

## CHAPTER 22

# STEEL

### SECTION 2201 GENERAL

**2201.1 Scope.** The provisions of this chapter govern the quality, design, fabrication and erection of steel used structurally in buildings or structures.

### SECTION 2202 DEFINITIONS AND NOMENCLATURE

**2202.1 Definitions.** The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meaning shown herein.

**ADJUSTED SHEAR RESISTANCE.** In Type II shear walls, the unadjusted shear resistance multiplied by the shear resistance adjustment factors of Table 2211.3.

**STEEL CONSTRUCTION, COLD-FORMED.** That type of construction made up entirely or in part of steel structural members cold formed to shape from sheet or strip steel such as roof deck, floor and wall panels, studs, floor joists, roof joists and other structural elements.

**STEEL JOIST.** Any steel structural member of a building or structure made of hot-rolled or cold-formed solid or open-web sections, or riveted or welded bars, strip or sheet steel members, or slotted and expanded, or otherwise deformed rolled sections.

**STEEL MEMBER, STRUCTURAL.** Any steel structural member of a building or structure consisting of a rolled steel structural shape other than cold-formed steel, or steel joist members.

**TYPE I SHEAR WALL.** A wall designed to resist in-plane lateral forces that is fully sheathed and provided with hold-down anchors at each end of the wall segment. Type I walls are permitted to have openings where detailing for force transfer around the openings is provided (see Figure 2202.1).

**TYPE II SHEAR WALL.** A wall designed to resist in-plane lateral forces that is sheathed with wood structural panel or sheet steel that contains openings, that have not been specifically designed and detailed for force transfer around wall openings. Hold-down anchors for Type II shear walls are only required at the ends of the wall (see Figure 2202.1).

**TYPE II SHEAR WALL SEGMENT.** A section of shear wall with full-height sheathing and which meets the aspect ratio limits of Section 2211.3.2(3).

**UNADJUSTED SHEAR RESISTANCE.** In Type II walls, the unadjusted shear resistance is based on the design shear and the limitations of Section 2211.3.1.

**2202.2 Nomenclature.** The following symbols shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

$\phi$  = Resistance factor (see Section 2211.2.1).

$\Omega$  = Factor of safety (see Section 2211.2.1).

$\Omega_o$  = System overstrength factor (see Section 1617.6).

$C_o$  = Shear resistance adjustment factor from Table 2211.3.

$\Sigma L_i$  = Sum of widths of Type II shear wall segments, feet (mm/1,000).

$C$  = Compression chord uplift force, lbs (kN).

$V$  = Shear force in Type II shear wall, lbs (kN).

$h$  = The height of a shear wall measured as:

1. The maximum clear height from top of foundation to bottom of diaphragm framing above or,
2. The maximum clear height from top of a diaphragm to bottom of diaphragm framing above.

$v$  = Unit shear force, plf (kN/m).

$w$  = The width of a shear wall or wall pier in the direction of application of force measured as the sheathed dimension of the shear wall.

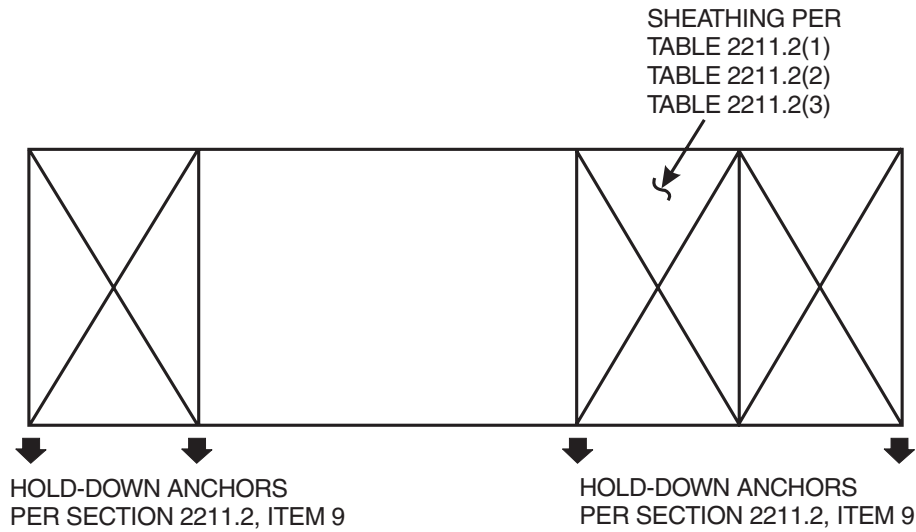
### SECTION 2203 IDENTIFICATION AND PROTECTION OF STEEL FOR STRUCTURAL PURPOSES

**2203.1 Identification.** Steel furnished for structural load-carrying purposes shall be properly identified for conformity to the ordered grade in accordance with the specified ASTM standard or other specification and the provisions of this chapter. Steel that is not readily identifiable as to grade from marking and test records shall be tested to determine conformity to such standards.

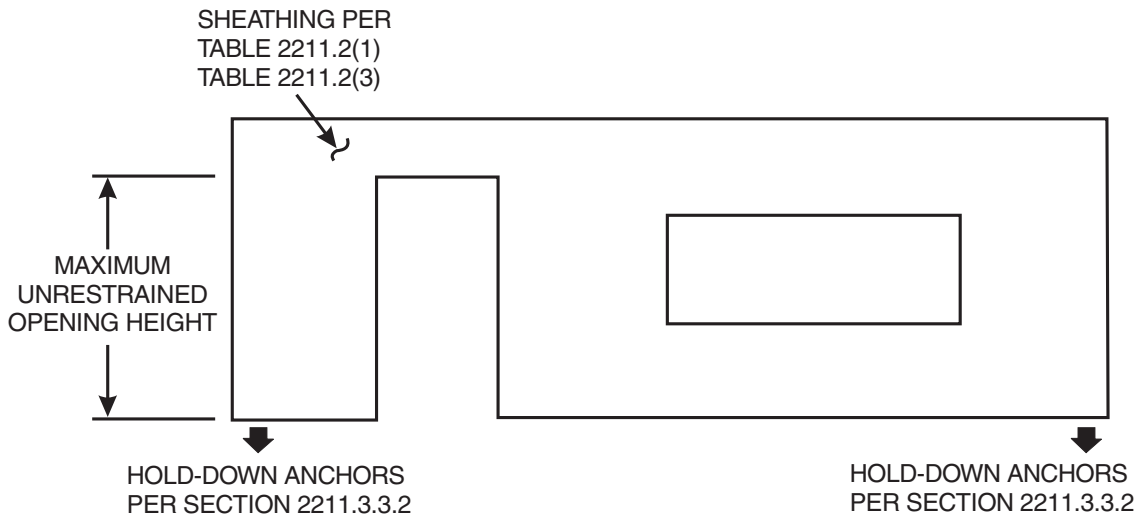
**2203.2 Protection.** Painting of structural steel shall comply with the requirements contained in either the *AISC Load and Resistance Factor Design Specification for Structural Steel Buildings* (AISC-LRFD), *AISC Specification for Structural Steel Buildings—Allowable Stress Design* (AISC 335) or *AISC Specification for the Design of Steel Hollow Structural Sections* (AISC-HSS). Individual structural members and assembled panels of cold-formed steel construction, except where fabricated of approved corrosion-resistant steel or of steel having a corrosion resistant or other approved coating, shall be protected against corrosion with an approved coat of paint, enamel or other approved protection.

### SECTION 2204 CONNECTIONS

**2204.1 Welding.** The details of design, workmanship and technique for welding, inspection of welding and qualification of welding operators shall conform to the requirements of the specifications listed in Sections 2205, 2206, 2207, 2209 and 2210. Special inspection of welding shall be provided where required by Section 1704.



TYPE I SHEAR WALL



TYPE II SHEAR WALL

FIGURE 2202.1  
TYPE I AND TYPE II SHEAR WALLS

**2204.2 Bolting.** The design, installation and inspection of bolts shall be in accordance with the requirements of the specifications listed in Sections 2205, 2206, 2209 and 2210. Special inspection of the installation of high-strength bolts shall be provided where required by Section 1704.

**2204.2.1 Anchor rods.** Anchor rods shall be set accurately to the pattern and dimensions called for on the plans. The protrusion of the threaded ends through the connected material shall be sufficient to fully engage the threads of the nuts, but shall not be greater than the length of the threads on the bolts.

## SECTION 2205 STRUCTURAL STEEL

**2205.1 General.** The design, fabrication and erection of structural steel for buildings and structures shall be in accordance with either the AISC-LRFD, AISC 335 or AISC-HSS. Where required, the seismic design of steel structures shall be in accordance with the additional provisions of Section 2205.2.

**2205.2 Seismic requirements for steel structures.** The design of structural steel structures to resist seismic forces shall be in accordance with the provisions of Section 2205.2.1 or 2205.2.2 for the appropriate seismic design category.

**2205.2.1 Seismic Design Category A, B or C.** Structural steel structures assigned to Seismic Design Category A, B or C, in accordance with Section 1616, shall be of any construction permitted in Section 2205. An *R* factor as set forth in Section 1617.6 for the appropriate steel system is permitted where the structure is designed and detailed in accordance with the provisions of AISC 341, Parts I and III. Systems not detailed in accordance with the above shall use the *R* factor in Section 1617.6 designated for “steel systems not detailed for seismic.”

**2205.2.2 Seismic Design Category D, E or F.** Structural steel structures assigned to Seismic Design Category D, E or F shall be designed and detailed in accordance with AISC 341, Part I or III.

**2205.3 Seismic requirements for composite construction.** The design, construction and quality of composite steel and concrete components that resist seismic forces shall conform to the requirements of the AISC LRFD and ACI 318. An *R* factor as set forth in Section 1617.6 for the appropriate composite steel and concrete system is permitted where the structure is designed and detailed in accordance with the provisions of AISC 341, Part II. In Seismic Design Category B or above, the design of such systems shall conform to the requirements of AISC 341, Part II.

**2205.3.1 Seismic Design Categories D, E and F.** Composite structures are permitted in Seismic Design Categories D, E and F, subject to the limitations in Section 1617.6, where substantiating evidence is provided to demonstrate that the proposed system will perform as intended by AISC 341, Part II. The substantiating evidence shall be subject to building official approval. Where composite elements or connections are required to sustain inelastic deformations, the substantiating evidence shall be based on cyclic testing.

## SECTION 2206 STEEL JOISTS

**2206.1 General.** The design, manufacturing and use of open web steel joists and joist girders shall be in accordance with one of the following Steel Joist Institute specifications:

1. *Standard Specifications for Open Web Steel Joists, K Series.*
2. *Standard Specifications for Longspan Steel Joists, LH Series and Deep Longspan Steel Joists, DLH Series.*
3. *Standard Specifications for Joist Girders.*

Where required, the seismic design of buildings shall be in accordance with the additional provisions of Section 2205.2 or 2211.

## SECTION 2207 STEEL CABLE STRUCTURES

**2207.1 General.** The design, fabrication and erection including related connections, and protective coatings of steel cables for buildings shall be in accordance with ASCE 19.

**2207.2 Seismic requirements for steel cable.** The design strength of steel cables shall be determined by the provisions of ASCE 19 except as modified by these provisions.

1. A load factor of 1.1 shall be applied to the prestress force included in  $T_3$  and  $T_4$  as defined in Section 3.12.
2. In Section 3.2.1, Item (c) shall be replaced with “1.5  $T_3$ ” and Item (d) shall be replaced with “1.5  $T_4$ ”

## SECTION 2208 STEEL STORAGE RACKS

**2208.1 Storage racks.** The design, testing and utilization of industrial steel storage racks shall be in accordance with the *RMI Specification for the Design, Testing and Utilization of Industrial Steel Storage Racks*. Racks in the scope of this specification include industrial pallet racks, movable shelf racks and stacker racks, and does not apply to other types of racks, such as drive-in and drive-through racks, cantilever racks, portable racks or rack buildings. Where required, the seismic design of storage racks shall be in accordance with the provisions of Section 9.6.2.9 of ASCE 7.

## SECTION 2209 COLD-FORMED STEEL

**2209.1 General.** The design of cold-formed carbon and low-alloy steel structural members shall be in accordance with the *North American Specification for the Design of Cold-Formed Steel Structural Members* (AISI-NASPEC). The design of cold-formed stainless-steel structural members shall be in accordance with ASCE 8. Cold-formed steel light-framed construction shall comply with Section 2210.

**2209.2 Composite slabs on steel decks.** Composite slabs of concrete and steel deck shall be designed and constructed in accordance with ASCE 3.

**SECTION 2210  
COLD-FORMED STEEL  
LIGHT-FRAMED CONSTRUCTION**

**2210.1 General.** The design, installation and construction of cold-formed carbon or low-alloy steel, structural and nonstructural steel framing, shall be in accordance with the *Standard for Cold-Formed Steel Framing—General Provisions*, American Iron and Steel Institute (AISI-General) and AISI-NASPEC.

**2210.2 Headers.** The design and installation of cold-formed steel box and back-to-back headers, and double L-headers used in single-span conditions for load-carrying purposes shall be in accordance with the *Standard for Cold-Formed Steel Framing—Header Design*, American Iron and Steel Institute (AISI-Header), subject to the limitations therein.

**2210.3 Trusses.** The design, quality assurance, installation and testing of cold-formed steel trusses shall be in accordance with the *Standard for Cold-Formed Steel Framing—Trusses*, American Iron and Steel Institute (AISI-Truss), subject to the limitations therein.

**SECTION 2211  
COLD-FORMED STEEL  
LIGHT-FRAMED SHEAR WALLS**

**2211.1 General.** In addition to the requirements of Section 2210, the design of cold-formed steel light-framed shear walls, to resist wind and seismic loads shall be in accordance with the requirements of Section 2211.2 for Type I (segmented) shear walls or Section 2211.3 for Type II (perforated) shear walls.

Light-framed structures assigned to Seismic Design Categories A, B and C, in accordance with Section 1616, shall be of any construction permitted in Section 2210. An *R* factor as set forth in Section 1617.6 for the appropriate steel system is permitted where the lateral design of the structure is in accordance with the provisions of Section 2211.4. Systems not detailed in accordance with Section 2211.4 shall use the *R* factor in Section 1617.6 designated for “steel systems not detailed for seismic.”

In Seismic Design Categories D, E and F, the lateral design of light-framed structures shall also comply with the requirements in Section 2211.4

**2211.2 Type I shear walls.** The design of Type I shear walls, of cold-formed steel light-framed construction, to resist wind and seismic loads, shall be in accordance with the requirements of this section.

1. The nominal shear value for Type I shear walls, as shown in Table 2211.2(1) for wind loads, Table 2211.2(2) for wind or seismic loads or Table 2211.2(3) for seismic loads, is permitted to establish allowable shear values or design shear values.
2. Boundary members, chords, collectors and connections thereto shall be proportioned to transmit the induced forces.
3. As an alternative to the values in Tables 2211.2(1), 2211.2(2) and 2211.2(3), shear values are permitted to be calculated by the principles of mechanics by using ap-

proved fastener values and shear values appropriate for the sheathing material attached.

4. Type I shear walls sheathed with wood structural or sheet steel panels are permitted to have window openings, between hold-down anchors at each end of a wall segment, where details are provided to account for force transfer around openings.
5. The aspect ratio limitations of Section 2211.2.2, Item 5, shall apply to the entire Type I segment and to each wall pier at the side of each opening.
6. The height of the wall pier (*h*) shall be defined as the clear height of the pier at the side of an opening.
7. The width of a pier (*w*) shall be defined as the sheathed width of the pier.
8. The width of wall piers shall not be less than 24 inches (102 mm).
9. Hold-down anchors shall be provided at each end of a Type I shear wall capable of resisting the design forces.

**2211.2.1 Design shear determination.** Where allowable stress design (ASD) is used, the allowable shear value shall be determined by dividing the nominal shear value, shown in Tables 2211.2(1), 2211.2(2) and 2211.2(3), by a factor of safety ( $\Omega$ ) of 2.5.

Where load and resistance factor design (LRFD) is used, the design shear value shall be determined by multiplying the nominal shear value, shown in Tables 2211.2(1), 2211.2(2) and 2211.2(3), by a resistance factor ( $\phi$ ) of 0.55.

**2211.2.2 Limitations for systems.** The lateral-resistant systems listed in Tables 2211.2(1), 2211.2(2) and 2211.2(3) shall conform to the following requirements:

1. Studs shall be a minimum  $1\frac{5}{8}$  inches (41.3 mm) by  $3\frac{1}{2}$  inches (89 mm) with a  $\frac{3}{8}$ -inch (9.5 mm) return lip. As a minimum, studs shall be doubled (back to back) at shear wall ends.
2. Track shall be a minimum  $1\frac{1}{4}$  inches (31.8 mm) by  $3\frac{1}{2}$  inches (89 mm).
3. Both studs and track shall have a minimum uncoated base metal thickness of 33 mils (0.84 mm) and shall be of the following grades of structural quality steel: ASTM A 653 SS Grade 33, ASTM A 792 SS Grade 33 or ASTM A 875 SS Grade 33.
4. Fasteners along the edges in shear panels shall be placed not less than  $\frac{3}{8}$  inch (9.5 mm) in from panel edges.
5. The height-to-width shear wall aspect ratio (*h/w*) of wall systems shall not exceed the values in Tables 2211.2(1), 2211.2(2) and 2211.2(3). Where the limiting ratio of *h/w* is greater than 2:1, the shear values shall be multiplied by  $2w/h$ .
6. Panel thicknesses shown are minimums. Panels less than 12 inches (305 mm) wide shall not be used. All panel edges shall be fully blocked.
7. Where horizontal strap blocking is used to provide edge blocking, it shall be a minimum  $1\frac{1}{2}$  inches (38 mm) wide and of the same material and equal or greater thickness as the track and studs.

8. The design shear values for shear panels with different nominal shear values applied to the same side of a wall are not cumulative except as permitted in Tables 2211.2(1), 2211.2(2) and 2211.2(3). For walls with material applied to both faces of the same wall, the design shear value of material of the same capacity is cumulative. Where the material nominal shear values are not equal, the design shear value shall be either two times the design shear value of the material with the smaller values or shall be taken as the value of the stronger side, whichever is greater. Summing shear values of dissimilar material applied to opposite faces or to the same wall line is not allowed unless permitted by Table 2211.2(1).

**2211.2.2.1 Sheet steel sheathing.** Steel sheets, attached to cold-formed steel framing, are permitted to resist horizontal forces produced by wind or seismic loads.

1. Steel sheets shall have a minimum base metal thickness as shown in Table 2211.2(1) or 2211.2(3), and shall be of the following grades of structural quality steel: ASTM A653 SS Grade 33, ASTM A792 SS Grade 33 or ASTM A 875 SS Grade 33.
2. Nominal shear values, used to establish the allowable shear value or design shear value, are given in Tables 2211.2(1) for wind loads and 2211.2(3) for seismic loads.
3. Steel sheets are permitted to be applied either parallel or perpendicular to framing. All edges of steel sheets shall be attached to framing members, strap blocking or shall be overlapped and attached to each other with screw spacing as required for edges.
4. Screws used to attach steel sheets shall be a minimum No. 8 modified truss head.

**TABLE 2211.2(1)  
NOMINAL SHEAR VALUES FOR WIND FORCES IN POUNDS PER FOOT FOR SHEAR WALLS  
FRAMED WITH COLD-FORMED STEEL STUDS<sup>a</sup>**

ASSEMBLY DESCRIPTION	MAXIMUM HEIGHT/LENGTH RATIO <i>h/w</i>	FASTENER SPACING AT PANEL EDGES <sup>b</sup> (inches)				MAXIMUM FRAMING SPACING (inches o.c.)
		6	4	3	2	
<sup>15</sup> / <sub>32</sub> -inch structural 1 sheathing (4-ply) plywood one side	2:1	1,065 <sup>c</sup>	—	—	—	24
<sup>7</sup> / <sub>16</sub> -inch rated sheathing (OSB), one side	2:1	910 <sup>c</sup>	1,410	1,735	1,910	24
<sup>7</sup> / <sub>16</sub> -inch rated sheathing (OSB), one side, oriented perpendicular to framing	2:1	1,020 <sup>c</sup>	—	—	—	24
<sup>7</sup> / <sub>16</sub> -inch rated sheathing (OSB), one side	4:1 <sup>d</sup>	—	1,025	1,425	1,825	24
0.018-inch steel sheet, one side	2:1	485	—	—	—	24
0.027-inch steel sheet, one side	4:1 <sup>d</sup>	—	1,000	—	—	24

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

- a. Nominal shear values shall be multiplied by the resistance factor ( $\phi$ ) to determine design strength or divided by the safety factor ( $\Omega$ ) to determine allowable shear values as set forth in Section 2211.2.1.
- b. Screws shall be attached to intermediate supports at 12 inches on center unless otherwise shown.
- c. Where fully blocked gypsum board is applied to the opposite side of this assembly, in accordance with Table 2211.2(2) with screw spacing at 7 inches o.c. edge and 7 inches o.c. field, these nominal values are permitted to be increased by 30 percent.
- d. Where aspect ratio (*h/w*) is greater than 2:1, the design shear shall be reduced as required by Section 2211.2.2, Item 5.

**TABLE 2211.2(2)  
NOMINAL SHEAR VALUES FOR WIND AND SEISMIC FORCES IN POUNDS PER FOOT FOR SHEAR WALLS  
FRAMED WITH COLD-FORMED STEEL STUDS AND FACED WITH GYPSUM BOARD<sup>a,b</sup>**

WALL CONSTRUCTION	MAXIMUM HEIGHT/LENGTH RATIO <i>h/w</i>	ORIENTATION	SCREW SPACING (inches)		NOMINAL SHEAR VALUE (plf)
			Edge	Field	
<sup>1</sup> / <sub>2</sub> -inch gypsum board on both sides of wall; Studs maximum 24 inches o.c.	2:1	Gypsum board applied perpendicular to framing with strap blocking behind the horizontal joint and with solid blocking between the first two end studs	7	7	585
			4	4	850

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

- a. Nominal shear values shall be multiplied by the resistance factor ( $\phi$ ) to determine design strength or divided by the safety factor ( $\Omega$ ) to determine allowable shear values as set forth in Section 2211.2.1.
- b. Walls resisting seismic loads shall be subject to the limitations in Section 1617.6.

**TABLE 2211.2(3)  
NOMINAL SHEAR VALUES FOR SEISMIC FORCES IN POUNDS PER FOOT FOR SHEAR WALLS  
FRAMED WITH COLD-FORMED STEEL STUDS<sup>a</sup>**

ASSEMBLY DESCRIPTION	MAXIMUM HEIGHT/LENGTH RATIO $h/w$	FASTENER SPACING AT PANEL EDGES <sup>b</sup> (inches)				MAXIMUM FRAMING SPACING (inches o.c.)
		6	4	3	2	
<sup>15</sup> / <sub>32</sub> -inch Structural 1 Sheathing (4-ply) plywood one side	2:1 <sup>c</sup>	780	990	1,465	1,625	24
<sup>15</sup> / <sub>32</sub> -inch Structural 1 Sheathing (4-ply) plywood one side; end studs 0.043 inch minimum thickness	2:1	—	—	1,775	2,190	24
<sup>15</sup> / <sub>32</sub> -inch Structural 1 Sheathing (4-ply) plywood one side; all studs and track 0.043 inch minimum thickness	2:1	890	1,330	1,775	2,190	24
<sup>7</sup> / <sub>16</sub> -inch OSB one side	2:1 <sup>c</sup>	700	915	1,275	1,625	24
<sup>7</sup> / <sub>16</sub> -inch OSB one side end studs, 0.043 inch minimum thickness	2:1	—	—	1,520	2,060	24
0.018-inch minimum thickness steel sheet one side	2:1	390	—	—	—	24
0.027-inch minimum thickness steel sheet one side	2:1 <sup>c</sup>	—	1,000	1,085	1,170	24

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

- a. Nominal shear values shall be multiplied by the resistance factor ( $\phi$ ) to determine design strength or divided by the safety factor ( $\Omega$ ) to determine allowable shear values as set forth in Section 2211.2.1.
- b. Screws shall be attached to intermediate supports at 12 inches o.c. unless otherwise shown.
- c. In Seismic Design Category A, B and C the aspect ratio ( $h/w$ ) is permitted to be 4:1 where the design shear is reduced as required by Section 2211.2.2, Item 5.

**2211.2.2.2 Wood structural panel sheathing.**

Cold-formed steel framed wall systems, sheathed with wood structural panels, are permitted to resist horizontal forces produced by wind or seismic loads subject to the following:

1. Nominal shear values, used to establish the allowable shear value or design shear value, are given in Tables 2211.2(1), for wind loads, and 2211.2(3), for seismic loads.
2. Wood structural panels shall comply with DOC PS 1 or PS 2 and shall be manufactured using exterior glue.
3. Wood structural panels shall be attached to steel framing with flat-head self-drilling tapping screws with a minimum head diameter of 0.292 inch (8 mm).
4. Where <sup>7</sup>/<sub>16</sub>-inch oriented strand board (OSB) is specified, <sup>15</sup>/<sub>32</sub>-inch structural 1 sheathing (plywood) is permitted.
5. Structural panels are permitted to be applied either parallel or perpendicular to framing.
6. Increases of the nominal loads shown in Tables 2211.2(1) and 2211.2(3) shall not be permitted for duration of load as permitted in Chapter 23.

**2211.2.2.3 Gypsum board panel sheathing.**

Cold-formed steel framed wall systems, sheathed with gypsum board, are permitted to resist horizontal forces produced by wind or seismic loads subject to the following:

1. Nominal shear values, used to establish the allowable shear value or design shear value, are given in Table 2211.2(2).
2. The shear values listed in Table 2211.2(2) shall not be cumulative with the shear values of other materials applied to the same wall unless otherwise permitted herein.
3. The nominal shear values shown are for gypsum board that is applied to both sides of the wall.
4. Where gypsum board is only applied to one side of the wall, the nominal shear values shall be taken as one-half of the value shown.
5. Where gypsum board is applied perpendicular to studs, end joints of adjacent courses of gypsum board sheets shall not occur over the same stud.
6. Screws used to attach gypsum board shall be a minimum No. 6 in accordance with ASTM C 954.
7. Walls resisting seismic loads shall be subject to the limitations in Section 1617.6.

**2211.3 Type II shear walls.** Type II shear walls sheathed with wood structural panels or sheet steel are permitted to resist wind and seismic loads when designed in accordance with this section. Type II walls shall meet the requirements for Type I walls except as revised by this section.

**2211.3.1 Limitations.** The following limitations shall apply to the use of Type II shear walls:

1. A Type II shear wall segment, meeting the minimum aspect ratio ( $h/w$ ) of Section 2211.3.2, Item 3, shall be located at each end of a Type II shear wall. Openings shall be permitted to occur beyond the ends of the Type II shear wall; however, the width of such openings shall not be included in the width of the perforated shear wall.
2. In Seismic Design Categories B, C, D, E and F, the nominal shear values shall be based upon edge screw spacing not less than 4 inches o.c.
3. A Type II shear wall shall not have out-of-plane (horizontal) offsets. Where out-of-plane offsets occur, portions of the wall on each side of the offset shall be considered as separate perforated shear walls.
4. Collectors for shear transfer shall be provided through the full length of the Type II shear wall.
5. A Type II shear wall shall have uniform top of wall and bottom of wall elevations. Type II shear walls not having uniform elevations shall be designed by other methods.
6. Type II shear wall height,  $h$ , shall not exceed 20 feet (6096 mm).

**2211.3.2 Type II shear wall resistance.** The Type II shear wall resistance shall be equal to the adjusted shear resistance multiplied by the sum of the widths ( $\Sigma L_i$ ) of the Type II shear

wall segments and shall be calculated in accordance with the following:

1. The percent of full-height sheathing shall be calculated as the sum of widths ( $\Sigma L_i$ ) of Type II shear wall segments divided by the total width of the Type II shear wall including openings.
2. The maximum opening height ratio shall be calculated by dividing the maximum opening clear height by the shear wall height,  $h$ .
3. The unadjusted shear resistance shall be the design shear values calculated in accordance with Section 2211.2.1 based upon the values in Tables 2211.2(1) and 2211.2(3). The aspect ratio of all Type II shear wall segments used in calculations shall not exceed 2:1.

**Exception:** Where permitted by Tables 2211.2.1(1) and 2211.2(3), the aspect ratio ( $h/w$ ) of Type II wall segments greater than 2:1, but in no case greater than 4:1, is permitted to be included in the calculation of the unadjusted shear resistance for the wall, provided the values are multiplied by  $2w/h$ .

4. The adjusted shear resistance shall be calculated by multiplying the unadjusted shear resistance by the shear resistance adjustment factors of Table 2211.3. For intermediate percentages of full-height sheathing, the values are permitted to be determined by interpolation.

**2211.3.3 Anchorage and load path.** Design of Type II shear wall anchorage and load path shall conform to the requirements of this section, or shall be calculated using principles of mechanics.

**2211.3.3.1 Anchorage for in-plane shear.** The unit shear force,  $v$ , transmitted into the top and out of the base of the Type II shear wall full-height sheathing segments,

**TABLE 2211.3  
SHEAR RESISTANCE ADJUSTMENT FACTOR— $C_o$**

WALL HEIGHT ( $h$ )	MAXIMUM OPENING HEIGHT RATIO <sup>a</sup> AND HEIGHT				
	$h/3$	$h/2$	$2h/3$	$5h/6$	$h$
8'0"	2'8"	4'0"	5'4"	6'8"	8'0"
10'0"	3'4"	5'0"	6'8"	8'4"	10'0"
Percent full-height sheathing <sup>b</sup>	Shear Resistance Adjustment Factor				
10%	1.00	0.69	0.53	0.43	0.36
20%	1.00	0.71	0.56	0.45	0.38
30%	1.00	0.74	0.59	0.49	0.42
40%	1.00	0.77	0.63	0.53	0.45
50%	1.00	0.80	0.67	0.57	0.50
60%	1.00	0.83	0.71	0.63	0.56
70%	1.00	0.87	0.77	0.69	0.63
80%	1.00	0.91	0.83	0.77	0.71
90%	1.00	0.95	0.91	0.87	0.83
100%	1.00	1.00	1.00	1.00	1.00

a. See Section 2211.3.2, item 2.

b. See Section 2211.3.2, item 1.

and into collectors (drag struts) connecting shear wall segments, shall be calculated in accordance with the following:

$$v = \frac{V}{C_o \Sigma L_i} \quad \text{(Equation 22-1)}$$

where:

- $v$  = Unit shear force, plf (kN/m).
- $V$  = Shear force in Type II shear wall, lbs (kN).
- $C_o$  = Shear resistance adjustment factor from Table 2211.3.
- $\Sigma L_i$  = Sum of widths of Type II shear wall segments, feet (mm/1,000).

**2211.3.3.2 Uplift anchorage at Type II shear wall ends.** Anchorage for uplift forces due to overturning shall be provided at each end of the Type II shear wall. Where seismic loads govern, the uplift anchorage shall be determined in accordance with the requirements of Section 2211.4.3.

**2211.3.3.3. Uplift anchorage between Type II shear wall ends.** In addition to the requirements of Section 2211.3.3.1, Type II shear wall bottom plates at full-height sheathing shall be anchored for a uniform uplift force,  $t$ , equal to the unit shear force,  $v$ , determined in Section 2211.3.3.1.

**2211.3.3.4. Compression chords.** Vertical elements at each end of each Type II shear wall segment shall be designed for a compression force,  $C$ , from each story calculated in accordance with the following:

$$C = \frac{Vh}{C_o \Sigma L_i} \quad \text{(Equation 22-2)}$$

where:

- $C$  = Compression chord uplift force, lbs (kN).
- $V$  = Shear force in Type II shear wall, lbs (kN).
- $h$  = Shear wall height feet, (mm/1,000).
- $C_o$  = Shear resistance adjustment factor from Table 2211.3.
- $\Sigma L_i$  = Sum of widths of Type II shear wall segments, feet (mm/1,000).

**2211.3.3.5. Load path.** A load path to the foundation shall be provided for the uplift shear and compression forces as determined from Sections 2211.3.3.1 through 2211.3.3.4, inclusive. Elements resisting shear wall forces contributed by multiple stories shall be designed for the sum of forces contributed by each story.

#### 2211.4 Seismic Design Categories D, E and F.

**2211.4.1 General.** In addition to the requirements of Sections 2211.2 and 2211.3, light-framed cold-formed steel wall systems, that resist seismic loads, in buildings assigned to Seismic Design Category D, E or F, shall comply with the requirements of this section.

**2211.4.2 Connections.** Connections for diagonal bracing members, top chord splices, boundary members and collectors shall be designed to develop the lesser of the nominal

tensile strength of the member or the design seismic force multiplied by the seismic overstrength factor,  $\Omega_o$ , from Section 1617.6. The pull-out resistance of screws shall not be used to resist design seismic forces.

**2211.4.3 Anchorage of braced wall segments.** Studs or other vertical boundary members at the ends of wall segments, that resist seismic loads, braced with either sheathing or diagonal braces, shall be anchored such that the bottom track is not required to resist uplift by bending of the track web. Both flanges of the studs shall be braced to prevent lateral torsional buckling. Studs or other vertical boundary members and anchorage thereto shall have the nominal strength to resist design seismic force multiplied by the seismic overstrength factor,  $\Omega_o$ , from Section 1617.6.

**2211.4.4 Sheet steel sheathing.** Where steel sheathing provides lateral resistance, the design and construction of such walls shall be in accordance with the additional requirements of this section. Perimeter members at openings shall be provided and shall be detailed to distribute the shearing stresses. Wall studs and track shall have a minimum uncoated base metal thickness of 33 mils (0.84 mm) and shall not have an uncoated base metal thickness greater than 48 mils (1.10 mm). The nominal shear value for light-framed wall systems for buildings in Seismic Design Category D, E or F shall be based upon values from Table 2211.2(3).

**2211.4.5 Wood structural panel sheathing.** Where wood structural panels provide lateral resistance, the design and construction of such walls shall be in accordance with the additional requirements of this section. Perimeter members at openings shall be provided and shall be detailed to distribute the shearing stresses. Wood sheathing shall not be used to splice these members. Wall studs and track shall have a minimum uncoated base metal thickness of 33 mils (0.84 mm) and shall not have an uncoated base metal thickness greater than 48 mils (1.10 mm). The nominal shear value for light-framed wall systems for buildings in Seismic Design Category D, E or F shall be based upon values from Table 2211.2(3).

**2211.4.6 Diagonal bracing.** Where diagonal bracing is provided for lateral resistance, provisions shall be made for pretensioning or other methods of installing tension-only bracing shall be used to guard against loose diagonal straps. The  $l/r$  of the brace is permitted to exceed 200.

**2211.4.7 Gypsum board panel sheathing.** Gypsum board panel sheathing is permitted to resist seismic loads, subject to the limitations in Table 2211.2(2) and Section 1617.6.