2720 Residence

2720 71st Avenue SE
Mercer Island, Washington 98040

Structural Engineering Calculations

Supplement Calculations for DADU Lateral System Design

By

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April 28, 2022

Seismic Mass Calculation

Seismic Base at Main Floor with Concrete Base

Floor areas (sqft)

roof	425	

Roof Framing Seismic Mass (psf)

roof framing	14.00	
roofing (4.00 psf future PV panels)	6.00	
wall framing to diaphragm	5.00	
total	**25.00**	psf

roof

seismic mass (area x roof framing seismic mass) **10.62 kips**

Seismic Forces

(per attached spreadsheet calculations)

roof	1.90	kips		
			NS	***EW***
ASD = Seismic Force/1.4			Cumulative	Cumulative
roof	1.36		1.36 kips	1.36 kips

Wind Forces

(per attached spreadsheet calculations)

NS	6.87	kips	1.06	
EW	7.27	kips		
ASD = Wind Force/1.4				
NS	4.91	kips		
EW	5.19	kips		
			NS	***EW***
NS			Cumulative	
roof = ((1'+15.5'/2)/16.5') x 4.91 kips	2.61		**2.61 kips**	
EW				Cumulative
roof = ((1'+15.5'/2)/16.5') x 5.19 kips	2.76			**2.76 kips**

Lateral Force Summary (ASD)

			NS	***EW***
			Cumulative	Cumulative
		WIND/WIND	**2.61 kips**	**2.76 kips**

INPUT DATA

Typical floor height	h =	**14.5**	ft
Typical floor weight	w_x =	**11**	k
Number of floors	n =	**1**	
Importance factor (ASCE 11.5.1)	I =	**1.00**	(IBC Tab.1604.5)
Building location	Zip Code	**98040**	
Site class (A, B, C, D, E, F)		**D**	(If no soil report, use D)
The coefficient (ASCE Tab 12.8-2)	C_t =	**0.02**	
The coefficient(ASCE Tab. 12.2.1)	R =	**6.50**	

DESIGN SUMMARY

Total base shear

V = 0.17 W, (SD) = **2** k, (SD)

= 0.12 W, (ASD) = **1** k, (ASD)

Seismic design category = **D**

Latitude: 47.562605

Longitude: -122.2254

S_{DS} = **1.119** g

h_n = 14.5 ft k = 1.00 , (ASCE 12.8.3, pg 130) x = 0.75 , (ASCE Tab 12.8-2)

W = 11 k $\Sigma w_x h^k$ = 160 $T_a = C_t (h_n)^x$ = 0.15 Sec, (ASCE 12.8.2.1)

VERTICAL DISTRIBUTION OF LATERAL FORCES

Level No.	Level Name	Floor to floor Height ft	Height h_x ft	Weight w_x k	$w_x h_x^k$	C_{vx}	Lateral force @ each level F_x k	V_x k	O. M. k-ft	Diaphragm force ΣF_i k	ΣW_i k	F_{px} k
1	Roof		14.5	11	160	1.000	1.9			1.9	11	2
		14.50						1.9				
	Ground		0.0						27			

Hazards by Location

Search Information

Address: 2720 71st Ave SE, Mercer Island, WA 98040, USA

Coordinates: 47.5861883, -122.2437783

Elevation: 276 ft

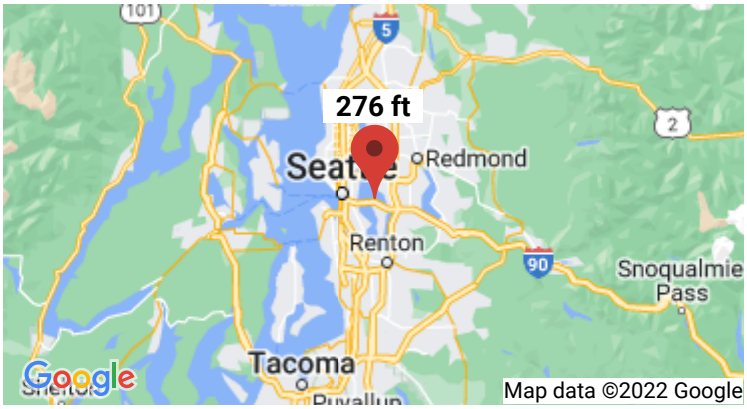
Timestamp: 2022-04-25T07:12:53.539Z

Hazard Type: Seismic

Reference Document: ASCE7-16

Risk Category: II

Site Class: D-default



Basic Parameters

Name	Value	Description
S_S	1.398	MCE_R ground motion (period=0.2s)
S_1	0.487	MCE_R ground motion (period=1.0s)
S_{MS}	1.678	Site-modified spectral acceleration value
S_{M1}	* null	Site-modified spectral acceleration value
S_{DS}	1.119	Numeric seismic design value at 0.2s SA
S_{D1}	* null	Numeric seismic design value at 1.0s SA

* See Section 11.4.8

Additional Information

Name	Value	Description
SDC	* null	Seismic design category
F_a	1.2	Site amplification factor at 0.2s
F_v	* null	Site amplification factor at 1.0s
CR_S	0.902	Coefficient of risk (0.2s)
CR_1	0.896	Coefficient of risk (1.0s)
PGA	0.598	MCE_G peak ground acceleration
F_{PGA}	1.2	Site amplification factor at PGA
PGA_M	0.718	Site modified peak ground acceleration

T_L	6	Long-period transition period (s)
SsRT	1.398	Probabilistic risk-targeted ground motion (0.2s)
SsUH	1.55	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	3.234	Factored deterministic acceleration value (0.2s)
S1RT	0.487	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.543	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	1.319	Factored deterministic acceleration value (1.0s)
PGAd	1.116	Factored deterministic acceleration value (PGA)

* See Section 11.4.8

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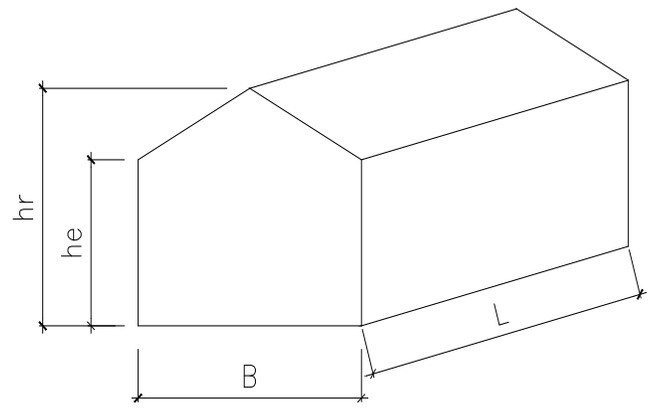
INPUT DATA

Exposure category (B, C or D)			B	
Importance factor, pg 77, (0.87, 1.0 or 1.15)	I	=	1.00	Category II
Basic wind speed (IBC Tab 1609.3.1V_{3S})	V	=	98	mph
Topographic factor (Sec.6.5.7.2, pg 26 & 45)	K_{zt}	=	1.9	
Building height to eave	h_e	=	14.5	ft
Building height to ridge	h_r	=	16.5	ft
Building length	L	=	19.75	ft
Building width	B	=	21.5	ft
Effective area of components	A	=	10	ft^2



DESIGN SUMMARY

Max horizontal force normal to building length, L, face	=	6.87	kips
Max horizontal force normal to building length, B, face	=	7.27	kips
Max total horizontal torsional load	=	20.34	ft-kips
Max total upward force	=	9.62	kips

ANALYSIS

Velocity pressure

$q_h = 0.00256\, K_h\, K_{zt}\, K_d\, V^2\, I$ = **27.79** psf

where: q_h = velocity pressure at mean roof height, h. (Eq. 6-15, page 27)

K_h = velocity pressure exposure coefficient evaluated at height, h, (Tab. 6-3, Case 1,pg 79) = **0.70**

K_d = wind directionality factor. (Tab. 6-4, for building, page 80) = **0.85**

h = mean roof height = **15.50** ft

< 60 ft, [Satisfactory]

Design pressures for MWFRS

$p = q_h\, [(G\, C_{pf}) - (G\, C_{pi})]$

where: p = pressure in appropriate zone. (Eq. 6-18, page 28).

$G\, C_{pf}$ = product of gust effect factor and external pressure coefficient, see table below. (Fig. 6-10, page 53 & 54)

$G\, C_{pi}$ = product of gust effect factor and internal pressure coefficient.(Fig. 6-5, Enclosed Building, page 47)

= **0.18** or **-0.18**

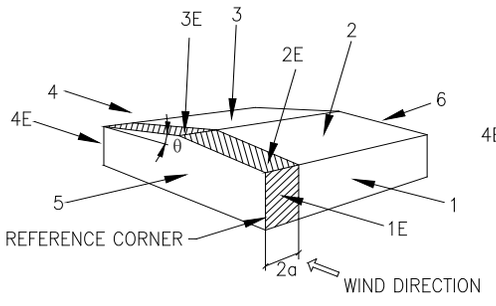
a = width of edge strips, Fig 6-10, note 9, page 54, MAX[MIN(0.1B, 0.4h), 0.04B,3] = **3.00 ft**

Net Pressures (psf), Basic Load Cases

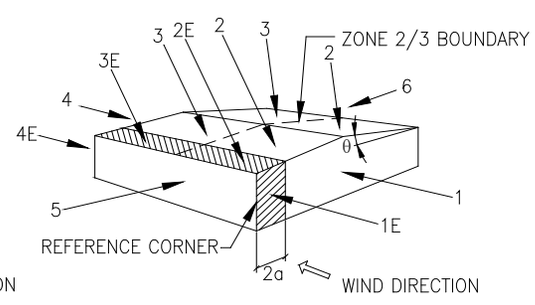
Surface	Roof angle θ = 10.54			Roof angle θ = 0.00		
	$G\, C_{pf}$	Net Pressure with		$G\, C_{pf}$	Net Pressure with	
		$(+GC_{pi})$	$(-GC_{pi})$		$(+GC_{pi})$	$(-GC_{pi})$
1	0.45	7.45	17.46	0.40	6.11	16.12
2	-0.69	-24.18	-14.18	-0.69	-24.18	-14.18
3	-0.41	-16.42	-6.41	-0.37	-15.29	-5.28
4	-0.34	-14.50	-4.49	-0.29	-13.06	-3.06
1E	0.68	13.90	23.91	0.61	11.95	21.96
2E	-1.07	-34.74	-24.74	-1.07	-34.74	-24.74
3E	-0.59	-21.38	-11.37	-0.53	-19.73	-9.73
4E	-0.51	-19.11	-9.10	-0.43	-16.95	-6.95
5	-0.45	-17.51	-7.50	-0.45	-17.51	-7.50
6	-0.45	-17.51	-7.50	-0.45	-17.51	-7.50

Net Pressures (psf), Torsional Load Cases

Surface	Roof angle θ = 10.54		
	$G\, C_{pf}$	Net Pressure with	
		$(+GC_{pi})$	$(-GC_{pi})$
1T	0.45	1.86	4.36
2T	-0.69	-6.05	-3.54
3T	-0.41	-4.10	-1.60
4T	-0.34	-3.63	-1.12
Surface	Roof angle θ = 0.00		
	$G\, C_{pf}$	Net Pressure with	
		$(+GC_{pi})$	$(-GC_{pi})$
1T	0.40	1.53	4.03
2T	-0.69	-6.05	-3.54
3T	-0.37	-3.82	-1.32
4T	-0.29	-3.27	-0.76

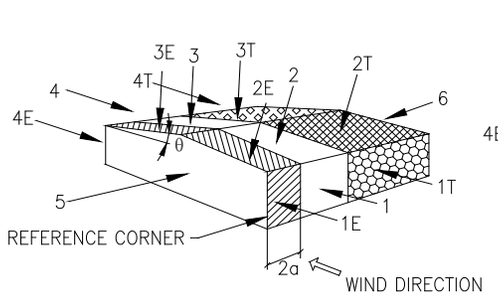


Transverse Direction

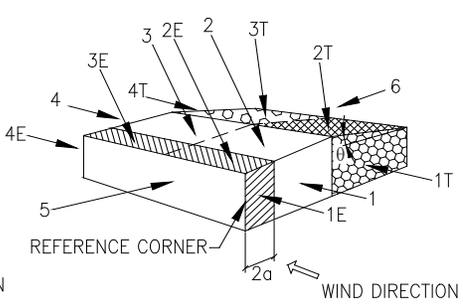


Longitudinal Direction

Basic Load Cases



Transverse Direction



Longitudinal Direction

Torsional Load Cases

Basic Load Cases in Transverse Direction

Surface	Area (ft^2)	Pressure (k) with $(+GC_{pi})$	Pressure (k) with $(-GC_{pi})$
1	199	1.49	3.48
2	150	-3.64	-2.13
3	150	-2.47	-0.96
4	199	-2.89	-0.90
1E	87	1.21	2.08
2E	66	-2.28	-1.62
3E	66	-1.40	-0.75
4E	87	-1.66	-0.79
Σ	Horiz.	6.87	6.87
	Vert.	-9.62	-5.37
10 psf min. Sec. 6.1.4.1	Horiz.	3.26	3.26
	Vert.	-4.25	-4.25

Basic Load Cases in Longitudinal Direction

Surface	Area (ft^2)	Pressure (k) with $(+GC_{pi})$	Pressure (k) with $(-GC_{pi})$
1	243	1.49	3.92
2	156	-3.76	-2.21
3	156	-2.38	-0.82
4	243	-3.17	-0.74
1E	90	1.08	1.98
2E	60	-2.09	-1.49
3E	60	-1.19	-0.59
4E	90	-1.53	-0.63
Σ	Horiz.	7.27	7.27
	Vert.	-9.27	-5.02
10 psf min. Sec. 6.1.4.1	Horiz.	3.33	3.33
	Vert.	-4.25	-4.25

Torsional Load Cases in Transverse Direction

Surface	Area (ft^2)	Pressure (k) with $(+GC_{pi})$	Pressure (k) with $(-GC_{pi})$	Torsion (ft-k) $(+GC_{pi})$	Torsion (ft-k) $(-GC_{pi})$
1	56	0.42	0.98	1	3
2	42	-1.02	-0.60	-1	0
3	42	-0.70	-0.27	0	0
4	56	-0.81	-0.25	3	1
1E	87	1.21	2.08	8	14
2E	66	-2.28	-1.62	-3	-2
3E	66	-1.40	-0.75	2	1
4E	87	-1.66	-0.79	11	5
1T	143	0.27	0.62	-1	-3
2T	108	-0.65	-0.38	1	0
3T	108	-0.44	-0.17	0	0
4T	143	-0.52	-0.16	-3	-1
Total Horiz. Torsional Load, M_T				19	19

Torsional Load Cases in Longitudinal Direction

Surface	Area (ft^2)	Pressure (k) with $(+GC_{pi})$	Pressure (k) with $(-GC_{pi})$	Torsion (ft-k) $(+GC_{pi})$	Torsion (ft-k) $(-GC_{pi})$
1	76	0.47	1.23	1	3
2	95	-2.31	-1.35	2	1
3	95	-1.46	-0.50	-1	0
4	76	-1.00	-0.23	2	1
1E	90	1.08	1.98	8	15
2E	60	-2.09	-1.49	2	1
3E	60	-1.19	-0.59	-1	-1
4E	90	-1.53	-0.63	12	5
1T	167	0.25	0.67	-1	-4
2T	156	-0.94	-0.55	-2	-1
3T	156	-0.60	-0.21	1	0
4T	167	-0.54	-0.13	-3	-1
Total Horiz. Torsional Load, M_T				20.3	20.3

Design pressures for components and cladding

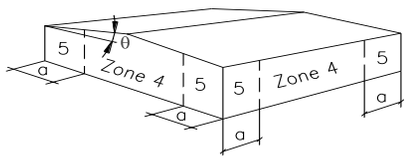
$p = q_h[(G C_p) - (G C_{pi})]$

where: p = pressure on component. (Eq. 6-22, pg 28)

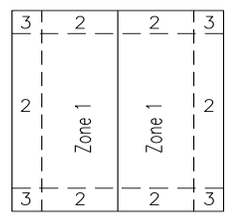
p_{min} = 10 psf (Sec. 6.1.4.2, pg 21)

G C_p = external pressure coefficient.

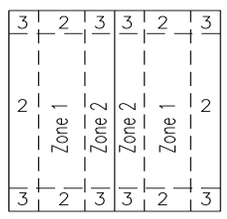
see table below. (Fig. 6-11, page 55~58)



Walls



Roof $\theta \le 7°$



Roof $\theta > 7°$

	Effective Area (ft^2)	Zone 1 GC_P	Zone 1 $-GC_P$	Zone 2 GC_P	Zone 2 $-GC_P$	Zone 3 GC_P	Zone 3 $-GC_P$	Zone 4 GC_P	Zone 4 $-GC_P$	Zone 5 GC_P	Zone 5 $-GC_P$
Comp.	10	0.50	-0.90	0.50	-1.70	0.50	-2.60	1.00	-1.10	1.00	-1.40

Comp. & Cladding Pressure (psf)	Zone 1 Positive	Zone 1 Negative	Zone 2 Positive	Zone 2 Negative	Zone 3 Positive	Zone 3 Negative	Zone 4 Positive	Zone 4 Negative	Zone 5 Positive	Zone 5 Negative
	18.90	-30.02	18.90	-52.25	18.90	-77.27	32.80	-35.58	32.80	-43.92

Hazards by Location

Search Information

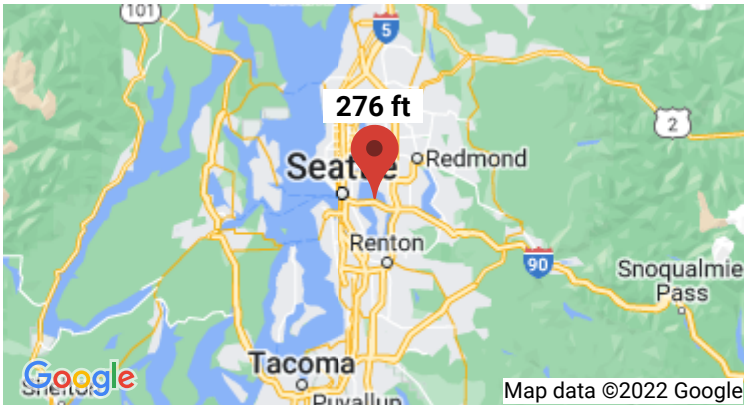
Address: 2720 71st Ave SE, Mercer Island, WA 98040, USA

Coordinates: 47.5861883, -122.2437783

Elevation: 276 ft

Timestamp: 2022-04-25T07:11:33.708Z

Hazard Type: Wind



ASCE 7-16

MRI 10-Year	67 mph
MRI 25-Year	73 mph
MRI 50-Year	78 mph
MRI 100-Year	83 mph
Risk Category I	92 mph
Risk Category II	97 mph
Risk Category III	104 mph
Risk Category IV	108 mph

ASCE 7-10

MRI 10-Year	72 mph
MRI 25-Year	79 mph
MRI 50-Year	85 mph
MRI 100-Year	91 mph
Risk Category I	100 mph
Risk Category II	110 mph
Risk Category III-IV	115 mph

ASCE 7-05

ASCE 7-05 Wind Speed	85 mph

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Disclaimer

Hazard loads are interpolated from data provided in ASCE 7 and rounded up to the nearest whole integer. Per ASCE 7, islands and coastal areas outside the last contour should use the last wind speed contour of the coastal area – in some cases, this website will extrapolate past the last wind speed contour and therefore, provide a wind speed that is slightly higher. NOTE: For queries near wind-borne debris region boundaries, the resulting determination is sensitive to rounding which may affect whether or not it is considered to be within a wind-borne debris region.

Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.

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DADU Shear Wall Design

shear wall location:	NORTH	roof diaphragm
shear force (kips)		1.38
floor height (ft)		16.00
wall length without opening (ft)		7.50
wall length with opening (ft)		3.50
wall segment length (ft)		7.50
shear flow (plf)		394.29
shear wall type per schedule on GN		SW4
dead loads from floor/roof framing (plf)		120.00
wall weight (plf)		160.00
hold down force (kips) with 0.6DL		4.68
hold down type per schedule on GN		5
shear wall location:	SOUTH	roof diaphragm
shear force (kips)		1.38
floor height (ft)		13.50
wall length without opening (ft)		11.00
wall length with opening (ft)		11.00
wall segment length (ft)		11.00
shear flow (plf)		125.45
shear wall type per schedule on GN		SW6
dead loads from floor/roof framing (plf)		105.00
wall weight (plf)		135.00
hold down force (kips) with 0.6DL		0.10
hold down type per schedule on GN		NO HD
shear wall location:	EAST	roof diaphragm
shear force (kips)		1.38
floor height (ft)		14.50
wall length without opening (ft)		8.00
wall length with opening (ft)		8.00
wall segment length (ft)		8.00
shear flow (plf)		172.50
shear wall type per schedule on GN		SW6
dead loads from floor/roof framing (plf)		60.00
wall weight (plf)		145.00
hold down force (kips) with 0.6DL		2.01
hold down type per schedule on GN		2
shear wall location:	WEST	roof diaphragm
shear force (kips)		1.38
floor height (ft)		14.50
wall length without opening (ft)		15.00
wall length with opening (ft)		15.00
wall segment length (ft)		15.00
shear flow (plf)		92.00
shear wall type per schedule on GN		SW6
dead loads from floor/roof framing (plf)		60.00
wall weight (plf)		145.00
hold down force (kips) with 0.6DL		-0.09
hold down type per schedule on GN		NO HD