



Structural Calculations

for

Site: Rob Birch/Cole Canyon Water Company
2300 N. Fork Park Rd
Eden, UT 84310

Project: 10.0' x 15.0'
Shed
SO# 2016334
EP- 18665

Store: 30 Salt Lake City
5501 South 320 West
Salt Lake City, UT 84107

Engineer: Richard J. Wills, P.E.
Tuff Shed Inc.
1777 South Harrison St., Ste. 600
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Date: January 18, 2024

18 JAN 2024



DESIGN CRITERIA

Building Code: 2021 IRC
Risk Category: II-Regular
Seismic Design Category: D
Basic Wind Speed: 115 mph
Wind Exposure: C

Building Specifications

Width: 10.0 ft.
Length: 15.0 ft.
Side Wall Height: 11.23 ft.
Stud Size: 2x4
Stud Spacing: 16 in. o.c.
Wall Sheathing: 3/8" Smartside Panel
Roof Sheathing: 7/16" OSB
Wall Wood Species & Grade: SPF #1/#2
Wall "A" Overhang: 4.0 in.
Wall "B" Overhang: 4.0 in.
Wall "C" Overhang: 4.0 in.
Wall "D" Overhang: .0 in.
Foundation: Concrete - Monolithic Foundation
Anchor: Titen HD Screw Anchor
Anchor Bolt Diameter: .5 in.

Roof Support

Span: 10.0 ft.
Left Overhang: 4.0 in.
Right Overhang: .0 in.
Roof Support Spacing: 16 in. o.c.
Pitch: 5./12
Lumber: SPF #1/#2
Roofing: Composition Shingles
Top Chord Live/Snow Load: 66 psf
Top Chord Dead Load: 10 psf
Bottom Chord Live Load: 0 psf
Bottom Chord Dead Load: 0 psf

Ground Snow Load, p_g : 79 psf
Exposure Factor, C_e : 1.00

Table 7.3-1 ASCE



Header: Wall D, Hdr 1

Top Chord Live/Snow Load: 66 psf Top Chord Dead Load: 10 psf Bottom Chord Live Load: 0 psf Bottom Chord Dead Load: 0 psf		Tributary Width= 5.0 ft. Height of wall above Header= 3.50 ft. Moment= 12,214 in.-lbs. Reaction= 921 lbs.	
Header Size: 2x6 Number of Headers: 2 Header depth= 5.50 in. Total header width= 3.0 in. Header span= 4.42 ft.		Header Size: 1½x3½ LVL Number of Headers: 2 Header depth= 3.50 in. Total header width= 3.50 in. Header span= 4.42 ft.	
Lumber SPF #1/#2		Lumber LVL 2600Fb	
<i>Bending</i> $S_x = 15.13 \text{ cu.in.}$ $F'_b = 1298 \text{ psi}$ $f_b = 808 \text{ psi}$		<i>Bending</i> $S_x = 7.15 \text{ cu.in.}$ $F'_b = 2979 \text{ psi}$ $f_b = 1709 \text{ psi}$	
<i>Good/No Good?</i> O.K.		<i>Good/No Good?</i> O.K.	
<i>Shear</i> $F'_v = 155 \text{ psi}$ $f_v = 84 \text{ psi}$		<i>Shear</i> $F'_v = 328 \text{ psi}$ $f_v = 113 \text{ psi}$	
<i>Good/No Good?</i> O.K.		<i>Good/No Good?</i> O.K.	
<i>Deflection</i> $E = 1,400,000 \text{ psi}$ $I = 41.594$ Deflection Ratio= L/180 Allowable Deflection= .29 in. $\Delta = .06 \text{ in.}$		<i>Deflection</i> $E = 1,900,000 \text{ psi}$ $I = 12.505$ Deflection Ratio= L/180 Allowable Deflection= .29 in. $\Delta = .15 \text{ in.}$	
<i>Good/No Good?</i> O.K.		<i>Good/No Good?</i> O.K.	
Lumber Factors $C_D = 1.15$ Duration $C_M = 1.00$ Wet Service $C_t = 1.00$ Temperature $C_L = 0.99$ Beam Stability $C_F = 1.30$ Size $C_{fu} = 1.00$ Flat Use $C_i = 1.00$ Incising $C_r = 1.00$ Repetitive Member $C_f = 1.00$ Form TL (L/x) L/240 LL (L/x) .05 in.		Lumber Factors $C_D = 1.15$ Duration $C_M = 1.00$ Wet Service $C_t = 1.00$ Temperature $C_L = 1.00$ Beam Stability $C_F = 1.00$ Size $C_{fu} = 1.00$ Flat Use $C_i = 1.00$ Incising $C_r = 1.00$ Repetitive Member $C_f = 1.00$ Form TL (L/x) L/240 LL (L/x) .13 in.	
O.K.		O.K.	

Trimmer for: Header: Wall D, Hdr 1				Trimmer for: Header: N/A			
		SPF #1/#2				SPF #1/#2	
Load= 921 lbs.		$F_b = 875$ psi		Load= lbs.		$F_b = 875$ psi	
width= 3.50 in.		$F_t = 450$ psi		width= 3.50 in.		$F_t = 450$ psi	
thickness= 1.50 in.		$F_v = 135$ psi		thickness= 1.50 in.		$F_v = 135$ psi	
No. of members= 1		$F_{cp} = 425$ psi		No. of members= 1		$F_{cp} = 425$ psi	
Unbraced Length(x)(width)= 90.0 in.		$F_c = 1150$ psi		Unbraced Length(x)(width)= 90.0 in.		$F_c = 1150$ psi	
Unbraced Length(y)(thickness)= 6.0 in.		$E_{min} = 510,000$ psi		Unbraced Length(y)(thickness)= 6.0 in.		$E_{min} = 510,000$ psi	
Effective Length factor, $K_{e(x)} = 1$				Effective Length factor, $K_{e(x)} = 1$			
Effective Length factor, $K_{e(y)} = 1$		Lumber Factors		Effective Length factor, $K_{e(y)} = 1$		Lumber Factors	
c= 0.8		$C_D = 1.15$	Duration	c= 0.8		$C_D = 1.15$	Duration
A= 5.25 sq.in.		$C_M = 1.00$	Wet Service	A= 5.25 sq.in.		$C_M = 1.00$	Wet Service
(l/d) _x = 25.71		$C_t = 1.00$	Temperature	(l/d) _x = 25.71		$C_t = 1.00$	Temperature
(l/d) _y = 4.00		$C_L = 1.00$	Beam Stability	(l/d) _y = 4.00		$C_L = 1.00$	Beam Stability
$E'_{min} = 510,000$ psi		$C_F = 1.15$	Size	$E'_{min} = 510,000$ psi		$C_F = 1.15$	Size
		$C_{fu} = 1.00$	Flat Use			$C_{fu} = 1.00$	Flat Use
		$C_i = 1.00$	Incising			$C_i = 1.00$	Incising
		$C_r = 1.00$	Repetitive Member			$C_r = 1.00$	Repetitive Member
		$C_f = 1.00$	Form			$C_f = 1.00$	Form
		$C_{ti} = 1.00$	Buckling Stiffness			$C_{ti} = 1.00$	Buckling Stiffness
Weak Axis Calculations(y)		Strong Axis Calculations (x)		Weak Axis Calculations(y)		Strong Axis Calculations (x)	
$F_{ce} = 26201.25$		$F_{ce} = 634.01$		$F_{ce} = 26201.25$		$F_{ce} = 634.01$	
$F^*_c = 1520.88$		$F^*_c = 1520.88$		$F^*_c = 1520.88$		$F^*_c = 1520.88$	
$F_{ce}/F^*_c = 17.23$		$F_{ce}/F^*_c = 0.42$		$F_{ce}/F^*_c = 17.23$		$F_{ce}/F^*_c = 0.42$	
$1+F_{ce}/F^*_c/2c = 11.39$		$1+F_{ce}/F^*_c/2c = 0.89$		$1+F_{ce}/F^*_c/2c = 11.39$		$1+F_{ce}/F^*_c/2c = 0.89$	
$C_p = 0.99$		$C_p = 0.37$		$C_p = 0.99$		$C_p = 0.37$	
$F'_c = 1502.59$		$F'_c = 566.69$		$F'_c = 1502.59$		$F'_c = 566.69$	
$P_{allowable} = 7,889$ lbs.		$P_{allowable} = 2,975$ lbs.		$P_{allowable} = 7,889$ lbs.		$P_{allowable} = 2,975$ lbs.	
Good/No Good? O.K.		Good/No Good? O.K.		Good/No Good? O.K.		Good/No Good? O.K.	

Top Chord Live/Snow Load: 66 psf		
Top Chord Dead Load: 10 psf		Tributary Width= 1.33 ft.
Bottom Chord Live Load: 0 psf		Moment= 15,234 in.-lbs.
Bottom Chord Dead Load: 0 psf		Reaction= 508 lbs.
Joist Size: 2x8		
Number of Joists: 1		
Joist depth= 7.25 in.		Lumber
Total Joist width= 1.50 in.		SPF #1/#2
Joist span= 10.0 ft.		
	$F_b = 875 \text{ psi}$	
	$F_t = 450 \text{ psi}$	
<i>Bending</i>	$F_v = 135 \text{ psi}$	
$S_x = 13.14 \text{ cu.in.}$	$F_{cp} = 425 \text{ psi}$	
$F'_b = 1389 \text{ psi}$	$F_c = 1150 \text{ psi}$	
$f_b = 1159 \text{ psi}$	$E = 1,400,000 \text{ psi}$	
	$E_{min} = 510,000 \text{ psi}$	
<i>Good/No Good?</i>	O.K.	<i>Lumber Factors</i>
	$C_D = 1.15$	Duration
<i>Shear</i>	$C_M = 1.00$	Wet Service
$F'_v = 155 \text{ psi}$	$C_t = 1.00$	Temperature
$f_v = 70 \text{ psi}$	$C_L = 1.00$	Beam Stability
<i>Good/No Good?</i>	O.K.	Size
	$C_F = 1.20$	Flat Use
	$C_{fu} = 1.00$	Incising
<i>Deflection</i>	$C_r = 1.15$	Repetitive Member
$E' = 1,400,000 \text{ psi}$	$C_r = 1.00$	Form
$I = 47.635$	TL (L/x)	LL (L/x)
Deflection Ratio= L/180	L/240	
Allowable Deflection= .67 in.	.50 in.	
$\Delta = .34 \text{ in.}$	.30 in.	
<i>Good/No Good?</i>	O.K.	O.K.

SEISMIC CALCULATIONS

(based on ASCE 7-16 and USGS Seismic maps)

Building Code: 2021 IRC

Seismic Design Classification: D

Site Class: D

$S_s = 1.178$ Figure 22-1/USGS Seismic Maps

$F = 1$ Section 12.14.8.1

$F_a = 1.2$ Table 11.4-1

$R = 6.5$ Table 12.14-1

$I = 1$ Table 11.5-1

$\rho = 1.30$

$W = 4,426$ lbs.

$S = 2,149$ lbs. 20% of snow weight (if applicable)

$S_{DS} = 0.94$ Eq. 12.14-12

$V = 1,239$ lbs. Eq. 12.14-12

Wind Calculations (C&C)

Alternate all-heights method

Wind Speed, v_{ASD} : 89 mph

Wind Exposure: C

Risk Category: II-Regular

Roof Angle= 22.62

Gable Wall Span= 10.0 ft.

Longitude Wall Span= 15.0 ft.

Enclosure Classification: Enclosed

K_{zt} = 1

K_z = 0.85

K_d = 0.85

Mean Roof Height= 12.27 ft.

Section 26.10

Section 26.8.2

Table 27.3-1

Table 26.6-1

LOW RISE BUILDINGS (ASCE 7-16 Chapt. 30)

GC_{pi} = 0.18

q_h = 14.68 psf

	<u>Zone 1</u>	<u>Zone 2</u>	<u>Zone 3</u>	<u>Zone 4</u>	<u>Zone 5</u>	
GC_p =	-0.9	-1.7	-2.6	-1.1	-1.4	(ASCE 7-16 Figures 30.3-1,30.3-2B,30.3-2a,30.3-2C)
GC_p =	0.5	0.5	0.5	1.0	1.0	(ASCE 7-16 Figures 30.3-1,30.3-2B,30.3-2a,30.3-2C)
p =	-15.85 psf	-27.59 psf	-40.80 psf	-18.79 psf	-23.19 psf	
p =	9.98 psf	9.98 psf	9.98 psf	17.32 psf	17.32 psf	
p =	-15.85 psf	-27.59 psf	-40.80 psf	-18.79 psf	-23.19 psf	
p =	9.98 psf	9.98 psf	9.98 psf	17.32 psf	17.32 psf	
p_{max} =	15 psf	15 psf	15 psf	17 psf	17 psf	
p_{min} =	-16 psf	-28 psf	-41 psf	-19 psf	-23 psf	

Wind Calculations (MWFRS)

ASCE 7-16 Chapt. 28 Part 1

Wind Speed, v_{ASD} : 89 mph
 Basic Wind Speed, V : 115 mph
 Wind Exposure: C
 Risk Category: II-Regular
 Roof Angle= 22.62
 Gable Wall Span= 10.0 ft.
 Longitude Wall Span= 15.0 ft.
 Overall Roof Height= 13.31 ft.
 Mean Roof Height= 12.27 ft.
 Enclosure Classification: Enclosed
 K_{zt} = 1
 K_d = 0.85
 K_{e1} = 0.85
 K_{e2} = 1
 GC_{pi} = ± 0.18
 q_h = 24.46 psf

Sections 26.12 & 26.13
 Section 26.8
 Table 26.10-1
 Table 26.6-1
 Table 26.9-1
 Table 26.11-1
 Eq. 26.10-1

GC_{pi}		1	2	3	4	5	6	1E	2E	3E	4E	5E	6E
	Load Case A	0.54	-0.45	-0.47	-0.41	N/A	N/A	0.77	-0.72	-0.65	-0.60	N/A	N/A
	Load Case B	-0.45	-0.69	-0.37	-0.45	0.40	-0.29	-0.48	-1.07	-0.53	-0.48	0.61	-0.43
p	Load Case A (- GC_{pi})	8.75 psf	-15.51 psf	-15.82 psf	-14.54 psf	N/A	N/A	14.46 psf	-21.99 psf	-20.26 psf	-19.03 psf	N/A	N/A
	Load Case A (+ GC_{pi})	17.56 psf	-6.71 psf	-7.02 psf	-5.73 psf	N/A	N/A	23.27 psf	-13.18 psf	-11.45 psf	-10.23 psf	N/A	N/A
	Load Case B (- GC_{pi})	-15.41 psf	-21.28 psf	-13.45 psf	-15.41 psf	5.38 psf	-11.50 psf	-16.14 psf	-30.58 psf	-17.37 psf	-16.14 psf	10.52 psf	-14.92 psf
	Load Case B (+ GC_{pi})	-6.60 psf	-12.48 psf	-4.65 psf	-6.60 psf	14.19 psf	-2.69 psf	-7.34 psf	-21.77 psf	-8.56 psf	-7.34 psf	19.32 psf	-6.12 psf

max. p_s = 23.27 psf
 max. p_r = 19.32 psf

Side Wall, maximum wind pressure
 Gable End Wall, maximum wind pressure

max. p_{roof} = -30.58 psf

V_L = 744 lbs.
 V_T = 1,343 lbs.
 Max. uplift pressure= -4,950 lbs.

Max. Longitudinal Shear per wall
 Max. Transversial Shear per wall
 Max. uplift pressure on the building due to wind on roof

Diaphragm Calculations

Length (for shear)
 Wall A: 10.0 ft.
 Wall B: 15.0 ft.
 Wall C: 10.0 ft.
 Wall D: 11.0 ft.

	Sheathing*	Nail Size	Edge Nailing	Boundary Nailing	v	v_{allow}	HF/SPF Factor
Roof	7/16" OSB	8d	6 in. o.c.	12 in. o.c.	v = 180.0 plf	165.6 plf	0.92
Wall	3/8" Smartside Panel	8d	6 in. o.c.	12 in. o.c.	v = 200.0 plf	164.0 plf	0.82
Wall	3/8" Smartside Panel	8d	4 in. o.c.	12 in. o.c.	v = 300.0 plf	246.0 plf	0.82

*Must be Rated sheathing

	Wind	Seismic	v_{allow}	C_u	$2b/h$	Nail Size	Edge Nailing	Sheathing	Notes
Wall A:	80.6 plf	43.4 plf	164.0 plf	1.00	1.00	8d	6" o.c.	3/8" Smartside Panel	
Wall B:	29.8 plf	28.9 plf	164.0 plf	1.00	1.00	8d	6" o.c.	3/8" Smartside Panel	
Wall C:	80.6 plf	43.4 plf	164.0 plf	1.00	1.00	8d	6" o.c.	3/8" Smartside Panel	
Wall D:	40.6 plf	39.4 plf	160.6 plf	1.00	0.98	8d	6" o.c.	3/8" Smartside Panel	
Roof=	29.8 plf		165.6 plf			8d	6" o.c.	7/16" OSB	

Foundation Calculations

$F_b = 1500$ psf	Min. allowable bearing pressure
Foundation Stem above grade= 6.0 in.	Height of foundation from the top of the grade to the top of the foundation/stemwall
Foundation Depth= 36.0 in.	Depth of the foundation from the top of the grade to the bottom of the footing
$P_{max} = 519.6$ plf	Max. load per foot of wall
$b_{req} = 4.16$ in.	min. required footing width
$PL_{max} = 921$ lbs.	Maximum point load
$b_{req} = 88.43$ sq.in.	Min. required footing area
Rectangular pad= 1.05 in.	min. required footing width

Overturing Calculations

Wall A		Wall B	
Min. No. anchor bolts= 2		Min. No. anchor bolts= 4	
Width= 10.0 ft.		Width= 15.0 ft.	
Height= 11.23 ft.		Height= 11.23 ft.	
Overturing Length= 9.08 ft.		Overturing Length= 14.08 ft.	
$P_{wind} = 1,343$ lbs.		$P_{wind} = 744$ lbs.	
$P_{seismic} = 620$ lbs.		$P_{seismic} = 620$ lbs.	
Wall Weight= 679.80 lbs.		Wall Weight= 1,042.70 lbs.	
Uplift _{wind} = 656.61 lbs.		Uplift _{wind} = .0 lbs.	
Uplift _{seismic} = 196.34 lbs.		Uplift _{seismic} = .0 lbs.	
Allowable Service, wind: 0.58	ok. No additional holddowns required.	Allowable Service, wind: 0.02	ok. No additional holddowns required.
Allowable Service, seismic: 0.11	ok. No additional holddowns required.	Allowable Service, seismic: 0.02	ok. No additional holddowns required.
Wall C		Wall D	
Min. No. anchor bolts= 2		Min. No. anchor bolts= 4	
Width= 10.0 ft.		Width= 11.0 ft.	
Height= 11.23 ft.		Height= 11.23 ft.	
Overturing Length= 9.08 ft.		Overturing Length= 10.08 ft.	
$P_{wind} = 1,343$ lbs.		$P_{wind} = 744$ lbs.	
$P_{seismic} = 620$ lbs.		$P_{seismic} = 620$ lbs.	
Wall Weight= 679.80 lbs.		Wall Weight= 771.18 lbs.	
Uplift _{wind} = 656.61 lbs.		Uplift _{wind} = 111.45 lbs.	
Uplift _{seismic} = 196.34 lbs.		Uplift _{seismic} = 97.47 lbs.	
Allowable Service, wind: 0.58	ok. No additional holddowns required.	Allowable Service, wind: 0.04	ok. No additional holddowns required.
Allowable Service, seismic: 0.11	ok. No additional holddowns required.	Allowable Service, seismic: 0.03	ok. No additional holddowns required.

Building Uplift

Wind uplift= -4,949.95 lbs.	
Min. building weight= 2,655.83 lbs.	
Additional min. dead load= .0 lbs.	additional dead load due to steel floor, wood base, or other permanent loads, if any, (not including foundation)
Net uplift= -2,294.11 lbs.	
Total no. of anchor bolts (min.)= 12	(Does not include additional holddowns for overturning of the walls.)
Anchor bolt uplift= 14,340.0 lbs.	
OK. No additional anchors needed.	

Max. Seismic Uplift

Seismic uplift= 2,939.31 lbs.	(0.6-0.14S _{DS})D+0.7E
Total no. of anchor bolts (min.)= 12	(Does not include additional holddowns for overturning of the walls.)
Anchor bolt uplift= 14,340.0 lbs.	
OK. No additional anchors needed.	

Bearing Wall Calculations

Axial Load

Stud Spacing= 16 in. o.c.
Max. Load on wall= 519.6 plf

depth= 3.50 in.
width= 1.50 in.

No. of members= 1

Length (depth)= 130.26 in.

Length (width)= 12.0 in.

$K_{e(x)} = 1$

$K_{e(y)} = 1$

$K_{cE} = 0.3$

$c = 0.8$

Load= 693 lbs.

Load per stud

$A = 5.25 \text{ sq.in.}$

$(l/d)_x = 37.22$

$(l/d)_y = 8.00$

$E_{min} = 510,000 \text{ psi}$

Weak Axis Calculations(y)

$F_{cE} = 6550.31$

$F^*_c = 1520.88$

$F_{cE}/F^*_c = 4.31$

$1+F_{cE}/F^*_c/2c = 3.32$

$C_P = 0.95$

$F'_c = 1439.75$

$P_{allowable} = 7,559 \text{ lbs.}$

Good/No Good? **O.K.**

Lumber

SPF #1/#2

$F_b = 875 \text{ psi}$

$F_t = 450 \text{ psi}$

$F_v = 135 \text{ psi}$

$F_{cP} = 425 \text{ psi}$

$F_c = 1150 \text{ psi}$

$E_{min} = 510,000 \text{ psi}$

$E = 1,400,000 \text{ psi}$

Lumber Factors

$C_D = 1.15$

Duration for gravity load

$C_M = 1.00$

Wet Service

$C_t = 1.00$

Temperature

$C_L = 1.00$

Beam Stability

$C_F = 1.15$

Size for F_c

$C_{fu} = 1.00$

Flat Use

$C_i = 1.00$

Incising

$C_r = 1.15$

Repetitive Member

$C_r = 1.00$

Form

$C_T = 1.00$

Buckling Stiffness (NDS 4.4.2)

$C_F = 1.50$

Size for F_b

$C_D = 1.60$

Duration for lateral load

$C_r = 1.50$

Repetitive Member (wind)

Strong Axis Calculations (x)

$F_{cE} = 302.66$

$F^*_c = 1520.88$

$F_{cE}/F^*_c = 0.20$

$1+F_{cE}/F^*_c/2c = 0.75$

$C_P = 0.19$

$F'_c = 289.09$

$P_{allowable} = 1,518 \text{ lbs.}$

Good/No Good? **O.K.**

Wind Load

Wind load per stud= 31.0 plf

Moment= 5,483 in.-lbs.

Reaction= 168 lbs.

Header depth= 3.50 in.

Total header width= 1.50 in.

Header span= 8.0 ft.

Bending

$S_x = 3.06 \text{ cu.in.}$

$F'_b = 3150 \text{ psi}$

$f_b = 1790 \text{ psi}$

Good/No Good? **O.K.**

Shear

$F'_v = 216 \text{ psi}$

$f_v = 48 \text{ psi}$

Good/No Good? **O.K.**

Combined Bending and Axial Loading

$F'_c = 402.21$

combine allowable compressive stress

$f_c = 17 \text{ psi}$

combine compressive stress

Combined stress index= 0.60

Good/No Good? **O.K.**