Structural Calculations For:

Paek Residence

2215 80th Ave SE

Mercer Island, WA 98040

6-3-20

Prepared for: MZA Architecture

Job #: 10604-2018-01-00

Date: June 3, 2020

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Criteria Sheet

Codes:

Structural:	IBC 2015
Loading:	ASCE 7-10
Wood:	NDS 2015
Steel:	AISC 360-10
Concrete:	ACI 318-14
Masonry:	TMS 402/602-13

Project Location:

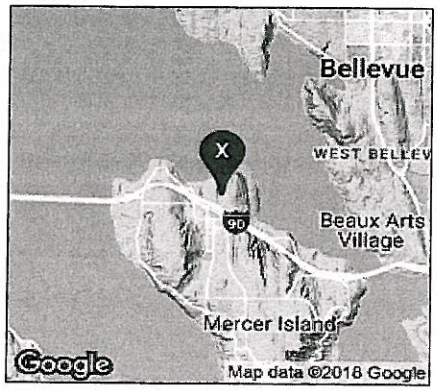
Street & Number:	2215 80th Ave SE
City:	Mercer Island WA
ZIP:	98040
Latitude:	47.5905 N
Longitude:	-122.2321 W

Occupancy Category

Risk Category: II ASCE 7 Table 1.5-1

Seismic Load Summary:

Analysis Procedure:	Equivalent Lateral Force Procedure		
Lateral System:	Wood Structural Panels Rated for Shear Resistance		
R:	6.50	C_d=	4
Base Shear V =	17.6 kips	Ω_o=	2.5
S_S=	1.365	S_1=	0.526
S_{DS}=	0.91	S_{D1}=	0.53
C_s=	0.140	I_E=	1.0



Wind Load Summary:

V=	110	K_{zt}=	1.00
Exposure =	C		

Dead Loads:

Roof		
Roofing	2.5	psf
1/2" Sheathing	1.8	psf
14" TJI 230 @ 16"oc	2.5	psf
Misc./Mech.	1.4	psf
Ceiling Finish	~~2.8~~ 1.8	psf
~~Future Solar Panels~~	~~4~~ 0	~~psf~~
	~~15~~ 10	psf
Use	~~15~~ 10	psf
Floor		
Finish Floor	1.5	psf
3/4" Sheathing	2.7	psf
Joists @ 16" oc	2.3	psf
Misc./Mech.	2.0	psf
Ceiling Finish	2.8	
	11.3	psf
Use	12	psf
Wall		
Siding	2	psf
1/2" Sheathing	1.8	psf
Wall Framing	2	psf
Insulation	1	psf
1/2" GWB	2.2	psf
	9	psf
Use	10	psf

Live Loads:

Snow	25	psf	+5 psf	Deck 60	psf
Floor	40	psf			

Soils:

Allowable Bearing 1500 psf

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Seismic Design

ASCE 7-10 Seismic Analysis Equivalent Lateral Force Procedure

Seismic Force Resisting System: Per Table 12.2-1	System:	Bearing Wall Systems
	Type:	Light-frame (wood) Walls Sheathed with Wood Structural Panels Rated for Shear Resistance

Risk Category	II	I, II, or III, or IV per Table 1.5-1
Site Class	D	per soils report (D assumed, without soils report)
Diaphragm Flexibility	Flexible	

Ω_o	2.5		
S_S	1.365	g	2% in 50 yr, Latitude & Longitude lookup
S_1	0.526	g	2% in 50 yr, Latitude & Longitude lookup
h_n	27.92	ft	
R	6.50		
I_e	1.0		Table 1.5-2
C_d	4		
Ct	0.02		Table 12.8-2
x	0.075		Table 12.8-2
T	0.03	sec	Eq. 12.8-7
T_0	0.12	sec	
T_S	0.58	sec	
k	1.000		
Fa	1.00		Table 11.4-1
Fv	1.50		Table 11.4-2
S_{MS}	1.37	g	Eq. 11.4-1
S_{M1}	0.79	g	Eq. 11.4-2
S_{DS}	0.910	g	Eq. 11.4-3
S_{D1}	0.526	g	Eq. 11.4-4
Cs	0.140		Eq. 12.8-2
	3.152		Eq. 12.8-3 need not exceed, $T < T_L$
	0.010		Eq. 12.8-5 or 12.8-6 minimum
Cs, design	0.140		
Bldg. Weight	125.8	k	
$V = C_S W$	17.6	k	Eq. 12.8-1, Strength Level Base Shear
$V = C_{Sasd} W$	12	k	Eq. 12.8-1 ASD Base Shear

$$T_a = C_t h_n^x \quad \text{Eq. 12.8.7}$$

$$S_{MS} = F_a S_S \quad \text{Eq. 11.4-1}$$
$$S_{M1} = F_v S_1 \quad \text{Eq. 11.4-2}$$
$$S_{DS} = {}^2/_3 S_{MS} \quad \text{Eq. 11.4-3}$$
$$S_{D1} = {}^2/_3 S_{M1} \quad \text{Eq. 11.4-4}$$

$$C_S = \frac{S_{DS}}{(R/I_e)} \quad \text{Eq. 12.8-2}$$
$$C_S = \frac{S_{D1}}{T(R/I_e)} \quad \text{Eq. 12.8-3}$$
$$C_S = \frac{S_{D1} T_L}{T^2 (R/I_e)} \quad \text{Eq. 12.8-4}$$
$$C_S \geq 0.044 S_{DS} I_e \quad \text{Eq. 12.8-5}$$
$$C_S \geq 0.01 \quad \text{Eq. 12.8-5}$$

$$C_{VX} = w_x h_x^k / \sum_{i=1}^{n} w_x h_i^k \quad \text{Eq. 12.8-12}$$

$$F_{px} = {}^{\sum_{i=x}^{n} F_i}/_{\sum_{i=x}^{n} w_i} w_{px} \quad \text{Eq. 12.10-1}$$
$$F_{px} \geq 0.2 S_{DS} I_e w_{px} \quad \text{Eq. 12.10-2}$$
$$F_{px} \leq 0.4 S_{DS} I_e w_{px} \quad \text{Eq. 12.10-3}$$

Vertical Distribution

ASD ρ= 1.3

Level	hx (ft)	Wx	hx^k (ft)	Wxhx^k	Cvx (%)	Story Shear ASD Fx (k)	SV (k)	Diaphragm Force (ρ not included) Fpx_{calc}	Fpx_{min}	Fpx_{max}	Fpx_{design}	γ=Fpx/Fx
Roof	27.9	33.7	27.9	941.2	0.415	**6.7**	6.7	5.12	4.29	8.59	**5.12**	0.77
Upper	17.9	63.6	17.9	1140.2	0.503	**8.1**	14.7	7.40	8.11	16.21	**8.11**	1.01
Main	6.5	28.4	6.5	184.8	0.082	**1.3**	16.0	2.79	3.62	7.24	**3.62**	2.77
	Sum	125.8		2266.2		16.0						

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Wind Design - MWFRS

ASCE 7-10 Chapter 27 - Directional Procedure

Design Method	ASD

Wind Coefficients

Exposure	C	**
V=	110	mph
K_d=	0.85	Table 26.6-1
K_h=	0.99	Table 27.3-1
G=	0.85	26.9.4

** Site is approximately 1000 ft from Lake Wash.

Location and Building Dimensions

Calculate Kzt?	YES	
Kzt	See Criteria Sheet	
Roof Angle - Transverse Dir	4.76	degrees
Roof Angle - Long Dir	0	degrees
Ground to top of roof	32	ft
Bot of roof to top of roof	2.5	ft
Mean Roof Height, h	30.75	ft
Short Plan Dimension	26	ft
Long Plan Dimension	56.75	ft
Parapet ?	Yes	
Ground to top of parapet	15	ft

Velocity Pressure at Mean Roof Height, q_h =	26.1	psf

Transverse Wind Pressures (E-W Direction)

L/B = 0.5 h/L = 1.2

Pressure Coefficients from Figure 27.4-1:

Bldg Face	C_p
Windward Wall	0.8
Leeward Wall	-0.50
Windward Roof	-1.3 / -0.18
Leeward Roof	-0.70

Wall Pressures (Unfactored):

Ht	K_z	q_z	$P_{ww\ walls}$	$P_{lwwalls}$	ASD P_{walls} (psf)
0-15	0.85	22.38	15.22	11.08	**15.78**
15-20	0.9	23.70	16.11	11.08	**16.32**
20-25	0.94	24.75	16.83	11.08	**16.74**
25-30	0.98	25.80	17.55	11.08	**17.17**
30-40	1.04	27.38	18.62	11.08	**17.82**

Roof Pressures (Unfactored) ASD

Windward		Leeward	Horiz Proj (psf)
Max	Min		
-4.0	-28.8	-15.5	**0.57**

Parapet (Unf) ASD

Windward	Leeward	Total (psf)
33.6	22.4	**33.6**

Longitudinal Wind Pressures (N-S Direction)

L/B = 2.2 h/L = 0.5

Pressure Coefficients from Figure 27.4-1:

Bldg Face	C_p
Windward Wall	0.8
Leeward Wall	-0.29
Windward Roof	-0.93 / -0.18
Leeward Roof	-0.7

Wall Pressures (Unfactored):

Ht	K_z	q_z	$P_{ww\ walls}$	$P_{lwwalls}$	ASD P_{walls} (psf)
0-15	0.85	22.38	15.22	6.44	**13.00**
15-20	0.9	23.70	16.11	6.44	**13.53**
20-25	0.94	24.75	16.83	6.44	**13.96**
25-30	0.98	25.80	17.55	6.44	**14.39**
30-40	1.04	27.38	18.62	6.44	**15.04**

Roof Pressures (Unfactored) ASD

Windward		Leeward	Horiz Proj (psf)
Max	Min		
-4.0	-20.7	-15.5	**0.00**

Parapet (Unf) ASD

Windward	Leeward	Total (psf)
33.6	22.4	**33.6**

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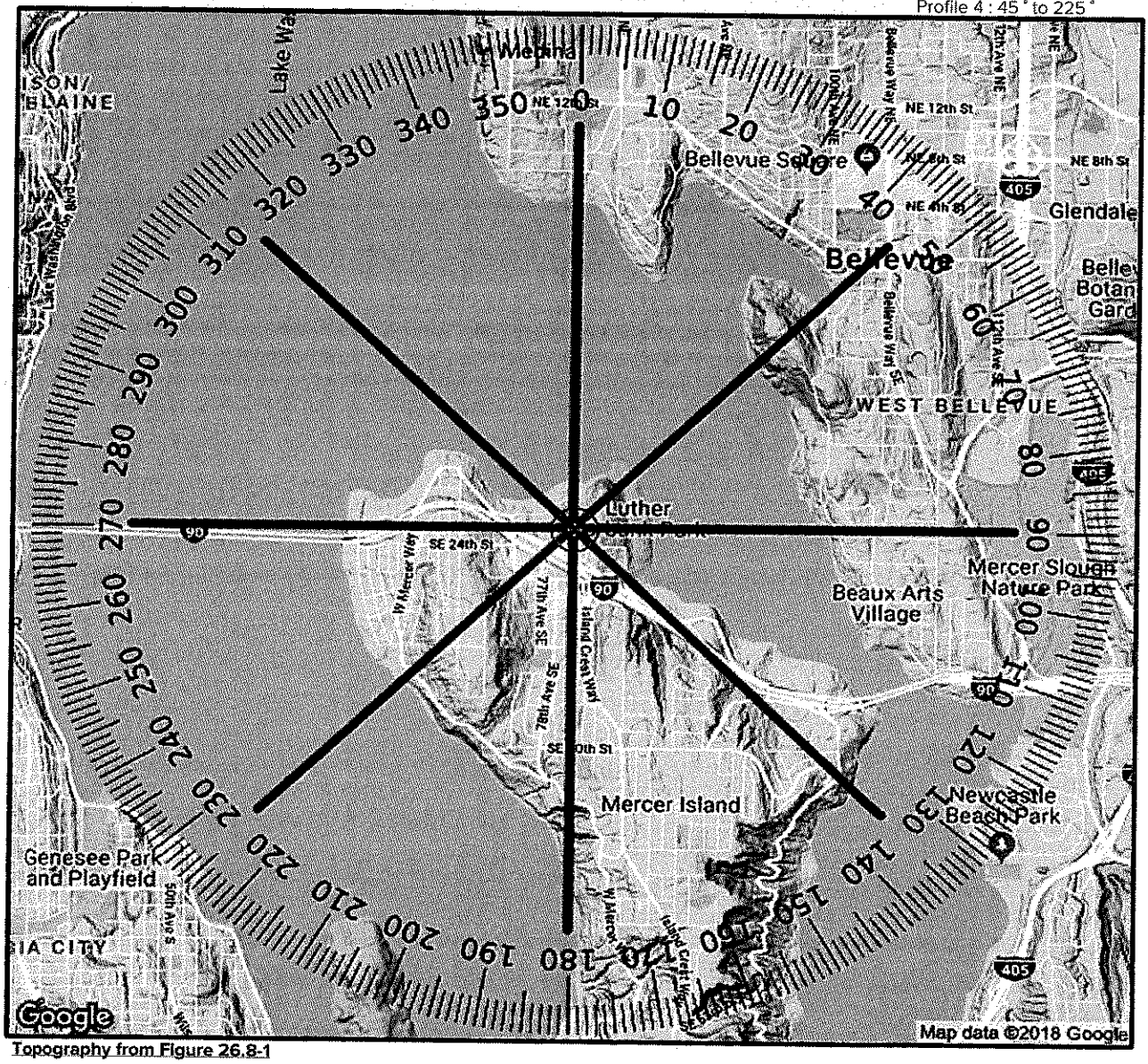
Site Address

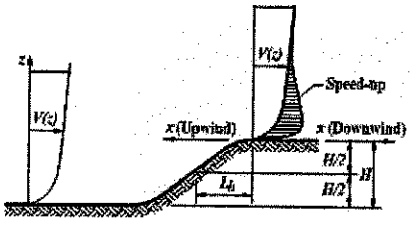
Address	2215 80th Ave SE			Wind Radius	2.00 Miles
City:	Mercer Islan	State:	WA	Angle	0 °
Lat Long	47.5905	-122.2321		Exposure	C

Profile 1 : 0 ° to 180 °
Profile 2 : 270 ° to 90 °
Profile 3 : 315 ° to 135 °
Profile 4 : 45 ° to 225 °

SITE MAP



Topography from Figure 26.8-1



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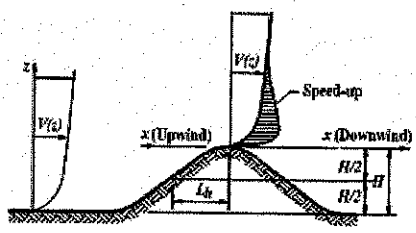

2-D RIDGE OR 3-D AXISYMMETRICAL HILL

$$K_{zt} = (1 + K_1 K_2 K_3)^2$$
$$K_1 = \text{Per Figure}$$
$$K_2 = (1 - |x|/\mu L_h)$$
$$K_3 = e^{-\gamma z / L_h}$$
$$K_{zt} = 1, \text{ If } H/Lh \le 0.2$$

PER FIGURE 26.8-1

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Paek Residence
Kzt Calculations

DATE 8/7/2018
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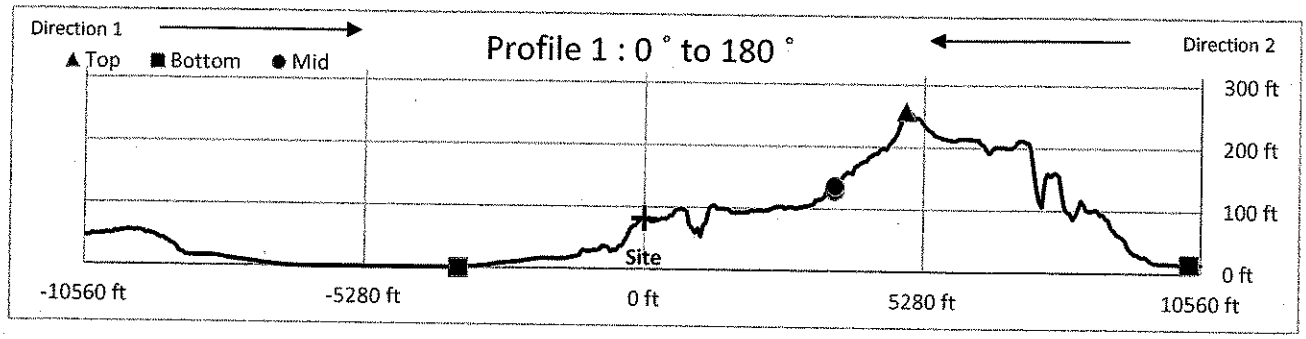
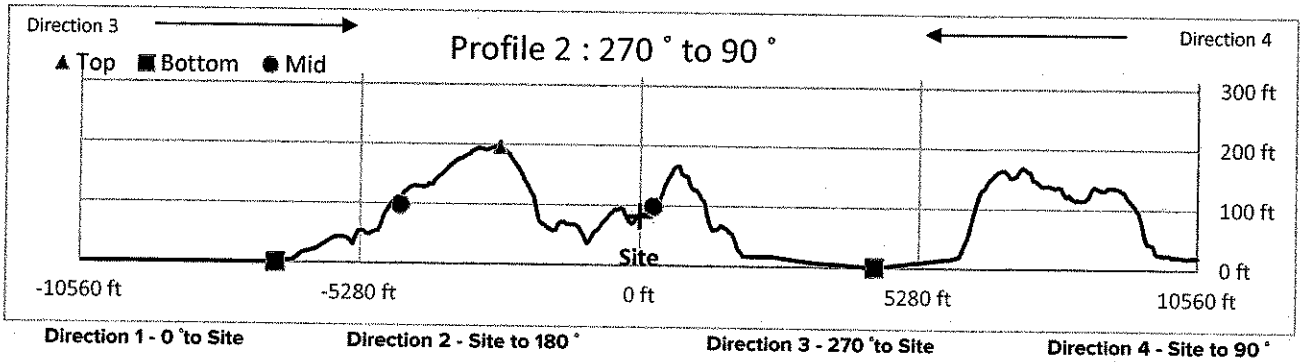
DESIGN JRC
SHEET 4





Direction 1 - 0 °to Site | **Direction 2 - Site to 180 °** | **Direction 3 - 270 °to Site** | **Direction 4 - Site to 90 °**

Site Conditions (26.8.1)

1. Unubstructed	Yes	
2. Isolated	Yes	
3. Upper Half Hill	No	Kzt=1
4. H/Lh ≥ 0.2	No	Kzt=1
5. H≥ 15'	Yes	

Site Conditions (26.8.1)

1. Unubstructed	Yes	
2. Isolated	Yes	
3. Upper Half Hill	No	Kzt=1
4. H/Lh ≥ 0.2	No	Kzt=1
5. H≥ 15'	Yes	

Site Conditions (26.8.1)

1. Unubstructed	Yes	
2. Isolated	No	Kzt=1

Site Conditions (26.8.1)

1. Unubstructed	Yes	
2. Isolated	No	Kzt=1

Terrain Data

Terrain	Escrpmnt
Top of Hill Dist.	4935
Bott. of Hill Dist.	-3502
L @ H/2	3600
Site	upwind
Top of Hill Elev.	257
Bott. of Hill Elev.	0
Site Elev.	81.8
Site Dist.	0
H/2	129

Terrain Data

Terrain	Ridge
Top of Hill Dist.	4935
Bott. of Hill Dist.	10348
L @ H/2	3608
Site	downwnd
Top of Hill Elev.	257
Bott. of Hill Elev.	15
Site Elev.	81.8
Site Dist.	0
H/2	136

Kzt Calculations

H=	257
Lh=	1335
x=	4935
z=	30.75
μ=	1.5
γ=	2.5
K1 value =	0.85
K1=	0.16
K2=	0.00
k3=	0.94
H/Lh =	0.19
Kzt =	1.00

Kzt Calculations

H=	242
Lh=	1327
x=	4935
z=	30.75
μ=	1.5
γ=	3
K1 value =	1.45
K1=	0.26
K2=	0.00
k3=	0.93
H/Lh =	0.18
Kzt =	1.00

Kzt =	1.00

Kzt =	1.00

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Kzt Calculations

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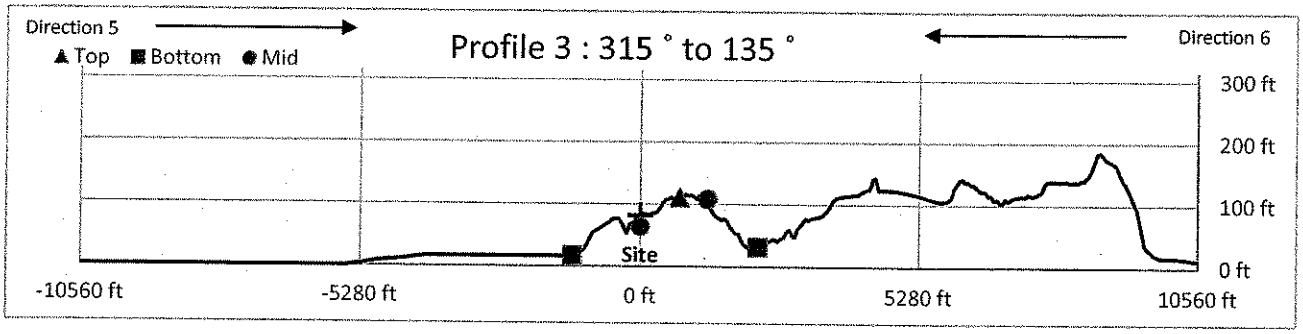
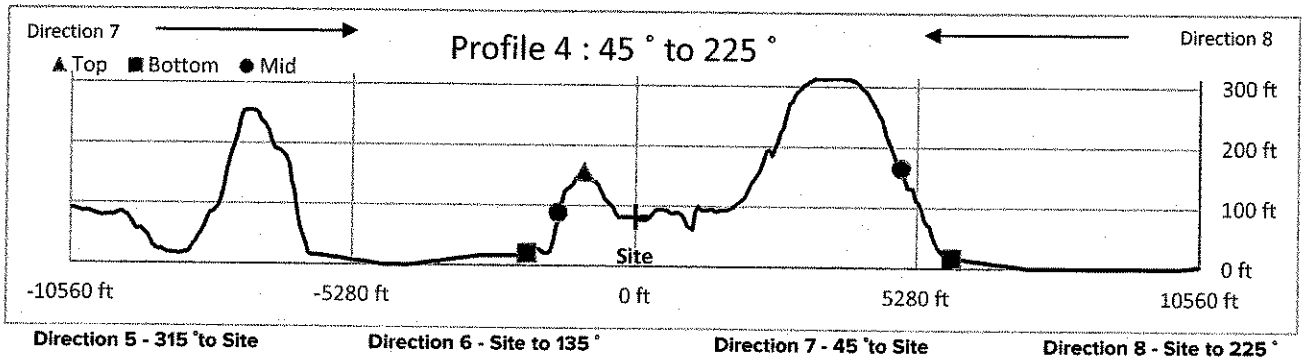
SHEET 5





Direction 5 - 315 °to Site | **Direction 6 - Site to 135 °** | **Direction 7 - 45 °to Site** | **Direction 8 - Site to 225 °**

Site Conditions (26.8.1)

1. Unubstructed	Yes	
2. Isolated	Yes	
3. Upper Half Hill	Yes	
4. H/Lh ≥ 0.2	No	Kzt=1
5. H≥ 15'	Yes	

Site Conditions (26.8.1)

1. Unubstructed	No	Kzt=1
2. Isolated	No	Kzt=1
		Kzt=1
		Kzt=1

Site Conditions (26.8.1)

1. Unubstructed	No	Kzt=1
2. Isolated	No	Kzt=1

Site Conditions (26.8.1)

1. Unubstructed	Yes	
2. Isolated	Yes	
3. Upper Half Hill	No	Kzt=1
4. H/Lh ≥ 0.2	Yes	
5. H≥ 15'	Yes	

Terrain Data

Terrain	Ridge
Top of Hill Dist.	743
Bott. of Hill Dist.	-1274
L @ H/2	0
Site	upwind
Top of Hill Elev.	111
Bott. of Hill Elev.	17
Site Elev.	81.8
Site Dist.	0
H/2	64

Terrain Data

Terrain	Ridge
Top of Hill Dist.	3715
Bott. of Hill Dist.	5943
L @ H/2	4988
Site	downwnd
Top of Hill Elev.	315
Bott. of Hill Elev.	16
Site Elev.	81.8
Site Dist.	0
H/2	166

Kzt Calculations

H=	95
Lh=	743
x=	743
z=	30.75
μ=	1.5
γ=	3
K1 value =	1.45
K1=	0.18
K2=	0.33
k3=	0.88
H/Lh =	0.13
Kzt =	1.00

Kzt = 1.00

Kzt = 1.00

Kzt Calculations

H=	298.516
Lh=	1273
x=	3715
z=	30.75
μ=	1.5
γ=	3
K1 value =	1.45
K1=	0.34
K2=	0.00
k3=	0.93
H/Lh =	0.23
Kzt =	1.00

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Kzt Calculations

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SHEET 6

Lateral Analysis

Seismic:

Weights:

$W_{ROOF} = (1757\,ft^2)(15\,psf) + (1470\,ft^2)(\frac{10'}{2}\,psf) = 33.71^k$

$W_{UPPER} = (1470\,ft^2)(12\,psf + \frac{10'}{2}\,psf) + (1170\,ft^2)(\frac{10'}{2}\,psf) + (59\,ft^2)(15\,psf + \frac{10'}{2}) + (193\,ft^2)(15\,psf + \frac{10'}{2}\,psf) + (455\,ft^2)[(\frac{3}{12})(115\,pcf) + 15\,psf + \frac{10'}{2}\,psf] = 59.20^k$

$W_{MAIN} = (1121\,ft^2)(12\,psf + 10\,psf) + (148\,ft^2)(15\,psf) = 26.88^k$ (Assumed Green Roof @ Garage)

$W_{STONE\ VENEER} = (269\,ft^2)(15\,psf)$ Garage North Wall
$+ (2 \times 58\,ft^2)(15\,psf)$ Feature Ext. Wall
$+ (206\,ft^2)(15\,psf)$

$8.87^k / 2$ into Upper Floor Dia $= 4.43^k$ (Upper)
$= 1.55^k$ (Main)

$W_{TOTAL} = 125.8^k$

Shears:

$V_{ROOF} = 6.7^k$ $\quad F_{px,\,Roof} = 5.12^k$

$V_{UPPER} = 8.1^k$ $\quad F_{px,\,upper} = 8.11^k$

$V_{MAIN} = 1.3^k$ $\quad F_{px,\,main} = 3.62^k$

$V_{BASE} = 16.0^k = 0.7 W C_{sp} = 0.7(125.8^k)(0.140)(1.3)$

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Lateral Analysis

Wind:

North-South Direction:

$V_{ROOF} = (80\ ft^2)(14.39\ psf) + (65\ ft^2)(13.96\ psf) = 2.06\ K$

$V_{UPPER/GARAGE} = (66\ ft^2)(13.96\ psf) + (130\ ft^2)(13.53\ psf) + (137\ ft^2)(13.00\ psf) + (210\ ft^2)(13.00\ psf) = 7.19\ K$

$V_{PARAPET} = (92\ ft^2)(33.6\ psf) = 3.09\ K$

$V_{MAIN} = (313\ ft^2)(13.00\ psf) = 4.07\ K$

$V_{BASE} = 16.41\ K$

East Direction:

$V_{ROOF} = (293\ ft^2)(16.74\ psf) + (75\ ft^2)(16.32\ psf)$ + (61 ft^2)(17.17 psf) = 7.18 K

$V_{UPPER} = (210\ ft^2)(16.32\ psf) + (345\ ft^2)(15.78\ psf) + (94\ ft^2)(15.78\ psf) = 10.35\ K$

$V_{PARAPET} = (52\ ft^2)(33.6\ psf) = 1.75^K$

$V_{BASE} = 19.28\ K$

West Direction:

$V_{ROOF} = (146\ ft^2)(0.57\ psf) + (93\ ft^2)(17.82\ psf) + (216\ ft^2)(17.17\ psf) = 5.45\ K$

$V_{UPPER} = (297\ ft^2)(16.74\ psf) + (275\ ft^2)(16.32\ psf) + (69\ ft^2)(17.17\ psf) = 10.64\ K$

$V_{MAIN} = (619\ ft^2)(15.78\ psf)$ + (30 ft^2)(16.32 psf) = 10.26 K

$V_{BASE} = 26.35\ K$

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LATERAL ANALYSIS

WIND:

NORTH-SOUTH DIRECTION:

$V_{ROOF} = (25\,ft^2)(14.39\,psf) + (113\,ft^2)(13.96\,psf) = 1.94^k$

$V_{UPPER/GARAGE} = (18\,ft^2)(13.96\,psf) + (130\,ft^2)(13.53\,psf) + (138\,ft^2)(13.00\,psf) + (177\,ft^2)(13.00\,psf) = 6.11^k$

$V_{PARAPET} = (81\,ft^2)(33.6\,psf) = 2.72^k$

$V_{MAIN} = (307\,ft^2)(13.00\,psf) = 3.99^k$

$V_{BASE} = 14.76^k$

EAST DIRECTION:

$V_{ROOF} = (243\,ft^2)(16.74\,psf) + (101\,ft^2)(16.32\,psf) = 5.72^k$

$V_{UPPER} = (183\,ft^2)(16.32\,psf) + (356\,ft^2)(15.78\,psf) + (103\,ft^2)(15.78\,psf) = 10.23^k$

$V_{PARAPET} = (52\,ft^2)(33.6\,psf) = 1.75^k$

$V_{BASE} = 17.7^k$

WEST DIRECTION:

$V_{ROOF} = (146\,ft^2)(0.57\,psf) + (264\,ft^2)(17.17\,psf) + (19\,ft^2)(16.74\,psf) = 4.93^k$

$V_{UPPER} = (271\,ft^2)(16.74\,psf) + (304\,ft^2)(16.32\,psf) + (18\,ft^2)(15.78\,psf) = 9.78^k$

$V_{MAIN} = (586\,ft^2)(15.78\,psf) = 9.25^k$

$V_{BASE} = 23.96^k$

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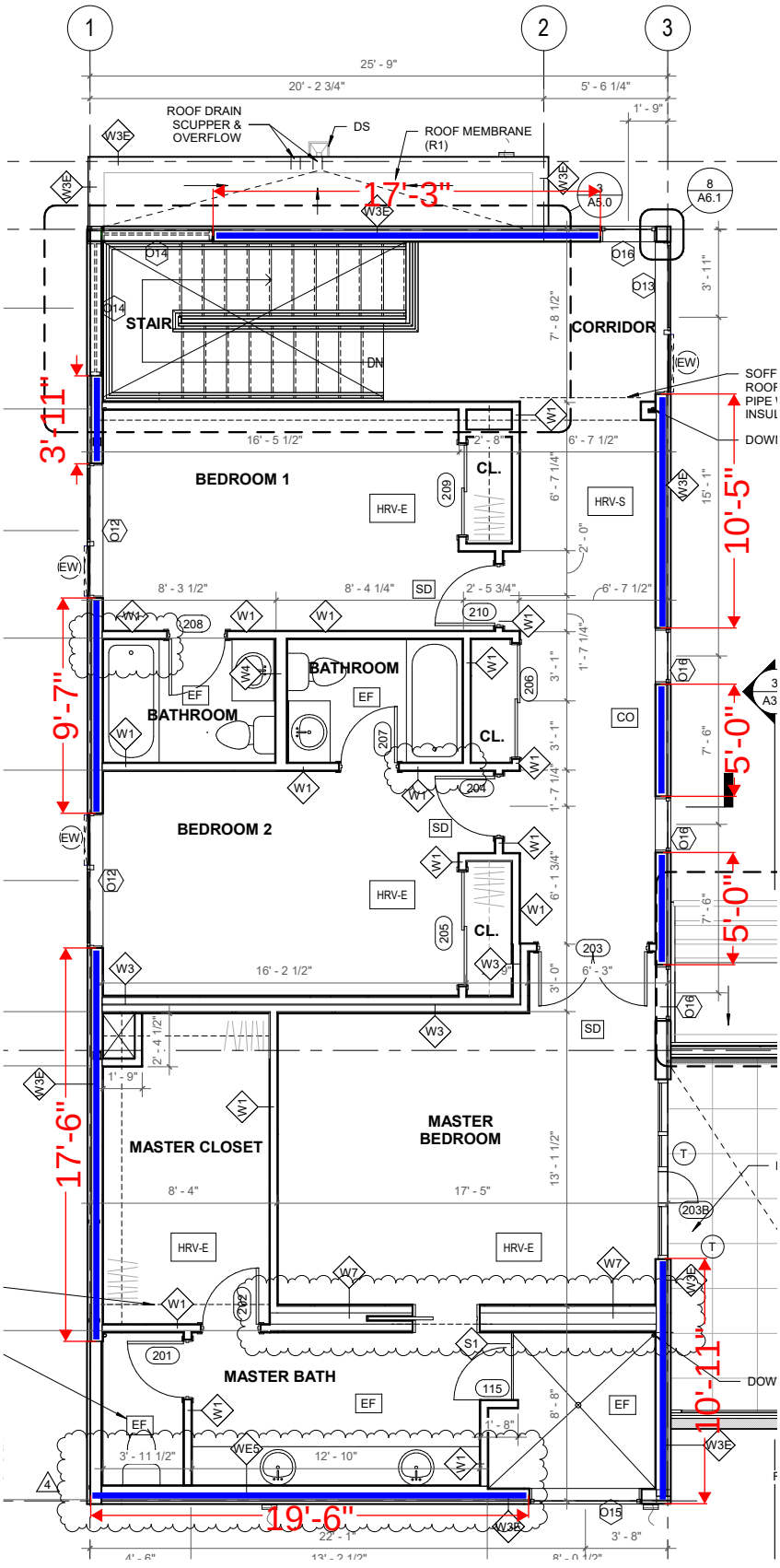
PROJECT: PAEK RESIDENCE, MERCER ISLAND, WA
DATE: 08/07/18
PROJ. #: JRC
DESIGN: L2
SHEET:

Lateral Design

Roof Diaphragm Shearwall Key Plan



N

$h_{HIGH} = 10.5'$

$l_{min} = \frac{10.5'}{2} = 5.25'$

l_{min} w/ Reduction $= \frac{10.5'}{3.5} = 3.31'$

$h_{LOW} = 8.5'$

$l_{min} = \frac{8.5'}{2} = 4.25'$

Diaphragm Aspect Ratio:

$L/w = 56.75'/26' = 2.18:1$

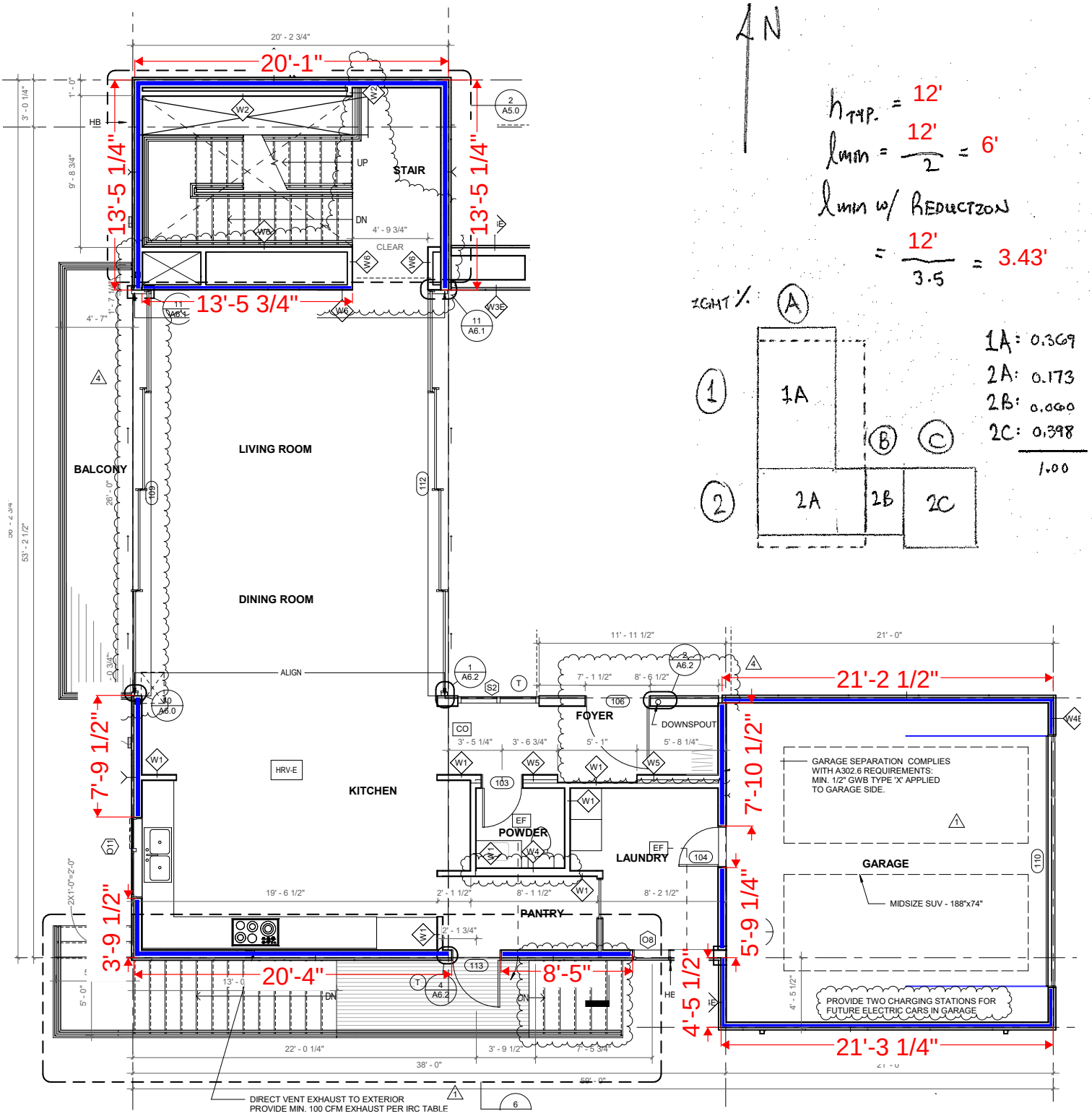
$< 3:1$

OK unblocked per SDPWS Table 4.2.4

L3

LATERAL DESIGN

UPPER FLOOR / GARAGE ROOF DIAPHRAGM SHEARWALL KEY PLAN:



$h_{TYP.} = 12'$

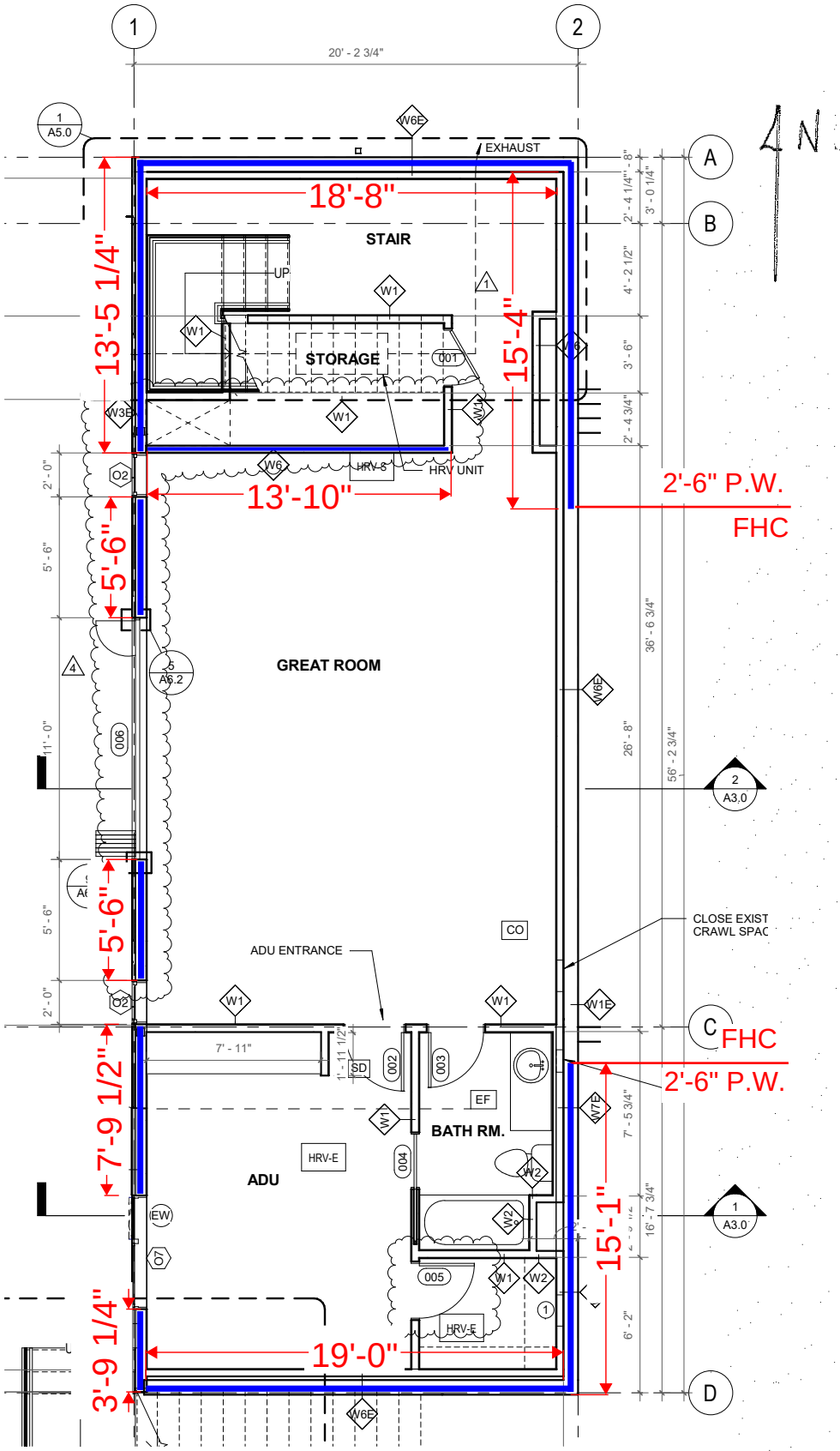
$l_{min} = \frac{12'}{2} = 6'$

l_{min} w/ REDUCTION $= \frac{12'}{3.5} = 3.43'$

L4

LATERAL DESIGN

MAIN FLOOR DIAPHRAGM SHEARWALL KEY PLAN



4 N.

$h = 8'$

$l_{min} = \frac{8'}{2} = 4'$

l_{min} w/ REDUCTION

$= \frac{8'}{3.5} = 2.29'$

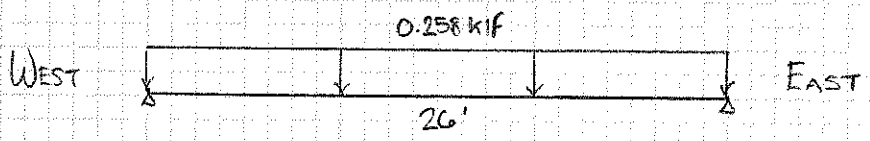
L5

LATERAL DESIGN

NORTH-SOUTH DIRECTION SHEARWALLS: SEISMIC

ROOF DIAPHRAGM:

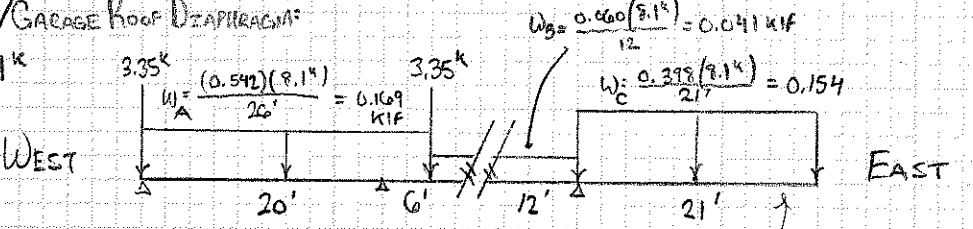
$V = 6.7^{K}$



V (kips):	3.35	3.35
L (ft):	30.69	31.34
γ (plf):	109	107
SW:	W6	W6
OT (kips):	0.99 - 0.6DL = ∅	1.12 - 0.6DL = .77 @ SHORT WALLS = .39 @ LONG WALL
HD:	NONE	CS16

UPPER FLOOR/GARAGE ROOF DIAPHRAGM:

$V = 8.1^{K}$



V (kips):	5.04	6.17	3.59
L (ft):	23.5	13.42	18
γ (plf):	215	460	200
SW:	W6	W2	W6
OT (kips):	2.93 + 0.99 = 3.92 - 0.6DL = 3.00	5.07 - 0.6DL	2.21 - 0.6DL
HD:	(2) CS16	HDU5	HDU2

CANTILEVERED DIAPHRAGM. SEE CALCS ATTACHED.

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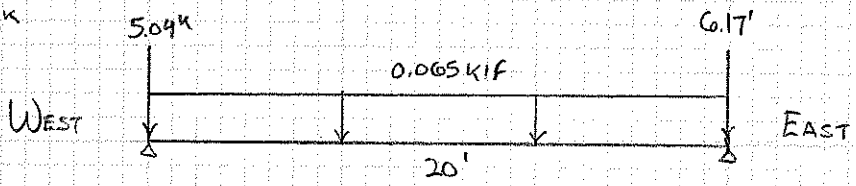
LATERAL DESIGN

NORTH-SOUTH DIRECTION SHEARWALLS: SEISMIC

MAIN FLOOR DIAPHRAGM:

V = 1.3K

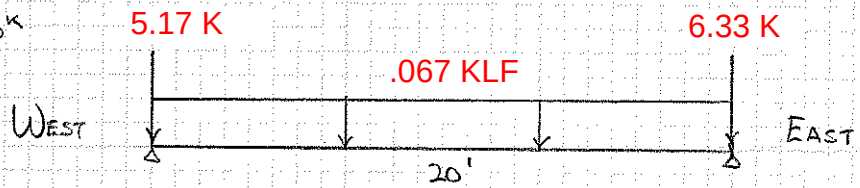


V (kips):	5.69	6.82
L (ft):	35.68	31.5
v (plf):	160	217
SW:	W6	W6
OT (kips):	1.28 + 3.92 = 5.2 K - 0.6DL	0.54 + 5.07 = 5.61 - 0.6DL
HD:	HDU5	HDU5

NORTH-SOUTH DIRECTION SHEARWALLS: WIND

MAIN FLOOR DIAPHRAGM:

V = 1.3K



V (kips):	5.84 K	7 K
L (ft):	35.68	31.5
v (plf):	164	222
SW:	W6	W6
OT (kips):	1.31 + 4.02 = 5.33 K - 0.6DL	0.55 + 5.2 = 5.75 - 0.6DL
HD:	HDU5	HDU5

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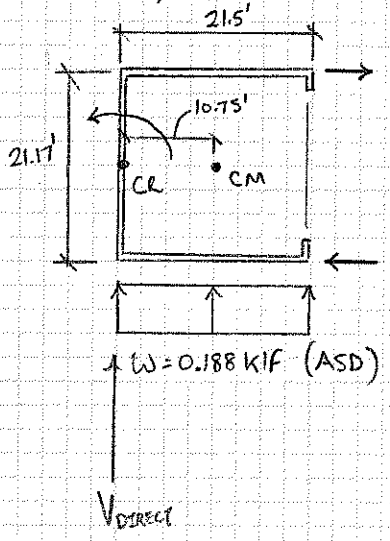
LATERAL DESIGN

CANTILEVERED DIAPHRAGM (N-S DIRECTION):

$F_{px,upper} = 8.11^k$

$V_{GARAGE} = (0.398)(8.11^k) = 3.23^k \quad (\rho = 1.0)$

$w = 3.23^k / 21.5 = 0.150$ klf, PER ANALYSIS, INCREASE × 1.25 = 0.188 klf



$V_{DIRECT} = (0.188\ klf)(21.5') = 4.04^k$

$V_{TORSION} = (4.04^k)(10.75') / 21.17' = 2.05^k \pm$

$V_{ACCIDENTAL} = (4.04^k)(0.05 \times 21.5')(A_x^* = 1.174) / 21.17'$

$= \pm 0.241^k$ *SEE L11 FOR CALC.

$V_{TOTAL,N-S} = V_{DIRECT} = 4.04^k$

$V_{TOTAL,E-W} = V_{TORSION} \pm V_{ACCIDENTAL} = \pm 2.29^k$

DIAPHRAGM CAPACITY:

$V = 4.04^k$

$v_s = 4.04^k / 21.17' = 0.191$

USE BLOCKED DIAPHRAGM w/ 8d @ 6" o.c. BOUNDARIES & EDGES, 12" o.c. FIELD

↳ $v_s = (540\ plf)(\frac{1}{2.0})(0.93)/1000 = 0.251$ klf OK

CHORD FORCE = $V_{TORSION} = 2.05^k$

TYPICAL TOP CHORD SPLICE = (8)16d = (8)(89#)(C_d=1.6) = 1.14^k

No Good.

USE CS16 STRAP w/ TOP CHORD SPLICE: $2.05^k - 1.14^k = 0.91^k$

CAPACITY = 1.71^k > 0.91^k OK.

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Cantilever Wood Diaphragm Deflection

Building: Paek Residence **Direction:** North-South

The shearwall modification formula is modified to acocunt for the difference in the shear distribution in the diaphragm vs. a shear wall.

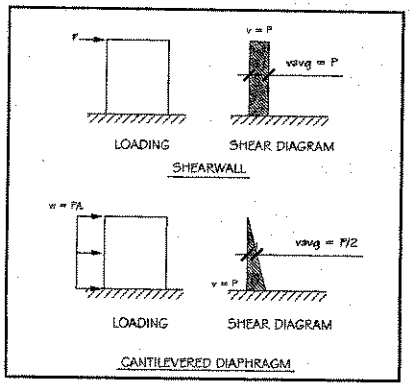
$$\delta_{unblocked} = \frac{3\left(\frac{v}{C_{ub}}\right)L^3}{EAb} + \frac{\left(\frac{v}{C_{ub}}\right)L}{2G_v t_v} + \frac{L\Delta_a}{2b} + 0.375Le_n$$

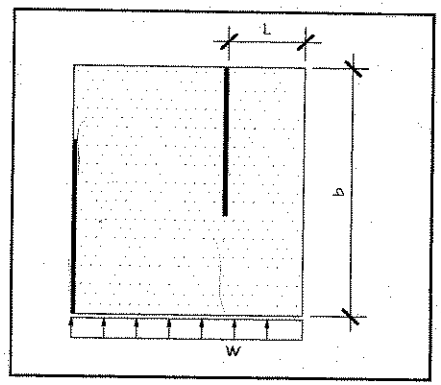
$$\delta_{blocked} = \frac{3vL^3}{EAb} + \frac{vL}{2G_v t_v} + \frac{L\Delta_a}{2b} + 0.375Le_n$$

Factors in the shear wall deflection equation (Shear, Nail Slip, and Chord Slip) is multiplied by 0.5 to account for the reduced average shear.
The flexural component has been derived from beam deflection equations.
Diaphragm Nailing Spacing = (Boundary - Other Edges - Field) = (B-E-F)

C_d = 4 (Seismic Deflection Amplification Factor, ASCE 7 Table 12.2-1)
Sheathing = Plywood (OSB or Ply)

Level	Cantilever Length L ft	Diaphragm Nailing Type	Plywood Thickness in	Diaphragm Nailing Spacing (B-E-F)	Diaphragm Depth b ft	Dist Load w_a lb/ft (ASD)	Shear/ft v_u lb/ft (Ult)	E psi, chord	A in^2, chord	$G_v t_v$ lb/in	e_n in	Chord Slip $\Sigma\Delta_c$ in	Joist Spacing in	C_{ub}	**Amplified Deflection δ in**
Upper	21.5	8d	0.5	Blocked (6-6-12)	21.2	154	223	1550000	16.625	40500	0.00575	0.0507484	16	1	**0.67**





Project: Paek Residence
Item: Garage Roof Cantilevered Diaphragm
Date: 8/7/2018
Engineer: JRC
Sheet:

Shear Wall Deflection - Multi-Story

Building: Paek Residence Direction: North-South

Shear wall deflection is equal to:

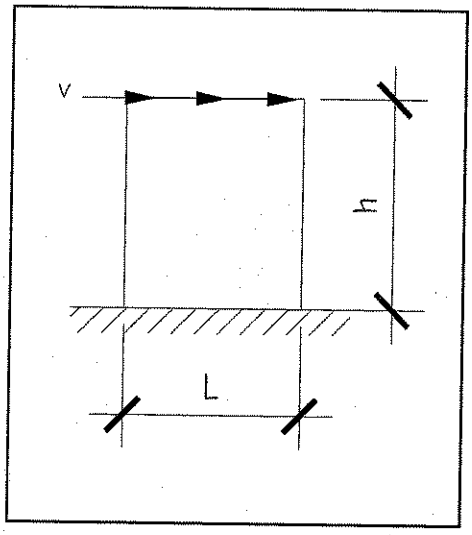
$$\delta_{sw} = \frac{8vh^3}{EAL} + \frac{vh}{G_v t_v} + \frac{h\Delta_a}{L} + 0.75he_n$$

Assumes 15/32" panels, 5-ply panels, MC< 19% at Fabrication, Blocked Construction

C_d = 4 (Seismic Deflection Amplification Factor, ASCE 7 Table 12.2-1)

Sheathing = Plywood (OSB or Ply)

Level	Story Height ft	Wall Height ft	Shear Wall Type	Wall Length ft	Shear/ft v_u lb/ft (Ult)	E psi, chord	A in^2, chord	$G_v t_v$ lb/in	e_n in	Holdown Slip Δ_a in	**Amplified Deflection δ in**	**Drift Ratio**	**Σδ in**
Roof	10.3	10.3	W6	16.75	231	1300000	19.25	40500	0.00635445	0.125	**0.76**	**0.0061**	**0.76**



Project:	Paek Residence
Item:	Garage Roof Cantilevered Diaphragm
Date:	8/7/2018
Engineer:	JRC
Sheet:	

LATERAL DESIGN

Story Drift Calculation - Summary

Building: Paek Residence Direction: North-South

Level	Cantilevered Diaphragm Deflection, $C_d\delta$ (in)	Shear Wall Deflection, $C_d\delta$ (in)	Total Deflection (in)	Story Height(ft)	Drift Ratio
Upper	0.67	0.76	1.43	10.3	0.012
		Σ =	1.43	10.3	0.012

Check For Irregularities

Deflection At Wall	0.76 in	
At Diaphragm Edge (Max)	1.43 in	
Avg Deflection	1.10 in	
1.2 * Avg =	1.32 in	TORSIONALLY IRREGULAR
1.4 * Avg =	1.54 in	NO EXTREME TORSIONAL IRREGULARITY

DUE TO $1.2\Delta_{AVG} > \Delta_{MAX}$, TORSIONAL IRREGULARITY OCCURS.

1) PER 12.3.3.4, INCREASE DIAPHRAGM FORCES × 1.25 FOR CONNECTION OF DIAPHRAGM TO VERT. ELEMENTS & COLLECTORS.

2) AMPLIFICATION OF ACCIDENTAL TORSIONAL MOMENT:

$$A_x = \left(\frac{\delta_{MAX}}{1.2\delta_{AVG}}\right)^2 = \left(\frac{1.43"}{1.2(1.10")}\right)^2 = 1.174$$

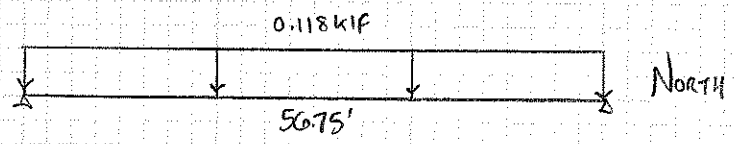
Paek Residence
Garage Roof Cantilevered Diaphragm
8/7/2018
JRC

LATERAL DESIGN

EAST-WEST DIRECTION SHEARWALLS: SEISMIC

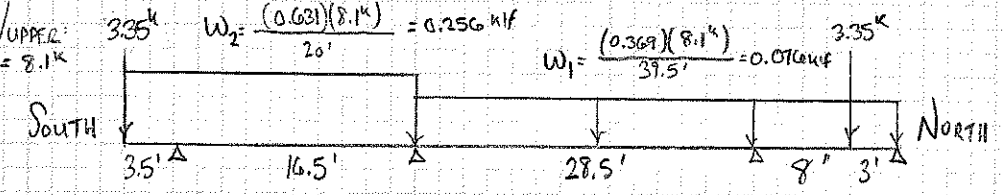
ROOF DIAPHRAGM:

$V_{ROOF} = 6.7^K$



V (kips):	3.35	3.35
L (ft):	8.67	17.33
v (plf):	386	193
SW:	W3	W6
OT (kips):	3.74 - 0.6DL = 3.36	2.17 - 0.6DL = 1.40 (11.25')
HD:	(2)CS16	CS16

UPPER FLOOR DIAPHRAGM:



V (kips):	6.35	3.19	1.39	3.77
L (ft):	48.75	21.5	14.17	20.17
v (plf):	130	148	98	187
SW:	W6	W6	W6	W6
OT (kips):	1.35 + 3.74 = 5.09 - 0.6DL = 3.91	1.53 - 0.6DL = ∅	1.01 - 0.6DL = ∅	1.93 + 2.17 = 4.10 - 0.6DL = 3.29
HD:	HDU4/(3)CS16	NONE	NONE	HDU4/(2)CS16

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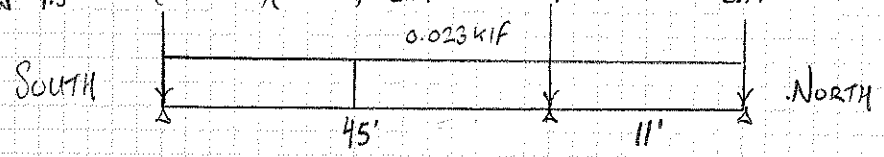
LATERAL DESIGN

EAST - WEST DIRECTION SHEARWALLS: SEISMIC

MAIN FLOOR DIAPHRAGM:

$V_{MAIN} = 1.3^k$ $= (15.83' + 1')(0.130 kif) = 2.19^k$ 1.39 3.77^k



V (kips):	2.71	2.04	3.90
L (ft):	18.75	13.83	18.75
v (plf):	145	148	208
SW:	W6	W6	W6
OT (kips):	@ HIGH = 1.16+5.09 = 6.25-0.6DL = 3.86 @ LOW = 0.36+5.09 = 5.45-0.6DL = 3.08	1.18+1.01 = 2.19-0.6DL = 1.30	@ HIGH = 1.66+4.10 = 5.76-0.6DL = 4.76 @ LOW = 0.52+4.10 = 4.62-0.6DL = 3.62
HD:	HDU4	HDU2	HDU5

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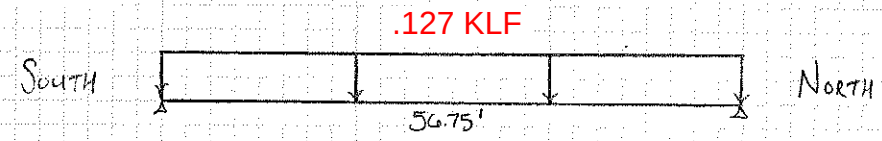
LATERAL DESIGN

EAST-WEST DIRECTION SHEARWALLS: WIND (E)

ROOF DIAPHRAGM:

V_{ROOF} = 7.18K

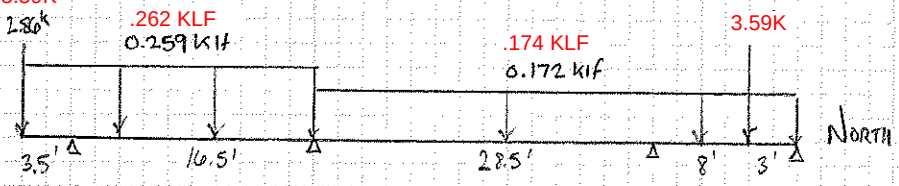


V (kips):	3.59	3.59
L (ft):	19.5	17.33
v (plf):	184	207
SW:	W6	W6
OT (kips):	1.84 - 0.6DL	2.07 - 0.6DL = 1.6
HD:	CS16	CS16

UPPER FLOOR DIAPHRAGM:

V_{UPPER} = 10.35K

$V_{PARAPET}$ = 1.75K



V (kips):	6.67	4.64	3.44	4.55
L (ft):	50	21.25	13.5	20.17
v (plf):	133	218	255	226
SW:	W6	W6	W6	W6
OT (kips):	1.60 + 1.84 = 3.44 - 0.6DL = 3.26	2.62 - 0.6DL = 1.26	3.06 - 0.6DL = 1.88	2.71 + 2.07 = 4.78 - 0.6DL = 3.59 K
HD:	HDU4/(2)CS16	HDU2	(2) CS16	HDU4/(3)CS16

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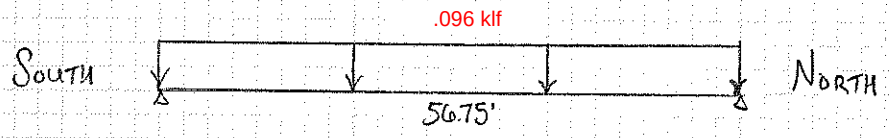
LATERAL DESIGN

EAST-WEST DIRECTION SHEARWALLS: WIND (W)

ROOF DIAPHRAGM:

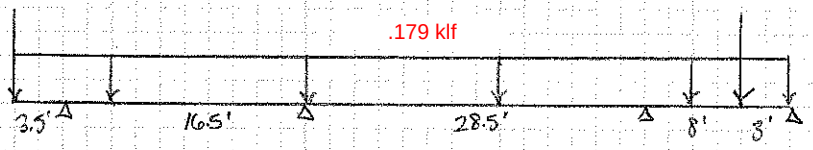
V_{ROOF} = 5.45 K



V (kips):	2.73	2.73
L (ft):	19.5	17.33
v (plf):	140	156
SW:	W6	W6
OT (kips):	1.33 - 0.6DL = .80	1.48 - 0.6DL = 1.01
HD:	CS16	CS16

UPPER FLOOR DIAPHRAGM:

V_{UPPER} = 10.64 K



V (kips):	4.83	4.03	3.54	3.72
L (ft):	50	21.25	13.5	20.17
v (plf):	97	190	262	185
SW:	W6	W6	W6	W6
OT (kips):	1.16 + .80 = 1.97 - 0.6DL = 1.67	2.09 - 0.6DL = 0.67	3.14 - 0.6DL = 1.96	2.22 + 1.01 = 3.23 - 0.6DL = 2.52
HD:	HDU2/CS16	HDU2	(2)CS16	HDU4/(2)CS16

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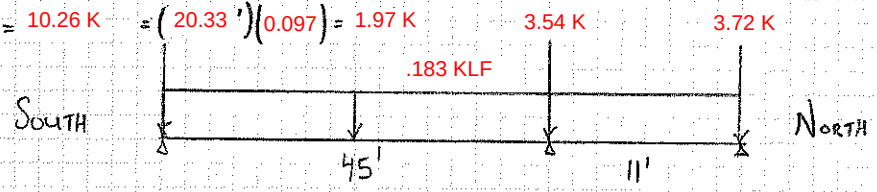
PROJECT: PAEK RESIDENCE, MERCER ISLAND, WA
DATE: 08/08/18
PROJ. #: JRC
DESIGN: LIS
SHEET:

LATERAL DESIGN

EAST-WEST DIRECTION SHEARWALLS: WIND (W)

MAIN FLOOR DIAPHRAGM:

V_{MAIN} = 10.26 K = (20.33 ')(0.097) = 1.97 K



V (kips):	6.09	8.66	4.73
L (ft):	18.75	13.83	18.75
v (plf):	325	626	252
SW:	W4	W2	W6
OT (kips):	2.6+1.67 = 4.27	5.01+1.96 = 6.97 - 0.6DL = 6.64	2.02+3.23=5.25 -.6D = 4.8
HD:	HDU4	HDU8	HDU5

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Shearwall Schedule Calculations

Hardware:

A35 Capacity: 600 # (connection 4) — Simpson C-2017

LTP4 Capacity: 575 # — Simpson C-2017

HGA10 Capacity: 840 # — Simpson C-2017

5/8"ø A.B. w/ 2x Sill Plate:

$= Z_{11} C_D = (860\#)(1.6) = 1376\#$ — NDS 2015

5/8"ø A.B. w/ 3x Sill Plate:

$= Z_{11} C_D = (1070\#)(1.6) = 1712\#$ — NDS 2015

16d x 0.135"ø x 3½" w/ 2x Side Member:

$= Z C_D \left(\frac{P}{10D}\right) = (89\#)(1.6)\left(\frac{1.25"}{1.35"}\right) = 132\#$ — NDS 2015

16d x 0.131"ø x 3¼" w/ 2x Side Member:

$= Z C_D \left(\frac{P}{10D}\right) = (84\#)(1.6)\left(\frac{1.00"}{1.31"}\right) = 103\#$ — NDS 2015

Shearwall W6:

15/32" CDX Plywood Sheathing w/ 8d @ 6"o.c.

Seismic: $= V_s [1 - (0.5 - G)]\left(\frac{1}{2.0}\right)$

$= 520\,plf \left[1 - (0.5 - 0.43)\right]\left(\frac{1}{2.0}\right) = \underline{242\,plf}$ Governs Seismic

Wind: $= (730\,plf)(0.93)\left(\frac{1}{2.0}\right) = 339\,plf$

A35/LTP4 @ 24"o.c. $= (575\#)\left(\frac{12"}{24"}\right) = 287\,plf$

Base Plate Nailing 16d @ 6"o.c. $= (132\#)\left(\frac{12"}{6"}\right) = \underline{264\,plf}$ Governs Wind

Sill Plate Anchorage 5/8"ø A.B. @ 48"o.c. $= (1376\#)\left(\frac{12"}{48"}\right) = 344\,plf$

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PROJECT: Paek Residence, Mercer Island, WA

DATE: 08/08/18

PROJ. #: JRC

DESIGN: LI7

SHEET:

Shearwall Schedule Calculations

Shearwall W4:

15/32" CDX Plywood Sheathing w/ 8d @ 4"o.c.

Seismic: $= (760\,plf)(0.93)\left(\frac{1}{2.0}\right) = \underline{353\,plf}$ Governs Seismic

Wind: $= (1065\,plf)(0.93)\left(\frac{1}{2.0}\right) = 495\,plf$

A35/LTP4 @ 16"o.c. $= (575\,\#)\left(\frac{12"}{16"}\right) = 431\,plf$

Base Plate Nailing 16d @ 4"o.c. $= (132\,\#)\left(\frac{12"}{4"}\right) = \underline{396\,plf}$ Governs Wind

Sill Plate Anchorage 5/8"ø A.B. @ 32"o.c. $= (1376\,\#)\left(\frac{12"}{32"}\right) = 516\,plf$

Shearwall W3:

15/32" CDX Plywood Sheathing w/ 8d @ 3"o.c.

Seismic: $= (980\,plf)(0.93)\left(\frac{1}{2.0}\right) = \underline{456\,plf}$ Governs Seismic

Wind: $= (1370\,plf)(0.93)\left(\frac{1}{2.0}\right) = 637\,plf$

A35/LTP4 @ 12"o.c. $= (575\,\#)\left(\frac{12"}{12"}\right) = 575\,plf$

Base Plate Nailing 16d @ 3"o.c. $= (132\,\#)\left(\frac{12"}{3"}\right) = \underline{528\,plf}$ Governs Wind

Sill Plate Anchorage 5/8"ø A.B. @ 24"o.c. $= (1376\,\#)\left(\frac{12"}{24"}\right) = 688\,plf$

Shearwall W2:

15/32" CDX Plywood Sheathing w/ 8d @ 2"o.c.

Seismic: $= (1280\,plf)(0.93)\left(\frac{1}{2.0}\right) = \underline{595\,plf}$ Governs Seismic

Wind: $= (1790\,plf)(0.93)\left(\frac{1}{2.0}\right) = 832\,plf$

A35/LTP4 @ 9"o.c. $= (575\,\#)\left(\frac{12"}{9"}\right) = \underline{767\,plf}$ Governs Wind

Baseplate Nailing (2) Rows 16d @ 4"o.c. $= (132\,\#)\left(\frac{12"}{4"}\right) \times 2 = 792\,plf$

Sill Plate Anchorage 5/8"ø A.B. @ 16"o.c. $= (1376\,\#)\left(\frac{12"}{16"}\right) = 1032\,plf$

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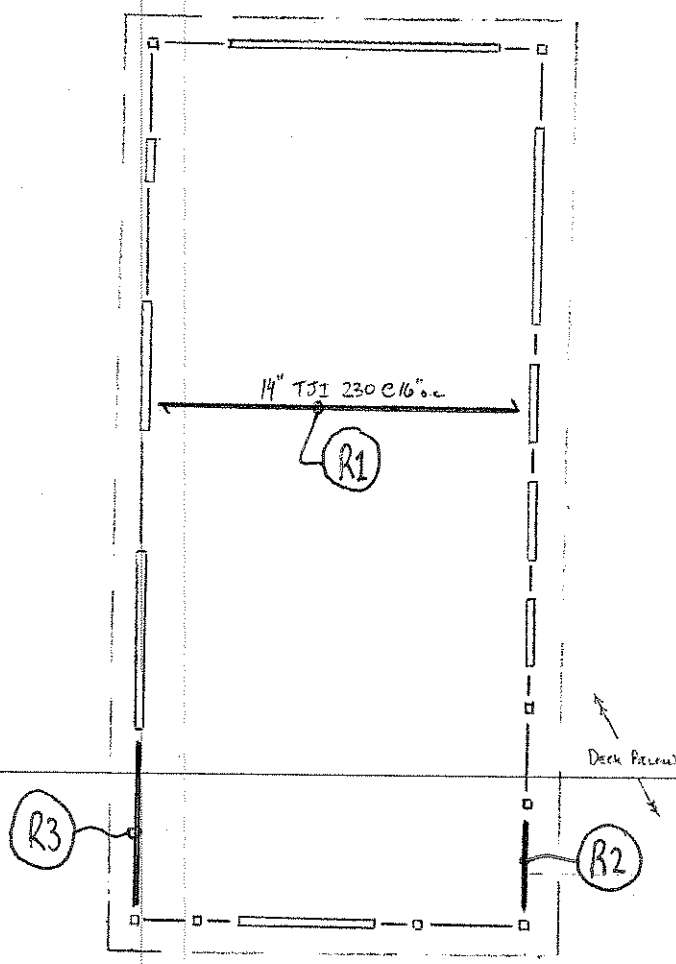
Roof Framing Key Plan:

Gravity Design

Roof Framing Plan



G1

GRAVITY DESIGN

ROOF FRAMING:

R1: 14" TJI 210 @ 16" o.c

$w = \left(\frac{16}{12}\right)(40\,psf) = 54\,plf$

$L = 25'$

$R = 0.68^k$ $M = 4.2\,ft\text{-}kips$

$R_a = 1.01^k$ $M_a = 4.5\,ft\text{-}kips$ $V_a = 1.95^k$

$\Delta = 1.09" = L/275$

$\Delta_{SL} = 0.69" = L/436$

@ 16" o.c : 14" TJI 210 @ 16" o.c

@ 24" o.c 14" TJI 360 @ 24" o.c

↳ $\Delta = 1.24" = L/241$

$\Delta_{SL} = 0.78" = L/386$

w/ CANTILEVER EAVE, R_{PLF} =

@ WEST = 0.572 k/f

@ EAST = 0.593 k/f

R2: 4×10

$w = 593\,plf$

$L = 7.5'$

$R = 2.22^k$ $M = 4.2\,ft\text{-}kips$

$F_b = 1.00\,ksi$ $F_v = 0.08\,ksi$

$\Delta = 0.14" = L/640$

R3: GL 3 1/8 × 10 1/2

$w = 572\,plf$

$L = 12.5'$

$R = 3.58^k$ $M = 11.2\,ft\text{-}k\text{-}ips$

$F_b = 2.34\,ksi$ $F_v = 0.14\,ksi$

$\Delta = 0.58" = L/259$

$\Delta_{SL} = 0.36" = L/414$

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PROJECT: PAEK RESIDENCE, MERCER ISLAND, WA

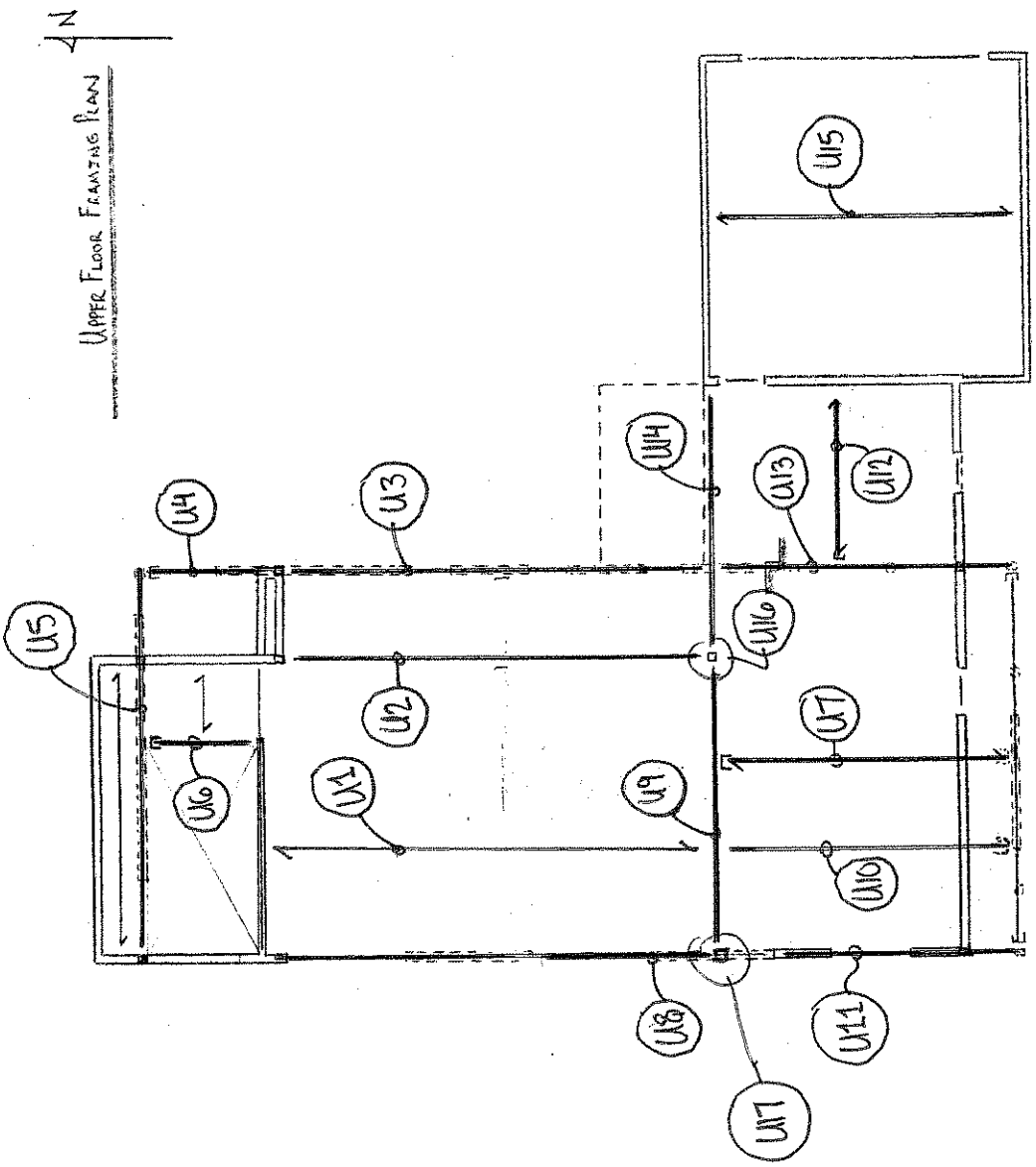
DATE: 08/06/18

PROJ. #: JRC

DESIGN: G2

SHEET:

GRAVITY DESIGN



UPPER FLOOR FRAMING KEY PLAN:

Gravity Design

Upper Floor Framing:

U1: (2) 14" TJI 560 @ 16" o.c.

$w = \left(\frac{16}{12}\right)(12\,psf + 40\,psf) = 70\,plf$

$L = 29'$

$R = 1.02^k$ $\quad M = 7.4$ ft-kips

$R_a = 1.27^k$ $\quad M_a = 11.3$ ft-kips

$\Delta = 0.698" = L/499$

U2: PSL 5 1/4 x 14

$w = \left(\frac{16}{12}\right)(52\,psf) = 70\,plf$

$L = 29'$

$R = 1.02^k$ $\quad M = 7.4$ ft-kips

$F_b = 0.52$ ksi $\quad F_v = 0.02$ ksi

$\Delta = 0.46" = L/750 > L/720$ OK (NANA WALL)

U3: GL 5 1/8 x 24 or W10x54

$w_1 = \left(\frac{25'}{2} + 2'\right)(40\,psf) + 115\,plf + \left(\frac{16}{12}\right)(12\,psf)$

$= 0.711$ kif $(D+S) + S.W.$

$= 0.660$ kif $(D+0.75L+0.75S) + S.W.$

$= 0.402$ kif $(D+L) + S.W.$

$w_2 = 0.711\text{ kif} + \left(\frac{11'}{2}\right)(40\,psf) = 951\,plf + S.W.$ $(D+S)$

$= 0.865$ kif $+ S.W.$ $(D+0.75L+0.75S)$

$= 0.492$ kif $+ S.W.$ $(D+L)$

$L_1 = 20.5'$ $\quad L_2 = 7'$

$R_1 = 10.7^k$ $\quad R_2 = 11.93^k$

$M = 74.4$ ft-kips

IF WOOD: GL 5 1/8 x 24	IF STEEL: W10x54
$F_b = 1.69$ ksi	$\frac{M_n}{\Omega_b} = 1666.2^k$
$F_v = 0.11$ ksi	$\frac{V_n}{\Omega_v} = 103.9^k$
$\Delta = 0.90" = L/369$	$\Delta = 1.09" = L/302$
Δ_{SL} 0.43" $= L/159$	$\Delta_{SL} = 0.56" = L/595$

U4: LSL 1 3/4 x 11 7/8

$w = 0.730$ kif

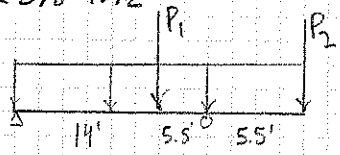
$L = 9'$

$R = 3.29^k$ $\quad M = 7.4$ ft-kips

$F_b = 2.16$ ksi $\quad F_v = 0.19$ ksi

$\Delta = 0.28" = L/379$

U5: GL 5 1/8 x 13 1/2 or PSL 5 1/4 x 14



$w = (120\,plf) + 100\,plf + \left(\frac{24}{12}\right)(40\,psf) + \left(\frac{16}{12}\right)(12\,psf)$ $= 0.32$ kif

$P_1 = \left(\frac{19.5'}{2}\right)\left(\frac{8'}{2}\right)(12\,psf) = 0.47^k$

$P_2 = R$ of U4 $= 3.29^k$

$R_1 = 2.46^k$ $\quad R_2 = 10.55^k$

$+M = 9.3$ ft-kips $\quad -M = 22.9$ ft-kips

$F_b = 2.24$ ksi $\quad F_v = 0.13$ ksi

$\Delta_{SPAN} = 0.37" = L/627$

$\Delta_{CANT} = 0.50" = 2L/265$

} PSL 5 1/4 x 11 7/8

↳ No Good w/ No London Backspan.

$EI_{PSL} = 2.0\left(\frac{5.25 \times 11.875^3}{12}\right) = 1.47\,k\cdot in^2$

$\frac{L_{240}}{L_{199}} = 1.21 \times 1.47 = 1.77\,k\cdot in^2$

Use GL 5 1/8 x 13 1/2 $= 1.89\,k\cdot in^2$

$\Delta_{CANT} = 0.51" = L/257$

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SWENSON SAY FAGÉT

PROJECT: Paek Residence, Mercer Island, WA

DATE: 08/06/18

PROJ. #: JRC

DESIGN: GH

SHEET

GRAVITY DESIGN

UPPER FLOOR FRAMING

U6: LSL 1¾×11⅞ (14")

$w = \left(\frac{19.5'}{2}\right)(52\,psf) = 0.51\,klf$

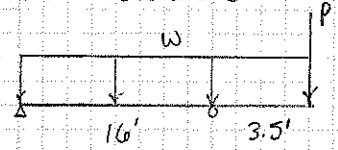
$L = 10.25'$

$R = 2.61\,K$ $\quad M = 6.7\,FT\text{-}K$

$F_b = .7\,KSI$ $\quad F_v = .06\,KSI$

$\Delta = .1" = L/1205$

U7: 11⅞" TJI 210 @ 16" o.c. (14")



$w = \left(\frac{16}{12}\right)(52\,psf) = 70\,plf$

$P = (45\,plf + 100\,plf)\left(\frac{16}{12}\right) = 193\#$

$R_1 = 0.51^k$ (NO UP) $\quad R_2 = 1.07^k$

$-M = 1.87\,ft\text{-}kips$ $\quad -M = 1.1\,ft\text{-}kips$

$R_a = 2.57^k$ $\quad M_a = 3.8\,ft\text{-}kips$

$\Delta_{SPAN} = 0.36" = L/630$

$\Delta_{CANT} = -0.11" = 2L/762$

U8: W12×152 !! OR GL 5½×31½

$w = \left(\frac{25'}{2} + 15'\right)(40\,psf) + 100\,plf + \left(\frac{16}{12}\right)(12\,psf)$

$= 0.6076\,klf + S.W. = 0.83\,klf$

$L = 29'$

$R = 12.0^k$ $\quad M = 87.0\,ft\text{-}kips$

$\frac{M_n}{\Omega_b} = 6006.3\,ft\text{-}kips$ $\quad \frac{V_n}{\Omega_v} = 170.4^k$

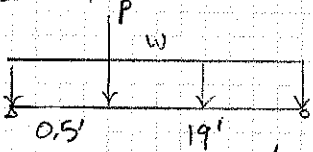
$\Delta_{SW} = 0.06" = L/5966$

$\Delta_{TL-SW} = 0.26" = L/1342$ ☆ 0.25"

C WOOD: $\Delta = 0.24" = L/1426$ (NANA WALL)

↳ $F_b = 0.71\,ksi$ $\quad F'_b = (2.4\,ksi)(C_D = 1.15)(C_L = 0.32) = 0.89\,ksi$

U9: W12×22



$w = (R_1\,of\,U7 = 0.51^k)\left(\frac{7}{16}\right) + \left(\frac{29.5'}{2}\right)(52\,psf)$

$= 1.15\,klf$

$P = R\,of\,U8 = 12.0^k$

$R_1 = 22.91^k$ $\quad R_2 = 11.52^k$

$M = 57.7\,ft\text{-}kips$

IF WOOD: (2)PSL7×14 $\quad$ IF STEEL: W12×22

$F_b = 1.51\,ksi$ $\quad \frac{M_n}{\Omega_b} = 73.1\,ft\text{-}kips$

$F_v = 0.17\,ksi$ $\quad \frac{V_n}{\Omega_v} = 92.0^k$

$\Delta = 0.96" = L/244$ $\quad \Delta = 0.86" = L/265$

U10: PSL 7×11⅞

$w = 120\,plf\,(Roof) + 100\,plf\,(wall) = 220\,plf$

$L = 25'$

$R = 2.75^k$ $\quad M = 17.2\,ft\text{-}kips$

$F_b = 1.25\,ksi$ $\quad F_v = 0.05\,ksi$

$\Delta = 0.99" = L/303$

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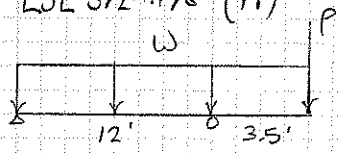
GRAVITY DESIGN

UPPER FLOOR FRAMING:

U11: LSL 3½×11⅞ (14)



$w = \left(\frac{25'}{2}+1.5'\right)(40\,psf) + 90\,plf + \left(\frac{16}{12}\right)(12\,psf)$
$= 0.61\,klf$

$P = 0.44^k$

$R_1 = 3.79^k$ $\quad R_2 = 7.25^k$

$+M = 10.8\,ft\text{-}kips$ $\quad -M = 5.0\,ft\text{-}kips$

$F_b = 1.57\,ksi$ $\quad F_v = 0.14\,ksi$

$\Delta_{SPAN} = 0.36'' = L/401$

$\Delta_{CANT} = -0.28'' = 2L/295$

U12:

$w = \left(\frac{16}{12}\right)\left(15\,psf + 0.75(1.5\times 40\,psf) + 0.75(25\,psf)\right)$
$= 105\,plf$

$L = 12'$

$R = 0.63^k$ $\quad M = 1.9\,ft\text{-}kips$

$F_b = 0.86\,ksi$ $\quad F_v = 0.04\,ksi$

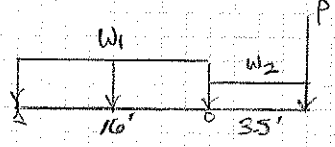
$\Delta = 0.40''$ $\quad \Delta_{LL} = 0.30'' = L/478$

$d_{REQ'D\ FOR\ DECK}$:

$14''$ Joist Depth
$-1.5''$ Decking
$-16'(1/4''/10')$ Slope of Deck
$11.85''$

Use 2×8 Depth

U13: PSL 7×14 or W12×22



$w_1 = \left(\frac{25'}{2}+2'\right)(33.75\,psf) + 110\,plf + \left(\frac{12'}{2}\right)(79\,psf) + \left(\frac{16}{12}\right)(42\,psf) = 1.13\,klf$ (1.04 klf D+S)

$w_2 = \left(\frac{25'}{2}+2'\right)(33.75\,psf) + 110\,plf + \left(\frac{16}{12}\right)(42\,psf)$
$= 0.806\,klf$ (0.71 klf D+S) (0.347 D)

$P = \left[\left(\frac{33.75}{40}\right)(120\,plf)\right]\left(\frac{1}{2}\right) = 0.35^k$ (0.492 D+S) (0.16 D)

$R_1 = 8.87^k + S.W.$ $\quad R_2 = 12.03^k + S.W.$

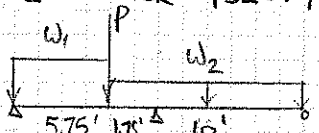
$+M = 34.8\,ft\text{-}kips$ $\quad -M = 5.3\,ft\text{-}kips$

$\frac{M_n}{\Omega_b} = 73.1\,ft\text{-}kips$ $\quad \frac{V_n}{\Omega_v} = 53.5^k$

$\Delta_{SPAN} = 0.34'' = L/571$

$\Delta_{CANT} = -0.23'' = L/366$

U14: W6×25 or PSL 5¼×14



$w_1 = \left(R_{2\ of\ U7} = 0.51^k\right)\left(\frac{12}{16}\right) = 0.93\,klf + \left(\frac{112\,psf}{52\,psf}\right) + \left(\frac{29.5'}{2}\right)(42\,psf)$

$w_2 = \left(\frac{16}{12}\right)(77\,psf) + \left(\frac{24}{12}/2\right)(33.75\,psf) = 0.114\,klf$

$P = \left(R_{2\ of\ U3}\right) + \left(R_{1\ of\ U8}\right) = 11.93^k + 8.87^k$
$= 20.8^k$

$R_1 = 0.47^k$ $\quad R_2 = 22.4^k$ $\quad R_3 = -1.1^k$

$M = 21.4\,ft\text{-}kips$

$\frac{M_n}{\Omega_b} = 46.9\,ft\text{-}kips$ $\quad \frac{V_n}{\Omega_v} = 31.4^k$

$\Delta = 0.12'' = L/777$

$L_{B,MAX} = 5.75'$

$L_p = 1.76 r_y\sqrt{\frac{E}{F_y}} = 5.37'$
$L_r = 23.7'$
$L_p < L_B < L_r$

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GRAVITY DESIGN

UPPER FLOOR FRAMING:

U15: 14" TJI 210 @16"oc → 3" GREEN ROOF

$w = \left(\frac{16}{12}\right)(15\,psf + 20\,psf + 25\,psf) = 80\,plf$

$L = 20.5'$

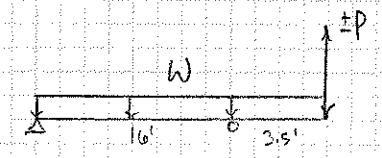
$R = 0.860^k$ $\quad M = 4.6\,ft\text{-}kips$

$R_a = 1.01^k$ $\quad M_a = (4.49\,ft\text{-}kips)(C_d = 1.15) = 5.16\,ft\text{-}kips$

$\Delta = 0.10" = L/2860$

$\Delta_{SL} = 0.38" = L/686O$

U10 w/ OVERTURNING: PSL 5 1/4 × 11 7/8 (LSL 3 1/2 × 14)



LC5: $(1.0 + 0.14S_{DS})D + 0.7\Omega_o E$

LC6b: $(1.0 + 0.10S_{DS})D + 0.75L + 0.75S + 0.75(0.7)\Omega_o E$

LC8: $(0.6 - 0.14S_{DS})D + 0.7\Omega_o E$

LC5: $w = (1.0 + 0.14(0.910))\left(\frac{16}{12}\right)(15\,psf) = 18\,plf$

$P = (3.74^k)(\Omega_o = 2.5) + \left[(1.127)(145\,plf)\right]\left(\frac{16}{12}\right) = 9.57^k$

LC6b: $w = (1.0 + 0.10(0.910))\left(\frac{16}{12}\right)(12\,psf) + \left(\frac{16}{12}\right)(0.75)(40\,psf) = 58\,plf$ $\quad (= 17.5\,plf$ w/o LL)

$P = (0.75)(3.74^k)(\Omega_o = 2.5) + \left[(1.09)(145) + 0.75(75\,plf)\right]\left(\frac{16}{12}\right) = 7.30^k$

LC8 $w = (0.6 - 0.14(0.910))\left(\frac{16}{12}\right)(12\,psf) = 7\,plf$

$P = -(3.74^k)(\Omega_o = 2.5) + (0.473)(145\,plf)\left(\frac{16}{12}\right) = -9.26^k$

$R_1 = -1.96^k,\ 2.08^k$ $\quad R_2 = -11.2^k,\ 11.9^k$

$+M = 32.9\,ft\text{-}kips$ $\quad -M = 33.6\,ft\text{-}kips$

$F_b = 3.27\,ksi$ $\quad F_v = 0.23\,ksi$ $\quad (F_b = 3.5\,ksi$ w/ 14") → w/o Ω_o:

$f'_b = (2.9\,ksi)(C_d = 1.6) = 4.64\,ksi$ ✓ $\quad (F_b = (2.25\,ksi)(C_d = 1.6)) = 3.6\,ksi$ ✓

$f'_v = (0.29\,ksi)(C_d = 1.6) = 0.46\,ksi$ ✓

$R_1 = -0.73^k,\ 0.85^k$

$R_2 = -4.37^k,\ 5.04^k$

U16: HSS 3×3×1/4

$P = 9.56^k + 16.6^k + 3.9^k = 30.06^k$ $\quad \frac{P_n}{\Omega_c}$ @ $KL = 10' = 30.6^k$

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GRAVITY DESIGN

UPPER FLOOR FRAMING:

U17:

COLUMN LOAD, $P = R_{of\ U9} = 22.91^{k}$ $(D+0.75L+0.75S)$

$KL = 12'$

C&C LOAD $= 0.7(-38.9\,psf) = -27.2\,psf$ (CONSERVATIVE AREA & HEIGHT)

$w_{COLUMN,\,WIND} = \left(\frac{28'}{2}+\frac{16/12}{2}\right)(-27.2\,psf)(0.75) = -300\,plf$

$R_{col} = -1.99^{k}$ $(w/o\ 0.75(0.7W))$

$M_{COL} = \frac{(0.3\,klf)(12')^2}{8} = 5.4\ ft\text{-}kips$

AISC SPECIFICATION CHAPTER H:

TRY HSS4×4×1/4 →

$\frac{P_n}{\Omega_c} = 50.8$ @ $kL = 12'$, $\frac{M_n}{\Omega_b} = 10.8\ ft\text{-}kips$

$\frac{P_r}{P_c} = \frac{22.91^{k}}{50.8^{k}} = 0.45 > 0.2$

$\therefore \frac{P_r}{P_c} + \frac{8}{9}\left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right) \le 1.0$

$= 0.45 + \frac{8}{9}\left(\frac{5.4\ ft\text{-}kips}{10.8\ ft\text{-}kips} + 0\right) = 0.89 < 1.0$ OK.

HSS4×4×1/4 OR EQUIV., $Z_x = Z_y = 3.07\,in^3$

DIAPHRAGM @ COL.: $V_{WIND} = 1.99^{k}\ (=R_{COL.})$

↳ $1.99^{k} / (2\ EDGES \times 0.235\,klf) = 4.2'$ OF UNBLOCKED DIAPHRAGM

USE BEAM AS DRAG @ SOUTH. USE BLKG @ NORTH

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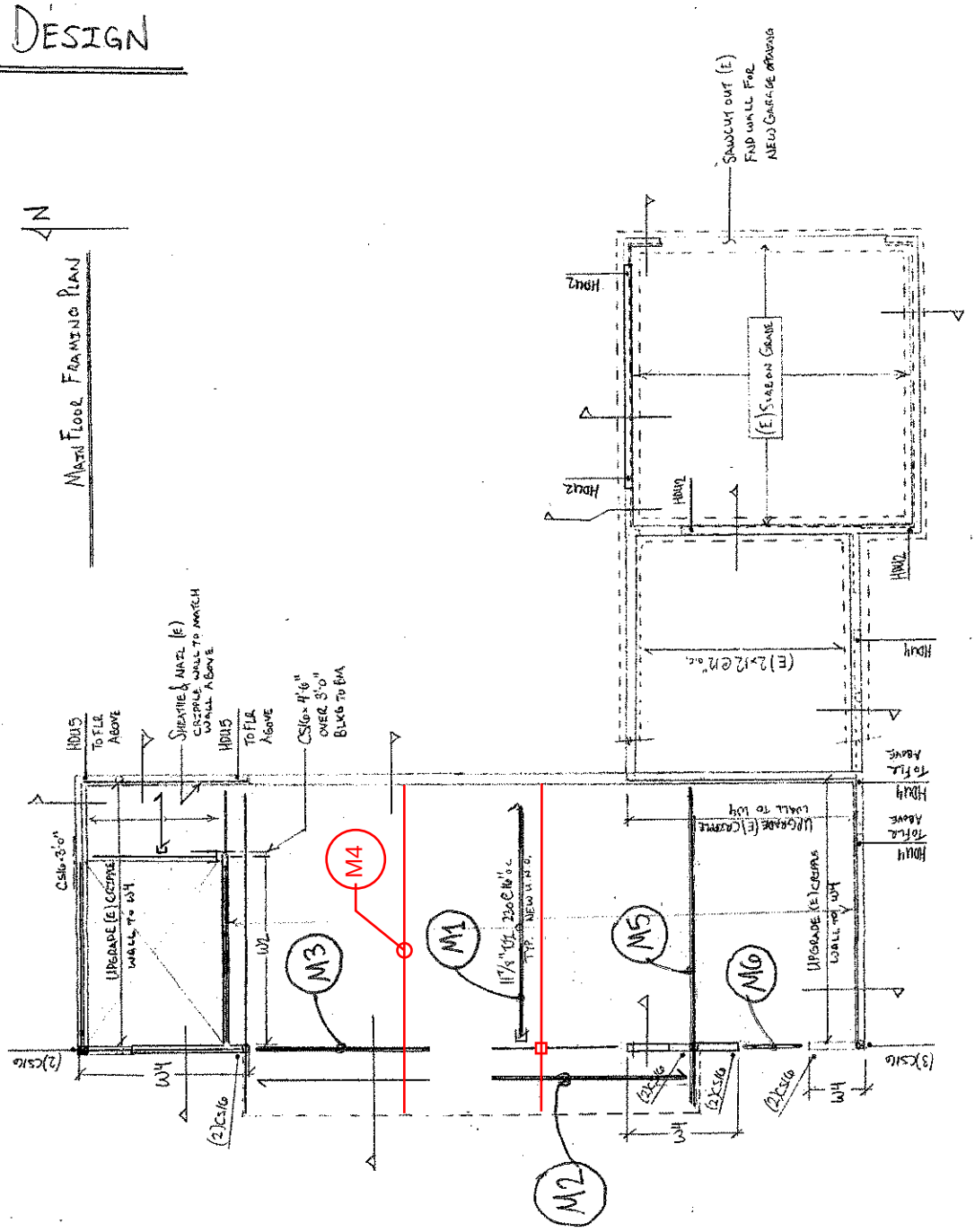
GRAVITY DESIGN



MAIN FLOOR FRAMING KEY PLAN

Gravity Design

Main Floor Framing:

M1: 11 7/8" TJI 210 @ 16" oc

See U1 for calc

M2: LVL 1 3/4 × 9 1/2 @ 16" oc or 4×10 @ 16" oc

$w = \left(\frac{16}{12}\right)\left(15\,psf + 0.75(1.5 \times 40\,psf) + 0.75(25\,psf)\right)$

$= 105\,plf$

$L = 16.5'$

$R = 0.87^k$ $M = 3.6\,ft\text{-}kips$

$F_b = 1.63\,ksi$ $F_v = 0.07\,ksi$

$\Delta = 0.70" = L/283$

$\Delta_{LL} = 0.53" = L/371$

M3: PSL 5 1/4 × 11 7/8

$w = \left(\frac{19.5'}{2}\right)(52\,psf) + \left(\frac{16}{12}\right)(75\,psf) + 100\,plf$

$= 707\,plf$

$L = 15.5'$

$R = 5.50^k$ $M = 21.3\,ft\text{-}kips$

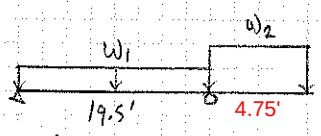
$F_b = 2.1\,ksi$ $F_v = 0.12\,ksi$

$\Delta = 0.63" = L/296$

$\Delta_{LL} = 0.42" = L/446$

@ adjacent HDR w/ French Door, $\Delta = 0.19" = L/724$. Good for Δ criteria

M4: W8×18



(16 plf D)

$w_1 = \left(\frac{16}{12}\right)\left(12\,psf + 0.75(40\,psf)\right) = 56\,plf$ (70 plf D+L)

$w_2 = (10')\left(15\,psf + 0.75(1.5 \times 40\,psf) + 0.75(30\,psf)\right) = .825\,klf$

(.750 klf D+L) (.150 klf D)

$R_1 =$ -.321 K, .07 K $R_2 =$ 4.94 K

$+M =$ .04 FT-K $-M =$ 9.31 FT-K

$\frac{M_n}{\Omega_b} = 424\,ft\text{-}kips$ $\frac{V_n}{\Omega_v} = 30.9^k$

$\Delta_{SPAN} =$ -.1" $= L/2100$

$\Delta_{CANT} =$ .25" $= 2L/460$

M5: W8×18

Similar to M4, w/ half trib.

$R_1 = -0.18^k$ $R_2 = 3.42^k$

M6: 4×8

$w = \left(\frac{14.5}{2}\right)(52\,psf) + 100\,plf = .61\,klf$

$L = 5.5'$

$R = 1.67^k$ $M = 2.3\,ft\text{-}kips$

$F_b = 0.90\,ksi$ $F_v = 0.08\,ksi$

$\Delta = 0.09" = L/763$

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PROJECT: Paek Residence, Mercer Island, WA

DATE: 08/13/18

PROJ. #: JRC

DESIGN: GIO

SHEET:

GRAVITY DESIGN

MAIN FLOOR FRAMING:

M1: HSS 3×3×1/4

$P = (R_2 \text{ OF } U9 = 9.89^k) + (1.11 \text{ klf})(\frac{16'}{2})$
$+ (R \text{ OF } M3 = 5.50^k) + (0.71 \text{ klf})(\frac{11.5'}{2})$
$+ (R \text{ OF } M4 = 6.97^k) = 35.3^k$

$KL = 8.0'$

$\frac{P_n}{\Omega_c} = 40.6^k$ OK (AISC TABLE 4-4)

↳ FOOTING:

$P = 35.3^k$

$q_A = 1.5 \text{ ksf}$

$A_{REQ} = 23.5 \text{ ft}^2$

USE 5'-0" SQ. × 12" DP. FOOTING
W/ (5) #5 EA. WAY BOTTOM.

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SSF STRUCTURAL ENGINEERING

PROJECT: PAEK RESIDENCE, MERCER ISLAND, WA
DATE: 08/13/18
PROJ. #: JRC
DESIGN: GII
SHEET: