Structural Calculations For:

Lumpkin Residence

Supplemental Calcs

5401 W. Mercer Way

Mercer Island, WA 98040

Prepared for:	Suyama Peterson Deguchi
Job #:	00043-2020-04
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STRUCTURAL ENGINEERING

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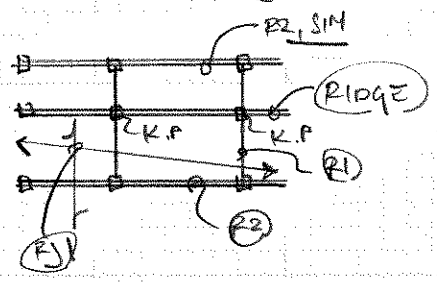
CARPORT GRAVITY FRAMING



RJ1 - TYP. ROOF RAFTERS, CARPORT

$W = \text{Roof} = 40(24/12) = 80$ PLF

$V = 573$ # $f_v = 55$ PSI $\Delta_{CANT} = 0.14'' = L/424$

$M = 1238$ lb-ft $f_b = 694$ PSI $\Delta_{BACK} = 0.26'' = L/590$

$\boxed{\text{AS } 2\times10 \text{ @ } 24''}$, 12.75 ft BACK + 4.25 ft CANT

RIDGE - TYP. RIDGE

$W = \text{Roof} = 40(18.75/2) = 375$ PLF

SPAN = 10 ft $\boxed{\text{GL } 5\tfrac{1}{2}\times9}$

$V = 1875$ # $f_v = 76$ PSI

$M = 4688$ lb-ft $f_b = 1190$ PSI

$\Delta_{TL} = 0.22'' = L/544$

R1 - CONT. BEAM SUPPORT OF RIDGE

$P = R_{RIDGE} = 40(20.5/2)(19/2)(1.25) = 4870$ #

AT $L = 13.25$ ft

SPAN = 19 ft $\boxed{\text{GL } 5\tfrac{1}{2}\times12}$

$V = 1720$ # $f_v = 82$ PSI

$M = 20601$ lb-ft $f_b = 1873$ PSI

$\Delta_{TL} = 0.65'' = L/352$

R2 - TYP. ENDS BEAM

$W = R_{RJ1} = 290$ PLF

SPAN = 10 ft GL $5\tfrac{1}{2}\times9$

$V = 1450$ # $f_v = 59$ PSI

$M = 3625$ lb-ft $f_b = 921$ PSI

$\Delta_{TL} = 0.19'' = L/704$

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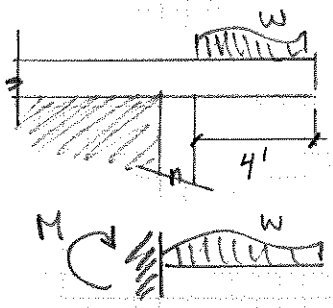
CARPORT CANTILEVER SLAB



$M = \frac{wL^2}{2}$

$= \frac{220(4)^2}{2}$

$M = 1760$ lb-ft

$= \underline{\underline{21.12 \text{ k-in}}}$

DL = CONC = 150 (8/12) = 100 PSF

AS 12" STRIP = 100 PLF

@ 1.6D = 160 PLF

1.2D = 120 PLF

LL = DECK = 60 PSF

AS 12" STRIP = 60 PLF

@ 1.6L = 96 PLF

W_{LRFD} = 220 PLF

AS 8" SLAB, check w/ #5 @ 12" o.c. TOP

$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{0.307(60)}{0.85(2.5)(12)} = 0.721"$ $\qquad d = \underline{\underline{2"}} - 8" = \underline{\underline{6"}}$

$\phi M_n = 0.9(A_s f_y)(d - a/2)$

$= 0.9(0.307)(60)(6 - 0.721/2)$

$= 93.48$ k-in

$\phi M_n > M_p$

$\Rightarrow 93.48 > 21.12$ k-in $\underline{\underline{\therefore \text{ OK}}}$

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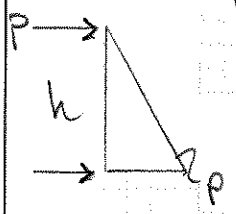
RETAINING WALL, TOP REINF.



PER RETAINING WALL CALCS, P_{TOP} = at h = 6ft, p = 35 PSF/ft

817 # @ BASE (lat) → 817 #
229 # @ BASE (EQ) → 690 #
= 1510 PLF

HORIZONTAL SPAN = 8'-9"

V_{ENDS} = 6607 #

M_{typ} = 14451 lb-ft
= 173.41 k-in

AS 8" WALL, TRY (4) #5 @ 12" STRIP

$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{4(0.307)(60)}{0.85(2.5)(12)} = 2.89$ in 1.5" CLR: d = 8" − 2" = 6"

$\phi M_n = 0.9(A_s f_y)(d - a/2)$
$= 0.9(4)(0.307)(60)(6 - 2.89/2)$
= 302.05 k-in

$\phi M_n > M_p$
→ 302.05 k-in > 173.41 k-in ∴ ok

REINFORCE w/ (4) #5 @ TOP

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LUMPKIN
PROJECT

top of RET. WALL REINF.

DATE 4/27/22

PROJ. # VMA

DESIGN

SHEET

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CARPORT LATERAL RE-DESIGN

PER ORIGINAL PERMIT CALCS, $V(7) = 1.20\ k\ (E),\ 1.42\ k\ (W)$ @ $R = 6.5$

USE STEEL CANT COLUMNS @ $R = 2.5$ (SPECIAL CANT. COL)

$V'(7) = 1.20\left(\frac{6.5}{2.5}\right) = 3.12\ k$

USE (4) COLS : $V(\text{EA. COL}) = 0.78\ k$, $\Omega_0 = 1.25$

$V(\Omega_0) = 0.98\ k$

AT A HEIGHT OF 8'-0"

$V = 780\ \#$ $\quad M = 6240\ lb\text{-}ft = 74.88\ k\text{-}in$

$V(\Omega_0) = 980\ \#$ $\quad M(\Omega_0) = 7800\ lb\text{-}ft = 93.60\ k\text{-}in$

} ASD LOADS

$M_p = \frac{F_y Z_x}{1.67} = \frac{46(13.1)}{1.67} = 360.84\ k\text{-}in >> 93.6$ ∴ OK

→ NOTE: CHECK YIELDING ONLY. PER AISC 1-7, SEISMIC DESIGN MANUAL, SELECTED SHAPE IS COMPACT & MEETS SEISMIC DESIGN W.T. REQ'M

USE HSS 5x5x1/2 , $Z_x = 13.1\ in^3$

CHECK BASEPLATE, NOTE: DUCTILE FAILURE OF COLUMN MEANS Ω_0 NEED NOT BE CONSIDERED

$V(LRFD) = 1.11\ k$

$M(LRFD) = 8.88\ k\text{-}ft$

} SEE SIMPSON DESIGN

CHECK SHEAR / DOWEL CONNECTION @ WALL

$M = 7800\ lb\text{-}ft$

$V_{DOWEL} = M/L = 7800\ lb\text{-}ft / 22.6\ ft = 346\ \#$, EA. END

JUST MATCH HORIZ. REINF. ⟹ (6) #5 AS (3T, 3B)

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STRUCTURAL ENGINEERING

PROJECT: LUMPKIN

DATE: 4/27/22

PROJ. #: VMA

DESIGN:

SHEET: CARPORT LATERAL

1.Project information

Customer company:
Customer contact name:
Customer e-mail:
Comment:

Project description:
Location:
Fastening description:

2. Input Data & Anchor Parameters

General
Design method:ACI 318-14
Units: Imperial units

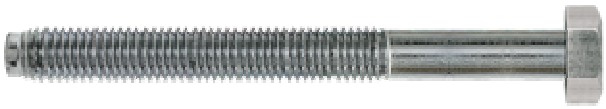
Anchor Information:
Anchor type: Cast-in-place
Material: F1554 Grade 36
Diameter (inch): 0.750
Effective Embedment depth, h_{ef} (inch): 16.000
Anchor category: -
Anchor ductility: Yes
h_{min} (inch): 17.50
C_{min} (inch): 4.50
S_{min} (inch): 4.50

Base Material
Concrete: Normal-weight
Concrete thickness, h (inch): 18.00
State: Cracked
Compressive strength, f'_c (psi): 2500
$\Psi_{c,V}$: 1.4
Reinforcement condition: A tension, A shear
Supplemental reinforcement: Not applicable
Reinforcement provided at corners: Yes
Ignore concrete breakout in tension: No
Ignore concrete breakout in shear: No
Ignore 6do requirement: No
Build-up grout pad: Yes

Base Plate
Length x Width x Thickness (inch): 12.00 x 9.00 x 0.25
Yield stress: 36000 psi

Profile type/size: HSS5X4X1/2

Recommended Anchor
Anchor Name: Heavy Hex Bolt - 3/4"Ø Heavy Hex Bolt, F1554 Gr. 36

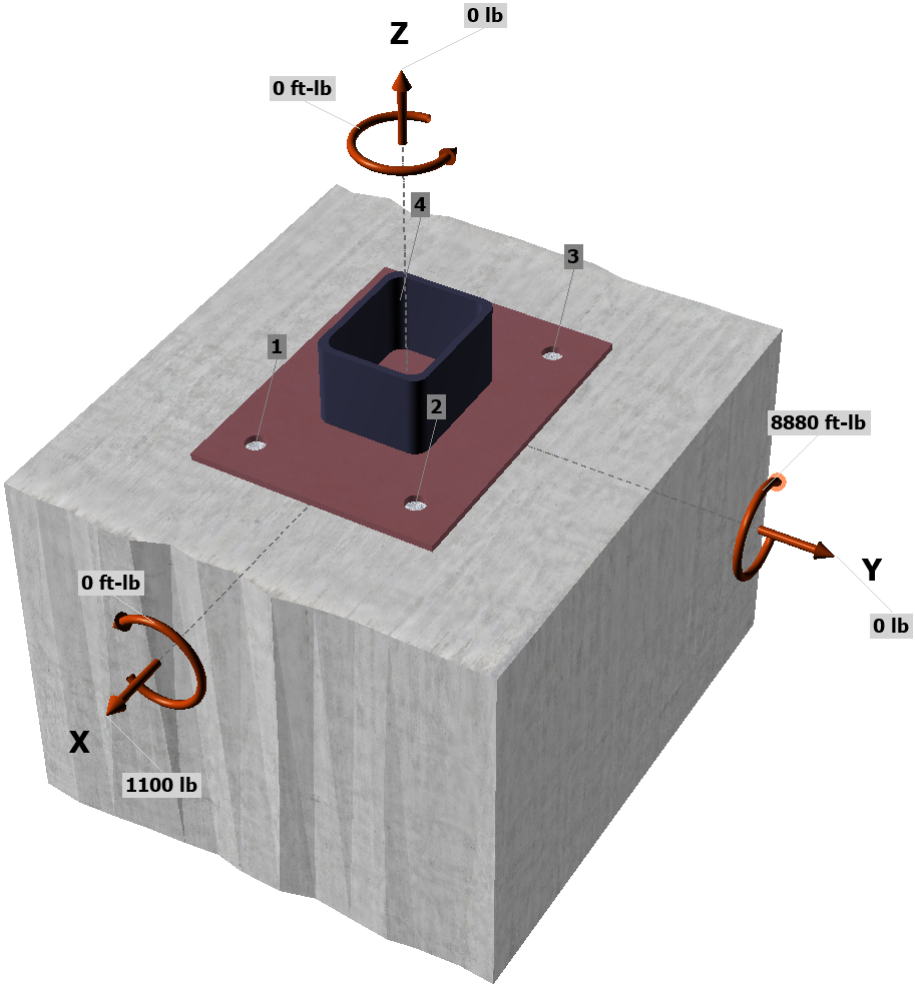


Load and Geometry
Load factor source: ACI 318 Section 5.3
Load combination: not set
Seismic design: Yes
Anchors subjected to sustained tension: Not applicable
Ductility section for tension: 17.2.3.4.3 (a) (iii)-(vi) is satisfied
Ductility section for shear: 17.2.3.5.3 (a) is satisfied
Ω_0 factor: not set
Apply entire shear load at front row: No
Anchors only resisting wind and/or seismic loads: No

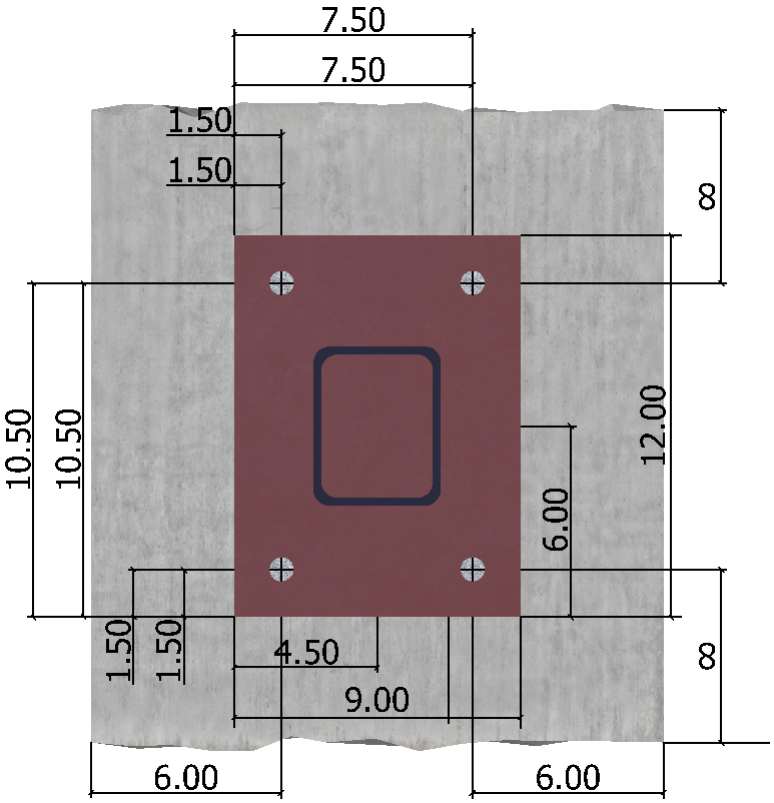
Strength level loads:

N_{ua} [lb]: 0
V_{uax} [lb]: 1100
V_{uay} [lb]: 0
M_{ux} [ft-lb]: 0
M_{uy} [ft-lb]: -8880
M_{uz} [ft-lb]: 0

<Figure 1>



<Figure 2>

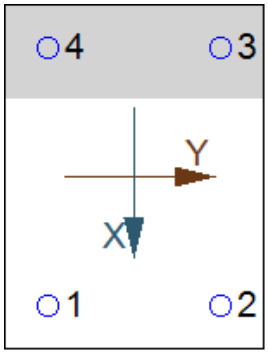


3. Resulting Anchor Forces

Anchor	Tension load, N_{ua} (lb)	Shear load x, V_{uax} (lb)	Shear load y, V_{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2+(V_{uay})^2}$ (lb)
1	5667.5	275.0	0.0	275.0
2	5667.5	275.0	0.0	275.0
3	0.0	275.0	0.0	275.0
4	0.0	275.0	0.0	275.0
Sum	11335.0	1100.0	0.0	1100.0

Maximum concrete compression strain (‰): 0.18
Maximum concrete compression stress (psi): 764
Resultant tension force (lb): 11335
Resultant compression force (lb): 11335
Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.00
Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.00
Eccentricity of resultant shear forces in x-axis, e'_{Vx} (inch): 0.00
Eccentricity of resultant shear forces in y-axis, e'_{Vy} (inch): 0.00

<Figure 3>



4. Steel Strength of Anchor in Tension (Sec. 17.4.1)

N_{sa} (lb)	ϕ	ϕN_{sa} (lb)
19370	0.75	14528

5. Concrete Breakout Strength of Anchor in Tension (Sec. 17.4.2)

$N_b = 16\lambda_a\sqrt{f'_c}h_{ef}^{5/3}$ (Eq. 17.4.2.2b)

λ_a	f'_c (psi)	h_{ef} (in)	N_b (lb)
1.00	2500	16.000	81275

$0.75\phi N_{cbg} = 0.75\phi\,(A_{Nc}/A_{Nco})\,\Psi_{ec,N}\,\Psi_{ed,N}\,\Psi_{c,N}\,\Psi_{cp,N}N_b$ (Sec. 17.3.1 & Eq. 17.4.2.1b)

A_{Nc} (in^2)	A_{Nco} (in^2)	$c_{a,min}$ (in)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	$0.75\phi N_{cbg}$ (lb)
864.00	2304.00	6.00	1.000	0.775	1.00	1.000	81275	0.75	13287

6. Pullout Strength of Anchor in Tension (Sec. 17.4.3)

$0.75\phi N_{pn} = 0.75\phi\Psi_{c,P}N_p = 0.75\phi\Psi_{c,P}8A_{brg}f'_c$ (Sec. 17.3.1, Eq. 17.4.3.1 & 17.4.3.4)

$\Psi_{c,P}$	A_{brg} (in^2)	f'_c (psi)	ϕ	$0.75\phi N_{pn}$ (lb)
1.0	0.91	2500	0.70	9566

7. Side-Face Blowout Strength of Anchor in Tension (Sec. 17.4.4)

$0.75\phi N_{sb} = 0.75\phi\{(1+c_{a2}/c_{a1})/4\}(160c_{a1}\sqrt{A_{brg}})\lambda\sqrt{f'_c}$ (Sec. 17.3.1 & Eq. 17.4.4.1)

c_{a1} (in)	c_{a2} (in)	A_{brg} (in^2)	λ_a	f'_c (psi)	ϕ	$0.75\phi N_{sbg}$ (lb)
6.00	99999.00	0.91	1.00	2500	0.75	25771

8. Steel Strength of Anchor in Shear (Sec. 17.5.1)

V_{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (lb)
11625	0.8	0.65	6045

9. Concrete Breakout Strength of Anchor in Shear (Sec. 17.5.2)

Shear parallel to edge in y-direction:

$V_{bx} = \min|7(l_e / d_a)^{0.2}\sqrt{d_a}\lambda_a\sqrt{f'_c}c_{a1}^{1.5};\ 9\lambda_a\sqrt{f'_c}c_{a1}^{1.5}|$ (Eq. 17.5.2.2a & Eq. 17.5.2.2b)

l_e (in)	d_a (in)	λ_a	f'_c (psi)	c_{a1} (in)	V_{bx} (lb)
6.00	0.750	1.00	2500	6.00	6614

$\phi V_{cbgy} = \phi\ (2)(A_{Vc} / A_{Vco})\Psi_{ec,V}\Psi_{ed,V}\Psi_{c,V}\Psi_{h,V}V_{bx}$ (Sec. 17.3.1, 17.5.2.1(c) & Eq. 17.5.2.1b)

A_{Vc} (in^2)	A_{Vco} (in^2)	$\Psi_{ec,V}$	$\Psi_{ed,V}$	$\Psi_{c,V}$	$\Psi_{h,V}$	V_{bx} (lb)	ϕ	ϕV_{cbgy} (lb)
243.00	162.00	1.000	1.000	1.400	1.000	6614	0.75	20833

10. Concrete Pryout Strength of Anchor in Shear (Sec. 17.5.3)

$\phi V_{cpg} = \phi k_{cp}N_{cbg} = \phi k_{cp}(A_{Nc} / A_{Nco})\Psi_{ec,N}\Psi_{ed,N}\Psi_{c,N}\Psi_{cp,N}N_b$ (Sec. 17.3.1 & Eq. 17.5.3.1b)

k_{cp}	A_{Nc} (in^2)	A_{Nco} (in^2)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕV_{cpg} (lb)
2.0	1026.00	2304.00	1.000	0.775	1.000	1.000	81275	0.70	39269

11. Results

Interaction of Tensile and Shear Forces (Sec. 17.6.)

Tension	Factored Load, N_{ua} (lb)	Design Strength, ϕN_n (lb)	Ratio	Status
Steel	5667	14528	0.39	Pass
Concrete breakout	**11335**	**13287**	**0.85**	**Pass (Governs)**
Pullout	5667	9566	0.59	Pass
Side-face blowout	5667	25771	0.22	Pass

Shear	Factored Load, V_{ua} (lb)	Design Strength, ϕV_n (lb)	Ratio	Status
Steel	**275**	**6045**	**0.05**	**Pass (Governs)**
|| Concrete breakout y+	550	20833	0.03	Pass
Pryout	1100	39269	0.03	Pass

Interaction check	$N_{ua}/\phi N_n$	$V_{ua}/\phi V_n$	Combined Ratio	Permissible	Status
Sec. 17.6..1	0.85	0.00	85.3%	1.0	Pass

3/4"Ø Heavy Hex Bolt, F1554 Gr. 36 with hef = 16.000 inch meets the selected design criteria.

ACI 318-14 Section 17.2.3.4.3(a) (i) & (ii) Calculations for Ductility requirement for tension load

Steel	Factored Load, N_{ua} (lb)	1.2 x Nominal Strength, N_n (lb)	Ratio
Steel	5667	23244	24.4%

Concrete	Factored Load, N_{ua} (lb)	Nominal Strength, N_n (lb)	Ratio	
Concrete breakout	**11335**	**23621**	**48.0%**	**Governs**
Pullout	5667	18220	31.1%	
Side-face blowout	5667	45814	12.4%	

ACI 318-14 Section 17.2.3.4.3(a) (i) & (ii) is not satisfied since steel ratio does not govern.

12. Warnings

- Brittle failure governs for tension. Governing anchor failure mode is brittle failure. Attachment shall be designed to satisfy the requirements of ACI 318-14 Section 17.2.3.4.3 for structures assigned to Seismic Design Category C, D, E, or F when the component of the strength level earthquake force applied to anchors exceeds 20 percent of the total factored anchor force associated with the same load combination. In case when ACI 318-14 Sections 17.2.3.4.3 (a)(iii) to (vi), (b), (c) or (d) is satisfied for tension loading, select appropriate checkbox from Inputs tab to disable this message. Alternatively, Ω0 factor can be entered to satisfy ACI 318-14 Section 17.2.3.4.3(d) to increase the earthquake portion of the loads as required.

- Per designer input, ductility requirements for shear have been determined to be satisfied – designer to verify.

- Designer must exercise own judgement to determine if this design is suitable.