Structural Calculations –Phenolic Composite, Acrylic, Tempered Glass Panel Systems- 1/4 in Low Profile System, with Connection Elements & Fasteners Analysis
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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, acrylic, or to a limited degree, tempered glass. 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 (panel backing or backing) and to panel assemblies with steel screw fasteners. In some instances, panel assemblies may be mounted upon interior wall partitions made of reinforced concrete masonry unit (CMU) walls. Backing fasteners include commercially available steel self-drilling self-tapping screws and concrete screws. Panel fasteners include wood screws, machine screws, & sheet metal 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, or contained within, extruded aluminum edge rails, mid-panel rails, corner rails, edge joint rails and caps. The panels and aluminum alloy components are collectively fastened as an assembly to the partition wall backing.

Connections between the decorative panels, aluminum rails and partition backing are made using various screw fasteners. Fasteners to steel framed backing consists of galvanized steel self-drilling tapping screws. 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). Additional analysis for phenolic composites has been performed for a widened panel width of 32 inches and extended panel height of 10 feet. 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. 1/4 inch thick tempered glass panel size is limited to the maximum fastener width by the maximum fastener height as these panels are dense and are to be contained at their edges (panel perimeter) within aluminum rails. This creates a condition where these panels are fastened to backing at the panel assembly corners.

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Tempered Glass Panel Dead Load (DL) = 3.2 PSF = [152.3 pcf x (0.25 in / 12 in per ft)].
Max. panel size = (fastener width max)(fastener height max) = (24 in)(34 in)/12 in/ft^2 = 5.67 sq.ft
19.1 lbs, DL = (3.2psf)(5.67sf+0.3) = Design DL Wt of Tempered Glass Assembly, 1/4 in thick.
1/4 in phenolic large panel limits DL/ fastener at 19.6 lbs. < 4.8 lbs = 19.1 lb / 4 fasteners at corners, OK.
5.67 sq. ft. = Typical maximum tributary area per connection = (24 in)(34 in)/ (12 in/ft)^2.
26.7 sq. ft = Extended panel size = 32 in/(12 in/ft)(10 ft).
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.
2.2 PSF, DL = 1/4 in. thick Phenolic Composite Panel Assembly Design DL – Weight with clips.
1/4 in thick Panel Dead Load (DL) = 1.84 PSF = [88.3 pcf x (0.25 in / 12 in per ft)].

Tributary Dead Loads per connection for various Panel Assemblies:

12.5 lbs = 1/4 in. Phenolic Composite Panel Assembly Tributary DL = (5.67 sq.ft)(2.2 psf)
58.74 lbs = 1/4 in. Phenolic Composite Panel Assembly Tributary DL = (26.7 sq.ft)(2.2 psf)
19.1 lbs = 1/4 in. Tempered Glass Panel Assembly Tributary DL = (5.67 sq.ft)(3.2 psf)
11.9 lbs = 1/4 in. Acrylic Composite Panel Assembly Tributary DL = (5.67 sq.ft)(2.1 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 12.5 lbs / connection DL for design of backing screw seismic out of plane perpendicular to load.
Use 58.74 lbs /connection DL for design of backing screw gravity connections, vertical condition.

Panel connections were analyzed for inverted sloping wall applications, including ceiling applications.

Each panel assembly consists of: Modular Panels & extruded aluminum alloy edge rails are fastened to panel backing at all panel edges. Panel assembly vertical and horizontal joints utilize aluminum alloy joint rails fastened to panel backing at 24 in to 34 in spacing vertically; and horizontally at spacing that may vary from 16 in to 32 in oc. Edge rails and corner rails are connected to backing with galvanized steel self-drilling tapping screws conforming to AISI Standard for cold formed steel framing, or with hardened steel concrete screws set in drilled holes for reinforced concrete masonry unit walls (CMU). Aluminum alloy panel edge rails have formed pockets that contain the decorative phenolic, acrylic, and glass wall panels at the panel edges.

ALUMINUM ALLOY EDGE RAILS & TRIM FOR 1/4 IN LOW PROFILE PANEL SYSTEMS ARE AS FOLLOWS:
Edge Joint (Part # 301),
Wainscot Cap (Part # 302),
Square Cap (Part # 303),
Vertical Edge Trim (Part # 305),
Vertical Joint (Part # 310),
Wall Clip (Part # 320),
Corner Guard (Part # 333)
Cap B (Part # 334)
Cap A (Part # 335)
Inside Corner Guard (Part # 341)
Cap (Part # 342)
Horizontal Joint (Part # 350)

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 = 12.5 lb Tributary DL (1/4 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 1/4 in PHENOLIC PANELS:

Eq. 13.3-1 $$F_p = 8.2 \text{ lbs} = \frac{(0.4)(a_p)(S_{DS})(W_p)}{(R_p / I_p)}[1+(2)(Z/h)] = \frac{(6.9)}{(2.5)}[3]$$

Eq. 13.3-2 $$\text{max. } F_p = 27.5 \text{ lbs} = (1.6)(S_{DS})(W_p)(I_p)$$

Eq. 13.3-2 $$\text{min. } F_p = 5.2 \text{ lbs} = (0.3)(S_{DS})(W_p)(I_p)$$

Therefore, F_p = 27.5 lbs = 1/4 in PHENOLIC panels - 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)] = (12.5 lb) +/- [3.4 lb per connection]
1/4 in PHENOLIC - Vertical Concurrent (gravity + seismic) forces = 15.9 lb max, or 9.1 lb min.

IBC 2009/CBC 2010 - Allowable Stress Design (ASD), out of plane seismic force for LARGE PANELS (maximum) 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 = 58.7 lb Trib DL (26.7 sq.ft. of 1/4 in. Phenolic)
I_p = 1.0 per Sec.13.1.3, ASCE R_p = 2.5 per 13.5-1 ASCE Z_{max} = 10 ft h_{max} = 10 ft

For 1/4 in Large PHENOLIC PANELS:

Eq. 13.3-1 $$F_p = 38.7 \text{ lbs} = \frac{(0.4)(a_p)(S_{DS})(W_p)}{(R_p / I_p)}[1+(2)(Z/h)] = \frac{(32.2)}{(2.5)}[3]$$

Eq. 13.3-2 $$\text{max. } F_p = 129.0 \text{ lbs} = (1.6)(S_{DS})(W_p)(I_p)$$

Eq. 13.3-2 $$\text{min. } F_p = 24.2 \text{ lbs} = (0.3)(S_{DS})(W_p)(I_p)$$

F_p = 129.0 lbs = 1/4 in Phenolic Large Panel –Max. Horiz. Out of Plane Seismic force / connection, perpendicular to panel face, any direction, in the most severe locale. Use to split between 3 connectors, split panel supports taking ½ panel loading from each side. **Therefore, F_p tributary/connection = 43.0 lbs/ connection.**
(W_p/3) = 19.6 lb = (58.7 / 3)
Vertical Concurrent force/connection = (DL) +/- [(0.2)(S_{DS})(W_p/3)] = (19.6 lb) +/- [5.4 lb per connection]
1/4 in PHENOLIC – Large Panels - Vertical Concurrent (gravity + seismic) forces = 25.0 lb max, or 14.2 lb min.

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Sloping PHENOLIC 1/4" Thick Panel Assemblies – APPLIED LOAD ANALYSIS AT 2 CONDITIONS
TRIBUTARY LOAD = 12.5 lb / connection. (5.67 sq. ft. tributary panel /connection)
TRIBUTARY LOAD = 19.6 lb / connection. (8.9 sq.ft.= 26.7 sq. ft. / 3 connections)

Applied Loads per fastener, Dead Loads and Seismic (values in pounds).

		W_p= 12.5 lb (A_t=5.76 sf) #8 Self Tapping Screw		W_p= 19.6 lb (A_t=26.7/3 sf) # 8 Self Tapping Screw	
Wall Angle Degrees from level	**Load Type**	**Shear**	**Tension**	**Shear**	**Tension**
90 (Vert. Wall)	Normal	**12.5**	0	**19.6**	0
	Seismic	15.9	27.5	24.9	43.0
70	Normal	11.7	4.3	18.3	6.7
	Seismic	24.3	31.0	38.1	48.6
60	Normal	10.8	6.3	16.9	9.9
	Seismic	27.6	**31.8**	25.0	**49.9**
45	Normal	8.9	8.9	14.0	14.0
	Seismic	30.7	30.7	48.1	48.1
30	Normal	6.3	10.8	9.9	16.9
	Seismic	**31.8**	27.6	**49.9**	25.0
0 (flat - Horiz.)	Normal	0	**12.5**	0	**19.6**
	Seismic	27.5	15.9	43.0	24.9

Load Summary: IBC 2009/CBC 2010

Sloping PHENOLIC 1/4 " Thick Wall Panel Assemblies
Dead Loads and Seismic for all sloping configurations. (values in pounds).

MAXIMUM APPLIED LOADS PER FASTENER

		PANEL PORTION W_p= 12.5 lb (A_t=5.76 sf) #8 Self Tapping Screw		LARGE PANEL-3 CONN/EDGE W_p= 19.6 lb (A_t=8.9 sf) # 8 Self Tapping Screw	
	Load Type	**Shear**	**Tension**	**Shear**	**Tension**
Use for Design of Connections	**Normal**	**12.5**	**12.5**	**19.6**	**19.6**
	Seismic	**31.8**	**31.8**	**49.9**	**49.9**

INTERACTION ANALYSIS – COMBINED SHEAR / TENSION (SMALL PANEL $A_P \leq 5.67$ S.F.)

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 Self-Drilling Panel Fastener in steel stud/GWB backing.

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 = 31.8 lbs = Maximum Applied Seismic out of plane tension per connection.
V_{G+S} = 15.9 lbs = Applied gravity + vertical seismic component per connection.

$$\frac{V_{G+S}}{V_a} + \frac{P_s}{P_a} = \frac{15.9}{258} + \frac{31.8}{113} = 0.06 + 0.28 = 0.34 < 1.0, \text{ OK}$$

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 PHENOLIC EDGE RAILS, MIDWALL HORIZ. JOINT RAILS, & BACKING FASTENERS - VERTICAL Wall condition (SMALL PANEL $A_P \leq 5.67$ S.F.)

Refer to typical connection drawing details "A" & "E" of Typical Connection Diagrams for Aluminum Alloy Extruded Clips & Rails.

Horizontal force To wall fastener screw at wall backing, Horizontal Joint Rail, Max of 49.9 lbs / connection.

$$\frac{(31.8 \text{ lb})(0.70 \text{ in})}{(0.35 \text{ in})} = \mathbf{63.6 \text{ lb}} < 113 \text{ lb allowable tension in fasteners at backing}$$

Apply horiz. force to Wall fastener at Wall backing along Base Edge Rail

$$\frac{(31.8 \text{ lb})(0.75 \text{ in})}{(0.40 \text{ in})} = 59.6 \text{ lb tension In fastener at backing (max)} < 113 \text{ lb allowable tension}$$

Vertical component of seismic force plus gravity per screw Horizontal Joint Rail to backing fastener

$$\frac{(15.9 \text{ lb})(0.45 \text{ in})}{(0.35 \text{ in})} = 20.4 \text{ lb} < 113 \text{ lb}$$ Allowable seismic in connection at backing fastener

Vertical component of seismic force plus gravity per screw connection at wall backing along Base Edge Rail

$$\frac{(15.9 \text{ lb})(0.45 \text{ in})}{(0.75 \text{ in})} = 9.5 \text{ lb} < 113 \text{ lb}$$ Allowable seismic in backing fastener

ANALYSIS OF SEISMIC LOAD causing PRYING ACTION ON MIDWALL HORIZ. JOINT RAIL FASTENERS and EDGE RAIL FASTENERS – HORIZONTAL (Ceiling or soffit) Installation (SMALL PANEL $A_P \leq$ 5.67 S.F.).
Refer to typical connection drawing details "A" & "E", rotated 90 degrees, of Typical Connection Diagrams for Extruded Aluminum Alloy Clips and Rails.
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Vertical (Out of plane force) For Horizontal Joint Rail per screw connection.

$$\frac{(15.9\ \text{lb})(0.75\ \text{in})}{(0.35\ \text{in})} = 31.8\ \text{lb tension in wall fastener} < 113\ \text{lb allowable seismic tension at backing}$$

Apply vertical force to Wall fastener screw at wall backing along Edge Rail

$$\frac{(15.9/2\ \text{lb})(0.75\ \text{in})}{(0.40\ \text{in})} = 14.9\ \text{lb tension in wall fastener} < 113\ \text{lb allowable seismic tension at backing}$$

Horiz. component seismic force + gravity at Horiz. joint rail

$$\frac{(31.8)(0.45\ \text{in})}{(0.35\ \text{in})} + \frac{(12.5)(0.70\ \text{in})}{(0.35\ \text{in})} = \textbf{65.9 lb}\ \text{tension} < 113\ \text{lb Allowable seismic in at in backing fastener}$$

Horiz. component seismic force plus gravity along Edge Rail.

$$\frac{(31.8\ \text{lb})(0.45\ \text{in})}{(0.40\ \text{in})} + \frac{(12.5/2)(0.75\ \text{in})}{(0.40\ \text{in})} = 47.5\ \text{lb tension in backing fastener} < 113\ \text{lb Allowable seismic tension}$$

INTERACTION ANALYSIS – COMBINED SHEAR / TENSION (LARGE PANEL CONNECTION. $A_P \leq 8.9$ S.F.)
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 Self-Drilling Panel Fastener in steel stud/GWB backing.
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 = 49.9 lbs = Maximum Applied Seismic out of plane tension per connection.
V_{G+S} = 25.0 lbs = Applied gravity + vertical seismic component per connection.

$$\frac{V_{G+S}}{V_a} + \frac{P_s}{P_a} = \frac{25.0}{258} + \frac{49.9}{113} = 0.10 + 0.44 = 0.54 < 1.0, \text{ OK}$$

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

ANALYSIS OF SEISMIC LOAD causing PRYING ACTION ON PHENOLIC EDGE RAILS, MIDWALL HORIZ. JOINT RAILS, & BACKING FASTENERS - VERTICAL Wall condition (LARGE PANEL CONN. $A_P \leq 8.9$ S.F.)
Refer to typical connection drawing details "A" & "E" of Typical Connection Diagrams for Aluminum Alloy Extruded Clips & Rails.

Horizontal force To wall fastener screw at wall backing, Horizontal Joint Rail, Max of 49.9 lbs / connection.

$$\frac{(49.9 \text{ lb})(0.70 \text{ in})}{(0.35 \text{ in})} = \mathbf{99.8 \text{ lb}} < 113 \text{ lb allowable tension (\#8 x 1-1/2 in screw) in fasteners at backing}$$

< 132 lb allowable tension (#10 x 2 in screw)

Apply horiz. force to Wall fastener at Wall backing along Base Edge Rail

$$\frac{(49.9 \text{ lb})(0.75 \text{ in})}{(0.40 \text{ in})} = 93.6 \text{ lb tension In fastener at backing (max)} < 113 \text{ lb allowable tension}$$

Vertical component of seismic force plus gravity per screw Horizontal Joint Rail to backing fastener

$$\frac{(25.0 \text{ lb})(0.45 \text{ in})}{(0.35 \text{ in})} = 32.1 \text{ lb} < 113 \text{ lb}$$

Allowable seismic in connection at backing fastener

Vertical component of seismic force plus gravity per screw connection at wall backing along Base Edge Rail

$$\frac{(25.0 \text{ lb})(0.45 \text{ in})}{(0.75 \text{ in})} = 15.0 \text{ lb} < 113 \text{ lb}$$

Allowable seismic in backing fastener

Given the above, it is advisable to use #10 x 2 in long self-drilling screw for backing panel fasteners when anchoring large phenolic panels (Individual panel size greater than 5.67 sq.ft.)

ANALYSIS OF SEISMIC LOAD causing PRYING ACTION ON MIDWALL HORIZ. JOINT RAIL and EDGE RAIL FASTENERS – HORIZONTAL (Ceiling or soffit) Installation (LARGE PANEL CONNECTION $A_P \leq$ 8.9 S.F.)
Refer to typical connection drawing details "A" & "E", rotated 90 degrees, of Typical Connection Diagrams for Extruded Aluminum Alloy Clips and Rails.
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Vertical (Out of plane force) For Horizontal Joint Rail per screw connection.

$$\frac{(25.0 \text{ lb})(0.75 \text{ in})}{(0.35 \text{ in})} = 50.0 \text{ lb tension in wall fastener} < 113 \text{ lb allowable seismic tension at backing}$$

Apply vertical force to Wall fastener screw at wall backing along Edge Rail

$$\frac{(25.0 / 2 \text{ lb})(0.75 \text{ in})}{(0.40 \text{ in})} = 23.4 \text{ lb tension in wall fastener} < 113 \text{ lb allowable seismic tension at backing}$$

Horiz. component seismic force + gravity at Horiz. joint rail

$$\frac{(49.9)(0.45 \text{ in})}{(0.35 \text{ in})} + \frac{(19.6)(0.70 \text{ in})}{(0.35 \text{ in})} = \textbf{103.4 lb} \text{ tension} < 113 \text{ lb Allowable seismic (\#8 screw) in backing fastener}$$

< 132 lb allowable tension (#10 x 2 in screw)

Horiz. component seismic force plus gravity along Edge Rail.

$$\frac{(49.9 \text{ lb})(0.45 \text{ in})}{(0.40 \text{ in})} + \frac{(19.6 / 2)(0.75 \text{ in})}{(0.40 \text{ in})} = 74.5 \text{ lb tension in backing fastener} < 113 \text{ lb Allowable seismic tension}$$

Given the above, it is advisable to use #10 x 2 in long self-drilling screw for backing panel fasteners when anchoring large phenolic panels (Individual panel size greater than 5.67 sq.ft.)

CONNECTION SUMMARY — **Calculated Load Capacity Between Elements**

ELEMENT		**PULLOUT (lbs)**	**SHEAR (lbs)**	**RAIL SHEAR (lbs)**
EDGE TRIM (PART# 305), EDGE JOINT (PART # 301), WALL CLIP (PART # 320), BEARING ON FASTENER				72.2 Normal 96.0 Seismic
EDGE TRIM (PART# 305), EDGE JOINT (PART # 301), SQUARE CAP (PART # 303), HORIZONTAL JOINT (PART # 350) SHEAR ON RAIL / INCH				344 Normal 457 Seismic
EDGE TRIM (PART# 305), EDGE JOINT (PART # 301), WALL CLIP (PART # 320),	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

EDGE TRIM (PART# 305), EDGE JOINT (PART # 301), WALL CLIP (PART # 320),	Normal	99	209	
	Seismic	132	278	

Backing – 20 ga (39 mil) Cold Formed Steel Stud Wall // Fasteners **- # 10 x 2 in self-drilling screw**

EDGE TRIM (PART# 305), EDGE JOINT (PART # 301), WALL CLIP (PART # 320), BEARING ON FASTENER				72.2 Normal 96.0 Seismic
EDGE TRIM (PART# 305), EDGE JOINT (PART # 301), SQUARE CAP (PART # 303), HORIZONTAL JOINT (PART # 350) SHEAR ON RAIL / INCH				344 Normal 457 Seismic
EDGE TRIM (PART# 305), EDGE JOINT (PART # 301), WALL CLIP (PART # 320),	Normal	150	250	
	Seismic	200	333	

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

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

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 x 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 x 10^3 ksi Modulus of Elasticity

SOLID PHENOLIC COMPOSITE WALL PANELS – 1/4 in thickness.

Values for allowable stresses as per Material Property Data Sheets available online for phenolic wall panels fabricated for interior applications comprised of 3/8 in or 1/2 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 = 6.0 ksi Compression stress [estimated @ (0.6)(F_t)]
F_v = 4.0 ksi Horizontal Shear stress [estimated @ (0.4)(F_t)]
F_t = 10.1 ksi Tensile strength
E = 1.3 x 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)].
2.2 PSF, DL = 1/4 in. thick Phenolic Composite Panel Assembly Design DL – Weight with clips.

ACRYLIC COMPOSITE WALL PANELS – 1/4 in. Thick.

Values for allowable stresses as per Material Property Data Sheets available online at www.matweb.com for acrylic wall panels fabricated for interior applications comprised of 1/4 in thicknesses.

SG = 1.19 Specific Gravity
DD = 74.3 pcf Dry Density

Design Working Stresses (for normal loading conditions)

F_b = 2.36 ksi Bending (Flexural) Stress Allowable = Ultimate / 4 FS = 9430 psi / 4
F_c = 3.62 ksi Compression stress Allowable = Ultimate / 4 FS = 14500 psi / 4
F_v = 0.58 ksi Horizontal Shear stress Allowable = estimated (0.40)(F_t)
F_t = 2.55 ksi Tensile strength allowable = Ultimate/4 FS = 10200 psi /4
E = 0.43 ksi Modulus of Elasticity

1/4 in thick Panel Dead Load (DL) = 1.55 PSF = [74.3 pcf x (0.25 in / 12 in per ft)].
1.8 PSF, DL = 1/4 in. thick Acrylic Composite Panel Assembly Design DL
2.1 PSF, DL = (1.8 psf panel + 0.3 psf rails/accessories) – Weight with edge rails.

TEMPERED GLASS WALL PANELS – 1/4 inches thick

Values for allowable stresses as per Material Property Data Sheet available on www.makeitfrom.com , www.ehow.com , and www.engineeringtoolbox.com
Tempered Glass wall panels fabricated for interior applications comprised of 1/4 thickness.

SG = 2.44 Specific Gravity
DD = 152.3 pcf Dry Density

Design Working Stresses (for normal loading conditions)

F_b = 6.0 ksi Allowable Modulus of Rupture = 24 ksi/4= Allowable Bending Stress / 4 FS (ICC)
F_c = 2.5 ksi Allowable Compression stress = 10 ksi ultimate / 4 FS (ICC)
F_v = 2.53 ksi Allowable Horizontal Shear stress [estimated @ (0.4)(F_t)]
F_t = 6.32 ksi Allowable Tensile strength = Ultimate / 4 FS = 25.3 x 10^3 psi / 4)
E = 9.1 x 10^3 ksi Modulus of Elasticity

Panel Dead Load (DL) = 3.2 PSF = = [152.3 pcf x (0.25 in / 12 in per ft)].
Max. panel size = (fastener width max)(fastener height max) = (24 in)(34 in)/12 in/ft^2 = 5.67 sq.ft
19.1 lbs, DL = ((3.2+0.3) psf)(5.67sf) = Design DL Wt of Tempered Glass Assembly, 1/4 in thick.
1/4 in phenolic large panel limits DL/ fastener at 19.6 lbs. < 4.8 lbs = 19.1 / 4 fasteners at corners, OK.

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.

EDGE TRIM (PART# 305), EDGE JOINT (PART # 301), WALL CLIP (PART # 320),
72.2 lbs = Shear Allowable, normal, per inch, **Edge Trim** = (0.055 in) (0.164in)(8 ksi)(1000 lbs/k)
96.0 lbs = Seismic Shear Allowable load/connection on Panel clip = (72.2)(1.33) lbs,

EDGE TRIM (PART# 305), EDGE JOINT (PART # 301),SQUARE CAP (PART # 303), HORIZONTAL JOINT (PART # 350)
344 lbs = Shear Allowable, normal/inch of rail resisting panel loads, **Edge Trim** = (0.043 in) (1.0in)(8 ksi)(1000 lbs/k)
457 lbs = Seismic Shear Allowable load/inch resisting panel loads = (344)(1.33) lbs,

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,

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 .

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