M-17, *Standard Specification for Gypsum Board*

   ASTM C1513-18, *Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections*

5. CSA Group, Mississauga, Ontario, Canada

   CAN/CSA S136-16 (2020) w/S2-20, *North American Specification for the Design of Cold-Formed Steel Structural Members* With Supplement 2

6. National Research Council of Canada, Ottawa, Ontario, Canada

   NBCC 2015, *National Building Code of Canada*, 2015 Edition

B. DESIGN

B1 General

Strength 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.

B1.1 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 and Associated Criteria for Buildings and Other Structures* (ASCE 7) in the United States and Mexico, and the *National Building Code of Canada* (NBCC) in Canada.

B2 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, D through J, and Appendix 1 of AISI S100 [CSA S136] with:

$\Omega_N = 0.9\,\Omega$

$\phi_N = 1.1\,\phi$

where

Ω = Safety factor per relevant section of AISI S100 [CSA S136]

ϕ = Resistance factor per relevant section of AISI S100 [CSA S136]

(ii) Section K2 of AISI S100 [CSA S136] with:

$\beta_o = 1.6$ for LRFD

$= 1.82$ for LSD

where

β_o = Target Reliability Index

Ω_N = Safety factor per Section K2.1.2 of AISI S100 [CSA S136]

ϕ_N = Resistance factor per Section K2.1.1(c) of AISI S100 [CSA S136]

If Section A1.2(b) of AISI S100 [CSA S136] is utilized, then supplementary tests are permitted to be performed and Section K2.1.1(b) of AISI S100 [CSA S136] is permitted to be employed for determination of Ω_N or ϕ_N, with P_m replaced by $P_{test}/P_{compute}$ and β_o in accordance with the provisions above.

In the use of AISI S100 [CSA S136] Section K2, 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 D1 of this Standard.

B3 Connection Design

Connections shall be designed in accordance with Chapter J of AISI S100 [CSA S136] or tested in accordance with Section K2.1 of AISI S100 [CSA S136].

B3.1 Screw Connections

B3.1.1 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.

B3.1.2 Edge Distance, End Distance and Spacing

B3.1.2.1 For screw fasteners in steel-to-steel connections to be considered fully effective, the minimum edge and end distance shall be 1.5 times the nominal diameter.

B3.1.2.2 For screw fasteners in steel-to-steel connections to be considered fully effective, the minimum center-to-center spacing shall be 3 times the nominal diameter.

Exception: Where the center-to-center spacing of screw fasteners in steel-to-steel connections is less than 3 times the nominal diameter but greater than or equal to 2 times the nominal diameter, screw fasteners shall be considered 80 percent effective.

B3.1.3 Gypsum Board

Screw fasteners for gypsum board to steel connections shall be in compliance with ASTM C1002, as applicable, with a bugle head style.

B3.1.4 Performance Requirements

When tested in accordance with the screw penetration test requirements of Section D3 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.

B3.2 Other Connections

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.

B3.3 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.

B4 Bracing

Bracing, when required, shall be designed in accordance with AISI S100 [CSA S136] or tested in accordance with Section K2.1 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 B1.1 of this Standard.

C. INSTALLATION

C1 General

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

C2 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.

C2.1 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. Factory punchouts shall be in accordance with Section A5.9.

C2.2 Cutting and Patching

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

C3 Connections

C3.1 Screw Connections

C3.1.1 Steel-to-Steel Screws

Use of a larger than specified screw size is permitted if the installation is in accordance with the minimum design spacing and edge distance.

C3.1.2 Installation

C3.1.2.1 Screw fasteners shall extend through the steel connection a minimum of three (3) exposed threads.

C3.1.2.2 Screw fasteners shall penetrate individual components of connections without causing permanent separation between components.

C3.1.3 Stripped Screws

C3.1.3.1 Stripped screw fasteners in direct tension shall not be considered effective.

C3.1.3.2 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.

C3.1.4 Gypsum Board

Gypsum board shall be attached to *cold-formed steel* framing in accordance with the *applicable building code* or an *approved* design standard.

C4 Miscellaneous

Utilities and insulation shall be installed in accordance with the requirements of this section, as applicable.

C4.1 Utilities

C4.1.1 Holes

C4.1.1.1 Holes shall comply with the requirements specified in Section C2.1.

C4.1.1.2 Penetrations of wall and ceiling assemblies that are required to have a fire resistance rating shall be protected in accordance with the *applicable building code* or in accordance with the *approved construction documents*.

C4.1.2 Plumbing

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

C4.1.3 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.

C4.2 Insulation

C4.2.1 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.

C4.2.2 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.

D. TESTING

D1 Composite Assemblies

Tests of composite assemblies, when required by Section B2 of this Standard, shall be in accordance with AISI S916, or other *approved* test methods with the calibration in accordance with Section K2.1 of AISI S100 [CSA S136]. The tests shall be conducted under the supervision of a *design professional*.

D2 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 K2.1 of AISI S100 [CSA S136]. The tests shall be conducted under the supervision of a *design professional*.

D3 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.

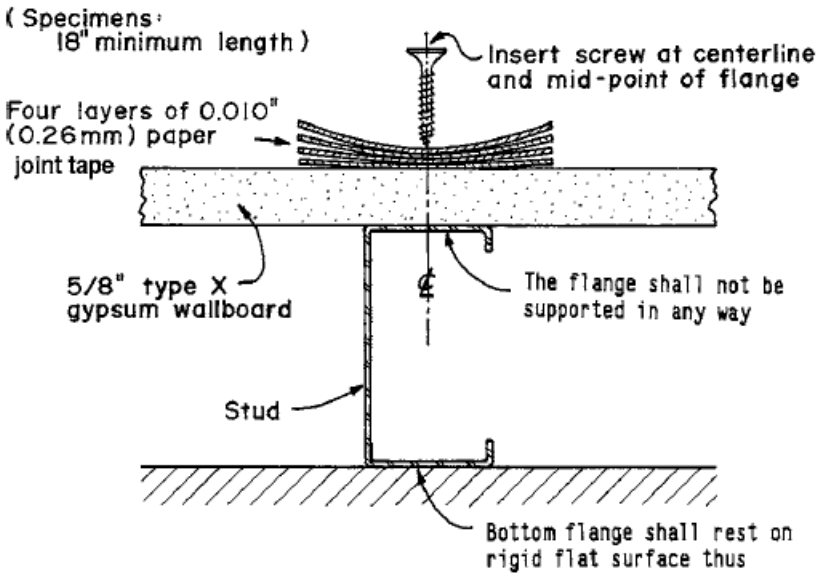

Figure 1-1 – Testing of C-Shape Members
(Reproduced, with permission from ASTM C645-11 *Standard Specification for Nonstructural Steel Framing Members*, copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428.)

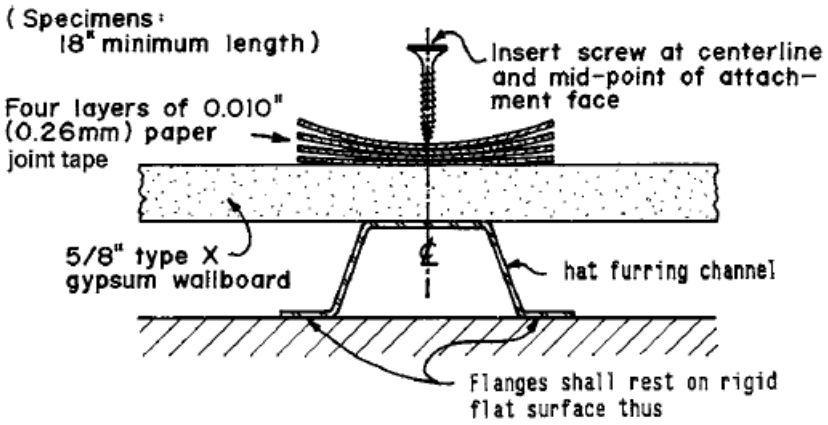

Figure 1-2 – Testing of Furring Channels
(Reproduced, with permission from ASTM C645-11 *Standard Specification for Nonstructural Steel Framing Members*, copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428.)

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.

American
Iron and Steel
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AISI STANDARD

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

2020 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.

1st Printing – December 2020

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 Nonstructural Framing*. 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 NONSTRUCTURAL FRAMING

A. GENERAL

A1 Scope and Applicability

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*. In the 2015 edition, 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 S240 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 and/or stiffness cannot be made in accordance with the design rules in AISI S100 [CSA S136]. 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 and/or stiffness could be made in accordance with the design rules in AISI S100 [CSA S136].

In 2007, AISI published the first edition of AISI S201, *North American Standard for Cold-Formed Steel Framing – Product Data*, to standardize requirements for cold-formed steel framing products. AISI S201 was intended to establish and encourage the production and use of standardized products in the United States, Canada, and Mexico. In 2020, the relevant requirements of AISI S201 for *nonstructural members* were incorporated into AISI S220. Within AISI S220, the phrase "standard shape" is intended to define standard industry practice. Use of "standard shapes" is not required by AISI S220.

A5 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.

In 2020, the product standards in AISI S201 were incorporated into this Standard. In addition, the second part of the four-part product designator was changed to clarify that the various member types can be used in a variety of applications; e.g., the "S" member type was redefined as a *C-shape* rather than as a *stud* framing member.

A5.4 Manufacturing Tolerance

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 and/or stiffness could be made in accordance with the design rules in AISI S100 [CSA S136].

B1.1 Loads and Load Combinations

Currently, ASCE 7 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.

B2 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 the following methods: Section A1.2(a) using tests, A1.2(b) using rational engineering analysis with confirmatory tests, or Section A1.2(c) using rational engineering analysis.

Traditional ASD practice for composite interior partition wall *studs* have employed Ω_N = 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 β_o=1.6 for LRFD and β_o=1.82 for LSD (with M_m = 1.10, V_m = 0.10, F_m = 1.00 and V_F = 0.05). The β_o value for LSD in Section B2 (a)(ii) will give the same reliability as ASD when the design is based on Section K2.1 of S100 [CSA S136]. Note, for this lower level of reliability, ϕ_N calculated per *Specification* Equation K2.1.1-2 may be greater than 1.0. A ϕ_N greater than 1.0 (just like a ϕ_N less than 1.0) simply reflects the necessary change in the nominal strength [resistance] such that the target reliability is achieved.

Calibration of β_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 β_o value for LSD in Section B2(b) for composite assemblies is taken from Section K2.1.1(a), Appendix B of S100 [CSA S136] and will give the same reliability as ASD when the design is based on testing.

B3 Connection Design

B3.1 Screw Connections

To be consistent with AISI S100 [CSA S136], the minimum edge distance requirement was revised to 1.5 times the screw nominal diameter in 2020.

The Standard requires that screw fasteners for gypsum board to steel connections be in compliance with ASTM C1002 with a bugle head style. ASTM C1002 is for fastening gypsum-to-steel with a steel thickness less than 0.033 inches (0.84 mm). ASTM C1513 is for fastening steel-to-steel with a steel thickness not greater than 0.118 inches (2.997 mm).

In 2020, references to ASTM C954 were removed from AISI S220 since ASTM C954 is for connections with *stud* thickness 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm). References to ASTM C1513 were removed from Section B3.1.3 of the Standard since ASTM C1513 is not applicable to steel-to-gypsum connections.

B5 Serviceability

The ICC *International Building Code* (ICC, 2018) and *NFPA 5000: Building Construction and Safety Code* (NFPA, 2018) set forth deflection limits for use in the United States and Mexico. Likewise, the *User's Guide - NBC 2015 Structural Commentaries (Part 4, of Division B)* (NRC, 2015) 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 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. TESTING

D1 Composite Assemblies

For *cold-formed steel nonstructural members* in interior non-load bearing wall assemblies, AISI S916 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, 2019), is generally an *approved* test method.

D2 Bridging Connectors

For *nonstructural members* in *light-frame construction*, AISI S915 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.

D3 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.

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