Minimum Wall Sheathing CRC - First Floor **SECTION 01**

The residence is sheathed in exterior 1/2" 5-ply plywood nailed with 8d common nails at 12" oc at edges and field. The boundary nailing capacity is half of the maximum spacing tabulated in the building codes. The residence is checked against the CRC prescriptive wall opening limits, assuming 6" oc (which is not the case) to assess the degree of wall continuity. A CBC analysis is performed in calculation 0301 which estimates the DC ratios for the 12" oc nailing.

Existing shear wall nailing - 8d at 12" OC [Fig: 0201.01]

Existing shear wall nailing - 8d - 2-1/2" penetration [Fig: 0201.02]

The minimum solid wall percent is given in the following CRC table.

R606.12.2.1 MINIMUM EXTERIOR SOLID WALL LENGTH (%) [Table: 0201.01]

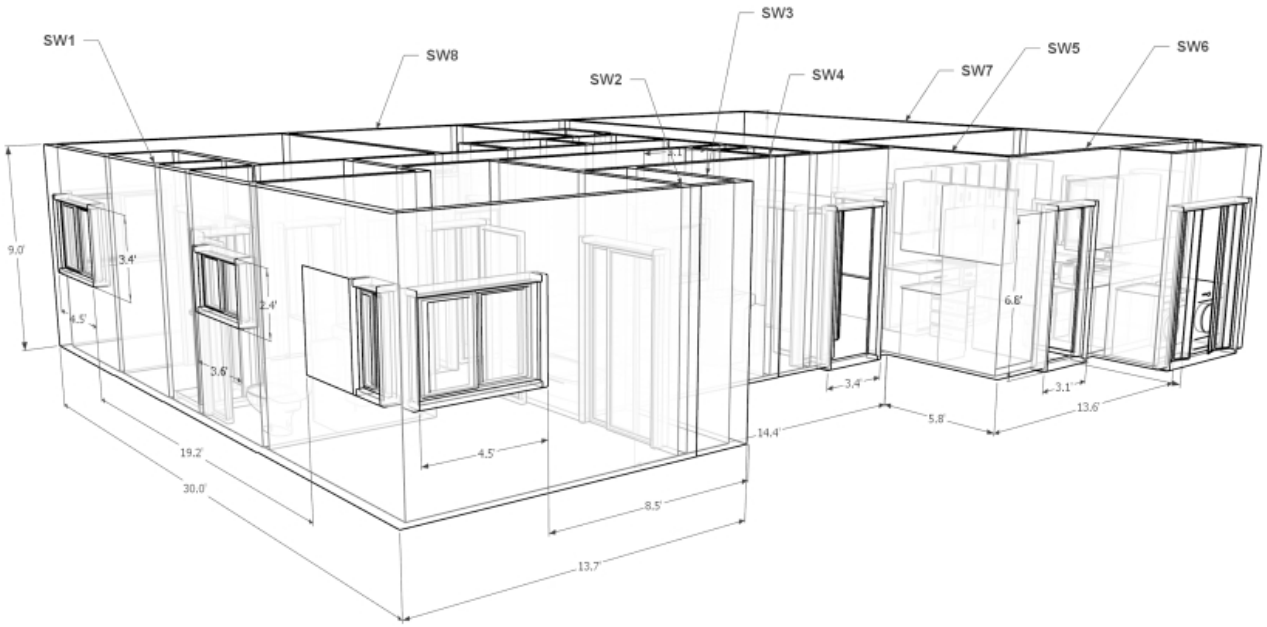
Seismic Design Category	One story or top story of two story	Wall supporting light-framed second story and roof	Wall supporting masonry second story and roof
Townhouses in C	20	25	35
D0 or D1	25	Not Permitted	Not Permitted
D2	30	Not Permitted	Not Permitted

The percent solid wall for each shear wall is:

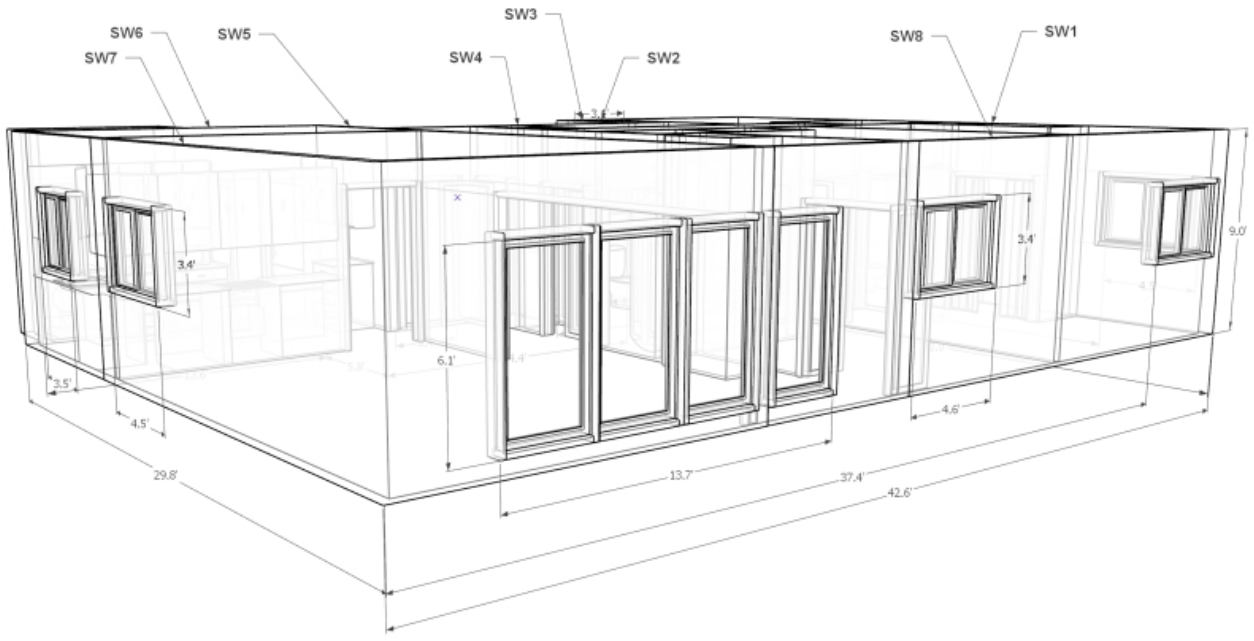
Percent Solid Shearwall [Table: 0201.02]

Wall No.	Length (ft)	Openings (ft)	Solid (%)
SW1	30	12.6	58
SW2	13.7	4.5	67
SW3	5.8	0	100
SW4	14.4	6.5	55
SW5	5.8	0	100
SW6	13.6	3.1	77
SW7	30	8	73
SW8	42	22.7	46

Therefore, if edge nailing requirements are met the residence meets the prescriptive opening requirements of the CRC.



First floor shear walls - north and west sides [Fig: 0201.03]



First floor shear walls - south and east sides [Fig: 0201.04]

Check required basic fastener spacing:

R602.3(1) FASTENING SCHEDULE [Table: 0201.03]

Panel thick-ness	Number and Type of Fastener [a][b][c]	Edge Spac-ing	Intermedi-ate Spacing
3/8 in.-1/2 in.	6d common (2 in. x 0.11 in) nail (subfloor, wall); 8d common (2 1/2 in. x 0.131 in.) nail (roof); or RSRS- 01 (2 7/8 in. x 0.113 in.) nail (roof)	6 in.	12 in.
19/32 in.- 1 in.	8d common nail (2 1/2 in. x 0.131 in.); or RSRS-01; (2 1/8 in. x 0.113 in.) nail (roof)	6 in.	12 in.
1/8 in.-1 1/4 in.	10d common (3 in. x 0.148 in.) nail; or 8d (2 1/2 in. x 0.131 in.) deformed nail	6 in.	12 in.

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Note: Table applies to wood structural panels, subfloor, roof
 and interior wall sheathing to framing and particleboard wall
 sheathing to framing [see Table FI602.3(3) for wood structural
 panel exterior wall sheathing to wall framing

 [a] Nails are smooth-common box or deformed shanks except where
 otherwise stated. Nails used for framing and sheathing connections
 shall have minimum average bending yield strengths as shown:
 80 ksi for shank diameter of 0.192 inch (20d common nail);
 90 ksi for shank diameters larger than 0.142 inch but not larger
 than 0.177 inch and 100 ksi for shank diameters of 0.142 inch or less.

 [b] Staples are l6 gage wire and have a minimum 7/16-inch diameter crown width.

 [c] Nails shall be spaced at not more than 6 inches on center at all supports
 where spans are 48 inches or greater.
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Check code required wind governed fastener spacing:

R602.3(3) WOOD WALL SHEATHING WIND PRESSURE REQUIREMENTS[a,b,c] [Table: 0201.04]

Minimum Nail Size	6d common\n(2.0 x 0.113)	8d Common\n(2.5 x 0.131)	8d Common\n(2.5 x 0.131)
Minimum Nail Penetration (in)	1.5	1.75	1.75
Minimum Panel Span Rating	24/0	24/16	24/16
Minimum Nominal Thickness (in)	3/8	7/16	7/16
Minimum Stud Spacing (in)	16	16	24
Edge Nail Spacing (in)	6	6	6
Field Nail Spacing (in)	12	12	12
Exposure B Vult (mph)	140	170	140
Exposure C Vult (mph)	115	140	115
Exposure D Vult (mph)	110	135	110

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[1] Panel strength axis parallel or perpendicular to supports. Three-ply plywood
 sheathing with studs spaced more than 16 inches on center shall be applied with
 panel strength axis perpendicular to supports.

 [2] Table is based on wind pressures acting toward and away from building surfaces
 in accordance with Section R301.2. Lateral bracing requirements shall be in
 accordance with Section 8602.10.

 [3] Wood structural panels with span ratings of Wall-16 or Wall-24 shall be permitted
 as an alternate to panels with a 24/0 span rating. Plywood siding rated 16 o.c. or
 24 o.c. shall be permitted as an alternate to panels with a 24/16 span rating.
 Wall-16 and Plywood siding 16 o.c. shall be used with studs spaced not more than
 16 inches on center.
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In order to meet the code prescriptive wind and seismic requirements the number of nails at the exterior sheathing panel boundaries need to be doubled - from 12" oc to 6" oc. Refer to CBC analysis in calculation 0301 for an analysis of DC ratios with reduced capacity

Foundation - CRC Requirements SECTION 02

The existing foundation on the north and west side of the residence is a concrete strip footing directly supporting the floor joists. On the south side the floor joists are supported on 2x4 framed walls varying in height, up to 6 feet. The framing is clad on the outside with 1x10 planks, spaced 1" apart for ventilation.

The foundation has two significant seismic deficiency. The first is a significant torsional irregularity arising from lack of shear stiffness and strength on the south and east walls. The existing structure has only one compression brace along each wall and the spaced planks do not provide meaningful strength or stiffness. This irregularity is a deficiency whether the floor diaphragm is considered semi-rigid or flexible. The second is the lack of adequate anchorage of the sill plates to the foundation. Existing anchorage typically consists of only a single 1/2" anchor bolt and small washer every 3 or 4 feet.

The torsional irregularities disqualify the foundation structure from following a CRC design process.

Seismic Model Inputs - CBC Requirements SECTION 03

Seismic demands on the residence were analyzed using a 3D FEM model. The model includes the full relevant geometry, loads and stiffness of the walls, roof, floors and foundation.

The in-plane stiffness of the T&G roof is taken as 300 pounds/inch/inch using test data from [USDA1972]. The in-plane stiffness of the plywood shear walls and subfloor is estimated at 1000 pounds/inch/inch after supplementary nailing, using values from CBC tables.

[USDA1972] USDA Forest Products Laboratory. 1972. "Shear Stiffness Of Two-Inch Wood Decks For Roof Systems", U.S.D.A. Forest Service RESEARCH PAPER, FPL 155 1972

AWC4.3A Unit Shear Capacity Wood-Frame Shear Walls [1-7] [Table: 0201.05]

component	property	–	–	wood	sheath	–	–
panel	thick(in)	5/16	3/8	3/8	7/16	15/32	15/32
nail	depth(in)	1-1/4	1-1/4	1-3/8	1-3/8	1-3/8	1-1/2
nail	size	6d	6d	8d	8d	8d	10d
———	——-	——-	——-	——-	——-	——-	——-
edge nail	value						
———	——-	——-	——-	——-	——-	——-	——-
6-in	vs(plf)	360	400	440	480	520	620
OSB 6-in	Ga(kip/in)	13	11	17	15	13	22
PLY 6-in	Ga(kip/in)	9.5	6.5	12	11	10	14
4-in	vs(plf)	540	600	640	700	760	920
OSB 4-in	Ga(kip/in)	18	15	25	22	19	30
PLY 4-in	Ga(kip/in)	12	11	15	14	13	17
3-in	vs(plf)	700	780	820	900	960	1200
OSB 3-in	Ga(kip/in)	24	20	31	28	25	37
PLY 3-in	Ga(kip/in)	14	13	17	17	15	19
2-in	vs(plf)	900	1020	1060	1170	1280	1540
OSB 2-in	Ga(kip/in)	37	32	45	42	39	52
PLY 2-in	Ga(kip/in)	18	17	20	21	20	23

```
[1] Nominal unit shear capacities shall be adjusted in
 accordance with 4.3.3 to determine ASD allowable unit
 shear capacity and LRFD factored unit resistance. For
 general construction requirements see 4.3.6. For specific
 requirements, see 4.3.7.1 for wood structural panel
 shear walls, 4.3.7.2 for particleboard shear walls, and
 4.3.7.3 for fiberboard shear walls. See Appendix A for
 common and box nail dimensions.

 [2] Shears are permitted to be increased to values
 shown for 15/32 inch (nominal) sheathing with same nailing
 provided (a) studs are spaced a maximum of 16 inches on center,
 or (b) panels are applied with long sdimension across studs.

 [3] For species and grades of framing other than Douglas-Fir-Larch
 or Southern Pine, reduced nominal unit shear capacities shall
 be determined by multiplying the tabulated nominal unit
 shear capacity by the Specific Gravity Adjustment Factor = [1-(0.5-G)],
 where G = Specific Gravity of the framing lumber from the
 NDS (Table l2.3.3A). The Specific Gravity Adjustment Factor shall
 not be greater than 1.

 [4] Apparent shear stiffness values Ga, are based on nail slip
 in framing with moisture content less than or equal to 19% at
 time of fabrication and panel stiffness values for shear walls
 constructed with either OSB or 3-ply plywood panels. When
 4-ply or 5-ply plywood panels or composite panels are used,
 Ga values shall be permitted to be multiplied by 1.2.
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[5] Where moisture content of the framing is greater than
19% at time of fabrication, G, values shall be multiplied by 0.5.

[6] Where panels are applied on both faces of a shear wall
and nail spacing is less than 6" on center 'on either side,
panel joints shall be offset to fall on different framing
members as shown below. Alternatively, the width of the
nailed face of framing members shall be 3" nominal or
greater at adjoining panel edges and nails at all panel
edges shall be staggered.

[7] Galvanized nails shall be hot-dipped or tumbled.
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The shear capacity adjustments for shear wall openings is taken from the AWC table below:

Table 4.3.3.5 Shear CapacitynAdjustment Factor, Co [Table: 0201.06]

Wall Hght - h	Max Opening Hght [1]				
h	h/3	h/2	2h/3	5h/6	h
8’ Wall	2’-8in	4’-0in	5’-4in	6’-8in	8’-0in
9’ Wall	3’-0in	4’-6in	6’-0in	7’-6in	9’-0in
10’ Wall	3’-4in	6’-0in	6’-8in	8’-4in	10’-0in
Percent Full-Hght Sheathing [2]	Effective Shear Capacity Ratio				
10%	1.00	0.69	0.53	0.43	0.36
20%	1.00	0.71	0.56	0.45	0.38
30%	1.00	0.74	0.59	0.49	0.42
40%	1.00	0.77	0.63	0.53	0.45
50%	1.00	0.80	0.67	0.57	0.50
60%	1.00	0.83	0.71	0.63	0.56
70%	1.00	0.87	0.77	0.69	0.63
80%	1.00	0.91	0.83	0.77	0.71
90%	1.00	0.95	0.91	0.87	0.83
100%	1.00	1.00	1.00	1.00	1.00

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[1] The maximum opening height shall be taken as the
 maximum opening clear height in a perforated shear wall.
 Where areas above and/or below an opening remain unsheathed,
 the height of each opening shall be defined as the clear
 height of the opening plus the unsheathed areas.

 [2] The sum of the perforated shear wall segment lengths, Sum(L),
 divided by the total length of the perforated shear wall. Lengths of
 perforated shear wall segments with aspect ratios greater than 2:1
 shall be adjusted in accordance with Section 4.3.4.3.
```

ASCE7-16; Risk II; Site D [Table: 0201.07]

Parameter	Value
SS	1.512
S1	0.685
FA	1
FV	1.5
SMS	1.512
SM1	1.027
SDS	1.008
SD1	0.685
TL	12
PGA	0.603
PGAM	0.603
FPGA	1
LE	1

Base shear coefficient [Table: 0201.08]

variable	value	[value]	description
SDS	1.00	1.00	short period design
R1	6.50	6.50	reduction factor
omega	3.00	3.00	overstrength factor

Seismic coefficent [Equ: 0201.01]

$$\mathrm{C_s} = \frac{\mathrm{SDS}}{\mathrm{R_1}}$$

C_s	SDS	R1
0.15 [-] [0.15 [-]]	[-]	6.50 [-]