DECORATIVE INTERIOR WALL PANEL FACING SYSTEM from WALL PANEL SYSTEMS, INC. (WPS)

The wall panel system analyzed herein is comprised of colored and textured panels of homogenous phenolic composites. Panels are fabricated to various modular dimensions to fit interior wall height and length constraints.

Extruded Aluminum alloy clips and rails manufactured by Wall Panel Systems Inc. (WPS) are mounted on non-structural interior wall partitions and to panel assemblies with steel screw fasteners. Fasteners include commercially available steel self-tapping screws, wood screws, machine screws and concrete screws.

The panel wall elements, anchorage, and assemblies are evaluated for vertical and lateral load resistance under the California Building Code (CBC) and International Building Code (IBC) as non-structural architectural finish components. The following is an analysis of the design seismic and gravity forces affecting typical wall panel assembly connections between the respective panel materials and the supporting partition walls.

Panel System:

The decorative wall panel assembly is mounted on interior wall partitions of cold formed steel framing and gypsum wall sheathing. Panel assemblies may be mounted on solid grouted, reinforced concrete masonry unit (CMU) partition walls. Partitions supporting the panel assemblies are collectively known as backing. Panels are grouped in modular patterns and assembled with the edges fastened to extruded aluminum edge rails, mid-panel rails, corner rails and clips. The panels and aluminum alloy components are collectively fastened as an assembly to the partition wall backing.

Connections between the decorative panels, aluminum connectors, and partition backing are made using various screw fasteners. Fasteners consist of galvanized steel self-drilling tapping screws, zinc-coated steel machine screws, wood screws, or sheet metal screws, as appropriate. Attachment of panel assemblies to CMU backing is accomplished by use of concrete screws set in drilled holes.

Panel Connection Spacing:

Typical wall connection spacing is given to occur at 24 inch o.c. maximum horizontally. This is the typical maximum horizontal spacing for partition wall studs in commercial applications. Vertical connections are analyzed for a 34 inch o.c. maximum spacing. (This is h/3 for an 8 foot wall height & h/4 for a 12 foot wall height). Panel edge connections to wall panel assemblies occur at the tops, bottoms and all vertical panel edges of partition walls. Panel material properties are referenced elsewhere in this document. Modular panel sizes vary according to the interior dimensions of the surface being faced. For the purposes of connection analysis we will base our calculations on panel dimensions that will result in a typical maximum area tributary to an individual panel to backing connection based upon dimensions of the supporting backing partitions.

5.67 sq. ft. = Typical maximum tributary area per connection = (24 in)(34 in)/ (12 in/ft)^2.

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Panel System Unit Dead Loads (DL) per square foot (psf) are listed below. Each system is comprised of decorative panels, alloy components, and fasteners that collectively comprise each panel assembly.

4.0 psf DL = Phenolic Composite, 1/2 in thick, Nominal DL for wall panel assembly.
3.0 psf DL = Phenolic Composite, 3/8 in thick, Nominal DL for wall panel assembly.

Tributary Dead Loads per connection for various Panel Assemblies:

22.7 lbs = 1/2 in. Phenolic Composite Panel Assembly Tributary DL = (5.67 sq.ft)(4.0 psf)
17.0 lbs = 3/8 in. Phenolic Composite Panel Assembly Tributary DL = (5.67 sq.ft)(3.0 psf)

Therefore for system consistency we will analyze various connections based upon the maximum values each connection will likely support utilizing similarly sized fasteners for the various panel materials:

Use 22.7 lbs per connection tributary panel DL for design of machine screw connections.
Use 22.7 lbs per connection tributary panel DL for design of Panel assembly to backing connections.

Inverted Sloping Panel applications: Panel connections have been analyzed for inverted sloping wall applications, including ceiling applications.

Each panel assembly consists of: Modular Panels, Extruded aluminum alloy clips or rails fastened to each panel at its vertical edges, top panel edges, bottom panel edges, and at mid-wall horizontal rails spaced at 34 inches o.c. maximum. Aluminum alloy edge rails, trim rails, horizontal joint receiver rails, and corner rails are connected to partition wall backing with galvanized steel self-drilling tapping screws conforming to AISI Standard for cold formed steel framing. An alternative backing may include reinforced concrete masonry unit walls (CMU). In this case, aluminum alloy rails are fastened to the CMU backing with hardened steel concrete screws set in drilled holes. Aluminum alloy panel clips and midwall clips are connected to decorative phenolic wall panels with zinc-coated steel machine screws.

Rails, edges, and trim pieces are connected to each other with lapped fitted joints and fitted tongue and groove slots. Aluminum alloy clips and midwall clips are connected to phenolic wall panels with two panel fasteners (machine screws) per clip rail.

ALUMINUM ALLOY CLIPS, RAILS, AND TRIM FOR PHENOLIC PANEL SYSTEMS ARE AS FOLLOWS:
SHADOWLINE SYSTEM
Panel Clip (Gen-002),
Edge Trim (SHA-101),
Vertical Joint (SHA-110),
Horizontal Joint (SHA-120),
Outside Corner Radius (SHA-130) ,
Outside Corner Square (SHA-131) ,
Outside Corner Open (SHA-132) ,
Inside Corner (SHA-140) ,
Edge Radius (SHA-102),
Mitered Outside Corner (SHA-139)
Vertical Joint (SHA-112),
Horizontal Joint (SHA-122),
Midwall Clip (GEN-013)
Top Edge (UAS-202).

OPEN REVEAL SYSTEM
Panel Clip (Gen-002),
Edge Trim (ORS-103),
Vertical Joint (ORS-111.1),
Horizontal Joint (GEN-121),
Horizontal Joint (ORS-121),
Outside Corner Receiver (CAP-133) ,
Outside Corner Cap Small (CAP-134) ,
Open Outside Corner (ORS-138) ,
Outside Corner Cap Large (CAP-135) ,
Inside Corner (ORS-141)
Top Edge (UAS-202)

CAPTURED SYSTEM
Panel Clip (Gen-002),
Edge Trim (ORS-103),
Edge Insert (ORS-150),
Vertical Joint (ORS-111),
Joint Insert (CAP-151),
Horizontal Joint (ORS-121),
Outside Corner Receiver (CAP-133) ,
Outside Corner Cap Small (CAP-134) ,
Outside Corner Cap Large (CAP-135) ,
Inside Corner (ORS-141)
Edge Insert (CAP-150),
J Edge Trim (CAP-105),
Edge Radius Return (CAP-104),
Top Edge (UAS-202).

CLEAN ROOM SYSTEM
Panel Clip (Gen-002),
Edge (CAP-103),
Rubber Edge Insert (RUB-170),
Vertical Joint (CAP-111),
Rubber Vertical Joint (RUB-171),
Horizontal Joint (CAP-121),
Rubber Horizontal Joint (RUB-172),
Outside Corner Receiver (CAP-133) ,
Outside Corner Cap Small (CAP-134) ,
Outside Corner Cap Large (CAP-135) ,
Inside Corner (CAP-141)
Rubber Edge Insert (RUB-170),
Top Edge (UAS-202).

IBC 2009/CBC 2010 - Allowable Stress Design (ASD), out of plane seismic force for vertical wall panel assembly attached to steel framing, per ASCE 7-05, Sec 13.3.1:

Lateral loads for out of plane seismic forces are evaluated as normal to the wall panel face, and for the vertical seismic force component in addition to gravity. Lateral analysis will be done under allowable stress design for non-structural components per IBC 2009/CBC 2010.

a_p = 1.0 per Table 13.5-1 S_{DS} = 1.373 most severe locale W_p = 22.7 lb Tributary DL (1/2 in. Phenolic)

I_p = 1.0 per Sec.13.1.3, ASCE R_p = 2.5 per 13.5-1 ASCE Z_{max} = 12 ft h_{max} = 12 ft

For PHENOLIC PANELS:

Eq. 13.3-1 $$F_p = 15.0 \text{ lbs} = \frac{(0.4)(a_p)(S_{DS})(W_p)}{(R_p / I_p)} [1 + (2)(Z/h)] = \frac{(12.5)}{(2.5)} [3]$$

Eq. 13.3-2 $$\text{max. } F_p = 49.9 \text{ lbs} = (1.6)(S_{DS})(W_p)(I_p)$$

Eq. 13.3-2 $$\text{min. } F_p = 9.4 \text{ lbs} = (0.3)(S_{DS})(W_p)(I_p)$$

Therefore, F_p = 49.9 lbs = PHENOLIC Maximum Horizontal Out of Plane Seismic force / connection, perpendicular to panel face, from any direction, in the most severe locale.

Vertical Concurrent force = (DL) +/- [(0.2)(S_{DS})(W_p)] = (22.7 lb) +/- [6.2 lb per connection]

PHENOLIC - Vertical Concurrent (gravity + seismic) forces = 28.9 lb max, or 16.5 lb min.

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Sloping PHENOLIC ½" Thick Wall Panel Assemblies – APPLIED LOAD ANALYSIS
Applied Loads per fastener, Dead Loads and Seismic (values in pounds).

		#8 Self Tapping Screw		# 8 Wood Screw		#8 Machine screw	
Wall Angle	**Load Type**	**Shear**	**Tension**	**Shear**	**Tension**	**Shear**	**Tension**
Degrees from level							
90 (Vert. Wall)	Normal	**22.7**	0	**11.4**	0	**11.4**	0
	Seismic	28.9	49.9	14.5	25.0	14.5	25.0
70	Normal	21.3	7.8	10.7	3.9	10.7	3.9
	Seismic	44.2	56.3	22.1	28.2	22.1	28.2
60	Normal	19.7	11.4	9.9	5.7	9.9	5.7
	Seismic	50.1	**57.7**	25.1	**28.9**	25.1	**28.9**
45	Normal	16.1	16.1	8.0	8.0	8.0	8.0
	Seismic	55.8	55.8	27.9	27.9	27.9	27.9
30	Normal	11.4	19.7	5.7	9.9	5.7	9.9
	Seismic	**57.7**	50.1	**28.9**	25.1	**28.9**	25.1
0 (flat - Horiz.)	Normal	0	**22.7**	0	**11.4**	0	**11.4**
	Seismic	49.9	28.9	25.0	14.5	25.0	14.5

Load Summary: IBC 2009/CBC 2010
Sloping PHENOLIC ½" Thick Wall Panel Assemblies
Dead Loads and Seismic for all sloping configurations. (values in pounds).

MAXIMUM APPLIED LOADS PER FASTENER

		#8 Self Tapping Screw		# 8 Wood Screw		#8 Machine screw	
	Load Type	**Shear**	**Tension**	**Shear**	**Tension**	**Shear**	**Tension**
Use for Design of Connections	**Normal**	**22.7**	**22.7**	**11.4**	**11.4**	**11.4**	**11.4**
	Seismic	**57.7**	**57.7**	**28.9**	**28.9**	**28.9**	**28.9**

INTERACTION ANALYSIS – COMBINED SHEAR / TENSION

Seismic force acts perpendicular (out-of-plane) in tension on fastener – panel connection.
Gravity + vertical component of seismic force acts in shear.
Combined forces interaction for the limiting connection: Phenolic Panel to Panel Fastener.

V_a = 258 lbs = Allowable Seismic Shear / panel backing screw connection = (193)(1.33).
P_a = 113 lbs = Allowable Tension Wall Panel to Panel Fastener connection = (85)(1.33).
P_s = 57.7 lbs = Maximum Applied Seismic out of plane tension per connection.
V_{G+S} = 28.9 lbs = Applied gravity + vertical seismic component per connection.

$$\frac{V_{G+S}}{V_a} + \frac{P_s}{P_a} = \frac{28.9}{258} + \frac{57.7}{113} = 0.11 + 0.51 = 0.62 < 1.0, \text{ OK}$$

Interaction Analysis indicates weakest connection link is adequate for most severe load condition (2009 IBC / 2010 CBC).

ANALYSIS OF SEISMIC LOAD APPLIED causing PRYING ACTION ON HORIZONTAL JOINT RECEIVER RAIL FASTENERS and EDGE RAIL FASTENERS – Vertical Wall condition.

Refer to typical connection drawing details "A" & "E" of Typical Connection Diagrams for Extruded Aluminum Rails and Clips, following these calculations.

Horizontal (Out of plane) force To wall fastener (self drilling tapping screws) at steel stud, Base Edge Trim Rail, maximum of 29.0 lbs per screw connection.

$$\frac{(28.9 \text{ lb})(2.25 \text{ in})}{(0.85 \text{in})} = 76.5 \text{ lb tension in wall fasteners at backing} < 113 \text{ lb allowable seismic tension}$$

Apply horiz. force to Wall fasteners at steel studs lb along Horiz. Joint Receiver

$$\frac{(57.7 \text{ lb})(2.6 \text{ in})}{(1.9 \text{ in})} = \mathbf{79.0\ lb} \quad \text{or} \quad \frac{(57.7)(1.9)}{(1.4)} = 78.3 \text{ lb tension in fastener at backing (max)} < 113 \text{ lb allowable tension}$$

Vertical component of seismic force plus gravity per screw connection at Base Edge Rail horiz to backing fastener

$$\frac{(28.9 \text{ lb})(0.70 \text{ in})}{(0.75 \text{ in})} = 27.0 \text{ lb} < 113 \text{ lb}$$ Allowable seismic in backing fastener

Vertical component of seismic force plus gravity per screw connection at Horizontal joint

$$\frac{(28.9 \text{ lb})(0.70 \text{ in})}{(0.75 \text{ in})} = 27.0 \text{ lb} < 113 \text{ lb}$$ Allowable seismic in backing

Receiver at backing fastener fastener

ANALYSIS OF SEISMIC LOAD APPLIED causing PRYING ACTION ON MIDWALL HORIZONTAL JOINT RAIL FASTENERS and EDGE RAIL FASTENERS – Horizontal (Ceiling or soffit) Installation.

Refer to typical connection drawing details "A" & "E", rotated 90 degrees, of Typical Connection Diagrams for Extruded Aluminum Rails and Clips, following these calculations.

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Vertical (Out of plane force) For Horizontal Joint Receiver Rail (UAS 220) max. of 58.0 lbs per screw connection.

$$\frac{(28.9\ \text{lb})(2.6\ \text{in})}{(1.20\ \text{in})} = 62.6\ \text{lb tension in wall fastener at backing} < 113\ \text{lb allowable seismic tension}$$

Apply vertical force to Wall fastener screw at backing.

$$\frac{(28.9\ \text{lb})(2.25\ \text{in})}{(0.85\ \text{in})} = 76.5\ \text{lb tension in wall fastener at backing} < 113\ \text{lb allowable seismic tension}$$

Vertical component of seismic force plus gravity per 2 screw connection at edge rail backing.

$$\frac{(28.9\ \text{lb})(0.70\ \text{in})}{(0.75\ \text{in})} = 27.0\ \text{lb tension} < 113\ \text{lb}$$ Allowable seismic in backing fastener

Vertical component of seismic force plus gravity per screw connection at horiz. joint rail.

$$\frac{(57.7\ \text{lb})(0.70\ \text{in})}{(0.75\ \text{in})} = 53.8\ \text{lb tension} < 113\ \text{lb}$$ Allowable seismic in backing fastener

CONNECTION SUMMARY	**Calculated Load Capacity Between Elements**		
Typical Panel Assembly ELEMENT	**PULLOUT (lbs)**	**SHEAR (lbs)**	**CLIP SHEAR (lbs)**
3/8 in thick Phenolic Composite Panel			
Normal	**225**	**124**	
Seismic	**299**	**165**	
Panel fasteners – (2) #8 x 1/2 in machine screws			
Normal	425	232	
Seismic	565	308	
Panel Clip (Gen 002)			
1/2 in thick Phenolic Composite Panel			
Normal	**225**	**165**	
Seismic	**299**	**219**	
Panel fastener – (2) #8 x 5/8 in machine screws			
Normal	425	232	
Seismic	565	308	
Panel Clip (Gen 002)			

CONNECTION SUMMARY **Calculated Load Capacity Between Elements**

ELEMENT	**PULLOUT (lbs)**	**SHEAR (lbs)**	**CLIP SHEAR (lbs)**
Panel Clip (Gen 002)			320 Normal 425 Seismic
Horizontal Joint Rails (SHA-120, SHA-R-122, ORS-121, CAP-121)			82 Normal #8 109 Seismic #8 95 Normal #10 126 Seismic #10
Midwall Clip (GEN-013)			82 Normal 109 Seismic 95 Normal #10 126 Seismic #10
Edge Trim Rails (SHA-101, ORS-103, CAP-103, UAS-202) Corner Rails (SHA-132, SHA-130, SHA-131, SHA-136, SHA-102, SHA-140, CAP-133, ORS-141, ORS-138, CAP-141)			164 Normal 218 Seismic

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Horizontal Joint Rails
Edge Trim Rails
Midwall Clip

	Normal	85	194
	Seismic	113	258

Backing – 20 ga (39 mil) Cold Formed Steel Stud Wall; Fasteners- #8 x 1-1/2 inch self-drilling screw

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Horizontal Joint Rails
Edge Trim Rails
Midwall Clip

	Normal	99	209
	Seismic	132	278

Backing – 20 ga (39 mil) Cold Formed Steel Stud Wall; Wall fasteners - # 10 x 2 inch self-drilling screw

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Horizontal Joint Rails, Edge Trim Rails , Midwall Clips

	Normal	150	250
	Seismic	200	333

Backing – Reinforced Concrete Masonry (CMU) // Fasteners – 1/4 x 1-1/2 in TITEN TTN CMU Screw

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MATERIAL PROPERTIES: Material property allowable stresses that follow are for normal duration of load. For Seismic Loads; these values are increased by 1/3 (1.33), except for Modulus of Elasticity "E".

ALUMINUM ALLOY FOR EXTRUDED PANEL CLIPS, MIDWALL CLIP RAILS, HORIZONTAL EDGE RAILS, VERTICAL EDGE RAILS, AND CORNER EDGE RAILS

Values are for extruded Aluminum alloy 6063-T5, no welds or welded joints, as per the Aluminum Association, Inc, datasheet available on www.matweb.com

SG = 2.7	Specific Gravity	DD = 168.5 pcf	Dry Density

Design Working Stress (normal loading conditions)

F_v = 17 ksi	Horizontal Shear stress	F_b = 12 ksi	Bending Stress
F_y = 21 ksi	Tensile (yield) strength	F_p = 8 ksi	Bearing stress
E = 10×10^3 ksi	Modulus of Elasticity		

COLD FORMED GALVANIZED STEEL WALL FRAMING (Wall partitions; sill plate, wall studs & top plates)

Values per AISI Specification – Prescriptive Method – 2004 Commentary

Galvanized cold formed steel framing – 20 gauge (39 mil) = 0.396 in thick
22 gauge (33 mil) = 0.336 in thick

SG = 7.9	Specific Gravity	DD = 490 pcf	Dry Density

Design Working Stress (normal loading conditions)

F_y = 33 ksi	Yield Strength	E = 29×10^3 ksi	Modulus of Elasticity

SOLID PHENOLIC COMPOSITE WALL PANELS – 1/4 in, 5/16 in, 3/8 in, & 1/2 in thicknesses.

Values for allowable stresses as per Material Property Data Sheets available online for phenolic wall panels fabricated for interior applications comprised of 5/16 in or 3/8 in thicknesses.

SG = 1.42	Specific Gravity	DD = 88.3 pcf	Dry Density

Design Working Stresses (for normal loading conditions)

F_b = 12.0 ksi	Bending (Flexural) Stress	
F_c = 2.0 ksi	Compression stress	[estimated @ (0.2)(F_t)]
F_v = 1.0 ksi	Horizontal Shear stress	[estimated @ (0.1)(F_t)]
F_t = 10.1 ksi	Tensile strength	
E = 1.3×10^3 ksi	Modulus of Elasticity	
450 lbs	Pullout strength/screw	[(2000 N / 4.448 lb per N) @ 0.24 in depth]

1/4 in thick Panel Dead Load (DL) = 1.84 PSF = [88.3 pcf x (0.25 in / 12 in per ft)].
5/16 in thick Panel Dead Load (DL) = 2.30 PSF = [88.3 pcf x (0.3125 in / 12 in per ft)].
3/8 in thick Panel Dead Load (DL) = 2.76 PSF = [88.3 pcf x (0.375 in / 12 in per ft)].
1/2 in thick Panel Dead Load (DL) = 3.68 PSF = [88.3 pcf x (0.50 in / 12 in per ft)].

2.2 PSF, DL = 1/4 in. thick Phenolic Composite Panel Assembly Design DL – Weight with clips.
2.6 PSF, DL = 5/16 in. thick Phenolic Composite Panel Assembly Design DL–Weight with clips.
3.0 PSF, DL = 3/8 in. thick Phenolic Composite Panel Assembly Design DL – Weight with clips.
4.0 PSF, DL = 1/2 in. thick Phenolic Composite Panel Assembly Design DL – Weight with clips.

ALLOWABLE SHEAR - ALUMINUM ALLOY EXTRUDED CLIPS AND RAILS SUBJECT TO LOADS:
Clip and rail material: Extruded Aluminum alloy 6063-T5, no welds or welded joints, as per the Aluminum Association, Inc, datasheet available on www.matweb.com
Calculated Shear assumes #8 fastener transfers load to Clips and Rails.

PANEL CLIP (GEN 002)
160 lbs = Shear Allowable, normal, per fastener, **Panel clips** = (0.164 in) (0.122)(8 ksi)(1000 lbs/k)
320 lbs = Shear Allowable, normal, per connection, **Panel clips** = (2)(0.164 in) (0.122)(8 ksi)(1000 lbs/k)
425 lbs = Seismic Shear Allowable load/connection on Panel clip = (320)(1.33) lbs,

EDGE TRIM RAILS (SHA-101, ORS-103, CAP-103, UAS-202)
CORNER RAILS (SHA-132, SHA-130, SHA-131, SHA-136, SHA-102, SHA-140, CAP-133, ORS-141, ORS-138, CAP-141)
82 lbs = Shear Allowable, normal, **Edge Trim & Corner Rails** per fastener = (0.164 in)(0.0625)(8 ksi)(1000 lbs/k)
109 lbs = Seismic allowable shear load/connection on Edge & /Corner rails = (1.33)(82 lbs).

HORIZONTAL JOINT RAILS (SHA-120, SHA-R-122, ORS-121, CAP-121)
82 lbs = Shear Allowable, normal, per connection, **Horizontal Joint Rails** = (0.164 in)(0.0625)(8 ksi)(1000 lbs/k)
109 lbs = Seismic Shear Allowed, per connection, **Horizontal Joint Rails** = (1.33)(0.164 in)(0.0625)(8 ksi)(1000 lbs/k)

MIDWALL CLIP (GEN-013)
82 lbs = Shear Allowable, normal, per connection, Midwall Clip = (0.164 in)(0.0625)(8 ksi)(1000 lbs/k)
109 lbs = Seismic Shear Allowable, per connection, Midwall Clip = (1.33)(0.164 in) (0.0625)(8 ksi)(1000 lbs/k)

FASTENERS - ALLOWABLE TENSION & SHEAR : CONCRETE MASONRY UNIT (CMU) SCREWS
1/4 in dia. Simpson TITEN Concrete &Masonry Screws (TTN). Material: Heat Treated Carbon Steel
Florida FL 2355.1 Report: Allowable tension / screw = 740 lbs. Allowable Shear / screw = 1242 lbs.
Using Factor of safety of 5.0 for installations under IBC.
Normal load tension / screw = 150 lbs. Seismic allowable tension / screw = 200 lbs = (150)(1.33) lbs.
Normal load shear / screw = 250 lbs Seismic allowable shear / screw = 332 lbs = (150)(1.33)lbs.
Using one 1/4 in dia, 1-1/2 in long screw / connection of clip rails or edging to wall backing (1-1/4 in embedment in CMU :
150 lbs = Tension, Normal Allowable load (pullout) / connection
200 lbs = Tension, Seismic Allowable load (pullout) / connection
250 lbs = Shear, Normal Allowable load / connection
332 lbs = Shear, Seismic Allowable load / connection

FASTENERS – SELF DRILLING TAPPING SCREWS – SCREW CAPACITY IN 20 GA STEEL WALL FRAMING.
AISI STANDARD "Commentary on the Standard for Cold-Formed Steel Framing -Prescriptive Method ", 2001 Edition, with2004 Supplement. Given below is Table C-B1, from Section B, "CONNECTIONS",

Table C-B1
Minimum Allowable Fastener Capacity for Steel-to-Steel Connections
[Safety factor = 3.0]

Screw Size	Minimum Shank Diameter (inch)	Minimum Head Diameter (inch)	Minimum Capacity (lbs)			
			Shear Capacity		Pullout Capacity	
			43 mils[1]	33 mils[1]	43 mils[1]	33 mils[1]
#8	0.164	0.322	244	164	94	72
#10	0.190	0.384	263	177	109	84

For SI: 1 inch = 25.4 mm, 1 lb = 4.448 N.
[1] The value represents the smaller thickness of two pieces of steel being connected.
From the values given in Table C-B1 above:

ALLOWABLE LOADS PER SCREW:
One #8 screw, set in 22 ga (33 mil) steel stud framing has:
Allowable normal load tension (pullout) of 72 lbs. Allowable seismic tension =97.8 lbs = (1.33) (72 lbs).
Allowable normal load shear of 164 lbs. Allowable seismic shear = 218.1 lbs = (1.33) (164 lbs)
Similarly, one #8 screw set in 20 ga (39 mil) steel stud framing, interpolating for thickness, we get:
Tension, normal allowable load (pullout) of 85.1 lbs = (39 mil / 33 mil) (72 lbs).
Tension, seismic allowable = 113.2 lbs = (1.33) (85.3 lbs).
Shear, normal allowable load of 193.8 lbs = (39 mil / 33 mil)(164 lbs),
Shear, seismic allowable = 257.8 lbs = (1.33) (193.8 lbs),
Similarly, one #10 screw set in 20 ga (39 mil) steel stud framing, interpolating for thickness, we get:
Tension, normal allowable load (pullout) of 99.3 lbs = (39 mil / 33 mil) (84 lbs).
Tension, seismic allowable = 132 lbs = (1.33) (99.3 lbs).
Shear, normal allowable load of 209.2 lbs = (39 mil / 33 mil)(177 lbs),
Shear, seismic allowable = 278 lbs = (1.33) (209.2 lbs),

ALLOWABLE LOADS - ONE #8 SCREW PER CONNECTION (20 ga):
Tension, normal allowable load (pullout)/connection = 85.1 lbs.
Tension, seismic allowable / connection = 113.2 lbs.
Shear, normal allowable load / connection = 193.8 lbs,
Shear, seismic allowable / connection = 257.7 lbs,

ALLOWABLE LOADS - ONE #10 SCREW PER CONNECTION (20 ga):
Tension, normal allowable load (pullout) / connection = 99.3 lbs.
Tension, seismic allowable /per connection = 132 lbs.
Shear, normal allowable load /connection = 209.2 lbs,

Shear, seismic, allowable /connection = 278 lbs,
FASTENER ALLOWABLE TENSION : MACHINE SCREWS

ALLOWABLE TENSION & SHEAR – WORKING STRENGTH & SHANK DIAMETER:
#8x32 machine screws for this connection are per the requirements of ANSI & ASME Standards.
Tensile Strength of screws = 60 ksi. Shank diameter = 0.164 in.
Tension allowable / screw = 850 lbs. Using Factor of safety of 4.0.
Tension, normal working load per screw = 212.5 lbs = 850/4.
Tension, Seismic load allowable per screw = 282.6 lbs = (212.5)(1.33) lbs.
Shear, normal working load per screw = 127.0 lbs = (212.5)(0.6) lbs
Shear, seismic load allowable per screw = 169.5 lbs = (282.6)(0.6)lbs.

When we use two #8 x 32 screws, per connection :
Tension, normal allowable load (pullout)/connection = 425 lbs.
Tension, seismic allowable/connection = 565 lbs.
Shear, normal allowable load / connection = 254 lbs,
Shear, seismic allowable load / connection = 339 lbs.

MACHINE SCREW - ALLOWABLE SHEAR - HORIZONTAL JOINT RAIL & PANEL CLIP CAPACITY:
Per NDS-2005, table 11M; #8 screw in single shear, two member connection, metal side plates.
Metal side plate is Horizontal Joint Rails (0.0625 in thick).
Shear, Normal allowable lateral load / screw = 116 lbs,
Shear, seismic allowable lateral load / screw = 154.3 lbs = (1.33)(116 lbs).
Using 2 screws / connection:
Shear, Normal allowable lateral load / connection = 232 lbs,
Shear, seismic allowable lateral load / connection = 308.6 lbs = (1.33)(232 lbs).

SUMMARY: SHEAR CONNECTION CAPACITY OF MACHINE SCREWS IN PHENOLIC COMPOSITE PANELS
The governing values for this connection will be the lowest values of the conditions given above.
Use for design the following allowable fastener / material shear loads for the machine screw connection:
Shear, Normal allowable lateral load /screw = 116 lbs,
Shear, Seismic allowable lateral load /screw = 154 lbs = (1.33)(116 lbs).
Using 2 screws / connection:
Shear, Normal allowable lateral load /connection = 232 lbs,
Shear, Seismic allowable lateral load /connection = 308 lbs = (1.33)(232 lbs).

TENSION CAPACITY (PULLOUT) OF MACHINE SCREWS IN PHENOLIC COMPOSITE PANELS:

Use FS = 4 for working strength of screws in material and for capacity based upon fastener strength.
Machine screws based upon ASME B 1.1, with tensile strength of 60 ksi, #8-32 has a capacity of 850 lbs.
Allowable screw tension based upon screw tensile strength = 212.5 lb working strength.

Screw pullout capacity in phenolic panels is based upon Material Property Data Sheets available on www.trespa.com , www.wilsonart.com , www.formica.com , & others.

Pan head machine #8 -32 screw @ 450 lb pullout capacity for 0.236 in depth. [2000 N / 4.448 lb per N)]
Allowable screw tension based upon phenolic panel material = 112.5 lb working strength.

Effective thread length in screw = (thread length) – (thickness of Midwall Clip GEN-002).
Effective thread length in screw for tension = 0.378 in = (0.50 in) – (0.122 in). 0.378 in > 0.236 in, OK.
Therefore, Allowable machine screw tension = 112.5 lb.

Normal Loads: Allowable tension per screw = 112.5 lbs
Allowable tension per connection = 225 lbs = (112.5 lbs / screw)(2 screws / connection).

Seismic Loads: Allowable tension per screw = 149.6 lbs = (1.33)(112.5 lbs),
Allowable tension per connection = 299.2 lbs = (2)(149.6 lbs)

SHEAR (Bearing)CAPACITY OF MACHINE SCREWS IN PHENOLIC COMPOSITE PANELS:
1/2 inch machine screw. Effective screw bearing length in Phenolic panel = 0.378 in
= (0.50 in) – (0.122 in) = (Panel thickness) – (Clip thickness).
Effective bearing area on Phenolic panel = 0.062 sq in = (0.164 in)(0.378 in).
Normal Loads: Allowable Bearing/screw on Phenolic panel = 62 lbs = (1000 psi) (0.062 sq in),
Seismic Loads: Allowable Bearing/screw on Phenolic panel = 82.5 lbs = (1.33)(62 lbs).

5/8 inch machine screw. Effective screw bearing length in Phenolic panel = 0.503 in
= (0.625 in) – (0.122 in) = (Panel thickness) – (Clip thickness).
Effective bearing area on Phenolic panel = 0.083 sq in = (0.164 in)(0.503 in).
Normal Loads: Allowable Bearing/screw on Phenolic panel = 82.5 lbs = (1000 psi) (0.083 sq in),
Seismic Loads: Allowable Bearing/screw on Phenolic panel = 109.7 lbs = (1.33)(82.5 lbs).

1/2 inch machine screw (3/8 in thick panels) :
Normal Loads: Allowable Shear /connection = 124 lbs = (62 lbs/screw)(2 /connection),
Seismic Loads: Allowable Shear /connection = 165 lbs = (2)(165 lbs).

5/8 inch machine screw (1/2 in thick panels) :
Normal Loads: Allowable Shear /connection = 165 lbs = (82.5 lbs/screw)(2 /connection),
Seismic Loads: Allowable Shear /connection = 219.4 lbs = (2)(109.7 lbs).

ABBREVIATIONS / ACRONYMS

Abbreviation	MEANING
AF&PA	American Forest and Paper Association
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ASD	Allowable Stress Design
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
AWC	American Wood Council
CBC	California Building Code
CONN	Connection
DIA	Diameter
DL	Dead Load
E	Modulus of Elasticity
ESR	Evaluation Service Report
FT	Foot or Feet
FS	Factor of Safety
GA	Gauge
IBC	International Building Code
ICC-ES	International Code Council – Evaluation Service, Inc.
IN	Inch or Inches
K	Kip or Kips (1000 pounds per kip)
KSI	Kips per Square Inch
LB	Pound or Pounds (weight or force)
LL	Live Load
LVL	Laminated Veneer Lumber
MDF	Medium Density Fiberboard
MIL	Mils or 1/1000 of an inch
MM	Millimeters
MPa	MegaPascals
N	Newtons
NDS-2005	National Design Specification for Wood Construction, 2005 edition
SG	Specific Gravity
PCF	Pounds per Cubic Foot
PSI	Pounds per Square Inch
PSF	Pounds per Square Foot
SG	Specific Gravity (relative to water where SG of water = 1.00)
SQ FT	Square Feet
SQ IN	Square Inches
STD	Standard Number
UBC	Uniform Building Code
WPS	Wall Panel Systems, Inc .

REFERENCES:

American Institute of Architects (AIA), Architectural Graphic Standards, 7th Edition

American Institute of Steel Construction (AISC) - Steel Construction Manual, 8th Edition

American Institute of Timber Construction (AITC) - Timber Construction Manual, 3rd Edition

American Forest & Paper Association/ American Wood Council, (AFPA/AWC) 2005 National Design Specification for Wood Construction- (NDS)

American Iron & Steel Institute (AISI) – Commentary on the Prescriptive Method for Cold Formed Steel Framing,

AFPA/AWC, 2005 NDS Supplement – Design Values for Wood Construction

American Society of Civil Engineers - Minimum Design Loads of Buildings and Other Structures (ASCE 7-05)

ASTM International – Fastener Standards & Publications web site.

California Building Code, 2010 Edition (2010 CBC; or CBC inclusive).

Composite Panel Association, Medium Density Fiberboard, Mechanical Properties - web site.

International Code Council (ICC) - International Building Code, 2009 Edition (2009 IBC, or IBC, inclusive).

ICC Evaluation Service Inc. ICC-ESR-1636, Structural Bamboo Poles

ICC Evaluation Service Inc. ICC-ESR-1671, Tapcon Screw Fasteners

ICC Evaluation Service Inc. ICC-ESR-2196, Hilti Kwik Pro Self Drilling Screws

International Conference of Building Officials (ICBO) - Maps of Known Active Fault Near-Source Zones in CA

National Earthquake Hazards Reduction Program (NEHRP) - NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures (2003 NEHRP Provisions).

Smith Fastener, Machine Screw Mechanical Performance Requirements web site

Structures and Codes Institute, S.K. Ghosh Associates, Inc, CodeMaster – Seismic Design

Simpson Strong-Tie Company, Wood Construction Connectors 2011-2012, Catalog C-2011

Simpson Strong-Tie, Anchoring and Fastening Systems for Concrete and Masonry Catalog SAS-2012

Wall Panel Systems, Inc, Construction Details & Installation Guides prepared by www.WallPanelSystems.net

Williams, Alan, Structural Engineering Reference Manual

Web Links :

http://www.matweb.com/
http://www.astm.org/Standards/fastener-standards.html
http://www.smithfast.com/msmechanicals.html
http://www.compositepanel.org/products/medium-density-fiberboard.html
http://www.confast.com/products/technical-info/tapcon-concretescrew.aspx
http://www.huduser.org/publications/pdf/commenton
http://www.strongtie.com/products/anchorsystems/mechanical/index.html?source=topnav#
http://www.strongtie.com/products/fasteners/index.html?source=topnav#
http://www.hilti.com/holcom/page/module/product/prca_rangedetail.jsf?lang=en&nodeId=-10709
http://wallpanelsystems.net/