STRUCTURAL CALCULATIONS

FOR THE

MARSHALL RESIDENCE

PHASE I-'B'

4307 EAST MERCER WAY
MERCER IS, WA 98040

ARCHITECT:

STUDIO ARCHITECTS
9-103rd AVE NE STE 203
BELLEVUE, WA 98004

8/16/19

SWENSON SAY FAGÉT
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SEATTLE 2124 Third Ave, Suite 100, Seattle, WA 98121 | O 206.443.6212
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STRUCTURAL ENGINEERING

Marshall
PROJECT

8/16/19
DATE

PROJ #

DESIGN

SHEET

Seismic Design Loads (ASCE 7-10)

			Latitude	47.57
			Longitude	-122.21
Risk Category	ii	Table 1.5-1		
USE GROUP	I			
IMP. FACTOR	1	Table 1.5-2		
SITE CLASS	D	Table 20.3-1		
R =	6.5	Table 12.2-1		

S_s =	1.41		ASCE 7-10 Maps or the USGS Website (http://geohazards.usgs.gov/)
S_1 =	0.54		ASCE 7-10 Maps or the USGS Website (http://geohazards.usgs.gov/)
F_a =	1	Table 11.4-1	
F_v =	1.5	Table 11.4-2	
S_{DS}=	0.937		
S_{D1}=	0.539		
Cs_{ULT}=	0.144	Eqn. 12.8-2	
Cs_{ASD}=	0.101		

Seismic Dead Load:

	15 psf Roof
	10 psf Floor
	10 psf Wall
Wroof	20 psf
Wfloor	20 psf

Vertical Design Loads

Criteria
ASCE 7-10
IBC 2015

Dead Loads

Rfg+PV Panels	3	psf	Flooring	1.7	psf
1/2" Ply	1.5	psf	3/4" Ply	2.3	psf
Rafter/Truss	2	psf	Joist	2	psf
Insulation	1	psf	5/8" GWB	2.5	psf
5/8" GWB	2.5	psf	Misc. Mech	1.5	psf
Misc. Mech	0.5	psf	Gypcrete	0	psf
	10.5	psf		10	psf
Use	15	psf	Use	10	psf

Live Loads

Roof	25	psf
Floor	40	psf

Soil Bearing 1500 psf

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Fax: 206.443.4870

Project:	Marshall Residence	Date:	8/16/2019
	4307 E Mercer Way	Project #:	10315-2015-02
	Mercer Is, WA 98040	Design:	Blaze
		Sheet:	Criteria 1

Wind Design Loads (ASCE 7-10)

Ch.27 Directional Procedure

Exposure	C	**Vult by R.C.**	Roof Angle =	25	degrees
Vasd=	85 mph	110	Ground to top of roof	25.00	ft
K_d=	0.85	Table 26.6-1	Bottom of roof to top of roof	5.00	ft
I=	1		(mean roof height) h=	22.50	ft
G=	0.85	26.9.1			

K_{zt}= 1.23

Pressure Coefficients from Figure 27.4-1:

Bldg Face	C_p
Windward Wall	0.8
Leeward Wall	-0.5
Windward Roof	0.4
Leeward Roof	-0.6

*Note= Cp values are conservative worst case values

ASD

Pressures:

Ht	K_z	q_z	$P_{ww\ walls}$	P_{lwalls}	**P_{walls} (psf)**
0-15	0.85	16.52	11.23	7.76	**18.99**
15-20	0.90	17.49	11.89	7.76	**19.65**
20-25	0.94	18.27	12.42	7.76	**20.18**
25-30	0.98	19.04	12.95	7.76	**20.71**
30-40	1.04	20.21	13.74	7.76	**21.50**
40-50	1.09	21.18	14.40	7.76	**22.17**
50-60	1.13	21.96	14.93	7.76	**22.69**
60-70	1.17	22.73	15.46	7.76	23.22

P_{roof} (psf)
15.53

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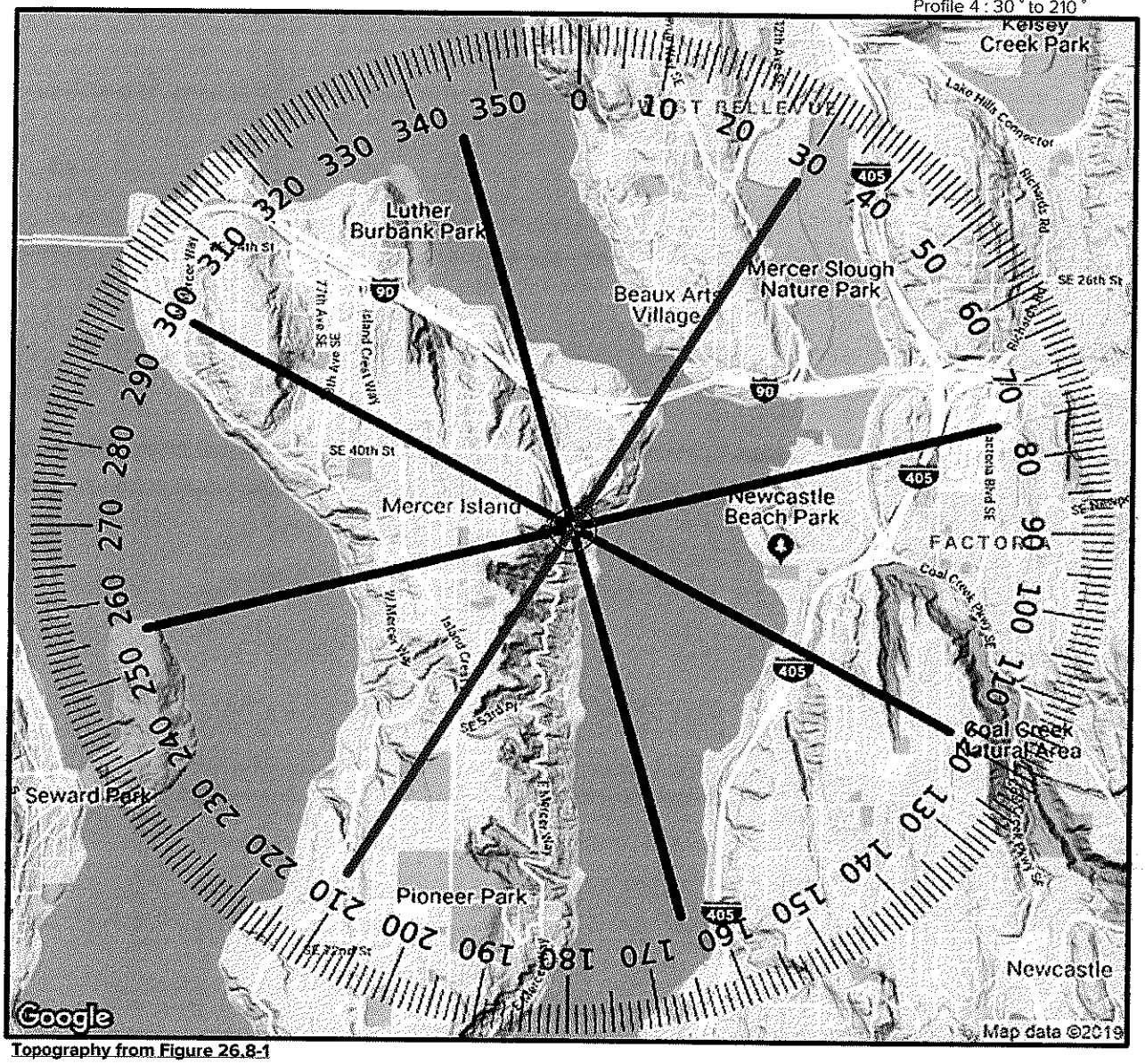
Project:	Marshall Residence 4307 E Mercer Way Mercer Is, WA 98040 0	Date: Project #: Design: Sheet:	8/16/2019 10315-2015-02 Blaze Criteria 2

Site Address

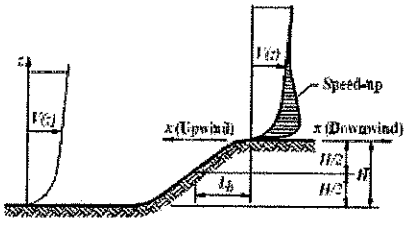
Address	4307 East Mercer Way			Wind Radius	2.00 Miles
City:	Seattle	State:	WA	Angle	-15 °
Lat Long	47.56919	-122.2104		Exposure	C

Profile 1 : -15 ° to 165 °
Profile 2 : 255 ° to 75 °
Profile 3 : 300 ° to 120 °
Profile 4 : 30 ° to 210 °

SITE MAP



Topography from Figure 26.8-1



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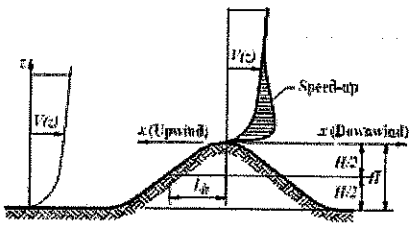

2-D RIDGE OR 3-D AXISYMMETRICAL HILL

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

PER FIGURE 26.8-1

MARSHALL RESIDENCE

4307 East Mercer Island

Kzt Calculations

DATE 8/8/2019

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DESIGN MBJ

SHEET 3

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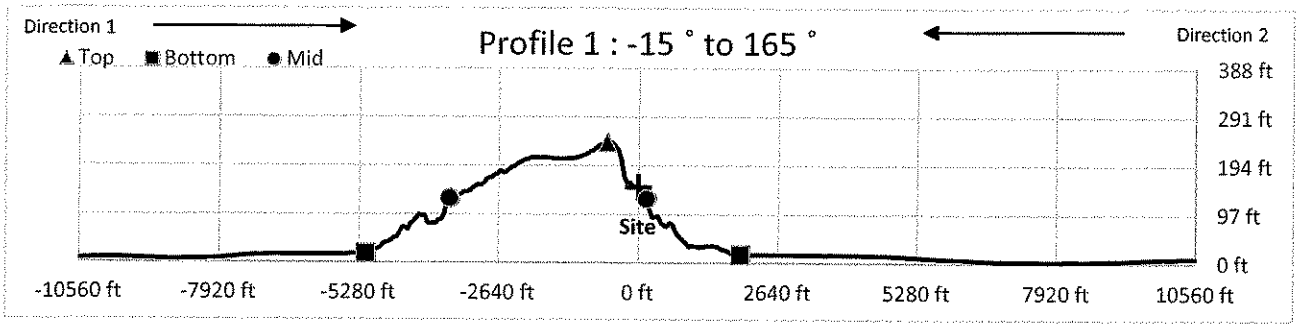

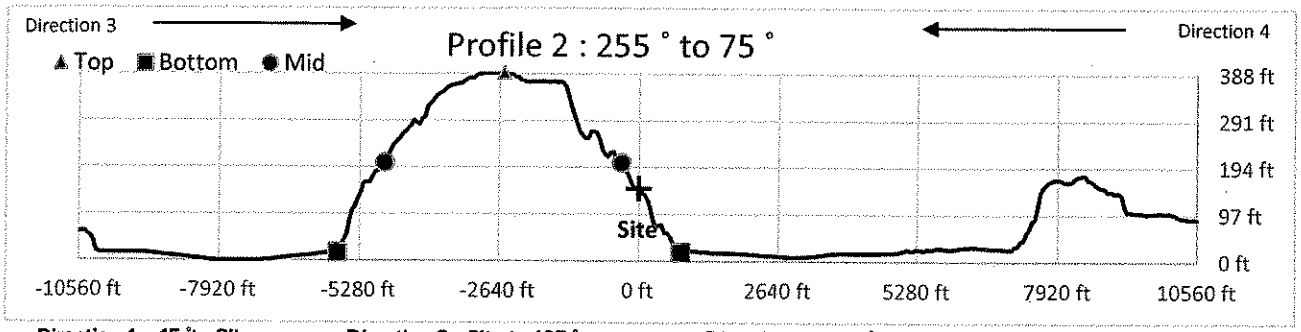

Direction 1 - -15 °to Site

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	

Terrain Data

Terrain	Hill
Top of Hill Dist.	-584
Bott. of Hill Dist.	-5150
L @ H/2	-3555
Site	downwnd
Top of Hill Elev.	239
Bott. of Hill Elev.	18
Site Elev.	150.9
Site Dist.	0
H/2	128

Kzt Calculations

H=	221
Lh=	2971
x=	584
z=	60
μ=	1.5
γ=	4
K1 value =	1.05
K1=	0.08
K2=	0.87
k3=	0.92
H/Lh =	0.07
Kzt =	1.00

Direction 2 - Site to 165 °

Site Conditions (26.8.1)

1. Unubstructed	Yes	
2. Isolated	Yes	
3. Upper Half Hill	Yes	
4. H/Lh ≥ 0.2	Yes	
5. H≥ 15'	Yes	

Terrain Data

Terrain	Hill
Top of Hill Dist.	-584
Bott. of Hill Dist.	1930
L @ H/2	159
Site	upwind
Top of Hill Elev.	239
Bott. of Hill Elev.	17
Site Elev.	150.9
Site Dist.	0
H/2	128

Kzt Calculations

H=	222
Lh=	743
x=	584
z=	60
μ=	1.5
γ=	4
K1 value =	1.05
K1=	0.31
K2=	0.48
k3=	0.72
H/Lh =	0.30
Kzt =	1.23

Direction 3 - 255 °to Site

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	

Terrain Data

Terrain	Hill
Top of Hill Dist.	-2547
Bott. of Hill Dist.	-5680
L @ H/2	-4800
Site	downwnd
Top of Hill Elev.	391
Bott. of Hill Elev.	16
Site Elev.	150.9
Site Dist.	0
H/2	204

Kzt Calculations

H=	374
Lh=	2253
x=	2547
z=	60
μ=	1.5
γ=	4
K1 value =	1.05
K1=	0.17
K2=	0.25
k3=	0.90
H/Lh =	0.17
Kzt =	1.00

Direction 4 - Site to 75 °

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	

Terrain Data

Terrain	Hill
Top of Hill Dist.	-2547
Bott. of Hill Dist.	800
L @ H/2	-320
Site	upwind
Top of Hill Elev.	391
Bott. of Hill Elev.	18
Site Elev.	150.9
Site Dist.	0
H/2	204

Kzt Calculations

H=	373
Lh=	2227
x=	2547
z=	60
μ=	1.5
γ=	4
K1 value =	1.05
K1=	0.18
K2=	0.24
k3=	0.90
H/Lh =	0.17
Kzt =	1.00

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Project MARSHALL RESIDENCE

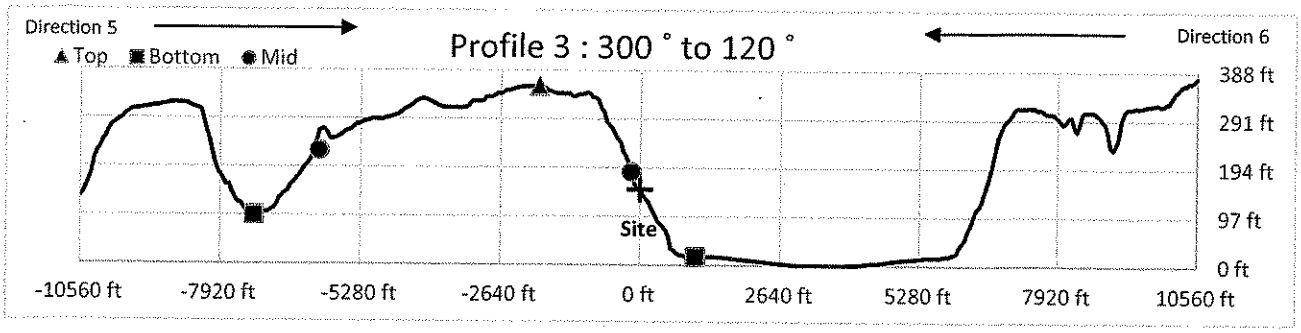
Kzt Calculations

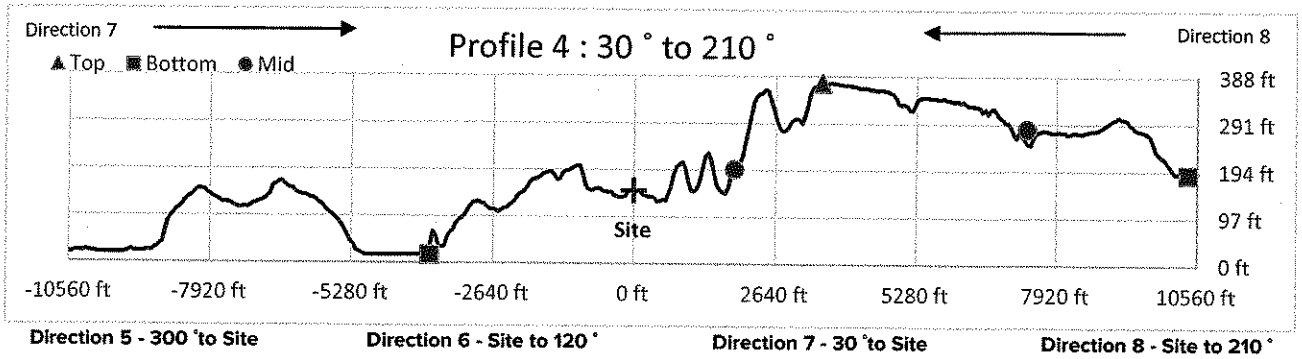
DATE 8/8/2019

PROJ. #

DESIGN MBJ

SHEET 4





Direction 5 - 300 ° to Site

Site Conditions (26.8.1)

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

	Ridge

Kzt Calculations

H=	339
Lh=	1750
x=	1910
z=	60
μ=	1.5
γ=	3
K1 value =	1.45
K1=	0.28
K2=	0.27
k3=	0.90
H/Lh =	0.19
Kzt =	1.00

Direction 6 - Site to 120 °

Site Conditions (26.8.1)

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

Terrain Data

Terrain	Ridge
Top of Hill Dist.	-1910
Bott. of Hill Dist.	1050
L @ H/2	160
Site	upwind
Top of Hill Elev.	356
Bott. of Hill Elev.	16
Site Elev.	150.9
Site Dist.	0
H/2	186

Kzt Calculations

H=	339
Lh=	1750
x=	1910
z=	60
μ=	1.5
γ=	3
K1 value =	1.45
K1=	0.28
K2=	0.27
k3=	0.90
H/Lh =	0.19
Kzt =	1.00

Direction 7 - 30 ° to Site

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.	3502
Bott. of Hill Dist.	-3821
L @ H/2	1870
Site	upwind
Top of Hill Elev.	374
Bott. of Hill Elev.	16
Site Elev.	150.9
Site Dist.	0
H/2	195

Kzt Calculations

H=	357
Lh=	1632
x=	3502
z=	60
μ=	1.5
γ=	3
K1 value =	1.45
K1=	0.32
K2=	0.00
k3=	0.90
H/Lh =	0.22
Kzt =	1.00

Direction 8 - Site to 210 °

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	

Terrain Data

Terrain	Ridge
Top of Hill Dist.	3502
Bott. of Hill Dist.	10400
L @ H/2	7376
Site	downwnd
Top of Hill Elev.	374
Bott. of Hill Elev.	187
Site Elev.	150.9
Site Dist.	0
H/2	280

Kzt Calculations

H=	187
Lh=	3874
x=	3502
z=	60
μ=	1.5
γ=	3
K1 value =	1.45
K1=	0.07
K2=	0.40
k3=	0.95
H/Lh =	0.05
Kzt =	1.00

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2124 Third Ave, Suite 100, Seattle, WA 98121 | O 206.443.6212
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Project MARSHALL RESIDENCE
Kzt Calculations

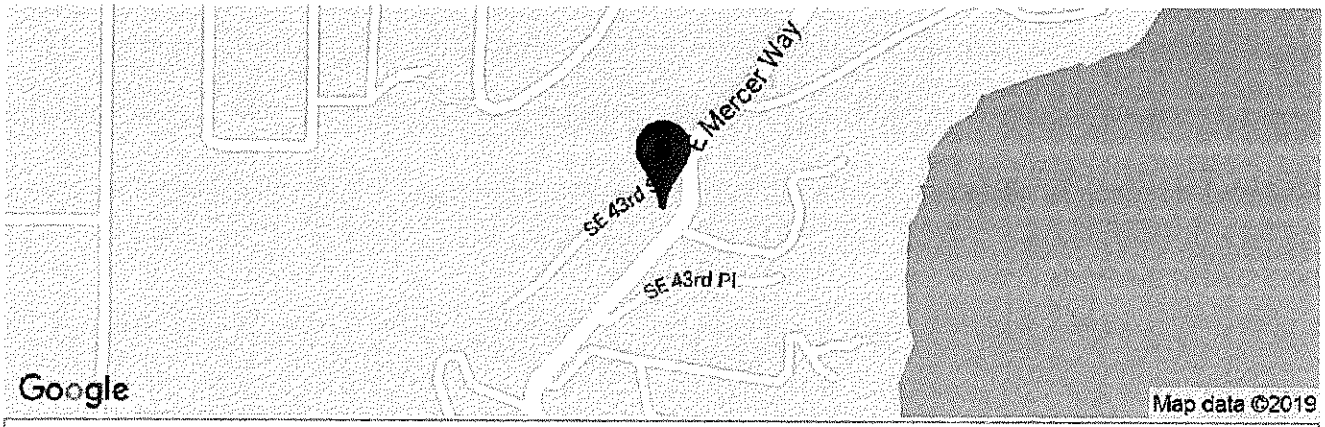
DATE 8/8/2019
PROJ. #
DESIGN MBJ
SHEET 5

OSHPD

MARSHALL RESIDENCE

4307 E Mercer Way, Mercer Island, WA 98040, USA

Latitude, Longitude: 47.569191, -122.21035740000002



Date	8/16/2019, 2:14:58 PM
Design Code Reference Document	ASCE7-10
Risk Category	II
Site Class	D - Stiff Soil

Type	Value	Description
S_S	1.405	MCE_R ground motion. (for 0.2 second period)
S_1	0.539	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.405	Site-modified spectral acceleration value
S_{M1}	0.809	Site-modified spectral acceleration value
S_{DS}	0.937	Numeric seismic design value at 0.2 second SA
S_{D1}	0.539	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	D	Seismic design category
F_a	1	Site amplification factor at 0.2 second
F_v	1.5	Site amplification factor at 1.0 second
PGA	0.58	MCE_G peak ground acceleration
F_{PGA}	1	Site amplification factor at PGA
PGA_M	0.58	Site modified peak ground acceleration
T_L	6	Long-period transition period in seconds
SsRT	1.405	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	1.469	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	3.298	Factored deterministic acceleration value. (0.2 second)
S1RT	0.539	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.578	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	1.309	Factored deterministic acceleration value. (1.0 second)
PGAd	1.278	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.957	Mapped value of the risk coefficient at short periods
C_{R1}	0.933	Mapped value of the risk coefficient at a period of 1 s

Marshall Residence 8/16/19 BL 4

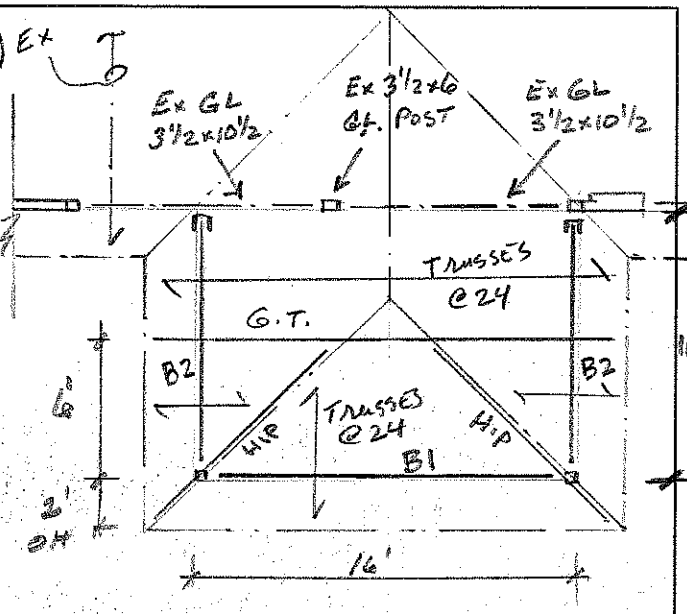
NEW OPEN Roof over Deck (UN-INSulated) Ex

Dead Loads

Roofing	3
Trusses	2.5
Soffit	2.5
Roof 1/2" PLY	1.5
	9.5 → use 10

LL = 25
TL = 35 psf

Trusses Thru-out



B1

w = .035(8 2/2 1/6) = .19 k/'
L = 15.7'
R = 1.5 k
M = 5.9 k'

4x12
f_b = .95 ksi
f_v = 50 psi
Δ = .42" = L/452

B2

M = 5.8 k'

.35 k/' + $P_{G.T.}$ = .1 k/' (10) = 1 k

5.75' 5.75'
2 k 1 k

4x12
f_b = .94 ksi
f_v = 64 psi
Δ = .2" = L/495

Check Ex. 3 1/2 x 10 1/2 G.L. HDR

w = .04(19/2) = .38 k/' (Ex)
P_{B2} = 2 k
R = 2.9 k
M = 9.8 k'

3 1/2 x 10 1/2
f_b = 1.82 ksi ✓
f_v = 105 psi
Δ = .26" = L/463

R_{TOT} @ Ex 3 1/2x6 Post
= .38(19/2) + 2.9 = 4.8 k $f_c = \frac{4.8}{3.5(6)}$ = 228 psi ✓

$R_{North\ Post}$ = .38(19/2) + 1.5 = 3.4 k (3) 2x4
f_c = 216 psi ✓

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Marshall Residence — PROJECT
8/16/19 — DATE
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SHEET 7

2' Deck Expansion
Check 2x8 Joists
To Cantilever 5'

Worst Case w/
Unbalanced Load
For Deflection

$M_- = .07(5)^2/2 = .88^{k'}/_{'}$

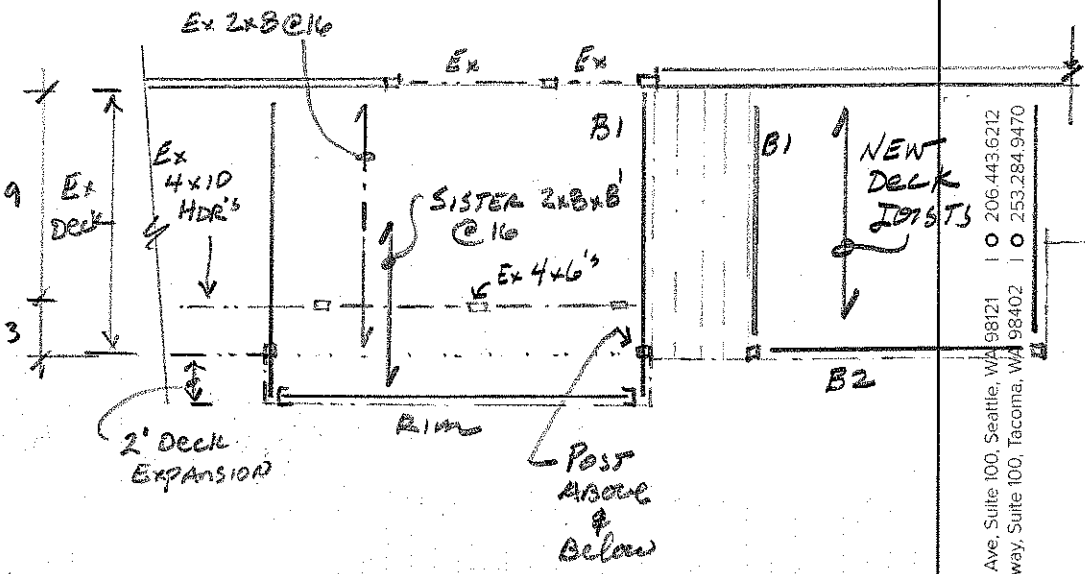
(2) 2x8 @ 16

$f_b = .53^{ksi}$

$\Delta = .32" = {}^{22}/_{378}$

okay

Provide Exterior Rim
For Added Stiffness &
Railing Support



Check Ex 4x10 HDR's

$L = 6'-6"$

$w = .07(14^2/2\ 1/9) = .74^{k}/_{'}$

$R = 2.5^{k}$

$M = 4.0^{k'}$

4x10

$f_b = .97\ ksi$

$f_c = 87\ psi$

$\Delta = .09" = {}^{1}/_{884}$

(NOTE: Exterior Rim will take some Redundant Load)

B2 $L = 13'$

$w = .07(5.5) = .39^{k}/_{'}$

$R = 2.5^{k}$

$M = 8.1^{k'}$

6x10

$f_b = 1.18\ ksi$

$\Delta = .42 = {}^{f}/_{372}$

Max Post Load $= 2.5 + 1.1 = 3.6^{k}$

4x4 Post min $f_c = \frac{3.6}{(3.5)^2} = 294\ psi$

2' ½ FTL

$f_{max} = \frac{3.6}{44} = 900\ psf$

okay

B1 Beam Supporting Stairs
@ Deck Elevations

$w = .07(3'\ max) = .2^{k}/_{'}$

$L = 11.5'$

$R = 1.1^{k}$

$M = 3.3^{k'}$

4x10

$f_b = .80\ ksi$

$\Delta = .23" = {}^{1}/_{607}$

3½ x 7½ GLB

$\Delta = .36 = {}^{1}/_{383}$

Deck Joists

$L = 11'$

$w = .07(1.33) = .093$

2x10 @ 16

$f_b = .29\ ksi$

$\Delta = .24 = {}^{1}/_{552}$

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SHEET 8

Quick Check of Lateral

IN E-W Direction, there is no increase in Wind & the Seismic DL is trivial

IN N-S Direction, Calculate Sail Area Tributary to the East Exterior Walls

A = 180 ft² (Roof Slope) (Chimney)

$P_{WIND} = 160(.015) + 20(.02)$

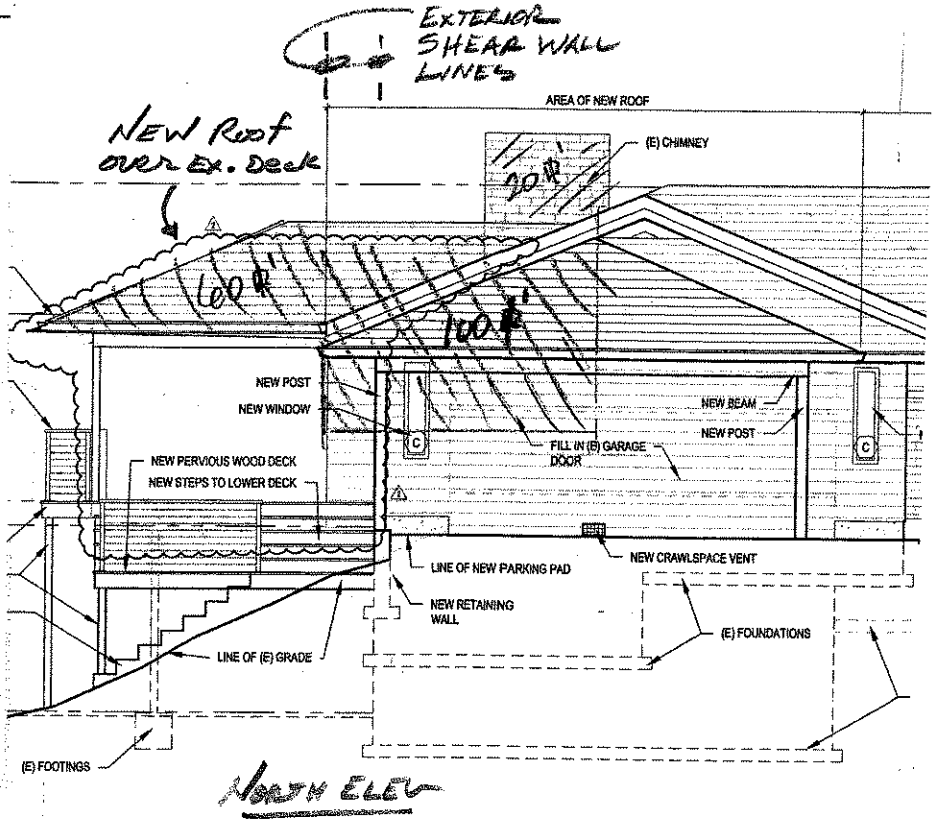
$= 2.8^{k}$

Length of Ext Wall Along East Elev

$= 4 + 6 + 3 + 4 + 3 = 20'$

$v_{Ave} = \frac{2.8^{k}}{20'} = 140^{\#}/_{'}$

No further upgrades Req'd



③ NORTHEAST EXT. ELEV.

SCALE: 1/4" = 1'-0"

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