PATRELL ENGINEERING GROUP, INC.
751 Sunny Grove Ln. • Glendora, CA 91741 • PH: (626) 335-4362 • FAX (626) 963-4812

ENGINEERING CALCULATIONS AND DETAILS FOR

SHADE SAIL DESIGN

EMERALD BAY BOY SCOUT CAMP SANTA CATALINA ISLAND LOS ANGELES COUNTY, CA

DATE: 10 DECEMBER 2008

ENGINEER: NANCY PATTON-FERRELL
RCE# 37018, CALIFORNIA
751 SUNNY GROVE LANE
GLENDORA, CA 91741
(626) 335-4362

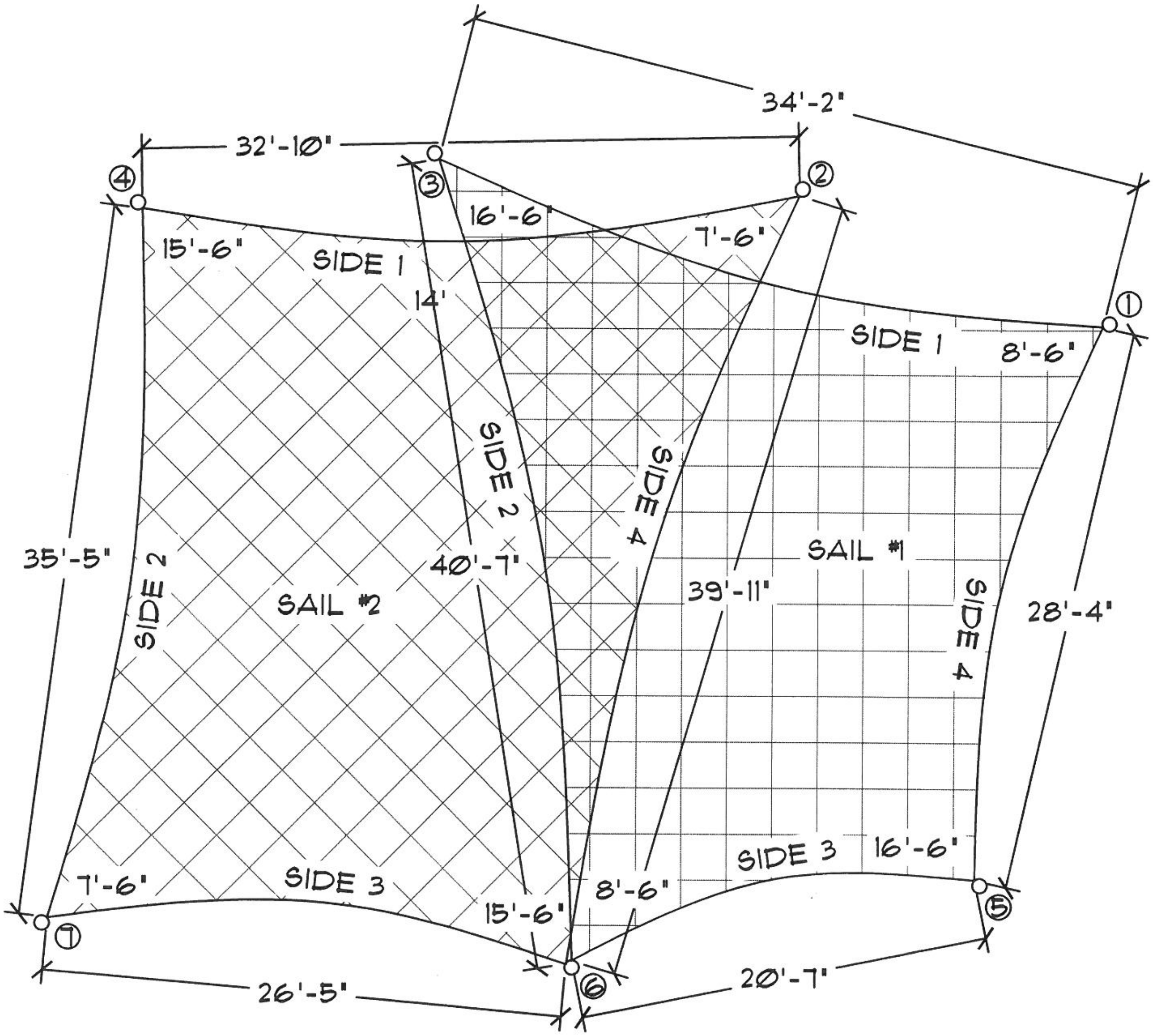
PATRELL ENGINEERING GROUP, INC.
751 Sunny Grove Ln.
Glendora, CA 91741
PH: (626) 335-4362
FAX: (626) 963-4812

Project: EMERALD BAY BOY SCOUT CAMP
CATALINA, CA
SO CAL SHADE SAILS

Engineer: MJK

Date: 12/08 Sheet 1 of 33

SHADE SAIL LAYOUT



PATRELL ENGINEERING GROUP, INC.
751 Sunny Grove Ln.
Glendora, CA 91741
PH: (626) 335-4362
FAX: (626) 963-4812

Project: EMERALD BAY BOY SCOUT CAMP
CATALINA, CA
SO CAL SHADE SAILS
Engineer: MJK
Date: 12/08

WIND LOADS: PER CBC 2007 SECTION 1603.1.4
ASCE 7-05 METHOD 2 - SECTION 6.5

1. BASIC WIND SPEED = 85 (35) FIG. 1609 IBC

   $V := 85\text{mph}$

   $K_d := 0.85$ TBL 6-4 - MAIN WIND FORCE RESISTING SYSTEM

2. $I := 1.0$ < 300 PEOPLE - CATEGORY II - TABLE 6-1 ASCE 7-05

3. EXP C $H \le 15\text{ft}$

   $K_z := 0.85$ TABLE 6-3 ASCE 7-05

4. $K_{zt} := 1.0$ ON FLAT GROUND - FIGURE 6-4
   NOT ON A HILL OR ESCARPMENT

5. $G := 0.85$ ASCE 7-05 6.5.8.1

6. Enclosure Classification - OPEN

7. GC_{pf} - N/A

8. $C_N := 1.8$ ASCE 7-05 $\theta = 15$ deg Fig. 6-18A
   CLEAR FLOW WINDWARD HALF

9. $q_h := .00256 \cdot \frac{lb \cdot hr^2}{mi^2 \cdot ft^2} \cdot K_z \cdot K_{zt} \cdot K_d \cdot V^2 \cdot I$ $\boxed{q_h = 13.36 \frac{lb}{ft^2}}$

10. $F := q_h \cdot G \cdot C_N \cdot A_f$ SECTION 6.5.15 $\boxed{F = 20.446 \frac{lb}{ft^2}}$

*USE 20.5 psf WIND LOADS on Horizontal Projection

PATRELL ENGINEERING GROUP, INC.
751 Sunny Grove Ln. Glendora, CA 91741
PH: (626) 335-4362 FAX: (626) 963-4812

Uplift Calculations

$G := 0.85$

$C_p := 0.7$

$F_u := q_h \cdot G \cdot C_p$ $\quad$ $F_u = 7.951 \frac{lb}{ft^2}$

*USE 10 psf (Min.) WIND LOADS Uplift

4/33

Main Wind Force Resisting System – Method 2		All Heights
Figure 6-6 (con't)	External Pressure Coefficients, C_p	Walls & Roofs
Enclosed, Partially Enclosed Buildings		

Wall Pressure Coefficients, C_p

Surface	L/B	C_p	Use With
Windward Wall	All values	0.8	q_z
Leeward Wall	0-1	-0.5	q_h
	2	-0.3	
	≥4	-0.2	
Side Wall	All values	-0.7	q_h

Roof Pressure Coefficients, C_p, for use with q_h

Wind Direction	Windward									Leeward		
	Angle, θ (degrees)									Angle, θ (degrees)		
	h/L	10	15	20	25	30	35	45	≥60#	10	15	≥20
Normal to ridge for θ ≥ 10°	≤0.25	-0.7 -0.18	-0.5 0.0*	-0.3 0.2	-0.2 0.3	-0.2 0.3	0.0* 0.4	0.4	0.01 θ	-0.3	-0.5	-0.6
	0.5	-0.9 -0.18	-0.7 -0.18	-0.4 0.0*	-0.3 0.2	-0.2 0.2	-0.2 0.3	0.0* 0.4	0.01 θ	-0.5	-0.5	-0.6
	≥1.0	-1.3** -0.18	-1.0 -0.18	-0.7 -0.18	-0.5 0.0*	-0.3 0.2	-0.2 0.2	0.0* 0.3	0.01 θ	-0.7	-0.6	-0.6

Wind Direction	h/L	Horiz distance from windward edge	C_p
Normal to ridge for θ < 10 and Parallel to ridge for all θ	≤ 0.5	0 to h/2	-0.9, -0.18
		h/2 to h	-0.9, -0.18
		h to 2 h	-0.5, -0.18
		> 2h	-0.3, -0.18
	≥ 1.0	0 to h/2	-1.3**, -0.18
		> h/2	-0.7, -0.18

*Value is provided for interpolation purposes.

**Value can be reduced linearly with area over which it is applicable as follows

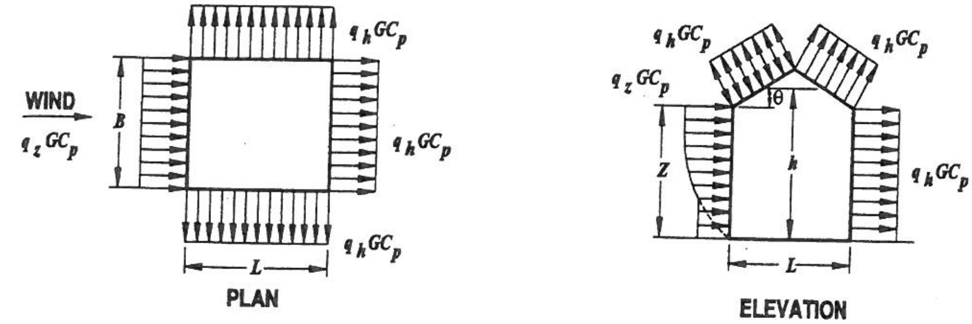
Area (sq ft)	Reduction Factor
≤ 100 (9.3 sq m)	1.0
200 (23.2 sq m)	0.9
≥ 1000 (92.9 sq m)	0.8

Notes:

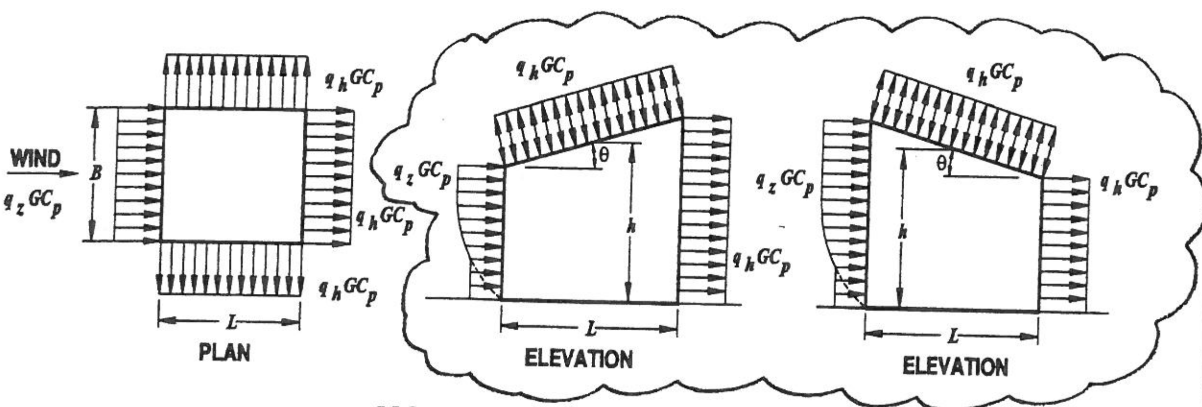
1. Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.
2. Linear interpolation is permitted for values of *L/B*, *h/L* and θ other than shown. Interpolation shall only be carried out between values of the same sign. Where no value of the same sign is given, assume 0.0 for interpolation purposes.
3. Where two values of C_p are listed, this indicates that the windward roof slope is subjected to either positive or negative pressures and the roof structure shall be designed for both conditions. Interpolation for intermediate ratios of h/L in this case shall only be carried out between C_p values of like sign.
4. For monoslope roofs, entire roof surface is either a windward or leeward surface.
5. For flexible buildings use appropriate G_f as determined by Section 6.5.8.
6. Refer to Figure 6-7 for domes and Figure 6-8 for arched roofs.
7. Notation:
   B: Horizontal dimension of building, in feet (meter), measured normal to wind direction.
   L: Horizontal dimension of building, in feet (meter), measured parallel to wind direction.
   h: Mean roof height in feet (meters), except that eave height shall be used for θ ≤ 10 degrees.
   z: Height above ground, in feet (meters).
   G: Gust effect factor.
   q_z, q_h: Velocity pressure, in pounds per square foot (N/m^2), evaluated at respective height.
   θ: Angle of plane of roof from horizontal, in degrees.
8. For mansard roofs, the top horizontal surface and leeward inclined surface shall be treated as leeward surfaces from the table.
9. Except for MWFRS's at the roof consisting of moment resisting frames, the total horizontal shear shall not be less than that determined by neglecting wind forces on roof surfaces.

#For roof slopes greater than 80°, use C_p = 0.8

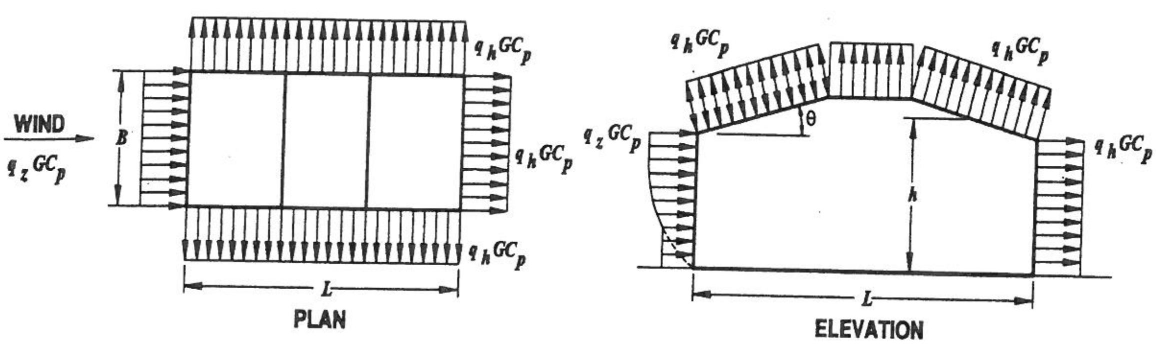
Main Wind Force Resisting System – Method 2		All Heights
Figure 6-6	External Pressure Coefficients, C_p	Walls & Roofs
Enclosed, Partially Enclosed Buildings		



GABLE, HIP ROOF



MONOSLOPE ROOF (NOTE 4)



MANSARD ROOF (NOTE 8)

PATRELL ENGINEERING GROUP, INC.
751 Sunny Grove Ln.
Glendora, CA 91741
PH: (626) 335-4362
FAX: (626) 963-4812

Project: EMERALD BAY BOY SCOUT CAMP
CATALINA, CA
SO CAL SHADE SAILS

Engineer: MJK

Date: 12/08

Sail 1

Job : Catalina Island

	Side 1 (1 to 2)	Side 2 (2 to 3)	Side 3 (3 to 4)	Side 4 (4 to 1)
Length (ft):	34.167	40.583	20.583	28.33
Height 1 (ft):	8.5	16.5	8.5	16.5
Height 2 (ft):	16.5	8.5	16.5	8.5
Δ Height:	8	8	8	8

	Side 1	Side 2	Side 3	Side 4	
Length on Rake (ft):	35.09	41.36	22.08	29.44	$((\text{Length})^2 + (\Delta \text{ Height})^2)^{1/2}$
Catenary %:	10%	10%	10%	10%	10% is Designer Standard
Catenary (ft):	3.51	4.14	2.21	2.94	(Length of Rake) * Catenary %
Trial C:	44.43	52.34	27.94	37.32	Parameter of the Catenary
Calc Catenary (ft):	3.51	4.14	2.21	2.94	C * (cosh ((L/2) / C) -1)
Arc Length (ft):	38.86	45.81	24.45	32.59	C * (sinh ((Length of Rake) / C)
			Total Length of Cable (ft):	141.70	Sum of Arc Lengths

	Side 1	Side 2	Side 3	Side 4	
Area of Deduction (ft^2):	82.50	114.64	32.67	58.06	(Length of Rake) * (Catenary) * 0.67
			Total Area of Deduction (ft^2):	287.87	Sum of Areas of Deduction

Sail Area (ft^2):	896.00	Area of Trapezoid
Design Area (ft^2):	608.13	Sail Area - Deducted Area
Projection Area (ft^2):	117.5	Area of Projected Horiz. Area

Dead Load (psf):	0.25	Material Weight
Live Load (psf):	5	
Total Load (psf):	5.25	

Cable Loading

Dead Load (lb):	152.03	DL * Design Area
Live Load (lb):	3040.63	LL * Design Area
Total Load (lb):	3192.67	TL * Design Area
Cable Pre-Tension (lb):	200.00	Applies to DL + LL Case Only

Wind Pressure (psf):	10	Uplift
Wind Load (lb):	6081.27	Pressure * Design Area

Wind Pressure (psf):	20.5	Horizontal Projection
Wind Load (lb):	2408.75	Pressure * Proj. Area

PATRELL ENGINEERING GROUP, INC.
751 Sunny Grove Ln. Glendora, CA 91741
PH: (626) 335-4362 FAX: (626) 963-4812

Uplift Load Distribution

Corner Reaction (lb):	1520.32	Wind Pressure (Uplift) / 4
Load on Cable (lb/ft):	42.42	TL / Cable Length

(0.5 Subtracted for Cable Weight)

Horizontal Projection Distribution

Corner Reaction (lb):	1204.38	Wind Pressure (Horizontal Projection) / 2
Load on Cable (lb/ft):	16.50	TL / Cable Length

(0.5 Subtracted for Cable Weight)

Uplift Governs

	Side 1	Side 2	Side 3	Side 4	
Sag Tension (lb):	2033.18	2395.30	1278.90	1708.01	Cable Load * (C + Catenary)

PATRELL ENGINEERING GROUP, INC.
751 Sunny Grove Ln.
Glendora, CA 91741
PH: (626) 335-4362
FAX: (626) 963-4812

Project: EMERALD BAY BOY SCOUT CAMP
CATALINA, CA
SO CAL SHADE SAILS

Engineer: MJK

Date: 12/08

Sail 2

Job : Catalina Island

	Side 1 (1 to 2)	Side 2 (2 to 3)	Side 3 (3 to 4)	Side 4 (4 to 1)
Length (ft):	32.833	35.4167	26.4167	39.9167
Height 1 (ft):	7.5	15.5	7.5	15.5
Height 2 (ft):	15.5	7.5	15.5	7.5
Δ Height:	8	8	8	8

	Side 1	Side 2	Side 3	Side 4	
Length on Rake (ft):	33.79	36.31	27.60	40.71	((Length)^2 + (Δ Height)^2)$^{1/2}$
Catenary %:	10%	10%	10%	10%	10% is Designer Standard
Catenary (ft):	3.38	3.63	2.76	4.07	(Length of Rake) * Catenary %
Trial C:	42.79	45.99	34.95	51.57	Parameter of the Catenary
Calc Catenary (ft):	3.38	3.63	2.76	4.07	C * (cosh ((L/2) / C) -1)
Arc Length (ft):	37.42	40.20	30.56	45.07	C * (sinh ((Length of Rake) / C)
			Total Length of Cable (ft):	153.25	Sum of Arc Lengths

	Side 1	Side 2	Side 3	Side 4	
Area of Deduction (ft^2):	76.51	88.33	51.04	111.04	(Length of Rake) * (Catenary) * 0.67
			Total Area of Deduction (ft^2):	326.93	Sum of Areas of Deduction

Sail Area (ft^2):	1078.00	Area of Trapezoid
Design Area (ft^2):	751.07	Sail Area - Deducted Area
Projection Area (ft^2):	127.5	Area of Projected Horiz. Area

Dead Load (psf):	0.25	Material Weight
Live Load (psf):	5	
Total Load (psf):	5.25	

Cable Loading

Dead Load (lb):	187.77	DL * Design Area
Live Load (lb):	3755.36	LL * Design Area
Total Load (lb):	3943.12	TL * Design Area
Cable Pre-Tension (lb):	200.00	Applies to DL + LL Case Only

Wind Pressure (psf):	10	Uplift
Wind Load (lb):	7510.71	Pressure * Design Area
Wind Pressure (psf):	20.5	Horizontal Projection
Wind Load (lb):	2613.75	Pressure * Proj. Area

PATRELL ENGINEERING GROUP, INC.
751 Sunny Grove Ln.
Glendora, CA 91741
PH: (626) 335-4362
FAX: (626) 963-4812

Uplift Load Distribution

Corner Reaction (lb):	1877.68	Wind Pressure (Uplift) / 4
Load on Cable (lb/ft):	48.51	TL / Cable Length

(0.5 Subtracted for Cable Weight)

Horizontal Projection Distribution

Corner Reaction (lb):	1306.88	Wind Pressure (Horizontal Projection) / 2
Load on Cable (lb/ft):	16.56	TL / Cable Length

(0.5 Subtracted for Cable Weight)

Uplift Governs

	Side 1	Side 2	Side 3	Side 4	
Sag Tension (lb):	2239.41	2407.05	1829.48	2698.86	Cable Load * (C + Catenary)

PATRELL ENGINEERING GROUP, INC.
751 Sunny Grove Ln. Glendora, CA 91741
PH: (626) 335-4362
FAX: (626) 963-4812

Project: EMERALD BAY BOY SCOUT CAMP
CATALINA, CA
SO CAL SHADE SAILS

Engineer: MJK

Date: 12/08

Column Design - Sail 1 - Column 1

Side 1 @ $h_1 := 8.5ft$

$T_{1h1} := 2033.18lb$

$arclength_{1h1} := 38.86ft$

$C_{1h1} := 44.43ft$

$\theta_{1h1} := atan\left(\frac{arclength_{1h1}}{C_{1h1}}\right)$

$\theta_{1h1} = 41.2 \cdot deg$

Side 4 @ $h_1 := 8.5ft$

$T_{4h1} := 1708.01lb$

$arclength_{4h1} := 32.59ft$

$C_{4h1} := 37.32ft$

$\theta_{4h1} := atan\left(\frac{arclength_{4h1}}{C_{4h1}}\right)$

$\theta_{4h1} = 41.1 \cdot deg$

$T_{xz1h1} := T_{1h1} \cdot cos(\theta_{1h1})$ $\boxed{T_{xz1h1} = 1530\,lb}$

$T_{xz4h1} := T_{4h1} \cdot cos(\theta_{4h1})$ $\boxed{T_{xz4h1} = 1287\,lb}$

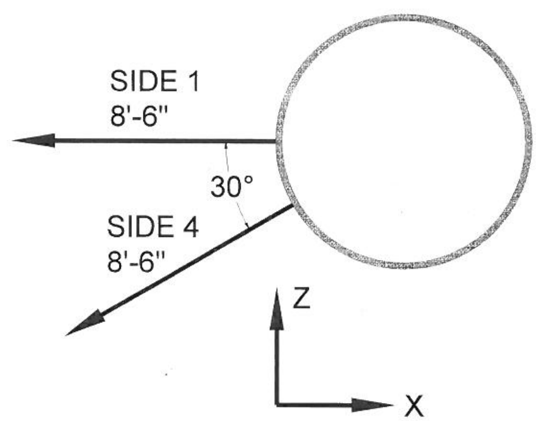
$T_{x4h1} := T_{xz4h1} \cdot cos(30deg)$ $\boxed{T_{x4h1} = 1114\,lb}$

$T_{z4h1} := T_{xz4h1} \cdot sin(30deg)$ $\boxed{T_{z4h1} = 643\,lb}$

$M_x := (T_{z4h1} + T_{xz1h1}) \cdot h_1$ $\boxed{M_x = 18476\,ft \cdot lb}$

$M_z := (T_{z4h1}) \cdot h_1$ $\boxed{M_z = 5468\,ft \cdot lb}$

PLAN VIEW OF COLUMN



6" φ Extra Strong Pipe Column $S_x := 12.2in^3$

$F_b := 0.6 \cdot 36000 \cdot \frac{lb}{in^2} \cdot 1.33$ (LDF)

$f_{bx} := \frac{M_x}{S_x}$ $f_{bx} = 18173 \cdot \frac{lb}{in^2}$

$f_{bz} := \frac{M_z}{S_x}$ $f_{bz} = 5378 \cdot \frac{lb}{in^2}$

$CombinedStress := \frac{f_{bx}}{F_b} + \frac{f_{bz}}{F_b}$

$\boxed{CombinedStress = 0.82}$

PATRELL ENGINEERING GROUP, INC.
751 Sunny Grove Ln. Glendora, CA 91741
PH: (626) 335-4362 FAX: (626) 963-4812

Column Design - Sail 2 - Column 2

Side 1 @ $h_3 := 7.5ft$

$T_{1h3} := 2239.41lb$

$arclength_{1h3} := 37.42ft$

$C_{1h3} := 42.79ft$

$\theta_{1h3} := atan\left(\frac{arclength_{1h3}}{C_{1h3}}\right)$

$\theta_{1h3} = 41.2 \cdot deg$

Side 4 @ $h_3 := 7.5ft$

$T_{4h3} := 2698.86lb$

$arclength_{4h3} := 45.07ft$

$C_{4h3} := 51.57ft$

$\theta_{4h3} := atan\left(\frac{arclength_{4h3}}{C_{4h3}}\right)$

$\theta_{4h3} = 41.2 \cdot deg$

$T_{xz1h3} := T_{1h3} \cdot cos(\theta_{1h3})$ $T_{xz1h3} = 1686\ lb$

$T_{xz4h3} := T_{4h3} \cdot cos(\theta_{4h3})$ $T_{xz4h3} = 2032\ lb$

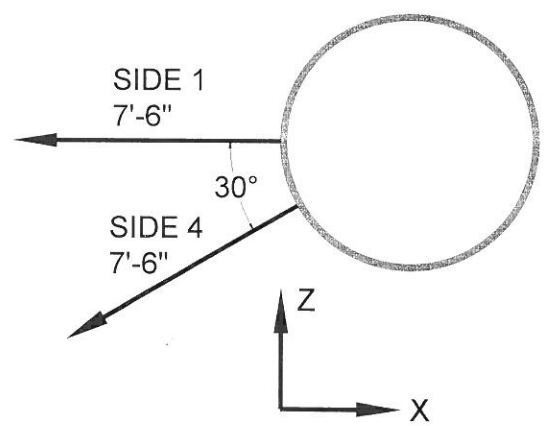
$T_{x4h3} := T_{xz4h3} \cdot cos(30deg)$ $T_{x4h3} = 1760\ lb$

$T_{z4h3} := T_{xz4h3} \cdot sin(30deg)$ $T_{z4h3} = 1016\ lb$

$M_x := (T_{x4h3} + T_{xz1h3}) \cdot h_3$ $M_x = 25842\ ft \cdot lb$

$M_z := (T_{z4h3}) \cdot h_3$ $M_z = 7621\ ft \cdot lb$

PLAN VIEW OF COLUMN



8" ϕ Standard Pipe Column $S_x := 16.8in^3$

$F_b := 0.6 \cdot 36000 \frac{lb}{in^2} \cdot 1.33$ (LDF)

$f_{bx} := \frac{M_x}{S_x}$ $f_{bx} = 18459 \cdot \frac{lb}{in^2}$

$f_{bz} := \frac{M_z}{S_x}$ $f_{bz} = 5443 \cdot \frac{lb}{in^2}$

$CombinedStress := \frac{f_{bx}}{F_b} + \frac{f_{bz}}{F_b}$

$CombinedStress = 0.832$

PATRELL ENGINEERING GROUP, INC.
751 Sunny Grove Ln. Glendora, CA 91741
PH: (626) 335-4362 FAX: (626) 963-4812

Column Design - Sail 1 - Column 3

Side 1 @ $h_4 := 16.5ft$

$T_{1h4} := 2033.18lb$

$arclength_{1h4} := 38.86ft$

$C_{1h4} := 44.43ft$

$\theta_{1h4} := atan\left(\frac{arclength_{1h4}}{C_{1h4}}\right)$

$\theta_{1h4} = 41.2 \cdot deg$

Side 2 @ $h_4 := 16.5ft$

$T_{2h4} := 2395.30lb$

$arclength_{2h4} := 45.81ft$

$C_{2h4} := 52.34ft$

$\theta_{2h4} := atan\left(\frac{arclength_{2h4}}{C_{2h4}}\right)$

$\theta_{2h4} = 41.2 \cdot deg$

$T_{xz1h4} := T_{1h4} \cdot \cos(\theta_{1h4})$ $\boxed{T_{xz1h4} = 1530\,lb}$

$T_{xz2h4} := T_{2h4} \cdot \cos(\theta_{2h4})$ $\boxed{T_{xz2h4} = 1802\,lb}$

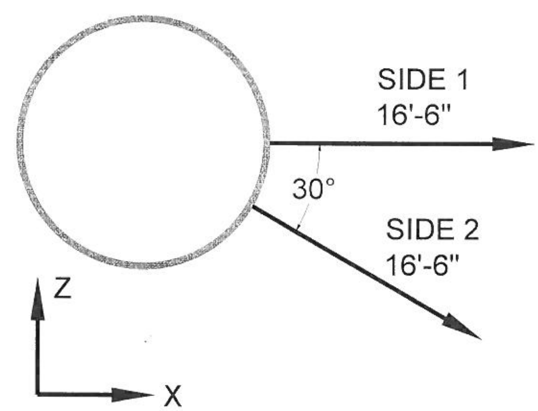
$T_{x2h4} := T_{xz2h4} \cdot \cos(30deg)$ $\boxed{T_{x2h4} = 1561\,lb}$

$T_{z2h4} := T_{xz2h4} \cdot \sin(30deg)$ $\boxed{T_{z2h4} = 901\,lb}$

$M_x := (T_{x2h4} + T_{xz1h4}) \cdot h_4$ $\boxed{M_x = 51007\,ft \cdot lb}$

$M_z := (T_{z2h4}) \cdot h_4$ $\boxed{M_z = 14870\,ft \cdot lb}$

PLAN VIEW OF COLUMN



10" ϕ Standard Pipe Column $S_x := 29.9in^3$

$F_b := 0.6 \cdot 36000 \frac{lb}{in^2} \cdot 1.33$ (LDF)

$f_{bx} := \frac{M_x}{S_x}$ $f_{bx} = 20471 \cdot \frac{lb}{in^2}$

$f_{bz} := \frac{M_z}{S_x}$ $f_{bz} = 5968 \cdot \frac{lb}{in^2}$

$CombinedStress := \frac{f_{bx}}{F_b} + \frac{f_{bz}}{F_b}$

$\boxed{CombinedStress = 0.92}$

PATRELL ENGINEERING GROUP, INC.
751 Sunny Grove Ln.
Glendora, CA 91741
PH: (626) 335-4362
FAX: (626) 963-4812

Project: EMERALD BAY BOY SCOUT CAMP
CATALINA, CA
SO CAL SHADE SAIL
Engineer: MJK
Date: 12/08 Sheet 13 of 33

Column Design - Sail 2 - Column #4

Side 1 @ $h_2 := 15.5ft$

$T_{1h2} := 2239.41lb$

$arclength_{1h2} := 37.42ft$

$C_{1h2} := 42.79ft$

$\theta_{1h2} := atan\left(\frac{arclength_{1h2}}{C_{1h2}}\right)$

$\theta_{1h2} = 41.2 \cdot deg$

Side 2 @ $h_2 := 15.5ft$

$T_{2h2} := 2407.05lb$

$arclength_{2h2} := 40.20ft$

$C_{2h2} := 45.99ft$

$\theta_{2h2} := atan\left(\frac{arclength_{2h2}}{C_{2h2}}\right)$

$\theta_{2h2} = 41.2 \cdot deg$

$T_{xz1h2} := T_{1h2} \cdot cos(\theta_{1h2})$ $\boxed{T_{xz1h2} = 1686\,lb}$

$T_{xz2h2} := T_{2h2} \cdot cos(\theta_{2h2})$ $\boxed{T_{xz2h2} = 1812\,lb}$

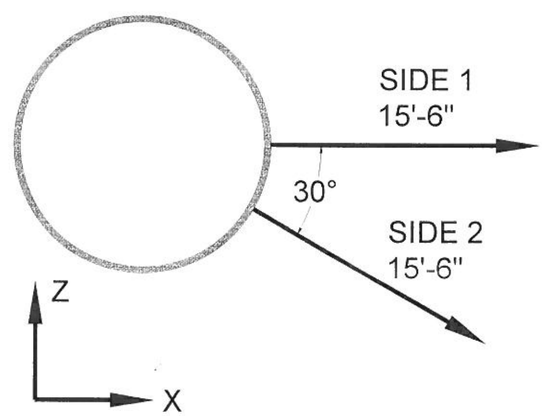
$T_{x2h2} := T_{xz2h2} \cdot cos(30deg)$ $\boxed{T_{x2h2} = 1569\,lb}$

$T_{z2h2} := T_{xz2h2} \cdot sin(30deg)$ $\boxed{T_{z2h2} = 906\,lb}$

$M_x := (T_{x2h2} + T_{xz1h2}) \cdot h_2$ $\boxed{M_x = 50456\,ft \cdot lb}$

$M_z := (T_{z2h2}) \cdot h_2$ $\boxed{M_z = 14045\,ft \cdot lb}$

PLAN VIEW OF COLUMN



10" ϕ Standard Pipe Column $S_x := 29.9in^3$

$F_b := 0.6 \cdot 36000 \frac{lb}{in^2} \cdot 1.33$ (LDF)

$f_{bx} := \frac{M_x}{S_x}$ $f_{bx} = 20250 \cdot \frac{lb}{in^2}$

$f_{bz} := \frac{M_z}{S_x}$ $f_{bz} = 5637 \cdot \frac{lb}{in^2}$

$CombinedStress := \frac{f_{bx}}{F_b} + \frac{f_{bz}}{F_b}$

$\boxed{CombinedStress = 0.901}$

PATRELL ENGINEERING GROUP, INC.
751 Sunny Grove Ln.
Glendora, CA 91741
PH: (626) 335-4362
FAX: (626) 963-4812

Column Design - Sail 1 - Column #5

Side 3 @ $h_4 := 16.5ft$

$T_{3h4} := 1278.90lb$

$arclength_{3h4} := 24.45ft$

$C_{3h4} := 27.94ft$

$\theta_{3h4} := atan\left(\frac{arclength_{3h4}}{C_{3h4}}\right)$

$\theta_{3h4} = 41.2 \cdot deg$

Side 4 @ $h_4 := 16.5ft$

$T_{4h4} := 1708.01lb$

$arclength_{4h4} := 32.59ft$

$C_{4h4} := 37.32ft$

$\theta_{4h4} := atan\left(\frac{arclength_{4h4}}{C_{4h4}}\right)$

$\theta_{4h4} = 41.1 \cdot deg$

$T_{xz3h4} := T_{3h4} \cdot cos(\theta_{3h4})$ $\boxed{T_{xz3h4} = 962\,lb}$

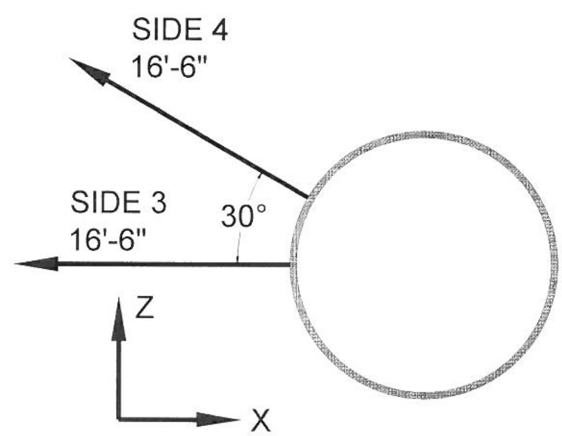
$T_{xz4h4} := T_{4h4} \cdot cos(\theta_{4h4})$ $\boxed{T_{xz4h4} = 1287\,lb}$

$T_{x4h4} := T_{xz4h4} \cdot cos(30deg)$ $\boxed{T_{x4h4} = 1114\,lb}$

$T_{z4h4} := T_{xz4h4} \cdot sin(30deg)$ $\boxed{T_{z4h4} = 643\,lb}$

$M_x := (T_{x4h4} + T_{xz3h4}) \cdot h_4$ $\boxed{M_x = 34264\,ft \cdot lb}$

$M_z := (T_{z4h4}) \cdot h_4$ $\boxed{M_z = 10614\,ft \cdot lb}$



PLAN VIEW OF COLUMN

8" ϕ Extra Strong Pipe Column $S_x := 24.5in^3$

$F_b := 0.6 \cdot 36000 \frac{lb}{in^2} \cdot 1.33$ (LDF)

$f_{bx} := \frac{M_x}{S_x}$ $f_{bx} = 16782 \cdot \frac{lb}{in^2}$

$f_{bz} := \frac{M_z}{S_x}$ $f_{bz} = 5199 \cdot \frac{lb}{in^2}$

$CombinedStress := \frac{f_{bx}}{F_b} + \frac{f_{bz}}{F_b}$

$\boxed{CombinedStress = 0.765}$

PATRELL ENGINEERING GROUP, INC.
751 Sunny Grove Ln.
Glendora, CA 91741
PH: (626) 335-4362
FAX: (626) 963-4812

Column Design - Sails 1 & 2 - Column #6

Sail #1

Side 2 @ $h_1 := 8.5ft$

$T_{12h1} := 2395.30lb$

$arclength_{12h1} := 45.81ft$

$C_{12h1} := 52.34ft$

$$\theta_{12h1} := atan\left(\frac{arclength_{12h1}}{C_{12h1}}\right)$$

$\theta_{12h1} = 41.2 \cdot deg$

Side 3 @ $h_1 = 8.5ft$

$T_{13h1} := 1278.90lb$

$arclength_{13h1} := 24.45ft$

$C_{13h1} := 27.94ft$

$$\theta_{13h1} := atan\left(\frac{arclength_{13h1}}{C_{13h1}}\right)$$

$\theta_{13h1} = 41.2 \cdot deg$

$T_{xz12h1} := T_{12h1} \cdot \cos(\theta_{12h1})$ $\boxed{T_{xz12h1} = 1802\,lb}$

$T_{xz13h1} := T_{13h1} \cdot \cos(\theta_{13h1})$ $\boxed{T_{xz13h1} = 962\,lb}$

Sail #2

Side 3 @ $h_2 := 15.5ft$

$T_{23h2} := 1829.48lb$

$arclength_{23h2} := 30.56ft$

$C_{23h2} := 34.95ft$

$$\theta_{23h2} := atan\left(\frac{arclength_{23h2}}{C_{23h2}}\right)$$

$\theta_{23h2} = 41.2 \cdot deg$

Side 4 @ $h_2 = 15.5ft$

$T_{24h2} := 2698.86lb$

$arclength_{24h2} := 45.07ft$

$C_{24h2} := 51.57ft$

$$\theta_{24h2} := atan\left(\frac{arclength_{24h2}}{C_{24h2}}\right)$$

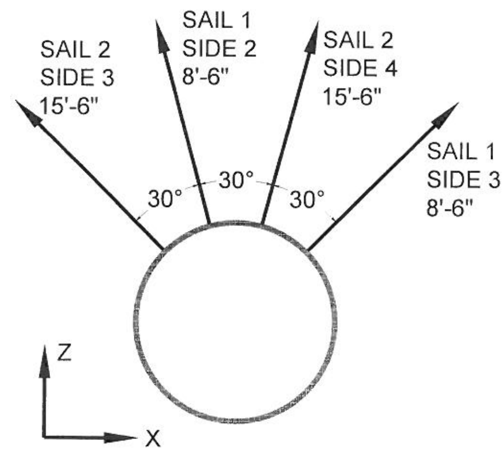
$\theta_{24h2} = 41.2 \cdot deg$

$T_{xz23h2} := T_{23h2} \cdot \cos(\theta_{23h2})$ $\boxed{T_{xz23h2} = 1377\,lb}$

$T_{xz24h2} := T_{24h2} \cdot \cos(\theta_{24h2})$ $\boxed{T_{xz24h2} = 2032\,lb}$

PATRELL ENGINEERING GROUP, INC.
751 Sunny Grove Ln. Glendora, CA 91741
PH: (626) 335-4362 FAX: (626) 963-4812

Project: EMERALD BAY BOY SCOUT CAMP
CATALINA, CA
SO CAL SHADE SAILS
Engineer: MJK
Date: 12/08



PLAN VIEW OF COLUMN

$T_{x12h1} := T_{xz12h1} \cdot \sin(15deg)$ $\boxed{T_{x12h1} = 467\,lb}$

$T_{x13h1} := T_{xz13h1} \cdot \sin(45deg)$ $\boxed{T_{x13h1} = 681\,lb}$

$T_{z12h1} := T_{xz12h1} \cdot \cos(15deg)$ $\boxed{T_{z12h1} = 1741\,lb}$

$T_{z13h1} := T_{xz13h1} \cdot \cos(45deg)$ $\boxed{T_{z13h1} = 681\,lb}$

$T_{x23h2} := T_{xz23h2} \cdot \sin(45deg)$ $\boxed{T_{x23h2} = 974\,lb}$

$T_{x24h2} := T_{xz24h2} \cdot \sin(15deg)$ $\boxed{T_{x24h2} = 526\,lb}$

$T_{z23h2} := T_{xz23h2} \cdot \cos(45deg)$ $\boxed{T_{z23h2} = 974\,lb}$

$T_{z24h2} := T_{xz24h2} \cdot \cos(15deg)$ $\boxed{T_{z24h2} = 1963\,lb}$

$M_x := (T_{x23h2} - T_{x24h2}) \cdot h_2 + (T_{x12h1} - T_{x13h1}) \cdot h_1$ $\boxed{M_x = 5123\,ft \cdot lb}$

$M_z := (T_{z13h1} + T_{z12h1}) \cdot h_1 + (T_{z23h2} + T_{z24h2}) \cdot h_2$ $\boxed{M_z = 66103\,ft \cdot lb}$

10" ϕ Extra Strong Pipe Column $S_x := 39.4in^3$

$F_b := 0.6 \cdot 36000 \cdot \frac{lb}{in^2} \cdot 1.33$ (LDF)

$f_{bx} := \frac{M_x}{S_x}$ $f_{bx} = 16782 \cdot \frac{lb}{in^2}$

$f_{bz} := \frac{M_z}{S_x}$ $f_{bz} = 20133 \cdot \frac{lb}{in^2}$

$CombinedStress := \frac{f_{bx}}{F_b} + \frac{f_{bz}}{F_b}$ $\boxed{CombinedStress = 0.755}$