**EXHIBIT C**

FRAMEWORK ENGINEERING
4526 NE 7th Ave
Portland, OR 97211

# STRUCTURAL REPORT

PROJECT ADDRESS: 22055 S BEAVERCREEK RD, BEAVERCREEK, OR 97004
MUNICIPALITY: Clackamas County Building Permits, Development Services Building, 150 Beavercreek Rd,
DATE: 16 JUL 2024

### STANDARDS USED

2022 ASCE 7 | 2022 OSSC | 2018 NDS, SDPWS

### PROJECT DESCRIPTION

Free standing pergola near an existing retaining wall. Design intent recommends a woodframe structure with column pairs at the corners. Structural scope includes:

1 / Design of woodframe pergola for both vertical and lateral loads
2 / Detailing of roof-to-beam-to column connection using concealed fasteners
3 / Detailing of post-base connection to resist moment using concealed hardware
4 / Design of foundation elements to resist column loads and avoid surcharging the existing retaining wall

### APPROACH

The following report is an explanation of structural load paths at the above listed address for the proposed construction project. It describes how the demands of the resulting structure are generated, applied, and analyzed, such that proportionately sized structural members can be selected and detailed with appropriate capacity and stiffness. It also sites applicable and appropriate reference standards but starts first with ASCE 7-16 Minimum Design Loads for Buildings and Other Standards.

If there are any questions about the project or the calculation procedure, please feel free to contact us directly.

John Voekel, PE
Framework Engineering
503 345-3075

License Number: 90078
Issued: MAY 2016

# LOAD ASSUMPTIONS

## PRIMARY LOAD PATH ASSUMPTIONS

Primary loads, or static loads, will be identified per unit (psf, plf, etc.) and distributed over a structural element by tributary area. Within the ASCE 7-22 Standard, unit loads will be referenced or calculated from Chapters 3-10 and then factored using Chapter 2. Below are the most common unit loads assumed for this project, but specific loads used at each structural element will be described in their respective calculations later in this report.

| | | |
|---|---|---|
| Roof Load (DL, LL) | 15 psf, 20 psf | ASCE 7-22 Chapters 3,4 |
| Floor Load (DL, LL) | 15 psf, 40 psf | ASCE 7-22 Chapters 3,4 |
| Deck Load (DL, LL) | 15 psf, 60 psf | ASCE 7-22 Chapters 3,4 |
| Snow Load (LL) | 25 psf | ASCE 7-22 Chapter 7 |
| Rain Load (LL) | 5 psf | ASCE 7-22 Chapter 8 |

## MOMENTARY LOAD PATH ASSUMPTIONS

Momentary loads, also known as lateral loads or dynamic loads, will be generated by selecting an appropriate analysis and distributing calculated global loads to individual diaphragms and panels. Both seismic loads and wind loads will be considered with the more conservative application of load used to design the structure. The distribution of loads and explanation of analysis selection will follow in this report.

## SOIL LOAD ASSUMPTIONS

Per 2015 International Building Code, Table 1806.2 Presumptive Load-Bearing Values, the following default presumptive load bearing values will be used where an accompanying Geotechnical Report does not justify other values.

| SOIL PARAMETER | VALUE |
|---|---|
| ALLOWABLE SOIL BEARING PRESSURE | 1500 psf |
| PASSIVE SOIL PRESSURE | 350 pcf |
| ACTIVE SOIL PRESSURE | 40 pcf |
| COEFFICIENT OF FRICTION | - |
| COHESION | - |
| SKIN FRICTION | - |

# SEISMIC ANALYSIS & PARAMETERS

## CHOOSE SEISMIC ANALYSIS PROCEDURE

For selection of seismic analysis procedure, this structural report relies on ASCE 7-22 Chapter 11: Seismic Design Criteria for selection of appropriate seismic analysis procedure(s), specifically Section 11.1.3 based on the type of structure or component(s).

USED

Chapter 12: Seismic Design Requirements for Building Structures

Selecting from: "ASCE 7-22 Table 12.6-1 Permitted Analytical Procedures", the Equivalent Lateral Force Procedure will be used (Section 12.8) in lieu of the Simplified Lateral Force Procedure (Section 12.14); the Modal Response Spectrum Analysis (Section 12.9); or the Seismic Response History Procedure (Chapter 16).

NOT USED

Chapter 13: Seismic Design Requirements for Nonstructural Components

Chapter 15: Seismic Design Requirements for Nonbuilding Structures

Chapter 16: Seismic Response History Procedures

Chapter 17: Seismic Design Requirements for Seismically Isolated Structures

Chapter 18: Seismic Design Requirements for Structures with Damping Systems

## IDENTIFY SEISMIC PARAMETERS

| | |
|---|---|
| Primary Lateral Force-Resisting System: | Timber Cant. Columns |
| Diaphragm Rigidity: | Flexible |
| Latitude | 45.2867508 °N |
| Longitude | 122.5298951 °W |

| PARAMETER | VALUE | REFERENCE |
|---|---|---|
| Risk / Occupancy Category | II | ASCE 7-22 Table 1.5-1 |
| Seismic Importance Factor, $I_e$ | 1 | ASCE 7-22 Table 1.5-2 |
| Site Class | D | ASCE 7-22 Chapter 20 |
| Seismic Design Category | D | ASCE 7-22 Table 11.6-1(2) |
| $S_{DS}$ | 0.601 g | USGS Design Maps Summary |
| $S_1$ | Null | USGS Design Maps Summary |
| $S_{D1}$ | 0.345 g | USGS Design Maps Summary |
| Design Coefficients & Factors; R, $W_0$, $C_d$ | 1, 1.25, 1 | ASCE 7-22 Table 12.2-1 |
| Redundancy Factor, p | 1 | ASCE 7-22 Section 12.3.4.2 |
| Allowable Story Drift | 0.025 | ASCE 7-22 Table 12.12-1 |

# WIND ANALYSIS & PARAMETERS

## CHOOSE WIND ANALYSIS PROCEDURE

For selection of wind analysis procedure, this structural report relies on ASCE 7-22 Chapter 26 Wind Loads: General Requirements for selection of appropriate wind analysis procedure(s), specifically Figure 26.1-1 – in tandem with engineering judgement.

USED

Chapter 26: Wind Loads General requirements

Chapter 27: Wind Loads on Buildings – MWFRS (Directional Procedure)

NOT USED

Chapter 28: Wind Loads on Buildings – MWFRS (Envelope Procedure)

Chapter 29: Wind Loads on Other Structures and Building Appurtenances – MWFRS

Chapter 30: Wind Loads – Components and Cladding (C&C)

Chapter 31: Wind Tunnel Procedure

## IDENTIFY WIND PARAMETERS

| | |
|---|---|
| Enclosure Classification | Open |
| Structural Rigidity | Flexible |

| PARAMETER | VALUE | REFERENCE |
|---|---|---|
| Basic Wind Speed (mph) | 110 | ASCE 7-22 Figure 26.5-1 A, B or C |
| Wind Directionality Factor | 0.85 | ASCE 7-22 Table 26.6-1 |
| Exposure Category | C | ASCE 7-22 Section 26.7 |
| Topographic Factor | 1 | ASCE 7-22 Section 26.8 |
| Gust Effect Factor | does not apply | ASCE 7-22 Section 26.9 |
| Surface Roughness Category | B | ASCE7-22 Section 26.7.2 |

## CHECK IRREGULARITY

### HORIZONTAL (PLAN) IRREGULARITY CHECKLIST

The following is a list of Irregularity Types referenced in ASCE 7-22 Table 12.3-1 Horizontal Structural Irregularities, which will be examined for applicability to this project. Where an irregularity is present, the project will consider the Reference Sections assigned to the Type in Table 12.3-1:

| | |
|---|---|
| **1a. TORSIONAL IRREGULARITY**: where the maximum story drift, computed including accidental torsion with Ax = 1.0, at one end of the structure transverse to an axis is more than 1.2 times the average of the story drifts at the two ends of the structure. Torsional irregularity requirements in the reference sections apply only to structures in which the diaphragms are rigid or semirigid. | regular |
| **1b. EXTREME TORSIONAL IRREGULARITY**: where the maximum story drift, computed including accidental torsion with Ax = 1.0, at one end of the structure transverse to an axis is more than 1.4 times the average of the story drifts at the two ends of the structure. Extreme torsional irregularity requirements in the reference sections apply only to structures in which the diaphragms are rigid or semirigid.[1] | regular |
| **2. REENTRANT CORNER IRREGULARITY**: where both plan projections of the structure beyond a reentrant corner are greater than 15% of the plan dimension of the structure in the given direction. | regular |
| **3. DIAPHRAGM DISCONTINUITY IRREGULARITY**: where there is a diaphragm with an abrupt discontinuity or variation in stiffness, including one having a cutout or open area greater than 50% of the gross enclosed diaphragm area, or a change in effective diaphragm stiffness of more than 50% from one story to the next. | regular |
| **4. OUT-OF-PLANE OFFSET IRREGULARITY**: where there is a discontinuity in a lateral force-resistance path, such that as an out-of-plane offset of at least one of the vertical elements.[2] | regular |
| **5. NONPARALLEL SYSTEM IRREGULARITY**: where vertical lateral force-resisting elements are not parallel to the major orthogonal axes of the seismic force-resisting system. | regular |

| SUMMARY | regular |
|---|---|

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1. Structures with SDC E or F shall not be permitted with this irregularity

2. Elements supporting this irregularity shall be designed with over-strength factor, per Section 12.4.3

## VERTICAL IRREGULARITY CHECKLIST

The following is a list of Irregularity Types referenced in ASCE 7-22 Table 12.3-2 Vertical Structural Irregularities, which will be examined for applicability to this project. Where an irregularity is present, the project will consider the Reference Sections assigned to the Type in Table 12.3-2:

| | |
|---|---|
| **1a. STIFFNESS-SOFT STORY IRREGULARITY**: where there is a story in which the lateral stiffness is less than 70% of that in the story above or less than 80% of the average stiffness of the three stories above. | regular |
| **1b. STIFFNESS – EXTREME SOFT STORY IRREGULARITY**: where there is a story in which the lateral stiffness is less than 60% of that in the story above or less than 70% of the average stiffness of the three stories above.[3] | regular |
| **2. WEIGHT (MASS) IRREGULARITY**: where the effective mass of any story is more than 150% of the effective mass of an adjacent story. A roof that is lighter than the floor below need not be considered.[4] | regular |
| **3. VERTICAL GEOMETRIC IRREGULARITY**: where the horizontal dimension of the seismic force-resisting system in any story is more than 130% of that in an adjacent story.[5] | regular |
| **4. IN-PLANE DISCONTINUITY IN VERTICAL LATERAL FORCE-RESISTING ELEMENT IRREGULARITY**: where there is an in-plane offset of a vertical seismic force-resisting element resulting in overturning demands on a supporting beam, column, truss, or slab.[5] | regular |
| **5a. DISCONTINUITY IN LATERAL STRENGTH – WEAK STORY IRREGULARITY**: where the story lateral strength is less than 80% of that in the story above. The story lateral strength is the total lateral strength of all seismic-resisting elements sharing the story shear for the direction under consideration.[6] | regular |
| **5b. DISCONTINUITY IN LATERAL STRENGTH – EXTREME WEAK STORY IRREGULARITY**: where the story lateral strength is less than 65% of that in the story above. The story strength is the total strength of all seismic-resisting elements sharing the story shear for the direction under consideration.[7] | regular |

| SUMMARY | regular |
|---|---|

-------

3. Structures with SDC E or F shall not be permitted with this irregularity
4. See Equivalent Lateral Force Procedure
5. Elements supporting this irregularity shall be designed with over-strength factor, per Section 12.4.3
6. Structures with SDC E or F shall not be permitted with this irregularity
7. Structures with SDC D, E, or F (or with more than two stories or taller than 30 ft) shall not be permitted with this irregularity

## REDUNDANCY CHECKLIST

Per ASCE 7-22 Section 12.3.4.2 Redundancy Factor, p, for Seismic Design Categories D-F, p shall equal 1.3 unless one of the following two conditions is met, whereby p is permitted to be taken as 1.0

**a.** each story resisting more than 35% of the base shear in the direction of interest shall comply with Table 12.3-3 (shown below) — regular

**b.** Structures that are regular in plan at all levels provided that the seismic force-resisting systems consist of at least two bays of seismic force-resisting perimeter framing on each side of the structure in each orthogonal direction at each story resisting more than 35% of the base shear. The number of bays for a shear wall shall be calculated as the length of shear wall divided by the story height or two times the length of shear wall divided by the story height, hsx, for light-frame construction. — regular

**TABLE 12.3-3** *(for Section 12.3.4.2 condition a, shown above)*

**BRACED FRAMES**: removal of an individual brace, or connection thereto, would not result in more than a 33% reduction in story strength, nor does the resulting system have an extreme torsional irregularity (horizontal irregularity Type 1b)

**MOMENT FRAMES**: Loss of moment resistance at the beam-to-column connections at both ends of a single beam would not result in more than a 33% reduction in story strength, nor does the resulting system have an extreme torsional irregularity (horizontal irregularity Type 1b)

**SHEAR WALLS**: Removal of a shearwall within any story, or collector connections thereto, would not result in more than a 33% reduction in story strength, nor does the resulting system have an extreme torsional irregularity (horizontal irregularity Type 1b). The h:l ratios are determined per ASCE 7-16 Figure 12.3-2

**CANTILEVER COLUMNS**: Loss of moment resistance at the base connections of any single cantilever column would not result in more than a 33% reduction in story strength, nor does the resulting system have an extreme torsional irregularity (horizontal irregularity Type 1b) — regular

**OTHER**: no requirements

| | |
|---|---|
| Section 12.3.4.2 | regular |
| Table 12.3-1 Horizontal Structural Irregularities | regular |
| Table 12.3-2 Vertical Structural Irregularities | regular |
| **SUMMARY** | redundancy factor, p = 1.0 |

## COLLECTORS

Per ASCE 7-22 Section 12.3.3.4 Increase in Forces Due to Irregularities for Seismic Design Categories D-F, structures with the following Irregularities will require the increase of design forces by 25% for: connections of diaphragms to vertical elements, to collectors, and collector connections.

| | |
|---|---|
| Irregularity Types 1a, 1b, 2, 3, or 4 in Table 12.3-1 | regular |
| Irregularity Type 4 in Table 12.3-2 | regular |

| | |
|---|---|
| **SUMMARY** | 25% increase not required |

## OTHER MOMENTARY CONSIDERATIONS

### TORSION

INHERENT TORSION

Per ASCE 7-16 Section 12.8.4.1 Inherent Torsion, because this project idealizes diaphragms as flexible, horizontal forces are distributed by tributary seismic area -- and therefore, inherent torsion need not be considered.

ACCIDENTAL TORSION

Flexible diaphragms are also not subject to the requirements of ASCE 7-16 Section 12.8.4.2 Accidental Torsion, or Section 12.8.4.3 Amplification of Accidental Torsional Moment.

### STORY DRIFT LIMITATIONS

The Story Drift Limit used in this project is listed in SEISMIC PARAMETERS of this Structural Report, per ASCE 7-16 Table 12.12-1. Other Codes that were considered but do not apply to this project include:

Section 12.12.1.1 Moment Frames in Structures Assigned to Seismic Design Categories D-F

Section 12.12.3 Structural Separation

Section 12.12.4 Members Spanning between Structures

### P-DELTA EFFECTS

In accordance with ASCE 7-16 Section 12.8.7 P-Delta Effects, secondary moments need not be considered "…where the stability coefficient θ is equal or less than 0.10…" where: $\theta = P_x \Delta I_e / V_x h_{sx} C_d$

Using known variables, θ, Cd, Ie, Allowable Story Drift, and Vx, calculate "Px-delta" at each level. Px-delta is the minimum force to exceed ASCE 7-16 Section 12.8.7 conditions and require consideration of secondary moments.

| | | |
|---|---|---|
| Stability Coefficient, θ | 0.1 | ASCE 7-16 Section 12.8.7 |
| Deflection Amplication Factor, Cd | 1.0 | ASCE 7-16 Table 12.2-1 |
| Seismic Importance Factor, $I_e$ | 1.0 | ASCE 7-16 Table 1.5-2 |
| Allowable Story Drift, Δ | 0.025hsx | ASCE 7-16 Table 12.12-1 |

| Diaphragm | [1]Accumulated Shear | [2]Wx (DL+LL) | [3]Px-delta | Check |
|---|---|---|---|---|
| ROOF | 2160 | 15300 | 8640 | check p-delta |
| LEVEL 1 | 2160 | 15350 | 8640 | check p-delta |

1. Story shear for this diaphragm plus the floors above (see Equivalent Lateral Force Analysis)
2. Approximate weight of this diaphragm plus the floors above (includes DL + LL)
3. "Px-delta", the minimum force to exceed ASCE 7-16 Section 12.8.7 conditions and require consideration of secondary moments.

USGS web services were down for some period of time and as a result this tool wasn't operational, resulting in *timeout* error.
USGS web services are now operational so this tool should work as expected.

# BEAVER CREEK

## 22055 S Beavercreek Rd, Beavercreek, OR 97004, USA

### Latitude, Longitude: 45.2867508, -122.5298951


| | |
|---|---|
| **Date** | 4/9/2024, 2:37:34 PM |
| **Design Code Reference Document** | ASCE7-16 |
| **Risk Category** | II |
| **Site Class** | D - Default (See Section 11.4.3) |

| Type | Value | Description |
|---|---|---|
| $S_S$ | 0.752 | $MCE_R$ ground motion. (for 0.2 second period) |
| $S_1$ | 0.345 | $MCE_R$ ground motion. (for 1.0s period) |
| $S_{MS}$ | 0.902 | Site-modified spectral acceleration value |
| $S_{M1}$ | null -See Section 11.4.8 | Site-modified spectral acceleration value |
| $S_{DS}$ | 0.601 | Numeric seismic design value at 0.2 second SA |
| $S_{D1}$ | null -See Section 11.4.8 | Numeric seismic design value at 1.0 second SA |

| 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 | 0.339 | $MCE_G$ peak ground acceleration |
| $F_{PGA}$ | 1.261 | Site amplification factor at PGA |
| $PGA_M$ | 0.427 | Site modified peak ground acceleration |
| $T_L$ | 16 | Long-period transition period in seconds |
| SsRT | 0.752 | Probabilistic risk-targeted ground motion. (0.2 second) |
| SsUH | 0.845 | Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration |
| SsD | 1.5 | Factored deterministic acceleration value. (0.2 second) |
| S1RT | 0.345 | Probabilistic risk-targeted ground motion. (1.0 second) |
| S1UH | 0.398 | Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration. |
| S1D | 0.6 | Factored deterministic acceleration value. (1.0 second) |

| | |
|---|---|
| Address | 22055 S BEAVERCREEK RD |
| Job # | R24-037 |
| Engineer | John Voekel, PE |
| Structure Type | Wood Lateral Systems |
| Analysis: | New Construction Standard: 100%Vb |

## ASCE 7-10 Section 12.8 *Equivalent Lateral Force Procedure*

*Determine global seismic demand on structure.*

$$C_s = \frac{S_{DS}}{\left(\frac{R}{I_e}\right)}$$

$$V_n = C_s W$$

$$V_b = 0.7E\ V_n \rho$$

| | |
|---|---|
| R (Response Modification Factor Table) 12.2-1 | 1.0 |
| $S_{DS}$ (Design Spectral Response) 11.4.4, 11.4.7 | 0.60 |
| $I_e$ (Importance Factor Table) 12.2-1 | 1.0 |
| $C_s$ (Seismic Response Coefficient) 12.8.1.1 | 0.6010 |
| W (See Table Summary) | 5134 lbs |
| **$V_n$ (Nominal Base Shear) 12.8-1** | **3090 lbs** |
| 0.7E (ASD Load Case Magnifier) 2.4.1 | 0.70 |
| ρ, (Redundancy Factor) 12.3.4.2 | 1.0 |
| **Vb (Factored Base Shear)** | **2163 lbs** |

## ASCE 7-10 Section 12.8.3 *Vertical Distribution of Seismic Forces*

*Determine distribution of global seismic demand.*

$$T_a = C_t {h_n}^x$$

$$C_{vx} = \frac{w_x h_x^k}{\sum_{i=1}^{n} w_i h_i^k}$$

$$F_x = C_{vx} V_b$$

| | |
|---|---|
| Structural Height (See Table Summary) | 9.0 ft |
| $C_t$ (parameter for Ta) Table 12.8-2 | 0.02 |
| x (parameter for Ta) Table 12.8-2 | 0.75 |
| Ta (approximate period) 12.8-7 | 0.10 s |
| k (period dependent exponent) 12.8.3 | 1.00 |
| $\Sigma w_i h_i^k$ (See Table Summary) | 45934 ft-lbs |

$F_x$ forces calculated for each diaphragm in the Table Summary below using respective $C_{vx}$ values

## TABLE SUMMARY - VERTICAL DISTRIBUTION OF SEISMIC FORCES

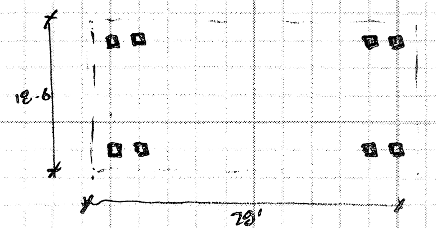
| DIAPHRAGMS | | Diaphragm Mass | | Exterior Wall Mass | | Interior Wall Mass | | $w_x$ (lbs) [1] | $h_x$ (ft) [2] | $w_x h_x^k$ (ft-lbs) [3] | $C_{vx}$ [4] | $F_x$ (lbs) [5] | Accum. Shear Load (lbs) [6] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Area | Unit Wt | Area | Unit Wt | Area | Unit Wt | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | ROOF | 510 | 10 | 1 | 1 | 1 | 1 | 5102 | 9.00 | 45918 | 1.000 | 2160 | 2160 |
| F1 | LEVEL 1 | 1 | 10 | 1 | 12 | 1 | 10 | 32 | 0.50 | 16 | 0.000 | 0 | 2160 |
| | | | | | | | | W | $h_{max}$ | $\Sigma w_i h_i^k$ | Total | Total | |
| | | | | | | | | 5134 | 9.00 | 45934 | 1.00 | 2160 | |

1. Effective seismic weight at this diaphragm (ASCE 7 Section 12.7.2) - Includes weight of the diaphragm, top half of the walls below, bottom half of the walls above (or full parapet)
2. Average height of diaphragm above grade (ft)
3. Effective seismic weight and height contribution to each diaphragm (ft-lbs)
4. Distribution of base shear to diaphragms (ASCE 7-10 Equation 12.8-12)
5. Story Shear (ASCE 7-10 Equation 12.8-11) rounded to nearest 10 lbs (includes 0.7E and ρ redundancy factor)
6. Accumulated shear at this diaphragm (value may be larger than Vb calculation due to Fx rounding up)

JOB: Beaver Creek | DATE: 16 JUL 2024 | BY: JPV

## LATERAL ANALYSIS:

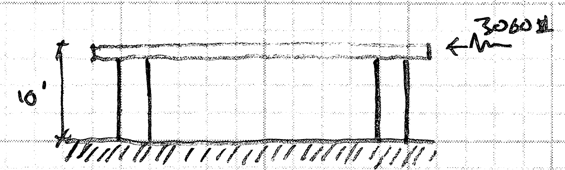
PLAN:




OPEN CANOPY.

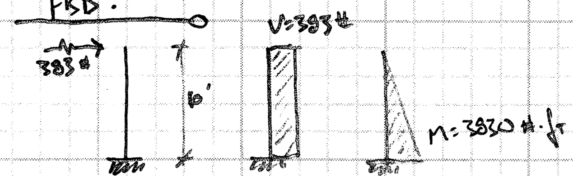
ROOF AREA: 510 sqft
WEIGHT: 10 psf
→ W = 5100 #

$C_s = 0.60$
R = 1.0
→ $V_b = C_s W$ = 3060 #




LOAD/COL: 3060/8 = 383 #/COL

FBD:

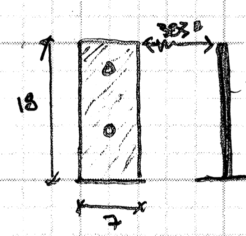



## CHECK 8×8 WOOD COLUMN:

MOMENT:
$f_b = M/S$ : 46 k·in / [7.5³/12] = 46 k·in / 35.1 in³ = **1307 psi** DEM.
$F'_b$ = 1500 psi × 1.6 $C_D$ = **2400 psi** CAP. OK ✓

SHEAR:
$f_v = 3V/2A$ = 3(383 #)/2(7.5×3.75) = **20.4 psi**
$F'_v$ = 170 × 1.6 = **272 psi**, OK ✓

## CHECK STEEL PLATE:




5/8" × 18" × 7" PLATE

V = 383 #
M = 7000 #·in

$\tau = 3V/2A$ = 3(383)/8.75 = **131 psi**, CAP: 0.6(36) = 21 ksi, OK
$\sigma_b = M/S$ = 7000/[7×(5/8)²]/6 = 7000/0.45 = **15.4 ksi, OK ✓**

CHECK DEFLECTION:

$PL^3/3EI$ = (383)(18)³ / 3(29000,000)(0.14) = **0.18"**
∴ DEFLECTION @ TOP OF STRUCTURE = 0.18 × 10/1.5 = **1.2", OK**

## ASCE 7-22 CHAPTER 26 WIND LOADS: GENERAL REQUIREMENTS

Per Section 26.1.2 Permitted Procedures, "The design wind loads for buildings and other structures, including the MWFRS and component and cladding elements thereof, shall be determined using one of the procedures as specified in this section." Here, we will outline the basic wind parameters and choose the most economical and appropriate wind analys(es) for the project.

| PARAMETER | VALUE | ASCE 7-22 REFERENCE |
|---|---|---|
| Risk / Occupancy Category | II | Section 1.5-1 |
| Wind Importance Factor, Iw | 1.0 | Table 1.5-2 |
| Basic Wind Speed (mph) | 110 | Section 26.5.1A |
| Wind Directionality Factor, Kd | 0.85 | Table 26.6-1 |
| Exposure Category / Surface Roughness | Exposure B | Section 26.7 |
| Topographic Factor, Kzt | 1.0 | Section 26.8 |
| Ground Elevation Factor, Ke | 1.0 | Section 26.9 & Table 26.9-1 |
| Reduction for Large-Volume Buildings, Ri | 1.0 | Section 26.13.1 |
| Enclosure Classification | Open | Section 26.12 |
| Mean Building Height, z | 10.0 ft | |
| Roof Angle | 3:12 | |
| Velocity Pressure Exposure Coefficient, Kz | | |
| Kz = 2.01 (15/zg) ^2/α | 0.575 | Table 27.3-1 / Table 28.3-1 |
| zg, Terrain Exposure Constant | 1200 ft | Table 26.11-1 |
| α, Terrain Exposure Constant | 7 | Table 26.11-1 |
| Velocity Pressure, qz | | |
| $q_z = 0.00256\,(K_z K_{zt} K_d K_e V^2)$ | **15.1 psf** | Section 26.10.2 & Equation 26.10-1 |
| Gust Effect Factor | **0.85** | Section 26.11 |
| Internal Pressure Coefficient, GCpi | **± 0.00** | Section 26.13 & Table 26.13-1 |

## SUMMARY OF WIND ANALYSIS PROCEDURES

| CHAPTER 27 [\DIRECTIONAL] | CHAPTER 28 [ENVELOPE] | CHAPTER 29 [APPURTENANCES] | CHAPTER 30 [C&C] | CHAPTER 31 [WIND TUNNEL] |
|---|---|---|---|---|
| PART 1 DIRECTIONAL | PART 1 ENVELOPE | 29.4 WALLS / SIGNS | PART 1 | WIND TUNNEL |
| PART 2 - CLASS 1 | PART 2 SIMPLIFIED | 29.5 OTHER STRUCTURES | PART 2 | |
| PART 2 - CLASS 2 | | 29.5.1 ROOFTOP STRUCT. | PART 3 | |
| | | | PART 4 | |
| | | | PART 5 | |
| | | | PART 6 | |

## ASCE 7-22 CHAPTER 27: WIND LOADS ON BUILDINGS - MWFRS (DIRECTIONAL PROCEDURE)

**APPLICABILITY –** Show that analysis is appropriate for this project.

| | | |
|---|---|---|
| 27.1.1 Building Types | Enclosed, Partially Enclosed, or Open | ✓ |
| 27.1.2-1 Conditions | Regular Shaped | ✓ |
| 27.1.2-2 | "The building does not have response characteristics making it subject to across wind loading, vortex shedding, instability due to galloping or flutter, or it does not have a site location for which channeling effects or buffeting in the wake of upwind obstructions warrant special consideration." | ✓ |
| 27.2 General Req'm | Roof is Gable & Hip, Monoslope, Mansard, Domed, Arched, Pitched, or Troughed per Figure 27.4-1 through 27.4-8 | ✓ |

**ANALYSIS PROCEDURE:**

See attached hand calculations that show distribution of wind loads. The values for the External Pressure Coefficient, as well as the logic for applying loads to the building geometry, were generated from the following ASCE 7-22 Figure and Section:

27.3.1 Enclosed and Partially Enclosed Rigid and Flexible Buildings $p = qGC_p - q_iGC_{pi}$

Figure 27.3-1 (for walls and roofs)

**27.3.3 Roof Overhangs**

The positive external pressure on the bottom surface of windward roof overhangs shall be determined using $C_p = 0.8$ in combination with the top surface pressures determined using Fig. 27.3-1 and $p = qGC_p$

| q, roof | G | Cp, roof | p, Roof | p, Overhang | p, Total |
|---|---|---|---|---|---|

SEE NEXT PAGE

| JOB Beaver Creek | DATE 16 JUL 2024 | BY JPV |
|---|---|---|

## WIND CHECK:

$q_z = 15.1$ psf, use **16 psf**

Roof Angle ≈ 10°

$C_{NW}$: A = −0.6, B = −1.4 A: 0.9, B: 1.6

$C_{NL}$: A: −1.0, B: 0.0 A: 1.5, B: 0.3

$p = q_h G C_N = 16(0.85)(-1.4) =$ **19 psf ↑** uplift

AREA = 500 sqft,

DEMAND = 500 × 19 × 0.6 = **5712 #** ↑

DEM/COL: 5712/8 = 714 #/col, OK by inspection ✓

## CHECK RAFTER-BEAM CONNECTION:

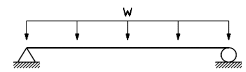
EA. rafter assumes 1/7 of TRIB AREA: 816 #/rafter ↑

408 #/connection

136 #/screw... OK ✓

**FRAMEWORK** ENGINEERING
16 JUL 2024

**Address** 22055 S BEAVERCREEK
**Job #** R24-037
**Engineer** JPV




LOADING & DEMAND CALCULATIONS

| SPANNING MEMBER ID | | | | GEOMETRY | | DISTRIBUTED LOADING (plf) | | | | | | DEMAND | | | | | | NOTES: |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member Schedule | Member Name | Floor Location | Gridline Location | Span (ft) | Spacing (in) | DL | LL | Lr | RL | SL | $w_u$ | Load Duration | Moisture Condition | LL Defl. | Total Defl. | Moment (lb-ft) | Shear (lbs) | |
| 01 | RAFTERS | S100 | | 14.25 | 48 | 40 | 0 | 80 | 20 | 80 | 120 | 1.15 | DRY | .48 in<br>L/360 | .71 in<br>L/240 | LOAD CASE 3<br>3050 | 860 | |
| 02 | BEAM | S100 | | 24.33 | | 90 | 0 | 180 | 45 | 180 | 270 | 1.15 | DRY | .81 in<br>L/360 | 1.22 in<br>L/240 | LOAD CASE 3<br>19980 | 3280 | TRIB WIDTH = 9'<br>DEFLECTION & MOMENT ARE REDUCED BY USE OF DOUBLE COLUMNS |

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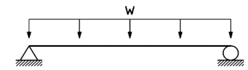
**Table Notes:**
1. Adjustment Factors: NDS Table 4.3.1 for Sawn Lumber; NDS Table 5.3.1 for Glulam; NDS Table 8.3.1 for SCL; and NDS Table 7.3.1 for I-Joists.
Beam Stability Factor, CL (NDS 4.4.1) is assumed to have full depth bridging / blocking at 8' or closer spacing, satisfying all d/b ratios less than 6.
Flat Use Factor, Cfu (NDS 4.3.7) is conservatively taken as 1.0 for all cases.
2. Capacity calculations use simple mechanics for Sawn Lumber and Glulams; and use ICC-ES Reports for Engineered Lumber.




SPECIFICATION & CAPACITY CALCULATIONS

| SPANNING MEMBER ID | | | | MEMBER SPECIFICATION (Size and Grade) | NDS Applicability of Adjustment Factors[1] | | | | | | | | | | | CAPACITY[2] | | | | DEMAND (increased considering self weight) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Member Schedule | Member Name | Floor Location | Gridline Location | | Nominal (psi) | $C_D$ | $C_M$ | $C_t$ | $C_L$ | $C_F$ | $C_V$ | $C_{fu}$ | $C_i$ | $C_r$ | Design (psi) | LL Defl. | Total Defl. | Moment (lb-ft) | Shear (lbs) | LL Defl. | Total Defl. | Moment (lb-ft) | Shear (lbs) |
| | | | | | Fb = 1000 | 1.15 | 1.00 | 1.00 | 1.00 | 1.30 | – | 1.00 | 1.00 | 1.00 | Fb' = 1495 | | | | | | | | |
| 01 | RAFTERS | S100 | | 4x8 DF #1 | Fv = 180 | 1.15 | 1.00 | 1.00 | – | – | – | – | 1.00 | – | Fv' = 207 | .39 in L/440 | .62 in L/280 | 3820 | 3502 | .48 in L/360 | .71 in L/240 | LOAD CASE 3 3190 | 900 |
| | | | | | E = 1700000 | – | 1.00 | 1.00 | – | – | – | – | 1.00 | – | E' = 1700000 | | | | | | | | |
| | | | | | Fb = 2400 | 1.15 | 1.00 | 1.00 | 1.00 | – | 0.95 | – | – | 1.00 | Fb' = 2613 | | | | | | | | |
| 02 | BEAM | S100 | | 8 3/4" x 10-1/2" 24F-V4 | Fv = 265 | 1.15 | 1.00 | 1.00 | – | – | – | – | – | – | Fv' = 305 | .93 in L/310 | 1.52 in L/190 | 35006 | 18666 | .81 in L/360 | 1.22 in L/240 | LOAD CASE 3 21630 | 3560 |
| | | | | | E = 1800000 | – | 1.00 | 1.00 | – | – | – | – | – | – | E' = 1800000 | | | | | | | | |

| | |
|---|---|
| **Address** | BEAVERCREEK |
| **Job #** | R24-037 |
| **Engineer** | John Voekel, PE |

## WOOD POST CALCULATIONS

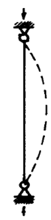
| | |
|---|---|
| **Grade** | DF Select Struct |
| **Moisture** | DRY |

**Note on calculation approach:**
Because the post sizes and heights are mostly similar across the whole floor (or floors) and the structural system uses only a few different sizes, this summary groups the calculation of 4x4, 4x6, and 6x6 posts collectively for both load durations 1.00 and 1.60. Compression perpendicular to grain is also checked (and is independent of load duration) to determine if posts require hardware or reinforcement at bearing conditions.

### MATERIAL PROPERTY ADJUSTMENTS

| | | |
|---|---|---|
| **$E'min = Emin\ C_M\ C_t\ C_i\ C_T$** | | |
| $E_{min}$ (Elastic Modulus) | NDS Table 4A | 690000 psi |
| $C_M$ (Moisture Adjustment Factor) | NDS Table 4A | 1.0 |
| $C_t$ (Temperature Factor) | NDS 4.3.4 / 2.3.3 | 1.0 |
| $C_i$ (Incising Factor) | NDS Table 4.3.8 | 1.0 |
| $C_T$ (Buckling Stiffness Factor) | NDS 4.3.11 | does not apply |
| **$E'_{min}$ (Adjusted Elastic Modulus)** | **NDS Table 4.3.1** | **690000 psi** |
| **$F*_c = Fc\ C_D\ C_M\ C_f$** | | |
| $F_c$ (Nominal Compression Stress) | NDS Table 4A | 1700 psi |
| $C_D$ (Load Duration Adjustment Factor) | NDS 4.3.2 | 1.0, 1.6 |
| $C_M$ (Moisture Adjustment Factor) for Fc | NDS Table 4A | 1.0 |
| $C_F$ (Size Factor) | NDS 4.3.6 | 1.4 |
| **$F*_c$ (Critical Buckling Design Value for $C_D$=1.00)** | | **2380 psi** |
| **$F*_c$ (Critical Buckling Design Value for $C_D$=1.60)** | | **3808 psi** |

### DIRECTIONAL STRENGTH



| | | 4x4 | | 6x6 | | 8x8 | |
|---|---|---|---|---|---|---|---|
| **$FcE = 0.822\ E'min / (le/d)^2$** | | X | Y | X | Y | X | Y |
| Ke buckling length coefficients | NDS Table G1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| l (Unbraced Length) | | 120 in | 120 in | 120 in | 120 in | 120 in | 120 in |
| $l_e$ (Effective Unbraced Length) | Ke x l | 120 in | 120 in | 120 in | 120 in | 120 in | 120 in |
| d (depth of member) | material properties | 3.50 in | 3.50 in | 5.50 in | 5.50 in | 7.50 in | 7.50 in |
| $F_{cE}$ (Adjusted Reference Compression Value) | NDS 3.7.1 | 482 psi | 482 psi | 1191 psi | 1191 psi | 2216 psi | 2216 psi |

### ALLOWABLE LOADS

| | | 4x4 X | 4x4 Y | 6x6 X | 6x6 Y | 8x8 X | 8x8 Y |
|---|---|---|---|---|---|---|---|
| **$F'c = Fc\ C_M\ C_F\ C_i\ C_P$** | | | | | | | |
| c (0.8 for sawn lumber) | NDS 3.7.1 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| $C_i$ (Incising Factor) for Fc | NDS Table 4.3.8 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| $C_P$ (Column Stability Factor) | NDS 3.7.1 | 0.19 | 0.19 | 0.43 | 0.43 | 0.67 | 0.67 |
| F'c (Allowable Compression Stress) | NDS Table 4.3.1 | 460 psi | 460 psi | 1033 psi | 1033 psi | 1584 psi | 1584 psi |
| Area | | 12.25 sqin | | 30.25 sqin | | 56.25 sqin | |
| **P = F'c x A (Allowable Compression Strength for $C_D$=1.00)** | **NDS 3.6.3** | **P = 5650 lbs** | | **P = 31250 lbs** | | **P = 89100 lbs** | |
| **P = F'c x A (Allowable Compression Strength for $C_D$=1.60)** | **NDS 3.6.3** | **P = 3600 lbs** | | **P = 20850 lbs** | | **P = 65400 lbs** | |

| | | 4x4 | 6x6 | 8x8 |
|---|---|---|---|---|
| **$F'_{c\perp} = Fc_{\perp}\ C_M\ C_t\ C_i\ C_b$** | | | | |
| $F_{c\perp}$ (Nominal Bearing Stress) to def. of 0.04" | NDS Table 4A | 625 psi | 625 psi | 625 psi |
| $C_M$ (Moisture Adjustment Factor) | NDS Table 4A | 1.00 | 1.00 | 1.00 |
| $C_i$ (Incising Factor) for Fc | NDS Table 4.3.8 | 1.00 | 1.00 | 1.00 |
| $l_b$ (bearing length measured parallel to grain, in) | | 3.5 in | 5.5 in | 7.5 in |
| $C_b$ (Bearing Area Factor) | NDS Table 3.10.4 | 1.10 | 1.00 | 1.00 |
| $F'_{c\perp}$ = (Allowable Bearing Stress) | NDS 3.10.2 | 688 psi | 625 psi | 625 psi |
| **P = $F'_{c\perp}$ x A (Allowable Bearing Strength)** | **NDS 3.10.3** | **P = 8400 lbs** | **P = 18900 lbs** | **P = 35150 lbs** |

FOOTINGS: 1.5x4x1500psf = 9000# / FOOTING, OK