SOLUTIONS 4 STRUCTURES Inc.

Page: 1 of 159
Date: 2026 01 21
Design by: TLC

***Structural Calculations for Vertical and Lateral Design of BBQ Structure***

PRCNC20260044

**Project & Location:**

**Structural Calculations**

**Bradley Heights Apartments**

(Lat 47.1652, Long -122.2921)
202 27th Avenue SE, Puyallup, WA

**Client:**

Timberlane Partners
Attn: Dave Enslow
dave@timberlanepartners.com

**Professional Engineer:**

Solutions 4 Structures, Inc
11605 135th St Ct E
Puyallup, WA 98374
Attn: Tom Chase, PE
tom@solutions4structures.com
(253) 314 - 9822

THOMAS LANE CHASE STATE OF WASHINGTON 29006 REGISTERED PROFESSIONAL ENGINEER

01-21-26

**Project Number:** 23.007

**Code / Location:** 2021 IBC

**Loads:**

1. Vertical Loads

| | Dead | Live |
|---|---|---|
| Roof | 22 PSF | 25 PSF (Snow) |

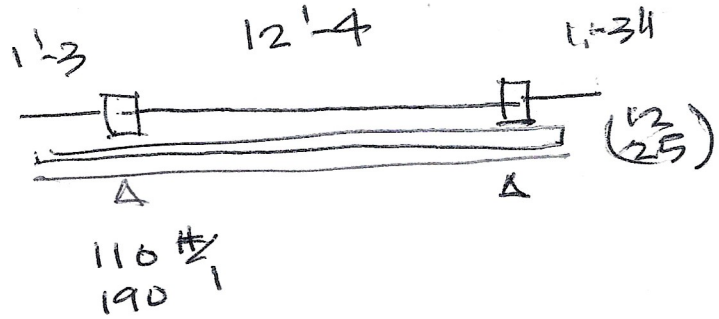
2. Lateral Loads
   Wind Criteria
      Basic Wind Speed = 97 MPH
      Exposure B
      Iw = 1.0, Kzt = 1.0
   Seismic Criteria
      Seismic Design Category "D"
      Site Class C
      $I_E$= 1.0, Ss = 1.263, S1 = 0.435
      SDS = 1.010, SD1 = 0.435

City of Puyallup Development & Permitting Services ISSUED PERMIT: Building, Planning, Engineering, Public Works, Fire, Traffic

City of Puyallup
Building
REVIEWED FOR COMPLIANCE
SKinnear
02/11/2026
8:30:29 AM
CITY OF PUYALLUP STATE OF WASHINGTON

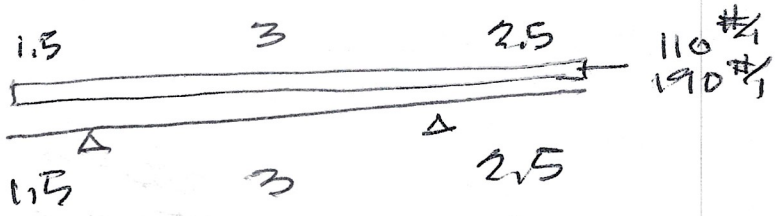
3. Soils Data (per GeoResources Inc. dated 02/10/2022)
      Bearing Capacity = 2,000 PSF

Calculations required to be provided by the Permittee on site for all Inspections




~11PSF

∴ 4X6 FLAT DECKING



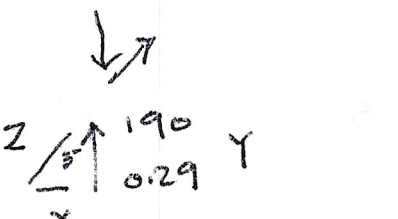

| | |
|---|---|
| 0.09 | 45 |
| 0.15 | 75 |

↑ EA ONE

| | |
|---|---|
| 0.19 | 95 |
| 0.29 | 195 |

EA ONE

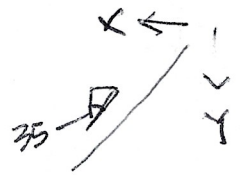
(2) 2X8




Y = 0.19
0.29

X = TAN35 (0.19, 0.29)

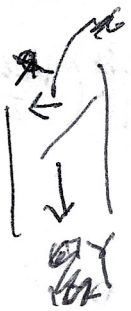
X = .133
.203

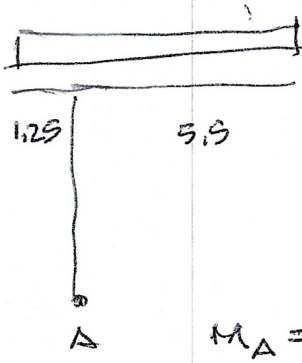



$TAN35° = \frac{X}{Y}$

Y = 95
195

X = 67





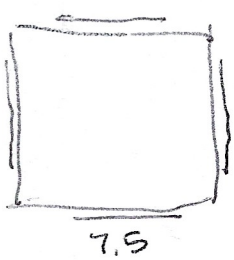

$M_A = \frac{110}{190}\frac{(5.5)^2}{2} - \frac{110}{190}\frac{(1.5)^2}{2}$

151.25
1540 #-1

1.125
14

~~4200~~ #-1
~~2800~~
TOTAL
D + L

~~2053~~ #-1
~~1260~~ #-1
2660



Project Title: Bradley Heights Apartments
Engineer: M. Oman
Project ID:
Project Descr: 3-4 Story Apartment Bldgs

# Wood Column

Project File: Beam Designs.ec6



**DESCRIPTION:** --None--

## Code References

Calculations per NDS 2018, IBC 2021, SDPWS 2015
Load Combinations Used : ASCE 7-16

## General Information

| | | | |
|---|---|---|---|
| Analysis Method | Allowable Stress Design | | |
| End Fixities | Top Free, Bottom Fixed | | |
| Overall Column Height | 9 ft | | |
| *( Used for non-slender calculations )* | | | |
| Wood Species | Hem-Fir | | |
| Wood Grade | No.1 | | |
| Fb + | 975.0 psi | Fv | 140.0 psi |
| Fb - | 975.0 psi | Ft | 650.0 psi |
| Fc - Prll | 850.0 psi | Density | 26.840 pcf |
| Fc - Perp | 405.0 psi | | |

| E : Modulus of Elasticity . . . | x-x Bending | y-y Bending | Axial |
|---|---|---|---|
| Basic | 1,300.0 | 1,300.0 | 1,300.0 ksi |
| Minimum | 470.0 | 470.0 | |

| | | | |
|---|---|---|---|
| Wood Section Name | **8x8** | | |
| Wood Grading/Manuf. | Graded Lumber | | |
| Wood Member Type | Sawn | | |
| Exact Width | **7.50** in | Allow Stress Modification Factors | |
| Exact Depth | **7.50** in | Cf or Cv for Bending | 1.0 |
| Area | 56.250 in^2 | Cf or Cv for Compressio | 1.0 |
| Ix | 263.672 in^4 | Cf or Cv for Tension | 1.0 |
| Iy | 263.672 in^4 | Cm : Wet Use Factor | 1.0 |
| | | Ct : Temperature Fact | 1.0 |
| | | Cfu : Flat Use Factor | 1.0 |
| | | Kf : Built-up columns | 1.0 |
| | | Use Cr : Repetitive ? | No |

Column Buckling Condition:
ABOUT X-X Axis: Lux = 9 ft, Kx = 2.1
Fully braced against buckling ABOUT Y-Y Axis

## Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Column self weight included : 94.359 lbs * Dead Load Factor
AXIAL LOADS . . .
Axial Load at 9.0 ft, Xecc = 0.50 in, Yecc = 0.50 in, D = 0.090, S = 0.150 k
Axial Load at 4.50 ft, Xecc = 4.0 in, Yecc = 4.0 in, D = 0.190, S = 0.290 k
BENDING LOADS . . .
Lat. Point Load at 4.50 ft creating Mx-x, D = 0.3420, S = 0.5910 k

## DESIGN SUMMARY

Bending & Shear Check Results

**PASS** Max. Axial+Bending Stress Ratio = **0.7159 : 1**
Load Combination +D+S
Governing NDS Forumla Comp + Mxx + Myy, NDS Eq. 3.9-
Location of max.above base 0.0 ft
At maximum location values are .
Applied Axial 0.8144 k
Applied Mx -4.369 k-ft
Applied My -0.170 k-ft
Fc : Allowable 375.602 psi

**PASS** Maximum Shear Stress Ratio = **0.1545 : 1**
Load Combination +D+S
Location of max.above base 4.470 ft
Applied Design Shear 37.320 psi
Allowable Shear 161.0 psi

**Maximum SERVICE Lateral Load Reactions . .**
Top along Y-Y 0.0 k Bottom along Y-Y 0.9330 k
Top along X-X 0.0 k Bottom along X-X 0.0 k

**Maximum SERVICE Load Lateral Deflections . . .**
Along Y-Y 0.3822 in at 9.0 ft above base
for load combination : +D+S
Along X-X 0.02642 in at 9.0 ft above base
for load combination : +D+S

**Other Factors used to calculate allowable stresses . . .**

| | Bending | Compression | Tension |
|---|---|---|---|

## Load Combination Results

| Load Combination | $C_D$ | $C_P$ | Maximum Axial + Bending Stress Ratios: Stress Ratio | Status | Location | Maximum Shear Ratios: Stress Ratio | Status | Location |
|---|---|---|---|---|---|---|---|---|
| D Only | 0.900 | 0.469 | 0.3308 | PASS | 0.0 ft | 0.07238 | PASS | 4.470 ft |
| +D+S | 1.150 | 0.384 | 0.7159 | PASS | 0.0 ft | 0.1545 | PASS | 4.470 ft |
| +D+0.750S | 1.150 | 0.384 | 0.60 | PASS | 0.0 ft | 0.1301 | PASS | 4.470 ft |
| +0.60D | 1.600 | 0.287 | 0.1109 | PASS | 0.0 ft | 0.02443 | PASS | 4.470 ft |

Project Title: Bradley Heights Apartments
Engineer: M. Oman
Project ID:
Project Descr: 3-4 Story Apartment Bldgs

# Wood Column

Project File: Beam Designs.ec6



**DESCRIPTION:** --None--

## Maximum Reactions

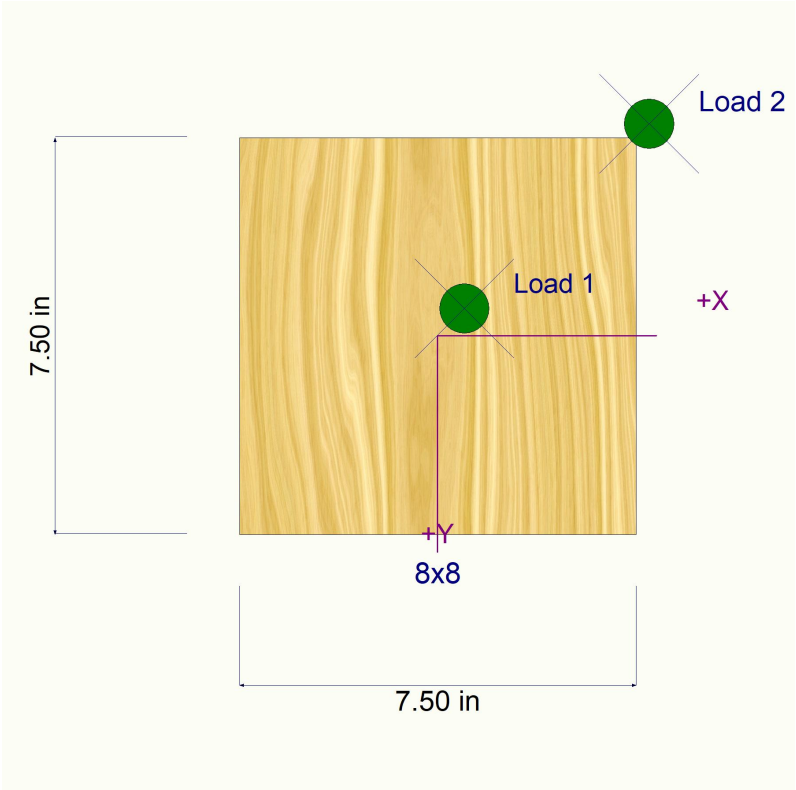
Note: Only non-zero reactions are listed.

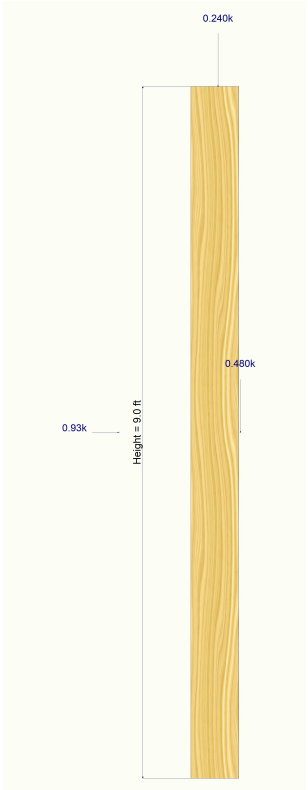
| Load Combination | X-X Axis Reaction @ Base | @ Top | k | Y-Y Axis Reaction @ Base | @ Top | Axial Reaction @ Base | My - End Moments @ Base | @ Top | k-ft | Mx - End Moments @ Base | @ Top |
|---|---|---|---|---|---|---|---|---|---|---|---|
| D Only | | | | 0.342 | | 0.374 | 0.067 | | | 1.606 | |
| +D+S | | | | 0.933 | | 0.814 | 0.170 | | | 4.369 | |
| +D+0.750S | | | | 0.785 | | 0.704 | 0.144 | | | 3.678 | |
| +0.60D | | | | 0.205 | | 0.225 | 0.040 | | | 0.964 | |
| S Only | | | | 0.591 | | 0.440 | 0.103 | | | 2.762 | |

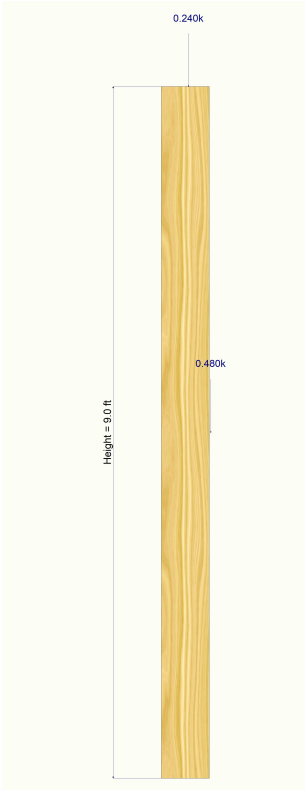
## Maximum Deflections for Load Combinations

| Load Combination | Max. X-X Deflection | Distance | Max. Y-Y Deflection | Distance |
|---|---|---|---|---|
| D Only | 0.0104 in | 9.000 ft | 0.141 in | 9.000 ft |
| +D+S | 0.0264 in | 9.000 ft | 0.382 in | 9.000 ft |
| +D+0.750S | 0.0224 in | 9.000 ft | 0.322 in | 9.000 ft |
| +0.60D | 0.0062 in | 9.000 ft | 0.084 in | 9.000 ft |
| S Only | 0.0159 in | 8.940 ft | 0.239 in | 8.940 ft |

## Sketches



# Lateral

BBQ Structure

SOLUTIONS 4 STRUCTURES Inc.

***Job #*** 23.007

***Designed:*** MAA

***Checked:***

***Project:*** BBQ Bradley Heights

**Seismic Demands on Non-Structural Components** (ASCE Section 13.3.1) I

**Site Class:**
Site Class: C (IBC 1613.3.2, ASCE Table 20.3-1)

**Site Location:**
Latitude: 47.1652 Longitude: -122.2921

**Site Coefficients:** (USGS Open-File Report 01-437)

| | | | |
|---|---|---|---|
| $S_S$ = | **1.263** | $F_a$ = | 1.20 |
| $S_1$ = | **0.435** | $F_V$ = | 1.50 |

$S_{MS} = F_a * S_S$ = 1.516 (IBC Eq.16-37)

$S_{M1} = F_V * S_1$ = 0.653 (IBC Eq.16-38)

**Spectral Response Parameters:**

$S_{DS} = 2/3 * S_{MS}$ = 1.0104 (IBC Eq.16-39)

$S_{D1} = 2/3 * S_{M1}$ = 0.4350 (IBC Eq.16-40)

**General Eqn:**

$Fp=.4 * ( a_p * S_{ds} * W_p / (R_p/I_p)) * ( 1+ 2 * z / h )$ (ASCE Eqn 13.3-1) where:

| | | | |
|---|---|---|---|
| $W_p$ = | 1,406 | lbs: | (Total Component Operating Weight) |
| $S_{ds}$ = | 1.01 | | spectral acceleration from above |
| $a_p$ = | 1.00 | | Component Application factor (ASCE Table 13.5-1 or 13.6-1) |
| $R_p$ = | 2.50 | | Component Response Modification factor (ASCE Table 13.5-1 or 13. |
| $I_p$ = | 1.00 | | Component Importance factor (ASCE Section 13.1.3) |
| z = | 8.50 | Ft: | (Height of component in structure to point of attachment) |
| h = | 8.50 | Ft: | (average roof height of structure with respect to the base) |
| therefore, **$F_p$ =** | **682** | lbs | |

**However:**

$F_p$ is not required to be taken greater than: **2,557** lbs: $F_p = 1.6 * S_{ds} * I_p * W_p$ (ASCE Eqn 13.3-2)

$F_p$ shall not be taken less than: **426** lbs: $F_p = 0.3 * S_{ds} * I_p * W_p$ (ASCE Eqn 13.3-3)

**Summary:**

| | | | |
|---|---|---|---|
| Fp (ult) = | **682** | lbs: | (Ultimate Strength Design) |
| Fp (asd) = Fp (ult) / 1.4 | **487** | lbs: | (Allowable Stress Design) |

This is a beta release of the new ATC Hazards by Location website. Please contact us with feedback.

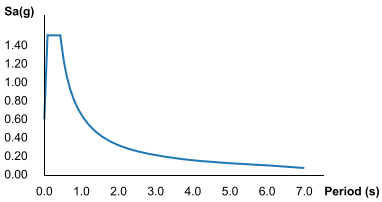
The ATC Hazards by Location website will not be updated to support ASCE 7-22. Find out why.

# Hazards by Location

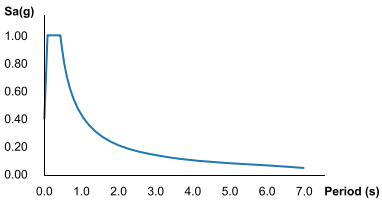
## Search Information

| | |
|---|---|
| **Coordinates:** | 47.16516801120486, -122.2920663220895 |
| **Elevation:** | 386 ft |
| **Timestamp:** | 2023-05-11T15:08:01.436Z |
| **Hazard Type:** | Seismic |
| **Reference Document:** | ASCE7-16 |
| **Risk Category:** | II |
| **Site Class:** | C |


### MCER Horizontal Response Spectrum




### Design Horizontal Response Spectrum




## Basic Parameters

| Name | Value | Description |
|---|---|---|
| $S_S$ | 1.264 | $MCE_R$ ground motion (period=0.2s) |
| $S_1$ | 0.436 | $MCE_R$ ground motion (period=1.0s) |
| $S_{MS}$ | 1.516 | Site-modified spectral acceleration value |
| $S_{M1}$ | 0.654 | Site-modified spectral acceleration value |
| $S_{DS}$ | 1.011 | Numeric seismic design value at 0.2s SA |
| $S_{D1}$ | 0.436 | Numeric seismic design value at 1.0s SA |

## Additional Information

| Name | Value | Description |
|---|---|---|
| SDC | D | Seismic design category |
| $F_a$ | 1.2 | Site amplification factor at 0.2s |
| $F_v$ | 1.5 | Site amplification factor at 1.0s |
| $CR_S$ | 0.914 | Coefficient of risk (0.2s) |
| $CR_1$ | 0.898 | Coefficient of risk (1.0s) |
| PGA | 0.5 | $MCE_G$ peak ground acceleration |
| $F_{PGA}$ | 1.2 | Site amplification factor at PGA |
| $PGA_M$ | 0.6 | Site modified peak ground acceleration |
| $T_L$ | 6 | Long-period transition period (s) |
| SsRT | 1.264 | Probabilistic risk-targeted ground motion (0.2s) |
| SsUH | 1.383 | Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years) |
| SsD | 1.5 | Factored deterministic acceleration value (0.2s) |
| S1RT | 0.436 | Probabilistic risk-targeted ground motion (1.0s) |
| S1UH | 0.485 | Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years) |
| S1D | 0.6 | Factored deterministic acceleration value (1.0s) |
| PGAd | 0.5 | Factored deterministic acceleration value (PGA) |

*The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.*

*Please note that the ATC Hazards by Location website will not be updated to support ASCE 7-22. Find out why.*

## Disclaimer

Hazard loads are provided by the U.S. Geological Survey Seismic Design Web Services.

While the information presented on this website is believed to be correct, ATC and its sponsors and contributors assume no responsibility or liability for its accuracy. The material presented in the report should not be used or relied upon for any specific application without competent examination and verification of its accuracy, suitability and applicability by engineers or other licensed professionals. ATC does not intend that the use of this information replace the sound judgment of such competent professionals, having experience and knowledge in the field of practice, nor to substitute for the standard of care required of such professionals in interpreting and applying the results of the report provided by this website. Users of the information from this website assume all liability arising from such use. Use of the output of this website does not imply approval by the governing building code bodies responsible for building code approval and interpretation for the building site described by latitude/longitude location in the report.

SOLUTIONS 4 STRUCTURES Inc.

**Job #** 23.007 **Sheet:**

**Designed:** TLC **Date:** 5/12/25

**Checked:** **Date:**

***Project:*** Bradley Heights Apartments 3 story

## *WIND ANALYSIS:*

IBC 2021 / ASCE 7-16

***Risk Category*** II I, II, III or IV Figure 26.5-1B $I_W$= 1.00 (ASCE Table 1.5-2)

100 Typical

**Basic Wind Speed, V=** 97 mph Section 26.5.1 **Exposure Category:** B Section 26.7.2

**Mean Roof Height, h=** 10.00 feet Alpha = 7

**Parapet Height above roof, p=** - feet $Z_g$ = 1200

**Building Width, B=** 7.00 feet

**Building Length, L=** 15.00 feet Partially Open Building

**Ground Elevation factor:** 386 Elev. (ft) Section 26.9 GCpi =+/- 0.18 Table 26.13-1

G = 0.8500 gust effect factor defined in section 26.11.1

$K_z = 2.01\ (z/z_g)^{2/alpha}$ (ASCE 7-16 **Table 27.3-1**) Section 26.10.1

$K_{zt} = (1 + K_1 K_2 K_3)^2$ = 1.00 (ASCE 7-16 **Eq. 26.8-1**) Section 26.8.2

$K_e$ = 0.99 (ASCE 7-16 **Table 26.9-1**) Section 26.9

$K_d$ = 0.85 (ASCE 7-16 **Table 26-1**) Section 26.6

I = 1.00 (ASCE 7-16 **Table 1.5-2**)

**Windward:** P = qGCp - qi(GCpi) (ASCE 7-16) **(Eq. 27.3-1)**

$C_p$ = 0.8 (windward) Figure 27.3-1

| | Table 27.3-1 | Eq. 27.3-1 | Eq. 27.4-1a | Eq. 27.4-1b | Eq. 27.4-1 | Eq. 27.4-1 |
|---|---|---|---|---|---|---|
| h | Sec. 27.3.1 | Sec. 27.3.2 | External | Internal | Total | Total |
| feet | $K_z$ | $q_z$ (psf) | $q_z GC_p$ | $-q_i(GC_{pi})$ | q G Cp + qi(G | q G Cp - qi(GCpi) |
| 10 | 0.51 | 10.33 | 7.03 | - | #VALUE! | #VALUE! |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |
| 10 | $q=q_h=q_i$= | 10.33 | 7.03 | 1.86 | #VALUE! | #VALUE! |
| 0 | $q=q_p$= | 0.00 | - | - | - | Parapet |

**Totals**

| Windward + Leeward | | h |
|---|---|---|
| Along B | Along L | feet |
| 9.6 (5.8) | 11.4 (6.9) | 10 |
| - | - | - |
| - | - | - |
| - | - | - |
| - | - | - |
| - | - | - |
| - | - | - |
| - | - | - |
| - | - | - |
| - | - | - |
| 9.6 (5.8) | 11.4 (6.9) | 10 |
| 0.0 (0.0) | 0.0 (0.0) | Parapet |

( ) values are ASD = ULT x 0.6

**Leeward:** P = qGCp - qi(GCpi) (ASCE 7-16) **(Eq.27.3-1)**

Figure 27.3-1

| | External | Internal | Total | Total | |
|---|---|---|---|---|---|
| $q_h$ (psf) | $q_h GC_p$ | $-q_i(GC_{pi})$ | q G Cp - qi(GC | q G Cp + qi(GCpi) | |
| 10.33 | -4.39 | 1.86 | -2.53 | -6.25 | Along L |
| 10.33 | -2.57 | 1.86 | -0.71 | -4.43 | Along B |

$C_p$ = -0.5 (Leeward along L)

$C_p$ = -0.29 (Leeward along B)

**Parapet:** $P_p = q_p GC_{pn}$ (ASCE 7-16) **(Eq. 27.3-3)**

Section 27.3.4

| | Windward | Leeward |
|---|---|---|
| $q_p$(psf) | $q_p GC_{pn}$ | $q_p GC_{pn}$ |
| 0.00 | 0.00 | 0.00 |

$GC_{pn}$ = 1.5 (Windward Parapet)

$GC_{pn}$ = -1.0 (Leeward Parapet)

**Walls:** $P = q_h [(GC_p)-(GC_{pi})]$ (ASCE 7-16) **(Eq. 30.3-1)** h ≤ 60 ft

Table 26.13-1

| Area ($ft^2$) | $GC_p$(4&5) | Windward | $GC_p$(4) | Leeward | $GC_p$(5) | Leeward |
|---|---|---|---|---|---|---|
| 10 | 1.00 | 12.2 (7.3) | -1.10 | -13.2 (-7.9) | -1.40 | -16.3 (-9.8) |
| 25 | 0.93 | 11.5 (6.9) | -1.03 | -12.5 (-7.5) | -1.26 | -14.9 (-8.9) |
| 50 | 0.88 | 10.9 (6.6) | -0.98 | -12.0 (-7.2) | -1.15 | -13.8 (-8.3) |
| 200 | 0.77 | 9.8 (5.9) | -0.87 | -10.9 (-6.5) | -0.94 | -11.6 (-6.9) |

$GC_{pi}$ = 0.18 (Windward)

$GC_{pi}$ = -0.18 (Leeward)

$q_h$(psf) = 10.33

( ) values are ASD = ULT x 0.6

This is a beta release of the new ATC Hazards by Location website. Please contact us with feedback.

The ATC Hazards by Location website will not be updated to support ASCE 7-22. Find out why.

## Hazards by Location

### Search Information

**Coordinates:** 47.16516801120486, -122.2920663220895

**Elevation:** 386 ft

**Timestamp:** 2023-05-11T15:05:14.182Z

**Hazard Type:** Wind


| ASCE 7-16 | | ASCE 7-10 | | ASCE 7-05 | |
|---|---|---|---|---|---|
| MRI 10-Year | 67 mph | MRI 10-Year | 72 mph | ASCE 7-05 Wind Speed | 85 mph |
| MRI 25-Year | 73 mph | MRI 25-Year | 79 mph | | |
| MRI 50-Year | 78 mph | MRI 50-Year | 85 mph | | |
| MRI 100-Year | 82 mph | MRI 100-Year | 91 mph | | |
| Risk Category I | 92 mph | Risk Category I | 100 mph | | |
| Risk Category II | 97 mph | Risk Category II | 110 mph | | |
| Risk Category III | 104 mph | Risk Category III-IV | 115 mph | | |
| Risk Category IV | 108 mph | | | | |

*The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.*

*Please note that the ATC Hazards by Location website will not be updated to support ASCE 7-22. Find out why.*

### Disclaimer

Hazard loads are interpolated from data provided in ASCE 7 and rounded up to the nearest whole integer. Per ASCE 7, islands and coastal areas outside the last contour should use the last wind speed contour of the coastal area – in some cases, this website will extrapolate past the last wind speed contour and therefore, provide a wind speed that is slightly higher. NOTE: For queries near wind-borne debris region boundaries, the resulting determination is sensitive to rounding which may affect whether or not it is considered to be within a wind-borne debris region.

Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.

While the information presented on this website is believed to be correct, ATC and its sponsors and contributors assume no responsibility or liability for its accuracy. The material presented in the report should not be used or relied upon for any specific application without competent examination and verification of its accuracy, suitability and applicability by engineers or other licensed professionals. ATC does not intend that the use of this information replace the sound judgment of such competent professionals, having experience and knowledge in the field of practice, nor to substitute for the standard of care required of such professionals in interpreting and applying the results of the report provided by this website. Users of the information from this website assume all liability arising from such use. Use of the output of this website does not imply approval by the governing building code bodies responsible for building code approval and interpretation for the building site described by latitude/longitude location in the report.

202 27th Ave SE, Puyallup, WA 98374

## 202 27th Ave SE

Building

Directions | Save | Nearby | Send to phone | Share

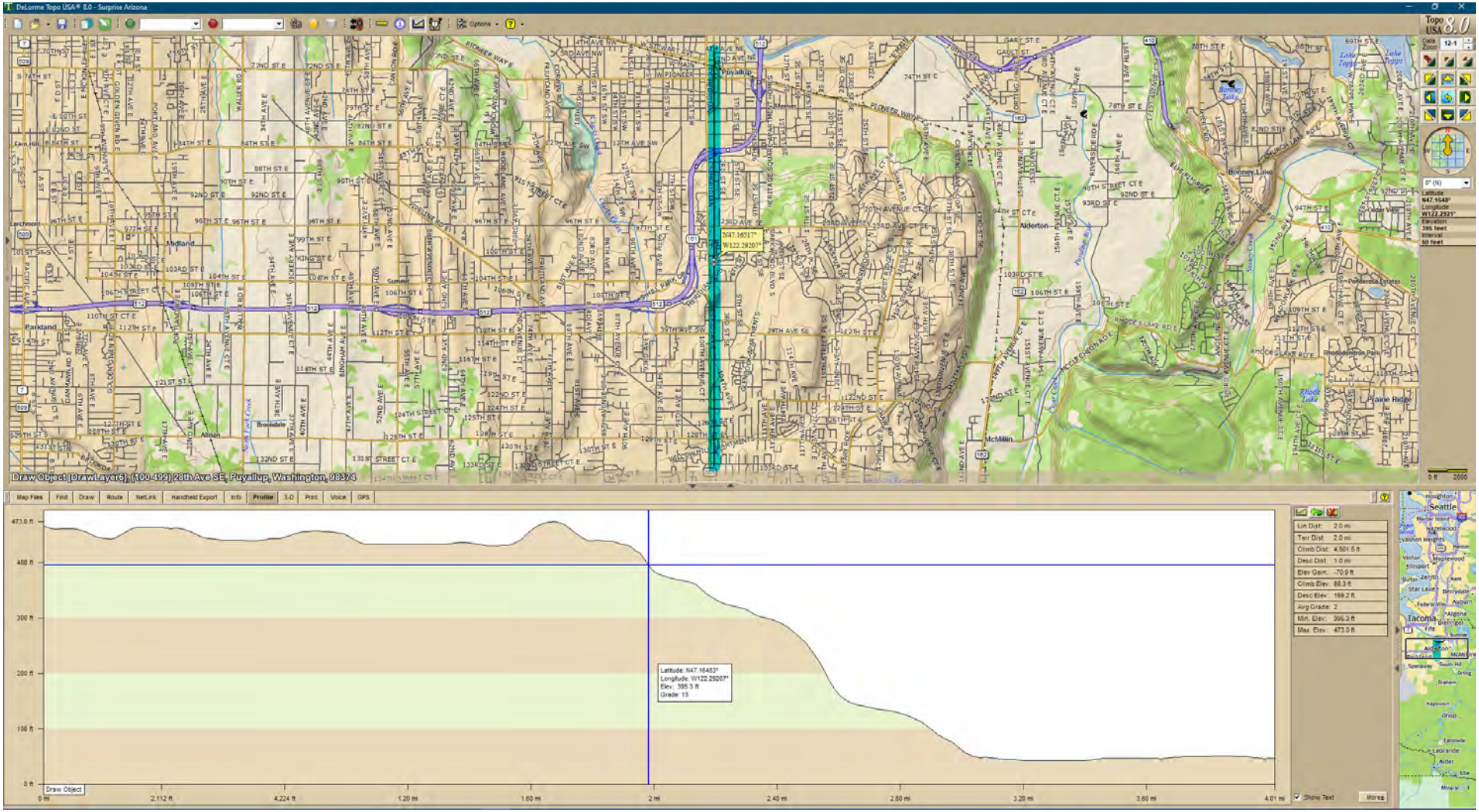
202 27th Ave SE, Puyallup, WA 98374

Suggest an edit on 202 27th Ave SE

Add a missing place

Add your business

### Photos


DeLorme Topo USA® 8.0 - Surprise Arizona
Topo USA 8.0
Draw Object [DrawLayer6], (100-499) 28th Ave SE, Puyallup, Washington, 98374
Map Files
Find
Draw
Route
NetLink
Handheld Export
Info
Profile
3-D
Print
Voice
GPS
473.0 ft
400 ft
300 ft
200 ft
100 ft
0 ft
Draw Object
0 mi
2.112 ft
4,224 ft
1.20 mi
1.60 mi
2 mi
2.40 mi
2.80 mi
3.20 mi
3.60 mi
4.01 mi
Lin Dist: 2.0 mi
Terr Dist: 2.0 mi
Climb Dist: 4,501.5 ft
Desc Dist: 1.0 mi
Elev Gain: -70.9 ft
Climb Elev: 88.3 ft
Desc Elev: 159.2 ft
Avg Grade: 2
Min. Elev: 396.3 ft
Max. Elev: 473.0 ft
Show Text
More
Seattle
Tacoma

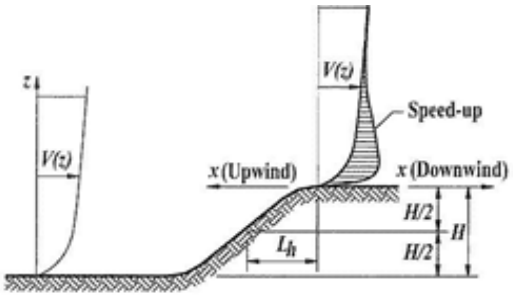
Kzt = 1.0

# 26.8 TOPOGRAPHIC EFFECTS

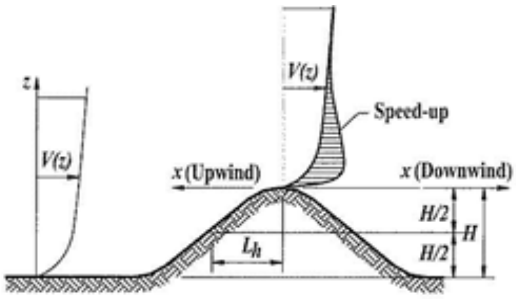
$K_{ZT}$ 1

Exposure Category: B

Hill Shape: 2D Escarpment




ESCARPMENT




2-D RIDGE OR 3-D AXISYMMETRICAL HILL

| | | | |
|---|---|---|---|
| $EL_{top}$ = | 473 ft | Elevation at crest of 2D Escarpment | |
| $EL_{Bot}$ = | 142.1 ft | Elevation at base of 2D Escarpment | |
| H = | 330.9 ft | 307.55 | |
| H/2 = | 165.45 ft | | |
| $L_h$ = | 3541 ft | | |
| $H/L_h$ = | 0.0934 | Kzt Calc Not Required | |

$K_1$ = 0.75H/Lh 0.070086

$K_1/(H/L_h)$ = 0.75 (Figure 26.8-1)

$K_2 = (1-(\frac{|x|}{\mu L_h})$ = 0.602372

x = 2112 ft 5311.5 distance KZT no long affects wind speed

upwind

$\mu$ = 1.5 (Figure 26.8-1)

$L_h$ = 3541 ft

$K_3 = e^{-\gamma z/Lh}$ = 0.989466

z = 15 ft height above ground surface at site

$\gamma$ = 2.5 (Figure 26.8-1)

$L_h$ = 3541 ft

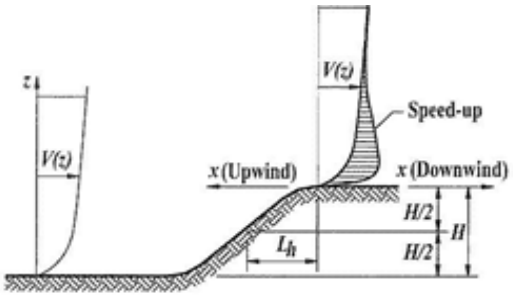
$K_{ZT} = (1+K_1 K_2 K_3)^2$ = 1.00 (Eq. 26.8-1)

# 26.8 TOPOGRAPHIC EFFECTS

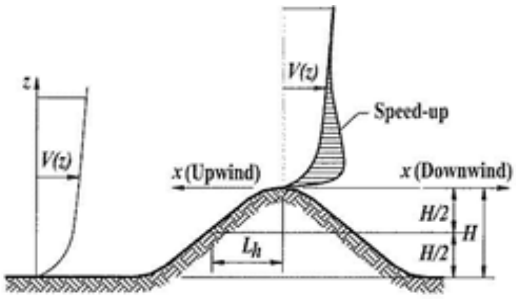
$K_{ZT}$ 2

Exposure Category: B

Hill Shape: 2D Escarpment




ESCARPMENT




2-D RIDGE OR 3-D AXISYMMETRICAL HILL

| | | | |
|---|---|---|---|
| $EL_{top}$ = | 301 ft | Elevation at crest of 2D Escarpment | |
| $EL_{Bot}$ = | 142.1 ft | Elevation at base of 2D Escarpment | |
| H = | 158.9 ft | | |
| H/2 = | 79.45 ft | 221.55 | |
| $L_h$ = | 940 ft | | |
| $H/L_h$ = | 0.1690 | Kzt Calc Not Required | |

$K_1$ = 0.75H/Lh 0.126782

$K_1/(H/L_h)$ = 0.75 (Figure 26.8-1)

$K_2 = (1-(\frac{|x|}{\mu L_h})$ = 0.562234

x = 1646 ft 3760 distance KZT no long affects wind speed

downwind

$\mu$ = 4 (Figure 26.8-1)

$L_h$ = 940 ft

$K_3 = e^{-\gamma z/Lh}$ = 0.960892

z = 15 ft height above ground surface at site

$\gamma$ = 2.5 (Figure 26.8-1)

$L_h$ = 940 ft

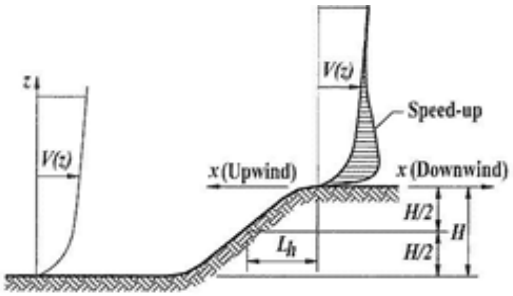
$K_{ZT} = (1+K_1 K_2 K_3)^2$ = 1.00 (Eq. 26.8-1)

# 26.8 TOPOGRAPHIC EFFECTS

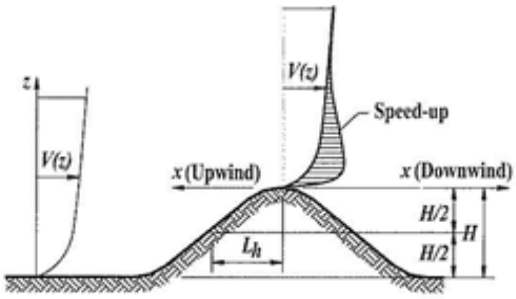
$K_{ZT}$ 3

Exposure Category: B

Hill Shape: 2D Escarpment




ESCARPMENT




2-D RIDGE OR 3-D AXISYMMETRICAL HILL

| | | | |
|---|---|---|---|
| $EL_{top}$ = | 177.4 | ft | Elevation at crest of 2D Escarpment |
| $EL_{Bot}$ = | 0 | ft | Elevation at base of 2D Escarpment |
| H = | 177.4 | ft | |
| H/2 = | 88.7 | ft | |
| $L_h$ = | 1144 | ft | |
| $H/L_h$ = | 0.1551 | | Kzt Calc Not Required |

$K_1$ = 0.75H/Lh 0.116302

$K_1/(H/L_h)$ = 0.75 (Figure 26.8-1)

$K_2 = (1-(\frac{|x|}{\mu L_h})$ = 0

x = 6598 ft 4576 distance KZT no long affects wind speed

downwind

$\mu$ = 4 (Figure 26.8-1)

$L_h$ = 1144 ft

$K_3 = e^{-\gamma z/Lh}$ = 0.967752

z = 15 ft height above ground surface at site

$\gamma$ = 2.5 (Figure 26.8-1)

$L_h$ = 1144 ft

$K_{ZT} = (1+K_1 K_2 K_3)^2$ = 1.00 (Eq. 26.8-1)

# $K_{ZT}$ Check

## 26.8 TOPOGRAPHIC EFFECTS

### 26.8.1 Wind Speed-Up over Hills, Ridges, and Escarpments

Wind speed-up effects at isolated hills, ridges, and escarpments constituting abrupt changes in the general topography, located in any exposure category, shall be included in the determination of the wind loads when buildings and other site conditions and locations of structures meet all of the following conditions:

| Y | N | |
|---|---|---|
| ☒ | ☐ | 1. The hill, ridge, or escarpment is isolated and unobstructed upwind by other similar topographic features of comparable height for 100 times the height of the topographic feature ($100H$) or 2 mi (3.22 km), whichever is less. This distance shall be measured horizontally from the point at which the height $H$ of the hill, ridge, or escarpment is determined. |
| ☒ | ☐ | 2. The hill, ridge, or escarpment protrudes above the height of upwind terrain features within a 2-mi (3.22-km) radius in any quadrant by a factor of two or more. |
| ☒ | ☐ | 3. The structure is located as shown in Fig. 26.8-1 in the upper one-half of a hill or ridge or near the crest of an escarpment. |
| ☐ | ☒ | 4. $H/L_h \geq 0.2$. |
| ☐ | ☐ | 5. $H$ is greater than or equal to 15 ft (4.5 m) for Exposure C and D and 60 ft (18 m) for Exposure B. |

### 26.8.2 Topographic Factor

The wind speed-up effect shall be included in the calculation of design wind loads by using the factor $K_{zt}$:

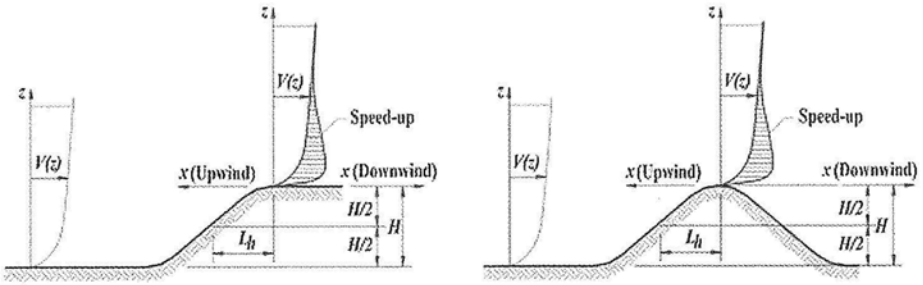
$$K_{zt} = (1 + K_1K_2K_3)^2 \qquad (26.8\text{-}1)$$

where $K_1$, $K_2$, and $K_3$ are given in Fig. 26.8-1.

If site conditions and locations of buildings and other structures do not meet all the conditions specified in Section 26.8.1 then $K_{zt} = 1.0$.

Kzt =1.0

### Diagrams




### Topographic Multipliers for Exposure C[a,b,c]

| | $K_1$ Multiplier | | | | $K_2$ Multiplier | | | $K_2$ Multiplier | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $H/L_h$ | 2D Ridge | 2D Escarpment | 3D Axisymmetrical Hill | $x/L_h$ | 2D Escarpment | All Other Cases | $z/L_h$ | 2D Ridge | 2D Escarpment | 3D Axisymmetrical Hill |
| 0.20 | 0.29 | 0.17 | 0.21 | 0.00 | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 |
| 0.25 | 0.36 | 0.21 | 0.26 | 0.50 | 0.88 | 0.67 | 0.10 | 0.74 | 0.78 | 0.67 |
| 0.30 | 0.43 | 0.26 | 0.32 | 1.00 | 0.75 | 0.33 | 0.20 | 0.55 | 0.61 | 0.45 |
| 0.35 | 0.51 | 0.30 | 0.37 | 1.50 | 0.63 | 0.00 | 0.30 | 0.41 | 0.47 | 0.30 |
| 0.40 | 0.58 | 0.34 | 0.42 | 2.00 | 0.50 | 0.00 | 0.40 | 0.30 | 0.37 | 0.20 |
| 0.45 | 0.65 | 0.38 | 0.47 | 2.50 | 0.38 | 0.00 | 0.50 | 0.22 | 0.29 | 0.14 |
| 0.50 | 0.72 | 0.43 | 0.53 | 3.00 | 0.25 | 0.00 | 0.60 | 0.17 | 0.22 | 0.09 |
| | | | | 3.50 | 0.13 | 0.00 | 0.70 | 0.12 | 0.17 | 0.06 |
| | | | | 4.00 | 0.00 | 0.00 | 0.80 | 0.09 | 0.14 | 0.04 |
| | | | | | | | 0.90 | 0.07 | 0.11 | 0.03 |
| | | | | | | | 1.00 | 0.05 | 0.08 | 0.02 |
| | | | | | | | 0.50 | 0.01 | 0.02 | 0.00 |
| | | | | | | | 2.00 | 0.00 | 0.00 | 0.00 |

[a]For values of $H/L_h$, $x/L_h$, and $z/L_h$ other than those shown, linear interpolation is permitted.
[b]For $H/L_h > 0.5$, assume that $H/L_h = 0.5$ for evaluating $K_1$ and substitute $2H$ for $L_h$ for evaluating $K_2$ and $K_3$.
[c]Multipliers are based on the assumption that wind approaches the hill or escarpment along the direction of maximum slope.

### Notation

$H$ = Height of hill or escarpment relative to the upwind terrain, in ft (m).
$K_1$ = Factor to account for shape of topographic feature and maximum speed-up effect.
$K_2$ = Factor to account for reduction in speed-up with distance upwind or downwind of crest.
$K_3$ = Factor to account for reduction in speed-up with height above local terrain.
$L_h$ = Distance upwind of crest to where the difference in ground elevation is half the height of hill or escarpment, in ft (m).
$x$ = Distance (upwind or downwind) from the crest to the site of the building or other structure, in ft (m).
$z$ = Height above ground surface at the site of the building or other structure, in ft (m).
$\mu$ = Horizontal attenuation factor.
$\gamma$ = Height attenuation factor.

### Equations

$K_{zt} = (1 + K_1 K_2 K_3)^2$
$K_1$ = determined from table below
$K_2 = (1 - |x|/\mu L_h)$
$K_3 = e^{-\gamma z/L_h}$

### Parameters for Speed-Up over Hills and Escarpments

| | $K_1/(H/L_h)$ | | | | $\mu$ | |
|---|---|---|---|---|---|---|
| | Exposure | | | | | |
| Hill Shape | B | C | D | $\gamma$ | Upwind of Crest | Downwind of Crest |
| 2D ridges (or valleys with negative $H$ in $K_1/(H/L_h)$) | 1.30 | 1.45 | 1.55 | 3 | 1.5 | 1.5 |
| 2D escarpments | 0.75 | 0.85 | 0.95 | 2.5 | 1.5 | 4 |
| 3D axisymmetrical hill | 0.95 | 1.05 | 1.15 | 4 | 1.5 | 1.5 |

**FIGURE 26.8-1 Topographic Factor, $K_{zt}$**

| wind combined | | | wind 3 story | | | wind 3 story + basement |
|---|---|---|---|---|---|---|
| 156 | 152 | 10 | 10.6875 | 159 | 10.5 | 10.6875 |
| | | 10 | 9.083333 | | 10.3 | 9.083333 |
| 102 | 101 | 10 | 1.05 | 103 | 10 | 1.05 |
| | | 10 | 9.083333 | | 10 | 9.083333 |
| 101 | 101 | 10 | 1.05 | 101 | 10 | 1.05 |
| | | 10 | 9.083333 | | 10 | 9.083333 |
| | | | | 101 | 10 | 1.05 |
| | | | | | 10 | 9.083333 |

SEISMIC:

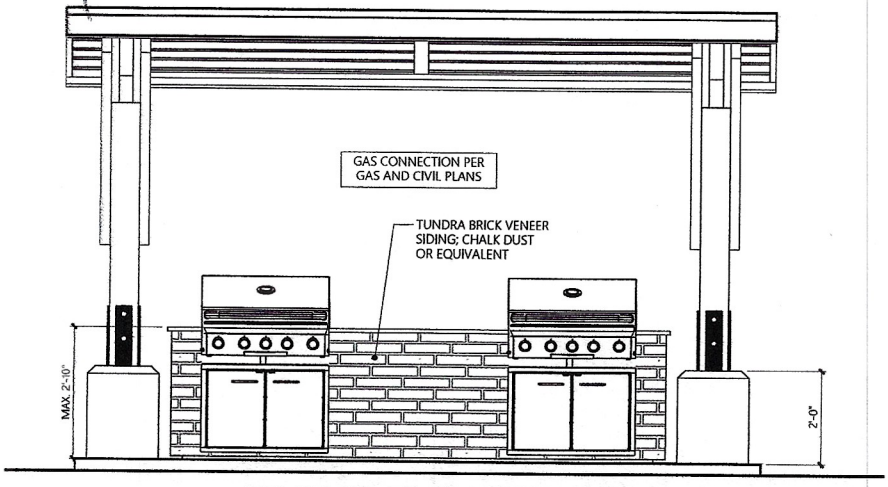
$15(6.25)(15\,psf) = 1406^{\#}$ (W)

$F_p = 682^{\#}$

EACH FRAME $= 341^{\#}$

$15(2)(20\,psf) = 600^{\#}$ EACH FRAME $300^{\#}$ ok

341 (682)

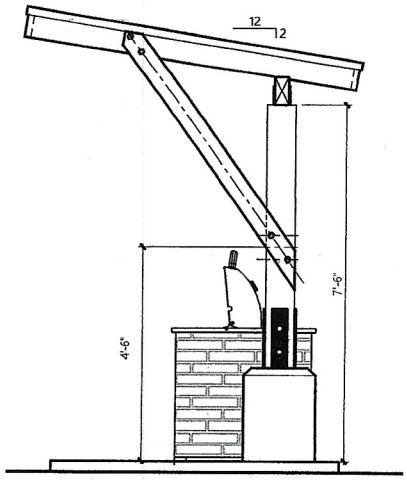



## FRONT ELEVATION

1/2" = 1'-0"

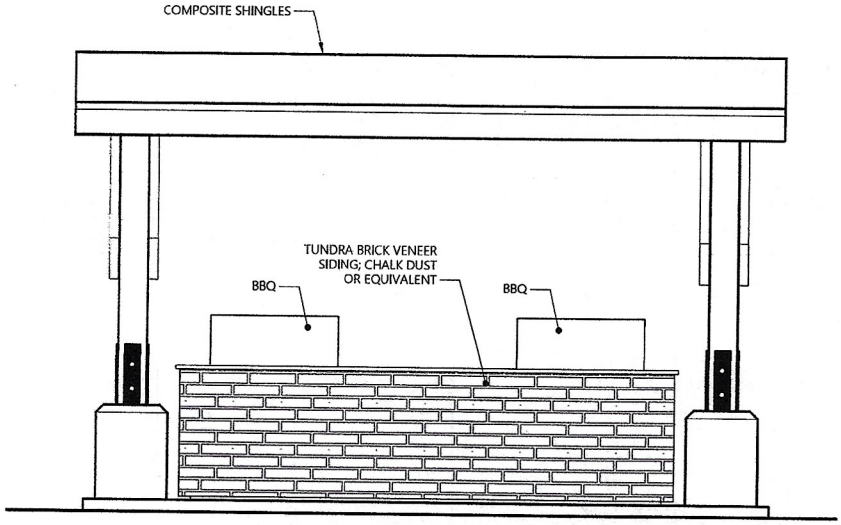
NOTES:

1. INSTALL PER MANUFACTURERS RECOMMENDATIONS.



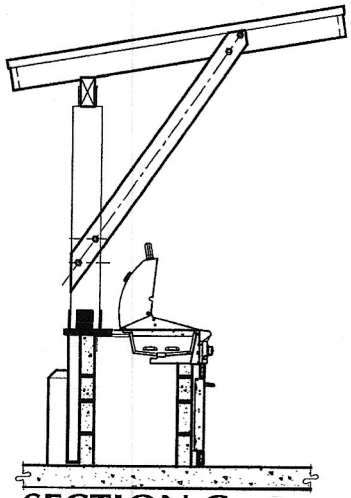

## SIDE ELEVATION

1/2" = 1'-0"



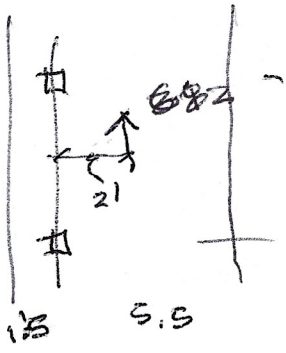

## REAR ELEVATION

1/2" = 1'-0"



## SECTION C

1/2" = 1'-0"




ROOT

$W = 682(2) = 1364^{\#}$

$T = C = \frac{1364}{12.33} = 111^{\#}$

$\uparrow 341^{\#}$ $\rightarrow 359^{\#}$

$\square \rightarrow 111$

$$P(4.5) = \frac{4.369}{4} \cdot 1.0923^{k-1}$$

$$P = 1.0923^{k}$$

$$P\,@\,\ell = 1.0923^{k}$$

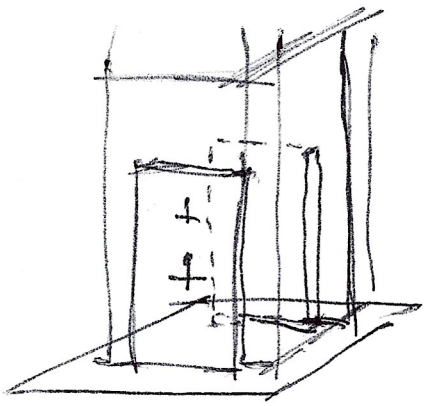
$$P = \frac{.933}{2} = .465^{k}\ (@\ \ell)$$

$$0.465^{k}\ (@\ \ell)\ 0.093^{k}$$

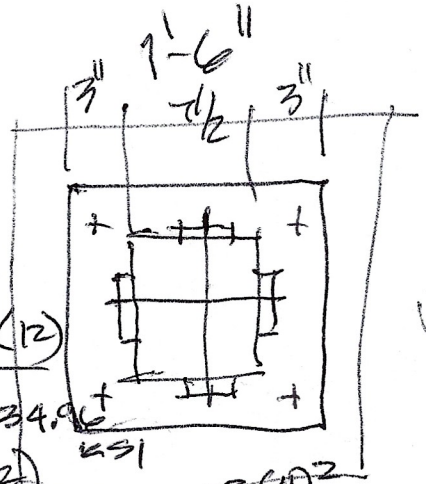
D =

C = 6.223

$\frac{6}{3} = 2$



$\ell(3) = 6''$

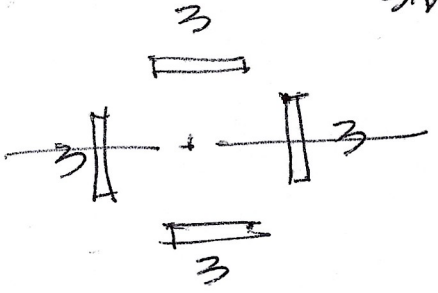




$$\frac{4.369}{2} = 2.1845^{k-1}$$

$$f_b = \frac{M}{S} \quad \frac{2.185^{k-1}(12)}{.75} = 34.96\ ksi$$

$$S = \frac{.25(3)^2}{6} = 0.375(2)$$

SIDE $\frac{.375(4)^2}{6} = 1.3333$




$$\frac{2.185(12)}{1.3333} = 19.7\ ok.$$

$$\frac{1/4(3)^3}{12}(2) + .75(2)(3.5)^2 + .75(2)(3.5)^2 = .375$$

$$I = 37.857\ in^4$$

$$S = \frac{37.857}{3.5} = 10.82$$

$$f_M = \frac{4.369^{k-1}}{10.82} = .403\ ksi$$

(2) 3/4" ϕ → M.B ← IN STEEL OK.

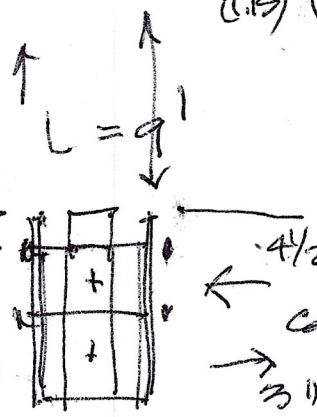
$$\frac{4.369(12)}{6} = 8.738$$

3/4 D.B SHEAR 3716 3343(2) 8547 C.686(1.15) 7689

ASSUME EA TAB SHARE

$$\frac{4.369}{2(7.5/12)} = 3.49^{k}\ \text{SHEAR}$$

(1.15) 1.738(2) 3997. 13½




4.6 Ft

$$2X(7.5) + 2Y(3.5) = 4.369^{k-1}(12)$$

$X = 2Y$ $\quad Y = 2.383^{k}$ $\quad X = 4.76^{k}$

$$\frac{4.369^{k-1}(12)}{7.5''/12} = 6.99^{k}$$

(2) 3/4" ϕ M.B 4.4 in² STEEL EA SIDE