

FORSMAN ENGINEERING

30014 2nd Court South
Federal Way, WA 98003
(253) 815-9182

STRUCTURAL CALCULATIONS

for

Turner Res Gazebo
At

3449 74th Ave SE
Mercer Island, WA 98040

Project #21015
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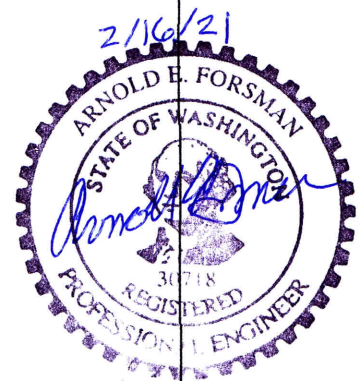
Codes:

2018 International Building Code

Loads:

Roof 10 psf dead load 25 psf live load, snow
Wind ASCE 7-16 Open structure, 110 mph wind speed, Exp "C", Risk
 category II, Kzt=1.0
Seismic ASCE 7-16 Importance factor 1.00, Site Category D, Sds=1.13

Foundation: All values assumed
 footings 1500 psf allowable bearing pressure
 lateral bearing 400 psf



Sheets 1-16

The items designed herein represent the entire scope of structural investigation performed. No other portions of the structure have been reviewed. These calculations apply to the location specified above. The site was not investigated and no judgment on the suitability of the site was made.

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SCOPE OF WORK

Forsman Engineering was asked to provide a lateral load analysis, review of major framing members, and drawings review for a wood framed single family stand-alone Gazebo. The roof framing is primarily manufactured trusses, the foundation is typical concrete pole barn type.

The attached calculations are to be used as a submittal for one potential building site. The cover sheet should have an original signature in blue ink over the seal.

Forsman Engineering will use that degree of care and skill ordinarily exercised under similar circumstances by members of the engineering profession in this local. No other warranty, either expressed or implied is made in connection with our rendering of professional services. For any dispute, claim, or action arising out of this design, Forsman Engineering shall have liability limited to the amount of the fee received by Forsman Engineering.

Questions regarding the attached should be addressed to Forsman Engineering.

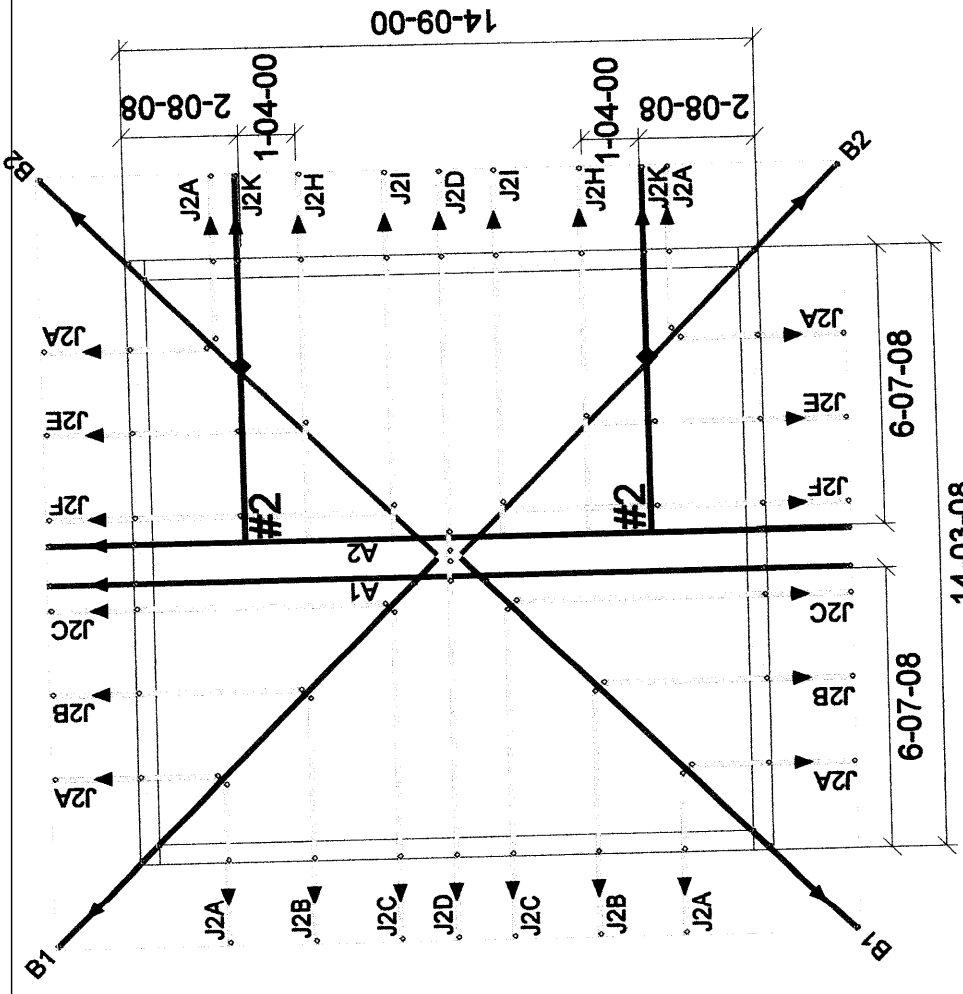
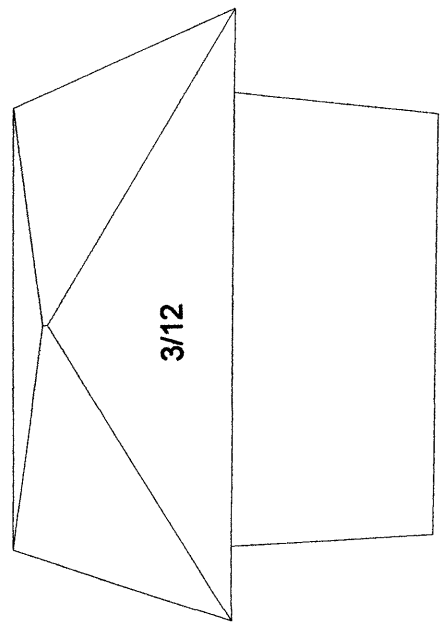
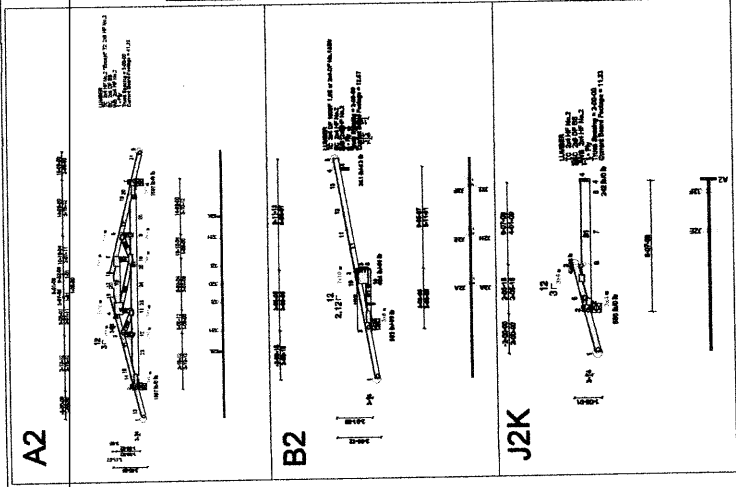
Arnold E. Forsman, P.E.
Forsman Engineering

1/4
51012



Date: 02/08/2008 | Engineer: M. J. Pardo | MW
 Main Office: 3200 35TH Avenue NE | Everett WA 98203
 Office: 425-799-3205 | Fax: 425-303-9823
 Data: chris@bmc.com | bmc@bmc.com

LONDON DESIGN BUILD
 20-127801T
 TURNER
 12-21-2020
 Designer: DALE C.



| DETAILS | HANGERS | QTY. |
|---------|----------|------|
| #2 | MUS26 | 2 |
| #3 | LUC26Z | |
| #4 | HGUS26-2 | |
| #5 | HUS26 | |

ATTENTION
 ▲ □ = LEFT SIDE INDICATOR
 RED MARK ON TRUSS IS LEFT SIDE
 YELLOW TAG ON TRUSS SHOWS "an L"
 ▲ □ = INDICADOR DE LADO IZQUIERDO
 MARCA ROJA EN ARMADURA ES LADO IZQUIERDO
 TAG AMARILLA EN ARMADURA MUESTRA "una L"

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JOB _____

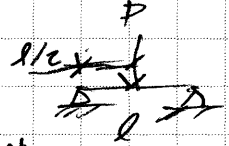
SHEET NO. 5 OF _____

CALCULATED BY _____ DATE _____

CHECKED BY _____ DATE _____

SCALE _____

Main Beam (B1)
L = 13.5'



$$P_{DL} = 10 \cdot 13/2 \cdot 16/2 = 520 \#$$

$$P_{SL} = 25 \cdot 13/2 \cdot 16/2 = 1300 \#$$

⇒ 8 1/2 x 13 1/2 GLB



WoodWorks[®]
SOFTWARE FOR WOOD DESIGN

COMPANY
Forsman Engineering
Feb. 10, 2021 08:41

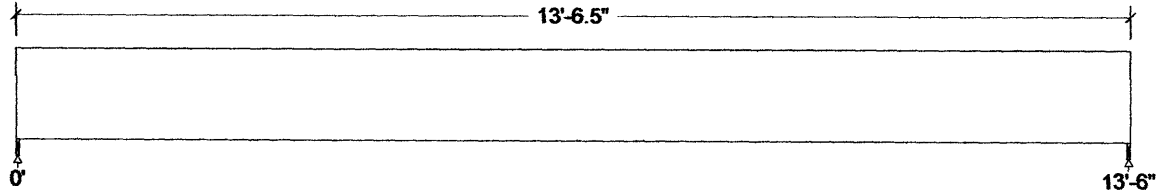
PROJECT
JN 19032 Wyzkowski Addition
Beam B1

Design Check Calculation Sheet
WoodWorks Sizer 11.1

Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] | | Magnitude | | Unit |
|-------------|------|--------------|----------|---------------|-----|-----------|-----|------|
| | | | | Start | End | Start | End | |
| Pd | Dead | Point | | 6.77 | | 520 | | lbs |
| Ps | Snow | Point | | 6.77 | | 1300 | | lbs |
| Self-weight | Dead | Full UDL | | | | 17.1 | | plf |

Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :



| | | | |
|-------------|-------|--|-------|
| Unfactored: | | | |
| Dead | 375 | | 375 |
| Snow | 650 | | 650 |
| Factored: | | | |
| Total | 1025 | | 1025 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 1787 | | 1787 |
| Support | 1836 | | 1836 |
| Des ratio | | | |
| Beam | 0.57 | | 0.57 |
| Support | 0.56 | | 0.56 |
| Load comb | #2 | | #2 |
| Length | 0.50* | | 0.50* |
| Min req'd | 0.50* | | 0.50* |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.07 | | 1.07 |
| Fcp sup | 625 | | 625 |

*Minimum bearing length setting used: 1/2" for end supports

Glulam-Unbal., West Species, 24F-1.8E WS, 5-1/2"x13-1/2"

9 laminations, 5-1/2" maximum width,

Supports: All - Timber-soft Beam, D.Fir-L No.2

Total length: 13'-6.5"; Clear span: 13'-5.5"; volume = 7.0 cu.ft.

Lateral support: top= at supports, bottom= at supports;

Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|--------------|----------------|--------------|------|-----------------|
| Shear | fv = 20 | Fv' = 305 | psi | fv/Fv' = 0.07 |
| Bending(+) | fb = 469 | Fb' = 2685 | psi | fb/Fb' = 0.17 |
| Live Defl'n | 0.06 = <L/999 | 0.45 = L/360 | in | 0.13 |
| Total Defl'n | 0.10 = <L/999 | 0.68 = L/240 | in | 0.15 |

Additional Data:

| FACTORS: | F/E(psi) | CD | CM | Ct | CL | CV | Cfu | Cr | Cfrt | Notes | Cn*Cvr | LC# |
|----------|--------------|------|------|------|-------|-------|------|------|------|-------|--------|-----|
| Fv' | 265 | 1.15 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | 1.00 | 2 |
| Fb'+ | 2400 | 1.15 | 1.00 | 1.00 | 0.973 | 1.000 | 1.00 | 1.00 | 1.00 | 1.00 | - | 2 |
| Fcp' | 650 | - | 1.00 | 1.00 | - | - | - | - | 1.00 | - | - | - |
| E' | 1.8 million | 1.00 | 1.00 | 1.00 | - | - | - | - | 1.00 | - | - | 2 |
| Eminy' | 0.85 million | 1.00 | 1.00 | 1.00 | - | - | - | - | 1.00 | - | - | 2 |

CRITICAL LOAD COMBINATIONS:

Shear : LC #2 = D+S, V max = 1006, V design = 1006 lbs
 Bending(+): LC #2 = D+S, M = 6532 lbs-ft
 Deflection: LC #2 = D+S (live)
 LC #2 = D+S (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load combinations: ASCE 7-10 / IBC 2015

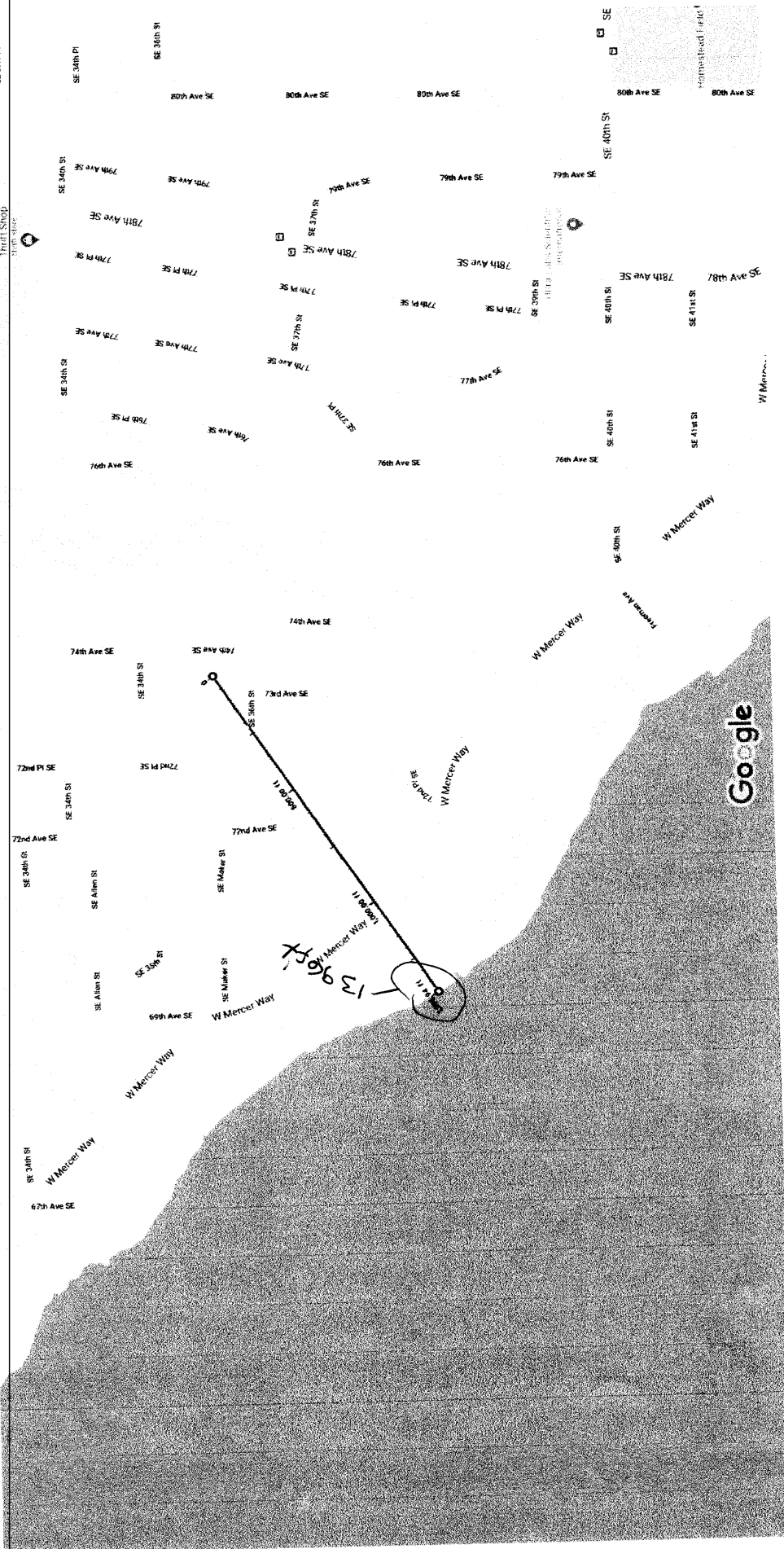
CALCULATIONS:

Deflection: EI = 2030e06 lb-in²
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow...)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
 Lateral stability(+): Lu = 13'-6.00" Le = 25'-4.56" RB = 11.7

Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. GLULAM: bxd = actual breadth x actual depth.
5. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
6. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).

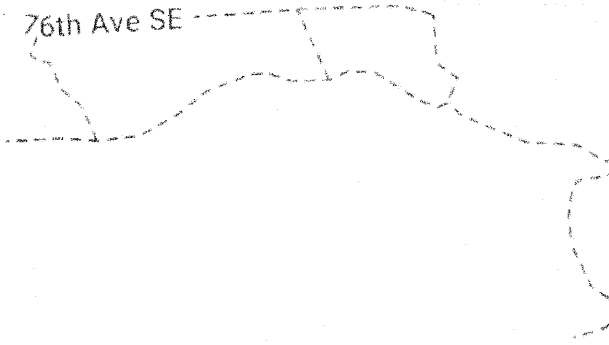
Mercer Island
Map data ©2021 Google





Turner Residence
 3449 74th Ave SE, Mercer Island, WA 98040, USA
 Latitude, Longitude: 47.5785387, -122.2408419

W Mercer Way
 SE Allen St
 72nd Ave SE
 72nd Pl SE
 SE 36th St
 74th Ave SE
 73rd Ave SE
 76th Pl SE
 76th Ave SE
 SE 37th Pl
 77th Pl SE
 77th Ave SE
 78th Ave SE



Map data ©2021

2/9/2021, 6:36:21 PM

ASCE7-16

II

D - Default (See Section 11.4.3)

Date
 Design Code Reference Document

Risk Category

Site Class

| Type | Value |
|-----------------|---------------------------|
| S _S | 1.413 |
| S ₁ | 0.491 |
| S _{MS} | 1.695 |
| S _{M1} | null - See Section 11.4.8 |
| S _{DS} | 1.13 |
| S _{D1} | null - See Section 11.4.8 |

Description

- MCE_R ground motion. (for 0.2 second period)
- MCE_R ground motion. (for 1.0s period)
- Site-modified spectral acceleration value
- Site-modified spectral acceleration value
- Numeric seismic design value at 0.2 second SA
- Numeric seismic design value at 1.0 second SA

Description

Type Value

| Type | Value | Description |
|------------------|-------------------------|---|
| SDC | null-See Section 11.4.8 | Seismic design category |
| F _a | 1.2 | Site amplification factor at 0.2 second |
| F _v | null-See Section 11.4.8 | Site amplification factor at 1.0 second |
| PGA | 0.605 | MCE _g peak ground acceleration |
| F _{PGA} | 1.2 | Site amplification factor at PGA |
| PGAM | 0.725 | Site modified peak ground acceleration |
| T _L | 6 | Long-period transition period in seconds |
| SsRT | 1.413 | Probabilistic risk-targeted ground motion. (0.2 second) |
| SsUH | 1.566 | Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration |
| SsD | 3.45 | Factored deterministic acceleration value. (0.2 second) |
| S1RT | 0.481 | Probabilistic risk-targeted ground motion. (1.0 second) |
| S1UH | 0.548 | Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration. |
| S1D | 1.39 | Factored deterministic acceleration value. (1.0 second) |
| PGAd | 1.182 | Factored deterministic acceleration value. (Peak Ground Acceleration) |
| C _{RS} | 0.902 | Mapped value of the risk coefficient at short periods |
| C _{R1} | 0.897 | Mapped value of the risk coefficient at a period of 1 s |

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JOB _____

SHEET NO. 11 OF _____

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SCALE _____

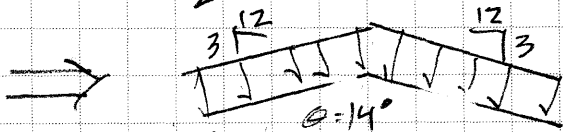
Lateral Analysis:

Wind: 110 mph, Exp "C"

$$q_z = 0.00256 K_z K_{zt} K_d U^2$$

$K_z = .85$
 $K_{zt} = 1.0$
 $K_d = .85$
 $G = 0.85$

$$q_z = 0.00256 (.85)(1.0)(.85)(110)^2 = 22 \text{ psf}$$



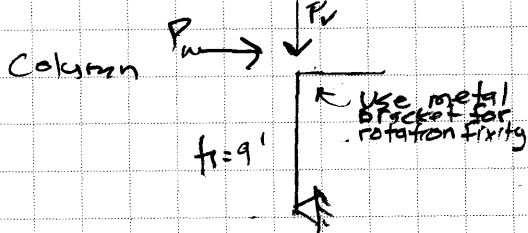
C_{NW} = 1.1

C_{NL} = 0.1

$$q_w = 22 (.85)(1.1) = 21 \text{ psf}$$

$$q_L = 22 (1.1)(.85) = 1.27 \text{ psf} \rightarrow 2 \text{ psf}$$

P_i: P_{DL} = 10 (16/2)(16/2) = 640 # P_{SL} = 25 (16/2)(16/2) = 1600 #



$$P_{ws} = (21)(16/2)(16/2)(\sin 14^\circ) = 325 \# \times .6 = \underline{195 \# / col}$$

↑ ASD

Seismic Load: S_{DS} = 1.13

$$C_s = 1.13 / 1.5 = .753$$

$$V_s = (.753)(16/2)(16/2)(10 \text{ psf}) = 482 \# \times .7 = \underline{337 \# / col}$$

Beam/Column Bracket, Try 1/4" metal plate w/SDS screws.



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SOFTWARE FOR WOOD DESIGN

COMPANY
Forsman Engineering
Feb. 10, 2021 18:08

PROJECT
JN 21015 Turner Res
Column1 fixed rot top

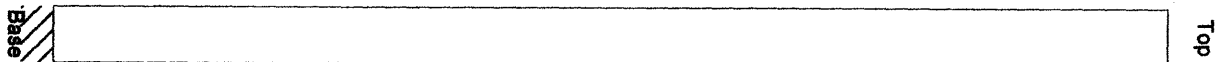
12/

Design Check Calculation Sheet
WoodWorks Sizer 11.1

Loads:

| Load | Type | Distribution | Location [ft] | | Magnitude | | Unit |
|-------------|------------|--------------|----------------|-----|-----------|-----|------|
| | | | Start | End | Start | End | |
| Pd | Dead | Axial | (Ecc. = 0.00") | | 640 | | lbs |
| Ps | Earthquake | Point | 8.75 | | 337 | | lbs |
| Self-weight | Dead | Axial | | | 56 | | lbs |

Lateral Reactions (lbs):



| Unfactored: | 0' | 9' |
|-------------|-----|----|
| Dead | | |
| Earthquake | 337 | |
| Factored: | | |
| L->R | 236 | |
| Load comb | #2 | #1 |

Typical Column

Timber-soft, Hem-Fir, No.2, 6x6 (5-1/2"x5-1/2")

Support: Non-wood

Total length: 9'; Clear span: 9'; volume = 1.9 cu.ft.; Post and timber

Fixed base; Free top; Load face = width(b); Ke x Lb: 0.7 x 9.0 = 6.3 [ft]; Ke x Ld: 0.7 x 9.0 = 6.3 [ft];

This section FAILS the design check

WARNING: This section violates the following design criteria: Deflection

Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|--|----------------|--------------|------|-----------------|
| Shear | fv = 12 | Fv' = 224 | psi | fv/Fv' = 0.05 |
| Bending(-) | fb = 893 | Fb' = 920 | psi | fb/Fb' = 0.97 |
| Axial | fc = 23 | Fc' = 481 | psi | fc/Fc' = 0.05 |
| Axial Bearing | fc = 23 | Fc* = 517 | psi | fc/Fc* = 0.04 |
| Combined (axial compression - side load bending) | | | | Eq.3.9-3 = 0.98 |
| Live Defl'n | 1.13 = L/95 | 1.20 = L/90 | in | 0.94 |
| Total Defl'n | 1.13 = L/95 | 0.90 = L/120 | in | 1.26 |

*OK, since only a
Gazebo - Handle
deflection in seismic
event. Also conservative
analysis.*

Additional Data:

| FACTORS: | F/E(psi) | CD | CM | Ct | CL/CP | CF | Cfu | Cr | Cfrt | Ci | LC# |
|----------|--------------|------|------|------|-------|-------|------|------|------|------|-----|
| Fv' | 140 | 1.60 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | 2 |
| Fb'- | 575 | 1.60 | 1.00 | 1.00 | 1.000 | 1.000 | 1.00 | 1.00 | 1.00 | 1.00 | 2 |
| Fc' | 575 | 0.90 | 1.00 | 1.00 | 0.929 | 1.000 | - | - | 1.00 | 1.00 | 1 |
| Fc'comb | 575 | 1.60 | - | - | 0.858 | - | - | - | - | - | 2 |
| E' | 1.1 million | 1.00 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | 2 |
| Emin' | 0.40 million | 1.00 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | 2 |
| Fc* | 575 | 0.90 | 1.00 | 1.00 | - | 1.000 | - | - | 1.00 | 1.00 | 1 |

CRITICAL LOAD COMBINATIONS:

Shear : LC #2 = D+.7E, V max = 236, V design = 236 lbs
 Bending(-): LC #2 = D+.7E, M = 2064 lbs-ft
 Deflection: LC #2 = D+.7E (live)
 LC #2 = D+.7E (total)
 Axial : LC #1 = D only, P = 696 lbs
 Combined : LC #2 = D+.7E; (1 - fc/FcE) = 0.99
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load combinations: ASCE 7-10 / IBC 2015

CALCULATIONS:

Deflection: EI = 83.9e06 lb-in²
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow...)
 Total Deflection = 1.00(Dead Load Deflection) + Live Load Deflection.



Design Notes:

- 1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
- 2. Please verify that the default deflection limits are appropriate for your application.

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JOB _____

SHEET NO. 14 OF _____

CALCULATED BY _____ DATE _____

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SCALE _____

Metal plate connector

$$M_{max} = 337 \times 9' = 3033 \text{ #}' \times 1/2 \text{ (moment top of base)}$$

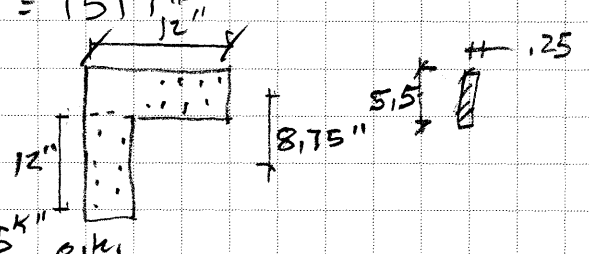
$$= 1517 \text{ #}'$$

$$S = (.25)(5.5)^2 / 6$$

$$= 126 \text{ in}^3$$

$$f_{xx} = 1517 / 126$$

$$= 1204 \text{ #}' = 14.5 \text{ ksi}$$

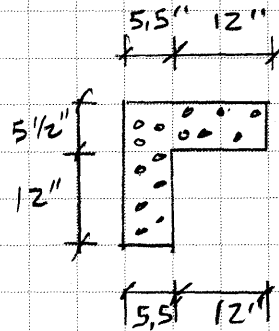


$$\text{SCREWS } \frac{1517 \text{ #}' \times 12}{8.75} = 2080 \text{ #}$$

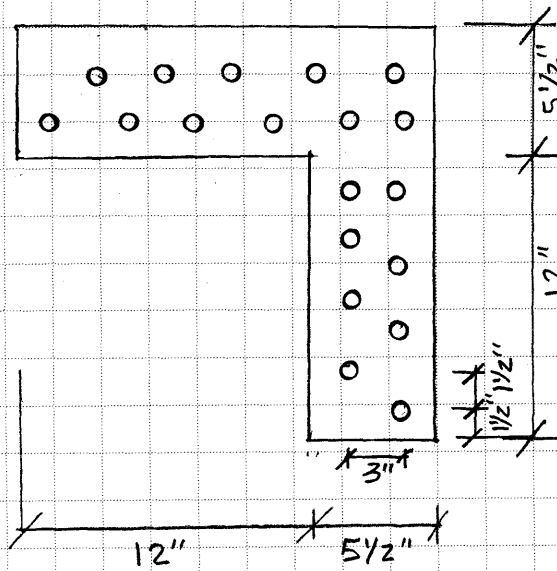
A.F. $2080 \text{ #} / (300 \times 16) = 413 \text{ screws}$

D.F. $2080 \text{ #} / (420 \times 16) = 311 \text{ screws}$

∴ Use (6) screws in 12" long x 5 1/2" legs
505253005



1/4" RE w/ S5S25300 as shown



PROJECT: _____

POLE: _____

Embedded Poles with Lateral Loads -- 2018 IBC Section 1805.7.2.1
 (not constrained at ground surface)

| | | | |
|-------|----------|-------|---|
| P | 337.00 | lbs | applied lateral load |
| M | 2,612.00 | lb-ft | applied moment at pole base |
| b | 2.00 | ft | width of pole or footing |
| d | 3.25 | ft | depth of embedment |
| S | 400.00 | psf | lateral bearing |
| h | 7.75 | ft | height of equivalent load |
| S1 | 433.33 | psf | pressure @ d/3 (d <= 12 ft) |
| S3 | 1,300.00 | psf | pressure @ d (d <= 12 ft) |
| A | 0.91 | | $2.34 * P / S1 * b$ |
| d req | 3.26 | ft | $(A/2) * [1 + \text{SQRT}(1 + 4.36 * h/A)]$ |
| Mmax | 2,984.39 | lb-ft | $P * (h + 0.34 * d)$ |