WoodWorks® Shearwalls 13.1.2

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Project Information

DESIGN SETTINGS

Design Code	Wind Standard	Seismic Standard
IBC 2021/AWC SDPWS 2021	ASCE 7-16 Directional (All heights)	ASCE 7-16

Load Combinations		Building Code Capacity Modification	
For Design and MWFRS Deflection	For Deflection (Wind:Serviceability)	Wind	Seismic
		1.00	1.00

Service Conditions and Load Duration				Max Shearwall Offset [ft]	
Duration Factor	Temperature Range	Moisture Content		Plan (within story)	Elevation (between stories)
		Fabrication	Service		
-	-	19% (<=19%)	10% (<=19%)	0.50	-

Maximum Height-to-width Ratio						
Wood panels		Fiberboard	Lumber		Gypsum	
Blocked	Unblocked		Wind	Seismic	Blocked	Unblocked
-	-	-	-	-	2.0	1.5

Ignore shear resistance contribution of...		Forces based on...	
Wall segments	Seismic	Hold-downs	Applied loads
Side with invalid aspect ratio	-	Drag struts	Applied loads

Shearwall relative rigidity:	Deflection-based stiffness of wall segments
Non-identical materials and construction on the shearline:	Allowed, except for material type
Deflection Equation:	3-term from SDPWS 4.3-1
Drift limit for wind design:	1 / 500 story height
FTAO strap:	Continuous at top of highest opening and bottom of lowest

Dead load in chord force for overturning design		
Tension end	Compression end	When completely counteracts overturning
Wall length / 2	Wall length / 2	Wall length / 2

SITE INFORMATION

Wind	
	-
Design Wind Speed	-
Serviceability Wind Speed	
Exposure	-
Enclosure	-
Min Wind Loads: Walls	-
Roofs	-

Topographic Information [ft]		
Shape	Height	Length
-	-	-
Site Location: -		
-		
-		

Case 2	E-W loads	N-S loads
Eccentricity (-)	-	-
Loaded at	-	

Seismic	
ASCE 7-16 12.8 Equivalent Lateral Force Procedure	
Risk Category	Category II - All others
Structure Type	Regular
Building System	Bearing Wall
Design Category	A
Site Class	D

Spectral Response Acceleration	
S1: 0.400g	Ss: 0.750g

Fundamental Period	E-W	N-S
T Used	0.135s	0.135s
Approximate Ta	0.135s	0.135s
Maximum T	0.189s	0.189s
Response Factor R	2.00	2.00

Fa: 1.20	Fv: 1.60

Structural Data

STORY INFORMATION

	Story Elev [ft]	Floor/Ceiling Depth [in]	Wall Height [ft]	Hold-down Length subject to shrinkage [in]	Hold-down Bolt length [in]
Ceiling	10.83	0.0			
Level 1	2.83	10.0	8.00	13.75	14.5
Foundation	2.00				

BLOCK and ROOF INFORMATION

Block Dimensions [ft]			Roof Panels Face	Type	Slope	Overhang [ft]
Block 1	1 Story	E-W Ridge				
Location X,Y =	0.00	-3.25	**North**	Side	30.0	1.00
Extent X,Y =	36.00	33.00	**South**	Side	30.0	1.00
Ridge Y Location, Offset	13.25	0.00	**East**	Gable	90.0	1.00
Ridge Elevation, Height	20.36	9.53	**West**	Gable	90.0	1.00

SHEATHING MATERIALS by WALL GROUP

Grp	Surf	Material	Ratng	Sheathing Thick in	GU in	Ply	Or	Gvtv lbs/in	Fasteners Size	Type	RS	Eg in	Fd in	Bk	Apply Notes
1	Ext	Plywood siding		3/8	-	3	Horz	25000	6d	Casing	N	2	12	Y	1,2
	Int	Gyp. wallboard		1/2	-	1	Horz	40000	5d	Cooler	N	7	7	Y	

Legend:
Grp – Wall Design Group number, used to reference wall in other tables (created by program)
Surf – Exterior or interior surface when applied to exterior wall
Ratng – Span rating, see SDPWS Table C4.2.3C
Thick – Nominal panel thickness
GU - Gypsum underlay thickness
Ply – Number of plies (or layers) in construction of plywood sheets
Or – Orientation of longer dimension of sheathing panels or lumber planks. Dbl. = Double diagonal.
Gvtv – Shear stiffness in lb/in. of depth from SDPWS Tables C4.2.3A-B
Type – Fastener type from SDPWS Tables 4.3A-D:
Common: common wire nail; Box: galvanized box nail; Casing: casing nail; Roof: galvanized roofing nail; Cooler: cooler nail; WBoard: wallboard nail; Screw: drywall screw; Gauge: nail measured by gauge; Galv: galvanized gauge nail; GWB: Gypsum wallboard blued nail
Size - From Tables 4.3A-D and Table A1; shown in Wall Input fastener dropdown
Common nails: 6d = 0.113 x 2", 8d = 0.131 x 2.5", 10d = 0.148 x 3", 12d = 0.148 x 3.5"
Box or casing nails: 6d = 0.099 x 2", 8d = 0.113 x 2.5", 10d = 0.128 x 3", 12d = 0.126 x 3.5"
Gauge, roofing and GWB nails: 13 ga = 0.92" x 1-1/8"; 11 ga = 0.120" x 1-1/8" (GWB nail for gypsum lath & plaster), 1-1/4" (gyp. L&P), 1-1/2" (wire lath & plaster, 1/2" fiberboard ,1/2" GWB), 1-3/4" (GSB, 5/8" GWB, 25/32" fiberboard, 2-ply GWB base), 2-3/8" (2-ply GWB face)
Cooler or wallboard nail: 5d = .086" x 1-5/8"; 6d = .092" x 1-7/8"; 8d = .113" x 2-3/8"; 6/8d = 6d base ply, 8d face ply for 2-ply GWB.
Drywall screws: No. 6, 1-1/4" long.
RS – Ring-shank nails (non-shearwalls only), with increased withdrawal capacity as per NDS 12.2.3.2.
Eg – Panel edge fastener spacing. For lumber sheathing, no. of nails per board at shear wall boundary. For 2-ply GWB, spacing of all nails in face ply.
Fd – Field spacing interior to panels. For lumber sheathing, no. of nails per board at interior studs. For 2-ply GWB, spacing of all nails in face ply.
Bk – Sheathing is nailed to blocking at all panel edges; Y(es) or N(o)
Apply Notes – Notes below table legend which apply to sheathing side

Notes:
1.Capacity has been reduced for framing specific gravity according to SDPWS Table 4.3A Note 3. A factor of 0.93 is applied for Hem.-Fir framing and 0.92 for S.-P.-F. For other materials with specific gravity G less than 0.5, it is G + 0.5.
2. Framing at adjoining panel edges must be 3" nominal or wider with staggered nailing according to SDPWS 4.3.7.1 (5)

FRAMING MATERIALS and STANDARD WALL by WALL GROUP

Wall Grp	Species	Grade	b in	d in	Spcg in	SG	E psi^6	Fcp	Standard Wall
1	S-P-F	No.1/No.2	1.50	3.50	16	0.42	1.40	425	

Legend:
Wall Grp – Wall Design Group
b – Stud breadth (thickness)
d – Stud depth (width)
Spcg – Maximum on-centre spacing of studs for design, actual spacing may be less.
SG – Specific gravity
E – Modulus of elasticity
Standard Wall - Standard wall designed as group.
Fcp - Compressive strength perpendicular to grain

Notes:
Check manufacture requirements for stud size, grade and specific gravity (G) for all shearwall hold-downs.
The following factors are applied to Fcp for compressive design and deformation under wall segment end studs :
Bearing area factor Cb from NDS 3.10.4, under window openings.

SHEARLINE, WALL and OPENING DIMENSIONS

North-south Shearlines	Type	Wall Group	Location X [ft]	Extent [ft] Start	Extent [ft] End	Length [ft]	FHS [ft]	Aspect Ratio	Height [ft]	Studs S	Studs N
Line 1											
Level 1											
Line 1	Seg		0.00	-3.25	29.75	33.00	32.75	-	8.00	-	-
Wall 1-1	Seg		0.00	-3.25	29.75	33.00	32.75	0.24	-	2	2
Line 2											
Level 1											
Line 2	Seg		36.00	-3.25	29.75	33.00	32.75	-	8.00	-	-
Wall 2-1	Seg		36.00	-3.25	29.75	33.00	32.75	0.24	-	2	2

East-west Shearlines	Type	Wall Group	Location Y [ft]	Extent [ft] Start	Extent [ft] End	Length [ft]	FHS [ft]	Aspect Ratio	Height [ft]	Studs W	Studs E
Line A											
Level 1											
Line A	Seg		-3.25	0.00	36.00	36.00	35.75	-	8.00	-	-
Wall A-1	Seg		-3.25	0.00	36.00	36.00	35.75	0.22	-	2	2
Line B											
Level 1											
Line B		1	29.75	0.00	36.00	36.00	24.00	-	8.00	-	-
Wall B-1	Seg	1	29.75	0.00	36.00	36.00	24.00	-	-	2	2
Segment 1		-	-	0.00	12.00	12.00	11.75	0.67	-	2	2
Opening 1		-	-	12.00	18.00	6.00	-	-	6.00	2	2
Segment 2		-	-	18.00	24.00	6.00	5.75	1.33	-	2	2
Opening 2		-	-	24.00	30.00	6.00	-	-	6.00	2	2
Segment 3		-	-	30.00	36.00	6.00	5.75	1.33	-	2	2

Legend:
Type – Seg: Segmented, Prf: Perforated, FT: FTAO (force transfer around openings), NSW: Non-shearwall, NW: Non-wood/Proprietary, ND: Not designed
Location – Position in structure perpendicular to wall
Length – Shear line: Distance between exterior perpendicular walls defining the shear line extent
Wall, segment, or opening: End-to-end length of the element
FHS – Depending on element, shows different definitions of full-height sheathing length (FHS):
Shear lines with multiple walls, segmented walls, or FTAO walls: Total shear-resisting FHS
Individual wall segments or walls without openings: Distance between hold-downs beff
Perforated walls: Sum of factored segment lengths bi defined in SDPWS 4.3.5.6
Aspect Ratio – Ratio of wall height to segment length (h/b); for FTAO walls, the aspect ratio of the central pier
Wall Group – Wall design group defined in Sheathing and Framing Materials tables, where it shows associated Standard Wall
Studs: Number of end studs at the south and north or west and east ends of a wall segment or a perforated or FTAO wall.

Loads

SEISMIC FORCES (Directly Applied by User)

Shear Line	Level	Profile	Distribution Method	Magnitude [lbs]
B	1	Point	Both	5600

Notes:
Seismic forces are assumed to be factored by the redundancy factor and the 0.70 load factor.

Design Summary

SHEARWALL DESIGN

Seismic Loads, Flexible Diaphragm
All shearwalls have sufficient design capacity.

Seismic Loads, Rigid Diaphragm
All shearwalls have sufficient design capacity.

HOLD-DOWN DESIGN

Seismic Loads, Flexible Diaphragm
All hold-downs have sufficient design capacity.

Seismic Loads, Rigid Diaphragm
All hold-downs have sufficient design capacity.

COMPRESSION FORCE DESIGN

Seismic Loads, Flexible Diaphragm
Bottom plate has sufficient perpendicular-to-grain compressive capacity under all wall end studs.

Seismic Loads, Rigid Diaphragm
Bottom plate has sufficient perpendicular-to-grain compressive capacity under all wall end studs.

This Design Summary does not include failures that occur due to excessive story drift from ASCE 7 12.12 (seismic).
Refer to Story Drift table in this report to verify this design criterion.
Refer to the Deflection table for possible issues regarding fastener slippage (SDPWS Table C4.2.3D).

Flexible Diaphragm Seismic Design

SEISMIC INFORMATION

Level	Mass [lbs]	Area [sq.ft]	Story Shear Fx [lbs] E-W	Story Shear Fx [lbs] N-S	Shear Resistance [lbs] E-W	Shear Resistance [lbs] N-S	Diaphragm Force [lbs] E-W Fpx	Diaphragm Force [lbs] E-W Design	Diaphragm Force [lbs] N-S Fpx	Diaphragm Force [lbs] N-S Design
1	0	0.0	0	0	16269	13200	0	0	0	0
All	0	–	0	0	–	–	–	–	–	–

Legend:
Mass – Sum of all generated and input building masses on level = wx in ASCE 7 Eqn. 12.8-12.
Story Shear – Total ASD-factored shear force induced at level x from Eqn. 12.8-11.
Shear Resistance – Lateral design strength of all shear-resisting elements on story, for use in weak story evaluation (4.1.8).
Diaphragm Force – used by Shearwalls only for drag strut forces, as per Exception to 12.10.2.1.
Fpx - Minimum ASD-factored force for diaphragm design from Eqns. 12.10-1, -2, and -3.
Design = The greater of the story shear and Fpx + transfer forces from discontinuous shearlines, factored by overstrength (omega) as per 12.10.1.1.
Omega = 2.5 as per 12.2-1.

Manually added or modified seismic loads and forces do not contribute to Story Shear shown here, nor are they included in the calculation of the diaphragm force Fpx, but they are distributed to the shearlines for shearwall design. Forces introduced via manually entered building masses are included in all calculations.

Vertical Earthquake Load Ev
Ev = 0 for Seismic Design Category A as per ASCE 7 12.4.2.2.

SHEAR RESULTS (flexible seismic design)

N-S Shearlines	W Gp	For Dir	ASD Shear Force [plf] v	vmax/vft	V [lbs]	Asp-Cub Int	Asp-Cub Ext	Allowable Shear [plf] Int	Ext	Co	C	Cmb	V [lbs]	Resp. Ratio
E-W Shearlines	**W Gp**	**For Dir**	**ASD Shear Force [plf] v**	**vmax/vft**	**V [lbs]**	**Asp-Cub Int**	**Asp-Cub Ext**	**Allowable Shear [plf] Int**	**Ext**	**Co**	**C**	**Cmb**	**V [lbs]**	**Resp. Ratio**
Line B														
Level 1														
LnB, Lev1	-	Both	-	-	5600	-	-	-	-	-		-	9069	-
Wall B-1	1^	Both	-	-	5600	1.0	1.0	89	378	-	S	-	9069	-
Seg. 1	-	Both	351.4	-	4217	1.0	1.0	89	378	-		378	4534	0.93
Seg. 2	-	Both	115.2	-	691	1.0	1.0	89	378	-		378	2267	0.30
Seg. 3	-	Both	115.2	-	691	1.0	1.0	89	378	-		378	2267	0.30

Legend:
W Gp - Wall design group defined in Sheathing and Framing Materials tables, where it shows associated Standard Wall. "^" means that this wall is critical for all walls in the Standard Wall group.
For Dir – Direction of seismic force along shearline.
v – Design shear force on segment = ASD-factored shear force per unit length of full-height sheathing (FHS)
vmax/vft - Perforated walls: Collector and in-plane anchorage force as per SDPWS eqn. 4.3-9 = V/FHS/Co. FHS is factored for narrow segments as per 4.3.3.4
FTAO walls: Shear force in piers above and below either openings or piers beside opening(s). Aspect ratio factor does not apply to these piers.
V – ASD factored shear force. For shearline: total shearline force. For wall: total of all segments on wall. For segment: force on segment
Asp/Cub – Unblocked wood structural panel factor Cub from SDPWS 4.3.5.3 or Aspect Ratio factor from 4.3.3.2, which for perforated walls is sum bi / FHS from 4.3.5.6 with bi defined in 4.3.3.4. For multi-segment walls, wall row shows Cub and segment rows show Asp. For single-segment walls and perforated walls, value shown is Asp for blocked walls and Cub for unblocked walls.
Int, Ext - Nominal unit shear capacity of interior and exterior sheathing, factored by Table 4.3-1 Note 3 for framing specific gravity and Note 10 for presence of hold-downs. For wall segments, also include unblocked factor Cub and aspect ratio adjustments.
Co - Adjustment factor for perforated walls from SDPWS Equation 4.3-6.
C - Sheathing combination rule, A = Add capacities, S = Strongest side or twice weakest, G = Stiffness-based using Eqns. 4.3-3,-4.
Cmb - Combined interior and exterior unit shear capacity including perforated wall factor Co.
V – Total factored shear capacity of shearline, wall or segment.
Crit Resp – Response ratio = v/Cmb = design shear force/unit shear capacity. "W" indicates that the wind design criterion was critical in selecting wall.

Notes:
Refer to Elevation View diagrams for individual level for uplift anchorage force t for perforated walls given by SDPWS 4.3.6.4.2,1.

Hold-Down and Compression Design (flexible seismic design)

Level 1 Line-Wall	Posit'n	Location [ft] X	Location [ft] Y	Tensile Hold-down or Compressive Stud Force [lbs] Shear	Dead	Ev	Cmb'd	Hold-down	Cap [lbs]	Crit Resp.
Line B										
B-1	L End	0.12	29.75	2871			2871	HDU5-SDS	4340	0.66
B-1	L End	0.12	29.75	2871			2871	Compression	4462	0.64
B-1	L Op 1	11.88	29.75	2871			2871	HDU5-SDS	4340	0.66
B-1	L Op 1	11.88	29.75	2871			2871	Compression	4462	0.64
B-1	R Op 1	18.13	29.75	962			962	HDU5-SDS	4340	0.22
B-1	R Op 1	18.13	29.75	962			962	Compression	4462	0.22
B-1	L Op 2	23.88	29.75	962			962	HDU5-SDS	4340	0.22
B-1	L Op 2	23.88	29.75	962			962	Compression	4462	0.22
B-1	R Op 2	30.13	29.75	962			962	HDU5-SDS	4340	0.22
B-1	R Op 2	30.13	29.75	962			962	Compression	4462	0.22
B-1	R End	35.88	29.75	962			962	HDU5-SDS	4340	0.22
B-1	R End	35.88	29.75	962			962	Compression	4462	0.22

Legend:
Line-Wall:
At wall or opening – Shearline and wall number
At vertical element – Shearline
Posit'n – Position of stud pack that hold-down is attached to:
V Elem – Vertical element: column or strengthened studs required where not at wall end or opening
L or R End – At left or right wall end
L or R Op n – At left or right side of opening n
t @ Op n – Uplift force t at opening n from offset opening in perforated wall above, from SDPWS 4.3.6.4.2.1
Location – Co-ordinates in Plan View
Tensile Hold-down or Compressive Stud Force – Upwards force on hold-down at one end of the wall or downward force on bottom plate under studs at the other end, for each force direction. Includes forces transferred from upper levels.
Shear – Overturning component = V x h / beff from SDPWS Eqn. 4.3-7; V = force on segment, ASD-factored by 0.70; h = wall height , beff = wall segment length – (tension stud pack width + hold-down anchor bolt offset) – (1/2 compression stud pack width). For perforated walls = V x h / Co sum (bi) from SDPWS Eqn. 4.3-8.
Dead – Dead load resisting component, factored for ASD by 0.60 for tension and 1.0 for compression
Ev – Vertical seismic load effect from ASCE 7 12.4.2.2 = -0.2 Sds x ASD factor x unfactored D = 0.0 SDS x factored D. Refer to Seismic Information table for more details.
Cmb'd – Sum of ASD-factored overturning, dead and vertical seismic forces. May also include the uplift force t from perforated walls from SDPWS 4.3.6.4.2.1 when openings are staggered.
Hold-down – Device model number from hold-down database; "Compression" for bearing of end stud pack on bottom plate
Cap – Hold-downs: Allowable ASD tension load from database; Compression: Allowable ASD bearing force = Ct CM Cb Fcp A; A = cross sectional area of end studs. Refer to Framing materials table for details.
Crit. Resp. – Critical Response = Combined ASD force/Allowable ASD tension load

Notes:
HDU5-SDS2.5 for studs with thickness > 0'-3" and depth > 0'-3.5" : Uses 14 1/4" x 2.5" SDS heavy-duty screws; 5/8" anchor bolt.
Combined force from ASCE 7 2.4.1 load combination 10 = - (0.6D - 0.7Ev + 0.7Eh); Eh (from 12.4.2.1) = - shear overturning force
Refer to the Shear Line Dimensions table for wall height h, effective segment length beff and perforated wall adjusted sum of bi, to the Story Table for joist depth, and to the Shear Results table for perforated factor Co.
Designer is responsible for design of connection from wall to floor or foundation for shear force shown in Shear Results table. Refer to SDPWS 4.3.6.4.3 for foundation anchor bolt requirements.

COLLECTOR FORCES (flexible seismic design)

Level 1 Line-Wall	Position on Wall or Opening	Location [ft] X	Location [ft] Y	Drag Strut Force [lbs] --->	Drag Strut Force [lbs] <---	Strap/Blocking Force [lbs] --->	Strap/Blocking Force [lbs] <---
Line B							
	Shearline force			5600	5600		
B-1	Left Opening 1	12.00	29.75	2350	-2350		
B-1	Right Opening 1	18.00	29.75	1417	-1417		
B-1	Left Opening 2	24.00	29.75	1175	-1175		
B-1	Right Opening 2	30.00	29.75	242	-242		

Legend:
Line-Wall - Shearline and wall number
Position…- Side of opening or wall end that drag strut is attached to
Location - Co-ordinates in Plan View
Drag strut Force - Axial force in transfer element at openings, gaps, or changes in design shear along shearline. + : tension; - : compression.
Based on ASD-factored shearline force shown. For SDC C-F, it is the greater of the design shearline force and the diaphragm force Fpx, added to shearline force
from story above and to forces transferred from discontinuous shearlines factored by overstrength (omega) as per 12.10.1.1.
Refer to Seismic Information table for diaphragm forces and omega factor.
For SDC D-F, if horizontal torsional irregularities 2, 3, or 4 are input, or vertical irregularity 4 detected or input, 25% increase from 12.3.3.4 applied.
Strap/Blocking Force – For FTAO walls, force transferred from above and below opening to shearwall pier.
-> Due to shearline force in the west-to-east or south-to-north direction
<- Due to shearline force in the east-to-west or north-to-south direction

DEFLECTION (flexible seismic design)

Wall, segment	W Gp	Dir	Srf	v plf	b ft	h ft	Bending A sq.in	Bending Defl in	Ga kips/in	Nail slip Vn lbs	Nail slip en in	Shear Defl in	Hold Defl in	Total Defl in
Level 1														
Line B														
B-1,1	1	Both	ExtS	502.0	12.00	8.00	10.5	.012	20.1	88	.007	.200	0.26	0.48
B-1,2		Both	ExtS	164.6	6.00	8.00	10.5	.008	20.1	88	.007	.065	0.41	0.48
B-1,3		Both	ExtS	164.6	6.00	8.00	10.5	.008	20.1	88	.007	.065	0.41	0.48

Legend:
Wall, segment – Wall and segment between openings, e.g. B-3,2 = second segment on Wall 3 on Shearline B.
W Gp – Wall design group, refer to Sheathing and Framing Materials tables.
Dir – Force direction.
Srf – Wall surface = Int(erior) or Ext(erior) for perimeter walls, 1 or 2 for interior partitions; Comb = Combined v and Ga for identical materials on each side; S = Ga from side with stronger shear resistance; W = 2 x Ga of weaker side.
v – Unfactored (strength-level) shear force per unit distance on wall segment = ASD force / 0.70, as per ASCE 7 12.8.6,.
Unblocked walls = v / Cub as per SDPWS 4.3.4.3, Cub = Unblocked factor from 4.3.5.3, shown in the Shear Results table.
Perforated walls = vmax from Eqn. 4.3-9, as per 4.3.4.2.
FTAO walls = Unit shear force in pier beside opening(s).
b – Wall or segment length.
Segmented wall or FTAO wall segments = Width of wall segment between openings.
Perforated wall = Sum of FHS segments, modified as in 4.3.3.4 per 4.3.4.2.
FTAO wall = Length of wall including openings.
h – Wall height.
FTAO piers = Distance from bottom of opening to top of wall; for end segments, results using that distance and the wall height are averaged.
Defl – Horizontal shear wall deflection due to given term:
Bending = 8vh^3 / EAb; A = Effective cross sectional area of segment end stud(s), E = stud mod. of elasticity in Framing Materials table
For i studs at one end and j at the other, A = 2 ij / (i + j) x area of one stud, based on Ex. C4.3.4-3
Shear = vh / 1000 Ga; Ga = 1.4 vs / (1.4 vs / Gvtv + 0.75 en) from SDPWS Eqn. C4.2.3-3.
vs = ASD sheathing capacity.
Gvtv = Shear stiffness from C4.3.4, shown in Sheathing Materials table.
en = Nail slip from Table C4.2.3D, of form aVn^b for WSP, varies linearly to value at capacity for other materials.
Vn = Strength-level shear force per nail along panel edge at ASD capacity = 1.4 vs.
Hold – Anchorage system (hold-down) = da x h / beff.
da = Vertical hold-down displacement; refer to Hold-down Displacement table for components.
beff = Effective wall segment length = b - (tension stud pack width + hold-down anchor bolt offset) - (1/2 compression stud pack width)
beff is given in the Shear Wall Dimensions table.
For FTAO walls, hold-down device at end of wall is applied to all segments, as per APA T555.
Total Defl – Deflection from bending + shear + hold-down, as per Eqn. 4.3-2.
For FTAO walls, the average of the values for the segments, as per APA T555.

WARNING - Fastener slip based on lumber with specific gravity not less than 0.5, however specific gravity for at least some walls is less than 0.5. Refer to the Framing Materials table.

HOLD-DOWN DISPLACEMENT (flexible seismic design)

Wall, segment	Dir	Hold-down	Tens. force lbs	Vert. Displacement Manuf in	Add in	da in	Slippage Vf lbs	da in	Shrink +Extra in	Comp. force lbs	Crush da in	Total da in	Horz Defl in
Level 1													
Line B													
B-1,1	Both	HDU5-SDS	2871	.105	.003	0.107	-	-	.248	4102	0.03	0.39	0.26
B-1,2	Both	HDU5-SDS	962	.035	.001	0.036	-	-	.248	1374	0.01	0.29	0.41
B-1,3	Both	HDU5-SDS	962	.035	.001	0.036	-	-	.248	1374	0.01	0.29	0.41

Legend:
Wall, segment – Wall and segment between openings, e.g. B-3,2 = second segment on Wall 3 on Shearline B
Dir – Force direction
Tens., Comp. – Accumulated ASD hold-down tension force T and strength-level end compression force C from overturning, dead and vertical earthquake loads.
Tens. – ASD-factored force, used for proportion of manufacturer's maximum elongation
Comp. – Strength level force as per ASCE 12.8.6
da – Vertical displacements due to the following components:
Vert. Displacement – Elongation when slippage calculated separately; displacement when combined elongation/slippage used
Manuf – Using manufacturer's value for anchor bolt length, or no bolt contribution for connector-only elongation
*Unless marked with * = (ASD tension force / ASD hold-down capacity) x max strength-level elongation or displacement*
** - Maximum strength-level elongation or displacement is used. May result in higher than actual displacements for lightly loaded hold-downs, causing the segment to draw less force due to lower than actual stiffness.*
Add – Due to longer anchor bolt length than manufacturer's value, or entire bolt length for connector-only elongation = TL / (Ab x Es)
T = Strength level tension force (not shown)
Ab = bolt cross-sectional area
Es = steel modulus = 29000000 psi
L = Lb – Lh
Lb = Total bolt length shown in Storey Information table
Lh = Manufacturer's anchor bolt length for given displacement/elongation from hold-down database
Slippage – Due to vertical slippage of hold-down fasteners attached to stud(s) when not combined with elongation
Nails = en from SDPWS Table C4.2.3D using values for wood structural panels
Bolts = Vf / (270,000 D^1.5) (NDS 11.3.6); D = bolt diameter, Vf = Tension force T / number of fasteners
Shrink + Extra – Wood shrinkage plus extra displacement due to mis-cuts, gaps, etc.
Shrinkage = 0.002 x (19% fabrication – 10% in-service moisture contents) x Ls
Ls = Length between anchor bolt fasteners subject to perp-to-grain shrinkage; see Story Information table
Crush – Deformation of bottom plate at compression end of wall segment
= 0.02" x [r / 0.73, r < 0.73; (1 + (r - 0.73) / 0.27), 0.73 < r < 1; 2 r^3, r > 1]
r = fcp / Fcp'; Fcp' = Ct CM Fcp; fcp = C / A, A = cross sectional area of end studs
Total da – Vert. Displacement + Slippage + Shrink + Crush + Extra
Horz Defl – Anchorage deflection term in SDPWS Eqn. C.4.3.4-1 = h / beff x da
h = Wall height. For end segments in FTAO walls, h is the average of the wall height and the distance from the bottom of opening to top of wall
beff = Effective wall segment length = b - (tension stud pack width + hold-down anchor bolt offset) - (1/2 compression stud pack width)
h and b are shown in Deflection table, beff in the Shear Wall Dimensions table

STORY DRIFT (flexible seismic design)

Level	Dir	Actual Story Drift (in) Const defl	Max dxe	Line	Max dx	Center of Mass	C of M dxe	C of M dx	Allowable Story Drift hsx ft	Delta a in	Ratio Max	Ratio C of M
1	E<->W	0.17	0.48	B	0.79	0.00	0.00	0.00	8.00	2.40	0.33	0.00

ASCE 7 Eqn. 12.8-15: dx = dxc + (dxe - dxc) Cd / Ie
Deflection amplification factor Cd from Table 12.2-1 = (E-W), 2.0 (N-S)
Importance factor Ie = 1.00

Legend:
Const defl (dxc) – Deflection due to shrinkage, gaps, bolt hole, etc. (constant with respect to force)
Max dxe – Largest deflection for any shearline on level in this direction; refer to Deflections table
Line – Shearline with largest deflection on level in this direction
hsx – Story height in ASCE Table 12.12-1 = Height of walls plus joist depth between this level and the one above.
Max dx – Largest amplified deflection on level in this direction using ASCE 7 Eq'n 12.8-15
C of M dxe - Deflection at the center of mass of this level; from interpolating deflections at adjacent shearlines.
C of M dx - Amplified deflection at center of mass using Eq'n 12.8-15. Does not include differences between top and bottom diaphragm deflection.
Delta a = Allowable story drift on this level from ASCE 7 Table 12.12-1
Ratio - Proportion of allowable story drift experienced, on this level in this direction.

Rigid Diaphragm Seismic Design

Rigid analysis not performed for level 1 because not all shearlines were loaded and rigidities could not be determined using the flexible diaphragm method

SEISMIC INFORMATION

Level	Mass [lbs]	Area [sq.ft]	Story Shear Fx [lbs] E-W	Story Shear Fx [lbs] N-S	Shear Resistance [lbs] E-W	Shear Resistance [lbs] N-S	Diaphragm Force [lbs] E-W Fpx	Diaphragm Force [lbs] E-W Design	Diaphragm Force [lbs] N-S Fpx	Diaphragm Force [lbs] N-S Design
1	0	0.0	0	0	16269	13200	0	0	0	0
All	0	–	0	0	–	–	–	–	–	–

Legend:
Mass – Sum of all generated and input building masses on level = wx in ASCE 7 Eqn. 12.8-12.
Story Shear – Total ASD-factored shear force induced at level x from Eqn. 12.8-11.
Shear Resistance – Lateral design strength of all shear-resisting elements on story, for use in weak story evaluation (4.1.8).
Diaphragm Force – used by Shearwalls only for drag strut forces, as per Exception to 12.10.2.1.
Fpx - Minimum ASD-factored force for diaphragm design from Eqns. 12.10-1, -2, and -3.
Design = The greater of the story shear and Fpx + transfer forces from discontinuous shearlines, factored by overstrength (omega) as per 12.10.1.1.
Omega = 3.0 as per 12.2-1.

Manually added or modified seismic loads and forces do not contribute to Story Shear shown here, nor are they included in the calculation of the diaphragm force Fpx, but they are distributed to the shearlines for shearwall design. Forces introduced via manually entered building masses are included in all calculations.

Vertical Earthquake Load Ev
Ev = 0 for Seismic Design Category A as per ASCE 7 12.4.2.2.

SHEAR RESULTS (rigid seismic design)

N-S Shearlines	W Gp	For Dir	ASD Shear Force [plf] v	vmax/vft	V [lbs]	Asp-Cub Int	Asp-Cub Ext	Allowable Shear [plf] Int	Ext	Co	C	Cmb	V [lbs]	Resp. Ratio
E-W Shearlines	**W Gp**	**For Dir**	**ASD Shear Force [plf] v**	**vmax/vft**	**V [lbs]**	**Asp-Cub Int**	**Asp-Cub Ext**	**Allowable Shear [plf] Int**	**Ext**	**Co**	**C**	**Cmb**	**V [lbs]**	**Resp. Ratio**
Line B														
Level 1														
LnB, Lev1	-	Both	-	-	5600	-	-	-	-	-		-	9069	-
Wall B-1	1	Both	-	-	5600	1.0	1.0	89	378	-	S	-	9069	-
Seg. 1	-	Both	350.5	-	4206	1.0	1.0	89	378	-		378	4534	0.93
Seg. 2	-	Both	116.2	-	697	1.0	1.0	89	378	-		378	2267	0.31
Seg. 3	-	Both	116.2	-	697	1.0	1.0	89	378	-		378	2267	0.31

Legend:
W Gp - Wall design group defined in Sheathing and Framing Materials tables, where it shows associated Standard Wall. "^" means that this wall is critical for all walls in the Standard Wall group.
For Dir – Direction of seismic force along shearline.
v – Design shear force on segment = ASD-factored shear force per unit length of full-height sheathing (FHS)
vmax/vft - Perforated walls: Collector and in-plane anchorage force as per SDPWS eqn. 4.3-9 = V/FHS/Co. FHS is factored for narrow segments as per 4.3.3.4
FTAO walls: Shear force in piers above and below either openings or piers beside opening(s). Aspect ratio factor does not apply to these piers.
V – ASD factored shear force. For shearline: total shearline force. For wall: total of all segments on wall. For segment: force on segment
Asp/Cub – Unblocked wood structural panel factor Cub from SDPWS 4.3.5.3 or Aspect Ratio factor from 4.3.3.2, which for perforated walls is sum bi / FHS from 4.3.5.6 with bi defined in 4.3.3.4. For multi-segment walls, wall row shows Cub and segment rows show Asp. For single-segment walls and perforated walls, value shown is Asp for blocked walls and Cub for unblocked walls.
Int, Ext - Nominal unit shear capacity of interior and exterior sheathing, factored by Table 4.3-1 Note 3 for framing specific gravity and Note 10 for presence of hold-downs. For wall segments, also include unblocked factor Cub and aspect ratio adjustments.
Co - Adjustment factor for perforated walls from SDPWS Equation 4.3-6.
C - Sheathing combination rule, A = Add capacities, S = Strongest side or twice weakest, G = Stiffness-based using Eqns. 4.3-3,-4.
Cmb - Combined interior and exterior unit shear capacity including perforated wall factor Co.
V – Total factored shear capacity of shearline, wall or segment.
Crit Resp – Response ratio = v/Cmb = design shear force/unit shear capacity. "W" indicates that the wind design criterion was critical in selecting wall.

Notes:
Refer to Elevation View diagrams for individual level for uplift anchorage force t for perforated walls given by SDPWS 4.3.6.4.2,1.

Hold-Down and Compression Design (rigid seismic design)

Level 1 Line-Wall	Posit'n	Location [ft] X	Location [ft] Y	Tensile Hold-down or Compressive Stud Force [lbs] Shear	Dead	Ev	Cmb'd	Hold-down	Cap [lbs]	Crit Resp.
Line B										
B-1	L End	0.12	29.75	2863			2863	HDU5-SDS	4340	0.66
B-1	L End	0.12	29.75	2863			2863	Compression	4462	0.64
B-1	L Op 1	11.88	29.75	2863			2863	HDU5-SDS	4340	0.66
B-1	L Op 1	11.88	29.75	2863			2863	Compression	4462	0.64
B-1	R Op 1	18.13	29.75	970			970	HDU5-SDS	4340	0.22
B-1	R Op 1	18.13	29.75	970			970	Compression	4462	0.22
B-1	L Op 2	23.88	29.75	970			970	HDU5-SDS	4340	0.22
B-1	L Op 2	23.88	29.75	970			970	Compression	4462	0.22
B-1	R Op 2	30.13	29.75	970			970	HDU5-SDS	4340	0.22
B-1	R Op 2	30.13	29.75	970			970	Compression	4462	0.22
B-1	R End	35.88	29.75	970			970	HDU5-SDS	4340	0.22
B-1	R End	35.88	29.75	970			970	Compression	4462	0.22

Legend:
Line-Wall:
At wall or opening – Shearline and wall number
At vertical element – Shearline
Posit'n – Position of stud pack that hold-down is attached to:
V Elem – Vertical element: column or strengthened studs required where not at wall end or opening
L or R End – At left or right wall end
L or R Op n – At left or right side of opening n
t @ Op n – Uplift force t at opening n from offset opening in perforated wall above, from SDPWS 4.3.6.4.2.1
Location – Co-ordinates in Plan View
Tensile Hold-down or Compressive Stud Force – Upwards force on hold-down at one end of the wall or downward force on bottom plate under studs at the other end, for each force direction. Includes forces transferred from upper levels.
Shear – Overturning component = V x h / beff from SDPWS Eqn. 4.3-7; V = force on segment, ASD-factored by 0.70; h = wall height , beff = wall segment length – (tension stud pack width + hold-down anchor bolt offset) – (1/2 compression stud pack width). For perforated walls = V x h / Co sum (bi) from SDPWS Eqn. 4.3-8.
Dead – Dead load resisting component, factored for ASD by 0.60 for tension and 1.0 for compression
Ev – Vertical seismic load effect from ASCE 7 12.4.2.2 = -0.2 Sds x ASD factor x unfactored D = 0.0 SDS x factored D. Refer to Seismic Information table for more details.
Cmb'd – Sum of ASD-factored overturning, dead and vertical seismic forces. May also include the uplift force t from perforated walls from SDPWS 4.3.6.4.2.1 when openings are staggered.
Hold-down – Device model number from hold-down database; "Compression" for bearing of end stud pack on bottom plate
Cap – Hold-downs: Allowable ASD tension load from database; Compression: Allowable ASD bearing force = Ct CM Cb Fcp A; A = cross sectional area of end studs. Refer to Framing materials table for details.
Crit. Resp. – Critical Response = Combined ASD force/Allowable ASD tension load

Notes:
HDU5-SDS2.5 for studs with thickness > 0'-3" and depth > 0'-3.5" : Uses 14 1/4" x 2.5" SDS heavy-duty screws; 5/8" anchor bolt.
Combined force from ASCE 7 2.4.1 load combination 10 = - (0.6D - 0.7Ev + 0.7Eh); Eh (from 12.4.2.1) = - shear overturning force
Refer to the Shear Line Dimensions table for wall height h, effective segment length beff and perforated wall adjusted sum of bi, to the Story Table for joist depth, and to the Shear Results table for perforated factor Co.
Designer is responsible for design of connection from wall to floor or foundation for shear force shown in Shear Results table. Refer to SDPWS 4.3.6.4.3 for foundation anchor bolt requirements.

COLLECTOR FORCES (rigid seismic design)

Level 1 Line-Wall	Position on Wall or Opening	Location [ft] X	Location [ft] Y	Drag Strut Force [lbs] --->	Drag Strut Force [lbs] <---	Strap/Blocking Force [lbs] --->	Strap/Blocking Force [lbs] <---
Line B							
	Shearline force			5600	5600		
B-1	Left Opening 1	12.00	29.75	2343	-2343		
B-1	Right Opening 1	18.00	29.75	1409	-1409		
B-1	Left Opening 2	24.00	29.75	1171	-1171		
B-1	Right Opening 2	30.00	29.75	238	-238		

Legend:
Line-Wall - Shearline and wall number
Position…- Side of opening or wall end that drag strut is attached to
Location - Co-ordinates in Plan View
Drag strut Force - Axial force in transfer element at openings, gaps, or changes in design shear along shearline. + : tension; - : compression.
Based on ASD-factored shearline force shown. For SDC C-F, it is the greater of the design shearline force and the diaphragm force Fpx, added to shearline force
from story above and to forces transferred from discontinuous shearlines factored by overstrength (omega) as per 12.10.1.1.
Refer to Seismic Information table for diaphragm forces and omega factor.
For SDC D-F, if horizontal torsional irregularities 1a or 1b are detected, or if other horizontal irregularities are input, or if vertical irregularity 4 detected or input, 25% increase from 12.3.3.4 applied.
Strap/Blocking Force – For FTAO walls, force transferred from above and below opening to shearwall pier.
-> Due to shearline force in the west-to-east or south-to-north direction
<- Due to shearline force in the east-to-west or north-to-south direction

DEFLECTION (rigid seismic design)

Wall, segment	W Gp	Dir	Srf	v plf	b ft	h ft	Bending A sq.in	Bending Defl in	Ga kips/ in	Nail slip Vn lbs	Nail slip en in	Shear Defl in	Hold Defl in	Total Defl in
Level 1														
Line B														
B-1,1	1	Both	ExtS	500.7	12.00	8.00	10.5	.012	20.1	88	.007	.199	0.26	0.48
B-1,2		Both	ExtS	166.0	6.00	8.00	10.5	.008	20.1	88	.007	.066	0.41	0.48
B-1,3		Both	ExtS	166.0	6.00	8.00	10.5	.008	20.1	88	.007	.066	0.41	0.48

Legend:
Wall, segment – Wall and segment between openings, e.g. B-3,2 = second segment on Wall 3 on Shearline B.
W Gp – Wall design group, refer to Sheathing and Framing Materials tables.
Dir – Force direction.
Srf – Wall surface = Int(erior) or Ext(erior) for perimeter walls, 1 or 2 for interior partitions; Comb = Combined v and Ga for identical materials on each side; S = Ga from side with stronger shear resistance; W = 2 x Ga of weaker side.
v – Unfactored (strength-level) shear force per unit distance on wall segment = ASD force / 0.70, as per ASCE 7 12.8.6,.
Unblocked walls = v / Cub as per SDPWS 4.3.4.3, Cub = Unblocked factor from 4.3.5.3, shown in the Shear Results table.
Perforated walls = vmax from Eqn. 4.3-9, as per 4.3.4.2.
FTAO walls = Unit shear force in pier beside opening(s).
b – Wall or segment length.
Segmented wall or FTAO wall segments = Width of wall segment between openings.
Perforated wall = Sum of FHS segments, modified as in 4.3.3.4 per 4.3.4.2.
FTAO wall = Length of wall including openings.
h – Wall height.
FTAO piers = Distance from bottom of opening to top of wall; for end segments, results using that distance and the wall height are averaged.
Defl – Horizontal shear wall deflection due to given term:
Bending = 8vh^3 / EAb; A = Effective cross sectional area of segment end stud(s), E = stud mod. of elasticity in Framing Materials table
For i studs at one end and j at the other, A = 2 ij / (i + j) x area of one stud, based on Ex. C4.3.4-3
Shear = vh / 1000 Ga; Ga = 1.4 vs / (1.4 vs / Gvtv + 0.75 en) from SDPWS Eqn. C4.2.3-3.
vs = ASD sheathing capacity.
Gvtv = Shear stiffness from C4.3.4, shown in Sheathing Materials table.
en = Nail slip from Table C4.2.3D, of form aVn^b for WSP, varies linearly to value at capacity for other materials.
Vn = Strength-level shear force per nail along panel edge at ASD capacity = 1.4 vs.
Hold – Anchorage system (hold-down) = da x h / beff.
da = Vertical hold-down displacement; refer to Hold-down Displacement table for components.
beff = Effective wall segment length = b - (tension stud pack width + hold-down anchor bolt offset) - (1/2 compression stud pack width)
beff is given in the Shear Wall Dimensions table.
For FTAO walls, hold-down device at end of wall is applied to all segments, as per APA T555.
Total Defl – Deflection from bending + shear + hold-down, as per Eqn. 4.3-2.
For FTAO walls, the average of the values for the segments, as per APA T555.

WARNING - Fastener slip based on lumber with specific gravity not less than 0.5, however specific gravity for at least some walls is less than 0.5. Refer to the Framing Materials table.

HOLD-DOWN DISPLACEMENT (rigid seismic design)

Wall, segment	Dir	Hold-down	Tens. force lbs	Vert. Displacement Manuf in	Add in	da in	Slippage Vf lbs	da in	Shrink +Extra in	Comp. force lbs	Crush da in	Total da in	Horz Defl in
Level 1													
Line B													
B-1,1	Both	HDU5-SDS	2863	.104	.003	0.107	-	-	.248	4091	0.03	0.39	0.26
B-1,2	Both	HDU5-SDS	970	.035	.001	0.036	-	-	.248	1386	0.01	0.29	0.41
B-1,3	Both	HDU5-SDS	970	.035	.001	0.036	-	-	.248	1386	0.01	0.29	0.41

Legend:
Wall, segment – Wall and segment between openings, e.g. B-3,2 = second segment on Wall 3 on Shearline B
Dir – Force direction
Tens., Comp. – Accumulated ASD hold-down tension force T and strength-level end compression force C from overturning, dead and vertical earthquake loads.
Tens. – ASD-factored force, used for proportion of manufacturer's maximum elongation
Comp. – Strength level force as per ASCE 12.8.6
da – Vertical displacements due to the following components:
Vert. Displacement – Elongation when slippage calculated separately; displacement when combined elongation/slippage used
Manuf – Using manufacturer's value for anchor bolt length, or no bolt contribution for connector-only elongation
*Unless marked with * = (ASD tension force / ASD hold-down capacity) x max strength-level elongation or displacement*
** - Maximum strength-level elongation or displacement is used. May result in higher than actual displacements for lightly loaded hold-downs, causing the segment to draw less force due to lower than actual stiffness.*
Add – Due to longer anchor bolt length than manufacturer's value, or entire bolt length for connector-only elongation = TL / (Ab x Es)
T = Strength level tension force (not shown)
Ab = bolt cross-sectional area
Es = steel modulus = 29000000 psi
L = Lb – Lh
Lb = Total bolt length shown in Storey Information table
Lh = Manufacturer's anchor bolt length for given displacement/elongation from hold-down database
Slippage – Due to vertical slippage of hold-down fasteners attached to stud(s) when not combined with elongation
Nails = en from SDPWS Table C4.2.3D using values for wood structural panels
Bolts = Vf / (270,000 D^1.5) (NDS 11.3.6); D = bolt diameter, Vf = Tension force T / number of fasteners
Shrink + Extra – Wood shrinkage plus extra displacement due to mis-cuts, gaps, etc.
Shrinkage = 0.002 x (19% fabrication – 10% in-service moisture contents) x Ls
Ls = Length between anchor bolt fasteners subject to perp-to-grain shrinkage; see Story Information table
Crush – Deformation of bottom plate at compression end of wall segment
= 0.02" x [r / 0.73, r < 0.73; (1 + (r - 0.73) / 0.27), 0.73 < r < 1; 2 r^3, r > 1]
r = fcp / Fcp'; Fcp' = Ct CM Fcp; fcp = C / A, A = cross sectional area of end studs
Total da – Vert. Displacement + Slippage + Shrink + Crush + Extra
Horz Defl – Anchorage deflection term in SDPWS Eqn. C.4.3.4-1 = h / beff x da
h = Wall height. For end segments in FTAO walls, h is the average of the wall height and the distance from the bottom of opening to top of wall
beff = Effective wall segment length = b - (tension stud pack width + hold-down anchor bolt offset) - (1/2 compression stud pack width)
h and b are shown in Deflection table, beff in the Shear Wall Dimensions table

STORY DRIFT (rigid seismic design)

Level	Dir	Actual Story Drift (in) Const defl	Max dxe	Line	Max dx	Center of Mass	C of M dxe	C of M dx	Allowable Story Drift hsx ft	Delta a in	Ratio Max	Ratio C of M
1	E<->W	0.17	0.48	B	0.79	0.00	0.00	0.00	8.00	2.40	0.33	0.00

ASCE 7 Eqn. 12.8-15: dx = dxc + (dxe - dxc) Cd / Ie
Deflection amplification factor Cd from Table 12.2-1 = (E-W), 2.0 (N-S)
Importance factor Ie = 1.00

Legend:
Const defl (dxc) – Deflection due to shrinkage, gaps, bolt hole, etc. (constant with respect to force)
Max dxe – Largest deflection for any shearline on level in this direction; refer to Deflections table
Line – Shearline with largest deflection on level in this direction
hsx – Story height in ASCE Table 12.12-1 = Height of walls plus joist depth between this level and the one above.
Max dx – Largest amplified deflection on level in this direction using ASCE 7 Eq'n 12.8-15
C of M dxe - Deflection at the center of mass of this level; from interpolating deflections at adjacent shearlines.
C of M dx - Amplified deflection at center of mass using Eq'n 12.8-15.
Delta a = Allowable story drift on this level from ASCE 7 Table 12.12-1
Ratio - Proportion of allowable story drift experienced, on this level in this direction.