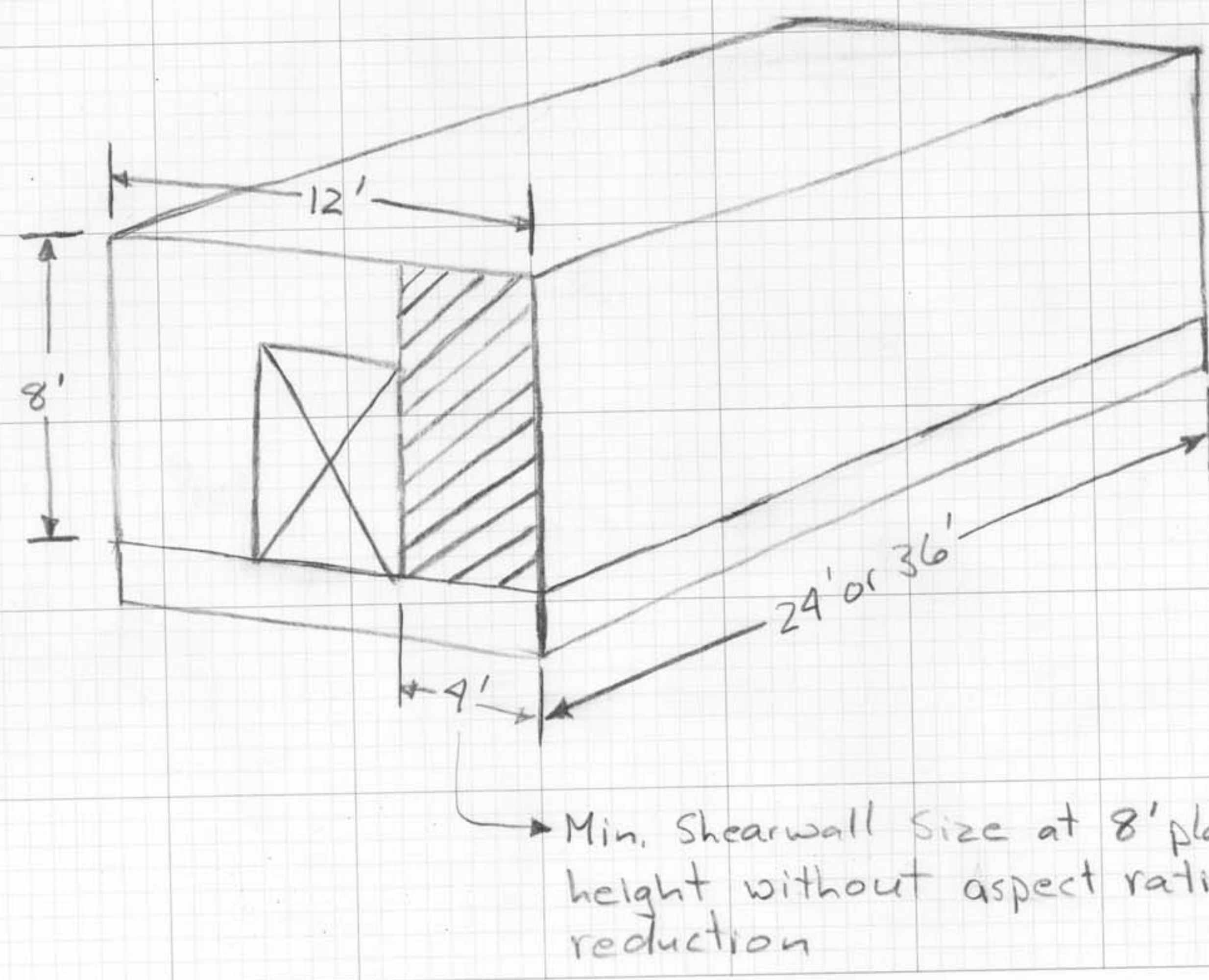
Modular Design Constraints

* Why 12'x36'? A major cost cutting and time saving practice is wood construction is using dimensions that are multiples of 4' & 16". Sheets of plywood, OSB, & drywall come in sheets of 4'x8', studs are typically spaced at 16" oc. Also, 36' & 24' are multiples of 12', Thus we can orientate the modules 90° from each other creating greater floorplan options.
* All shearwalls must stack. Thus to maximize the height capabilities of the modular building, all openings should Line up.



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DEAD LOADS

Roof Load:

Item:	Unit Weight:
Roof Sheathing - 1/2" plywood:	1.5 psf
Composition Roofing:	4.5 psf
Roof Framing:	2.0 psf
5/8" Gypsum Wall Board:	2.8 psf
Insulation	1.0 psf
Walls:	0.0 psf
Misc.:	0.5 psf
	12.3 psf

Seismic Roof Load:

Item:	Unit Weight:
Roof Sheathing - 1/2" plywood:	1.5 psf
Composition Roofing:	4.5 psf
Roof Framing:	2.0 psf
5/8" Gypsum Wall Board:	2.8 psf
Insulation:	1.0 psf
Walls:	4.0 psf
Misc.:	0.5 psf
	16.3 psf

Floor Load:

Item:	Unit Weight:
Floor Sheathing - 1.125" plywood:	3.4 psf
Floor Framing:	2.5 psf
Insulation:	1.5 psf
Flooring:	2.0 psf
Walls:	0.0 psf
Misc:	1.0 psf
	psf
	10.4 psf

Ceiling Load:

Item:	Unit Weight:
Lid Sheathing - 1/2" plywood:	1.5 psf
Ceiling Framing:	2.5 psf
Insulation:	1.5 psf
(2) 5/8" Gypsum Wall Board:	5.6 psf
Walls:	0.0 psf
Misc:	1.0 psf
	psf
	12.1 psf

Seismic Floor Load:

Item:	Unit Weight:
Floor Sheathing - 1.125" plywood:	3.4 psf
Floor Framing:	2.5 psf
Insulation:	1.5 psf
Flooring:	2.0 psf
Walls:	4.0 psf
Misc:	1.0 psf
	psf
Lid Sheathing - 1/2" plywood:	1.5 psf
Ceiling Framing:	2.5 psf
Insulation:	1.5 psf
(2) 5/8" Gypsum Wall Board:	5.6 psf
Walls:	4.0 psf
Misc:	1.0 psf
	psf
	30.5 psf

LIVE LOADS

Roof Load:

Min. Roof Live Load:	20.0 psf
Snow Load:	15.0 psf
Design Roof Load:	20.0 psf

Floor Load:

Residential:	40.0 psf

Balcony Load:

Residential:	60.0 psf

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Design of Pad Footings

Allowable Soil Bearing: 1200 psf
Ratio of Dead to Total Load: 0.6
Concrete Strength, fc': 4000 psi
Steel Yield Strength: 60000 psi
Column Dimension: 4 inches

Flexure:

Mark	Load	Pu	wu	Mu	h	d	F	Ku	As min.	Reinforcing
2.00	4800 lbs.	6528 lbs.	1632 psf	816 ft-lbs./ft	10 in.	7 in.	0.049	16.65	0.55	(3) # 4 bars
3.00	10800 lbs.	14688 lbs.	1632 psf	1836 ft-lbs./ft	10 in.	7 in.	0.049	37.47	0.83	(5) # 4 bars
4.00	19200 lbs.	26112 lbs.	1632 psf	3264 ft-lbs./ft	10 in.	7 in.	0.049	66.61	1.11	(6) # 4 bars
5.00	30000 lbs.	40800 lbs.	1632 psf	5100 ft-lbs./ft	10 in.	7 in.	0.049	104.08	1.39	(7) # 4 bars
6.00	43200 lbs.	58752 lbs.	1632 psf	7344 ft-lbs./ft	12 in.	9 in.	0.081	90.67	2.14	(7) # 5 bars
7.00	58800 lbs.	79968 lbs.	1632 psf	9996 ft-lbs./ft	12 in.	9 in.	0.081	123.41	2.49	(9) # 5 bars
8.00	76800 lbs.	104448 lbs.	1632 psf	13056 ft-lbs./ft	12 in.	9 in.	0.081	161.19	2.85	(7) # 6 bars
9.00	97200 lbs.	132192 lbs.	1632 psf	16524 ft-lbs./ft	12 in.	9 in.	0.081	204.00	3.65	(9) # 6 bars

Shear:

		Beam Shear				Punching Shear			
Mark	wu	Load'g Area	Vu	phi Vc		Load'g Area	Vu	phi Vc	
2.00	1632 psf	0.83 sf	1.36 kips	15.94 kips	ok	3.16 sf	5.16 kips	38.04 kips	ok
3.00	1632 psf	2.75 sf	4.49 kips	23.91 kips	ok	8.16 sf	13.32 kips	64.60 kips	ok
4.00	1632 psf	5.67 sf	9.25 kips	31.88 kips	ok	15.16 sf	24.74 kips	101.79 kips	ok
5.00	1632 psf	9.58 sf	15.64 kips	39.84 kips	ok	24.16 sf	39.43 kips	149.60 kips	ok
6.00	1632 psf	13.50 sf	22.03 kips	61.47 kips	ok	34.83 sf	56.84 kips	265.20 kips	ok
7.00	1632 psf	19.25 sf	31.42 kips	71.72 kips	ok	47.83 sf	78.05 kips	354.00 kips	ok
8.00	1632 psf	26.00 sf	42.43 kips	81.97 kips	ok	62.83 sf	102.53 kips	456.46 kips	ok
9.00	1632 psf	33.75 sf	55.08 kips	92.21 kips	ok	79.83 sf	130.28 kips	572.58 kips	ok

Standard Strap Holdowns:

* Strap shall provide for overturning forces. Strap will be nailed to post above and below and will be spliced with self-drilling, self tapping screws
* Design for target capacities of 4k, 8k, & 12k (ASD)

Bases: Strap has a minimum yield stress of 33ksi
Nails shall be .148"ø x 2 1/4" in DF Framing.
Screws shall be Hilti Kwik-Pro Self Drilling screws

① Strap Check

AISI Section 3.2 $T_N = \frac{A_n F_y}{\Omega_t}$ $F_y = 35$ ksi $\Omega = 1.67$

Type a: 3" x 14 GA strap w/(2) rows of nails:

$A_N = (3)(.075) - (.075)(.148)(2) = .2028 in^2$

$T_N = \frac{.02028 (33)}{1.67} = 4.01K \rightarrow OK$

Type b: 4 1/2" x 12 GA Strap w/ (3) Rows of Nails

$A_n = (4.5)(.105) - .105(.148)(3) = .4259 in^2$

$T_N = \frac{.4259 (33)}{1.67} = 8.42K \rightarrow OK$

Type c: 6" x 12" GA Strap w/ (4) rows of nails:

$A_N = 6(.105) - (.105)(.148)(4) = .5678 in^2$

$T_N = \frac{(.5678)(33)}{1.67} = 11.22K \rightarrow OK$

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. Nails

Per NDS Table 11P:

10d Common w/ 14 GA: $Z' = 1.6(103) = 165$ lbs

10d Common w/ 12 GA: $Z' = 1.6(110) = 176$ lbs

Type a: $n = \frac{4000\text{ lb}}{167\text{ lb}} = 24.2 \rightarrow$ use (28) nails

Type b: $n = \frac{8000\text{ lb}}{176\text{ lb}} = 45.5 \rightarrow$ use (48) nails

type c: $n = \frac{11{,}200\text{ lb}}{176\text{ lb}} = 63.6 \rightarrow$ use (66) nails

Strap to Plate Connection

For #12 screws: Capacity is based on screw strength or material strength. Plate is 12 Gage

$P_{screw} = 625$ lb

$P_{14\,GA} = 600$ lb

$P_{12\,GA} = 657$ lb

Type a: $n = \frac{4{,}000\text{ lb}}{600\text{ lb}} = 6.67 \longrightarrow$ (7) screws (1) row

Type b: $n = \frac{8000\text{ lb}}{625\text{ lb}} = 12.8 \longrightarrow$ 14 screws (2) rows

Type c $n = \frac{11{,}200\text{ lb}}{625} = 17.9 \longrightarrow$ 20 screws (3) rows

Min. Srew Spacing:

$3d = (3).216 = .648$ in

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Check Net Section of Strap w/ Screws:

Type a: $A_N = (3)(.75) - (.075)(.216) = .2088\ in^2$

$T_N = \frac{.2088(33)}{1.67} = 4.13^K > 4.0^K \rightarrow OK$

Type b: $A_N = 4.5(.105) - .105(.216)(2) = .4271\ in^2$

$T_N = \frac{.4271(33)}{1.67} = 8.44K > 8.0K \rightarrow OK$

Type C: $A_N = (6)(.105) - (.105)(.206)(3) = .5620\ in^2$

$T_N = \frac{.5620(33)}{1.67} = 11.11K > 11.0K \rightarrow OK$

Design for eccentricity

Worst Case: $T = 11,200\ lb$ $e = 2\ in$

$M_u = 11,200\ lb\ (2\ in) = 22400\ lb \cdot in$

Distance beween resisting fasteners = 12 in

$T = \frac{22,400}{12} = 1866\ lbs$

For Simpson SDS25300 Screws (12 GA PL & DF Framing)

$V = 300(1.6) = 480\ lb$

$n = \frac{1866\ lb}{480\ lb} = 3.89 \Rightarrow$ (6) SDS25300 screws each side of strap to rims

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