

12 AUG 2008

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SUBJ: PATIO COVER/CANOPY

I have reviewed the design and construction of the patio covers detailed herein. As demonstrated in the attached calculations the patio covers when constructed in accordance with the attached details meet or exceed the requirements of the 1997 Uniform Building Code (UBC), 2003 and 2006 International Building Codes, 2003 and 2006 International Residential Code, and the 2000 and 2005 Aluminum Design Manuals. The design loading is in accordance with UBC Appendix Chapter 31 Division III, IBC 1607.11.2.4, IBC Appendix I, or IRC Appendix H

Design Loading:

- 20 psf Live Load Commercial applications
- 10 psf Live Load Residential applications
- 100 lb point load on any roof member at any location (UBC 1607.4.4, IBC Table 1607.1 note 1) Not concurrent with other live loads or maximum snow load.
- Wind Load in accordance with the span tables
- Snow load in accordance with the span tables.
- Seismic - since structural weight is under 2 psf seismic loading can be considered insignificant since wind loading is much greater for all applications.

The attached Roof Span/Loading Tables indicate the maximum allowable load for a given rafter length and post spacing.

Loads up to 100 lbs each may be hung at any location on any rafter. Multiple smaller hanging loads up to 100 lbs total per rafter may be hung on each rafter. The hanging loads may not be concurrent with snow loads exceeding 10 psf. When higher snow loads are anticipated the hanging loads shall be removed.

For splices in the support beam:

- Splice shall be made in accordance with the approved splice design.
- Splices shall be permitted only when 3 or more posts are used. There shall be a minimum of 2 posts more than the number of splices used. For example if there is 4 posts used there may be 3 beam members with two splices. All splices shall be in accordance with the details shown herein.

The roof pitch can be any desired pitch up to 6:12 provided the rafter's horizontal projected length does not exceed the specified length.

For snow loads less than 30 psf the posts may bear directly on a concrete slab with a minimum thickness of 4 inches. For greater snow loads the slab shall be thickened to 6 inches for 16 inches square at each post location.

If placed on independent footings (no slab) the footings shall have a minimum bearing area of 1 square foot up to 30 psf snow load and 16" square for snow loads of 30 to 60 psf. The minimum footing weight shall be 500 lbs per footing for tributary areas  $\leq 40$  sf and 900 lbs for tributary areas of  $40\text{sf} < A \leq 72$  sf.

Typical installation is to attach the upper side of the canopy structure to a building wall. Rafter span shall be taken as the horizontal distance from the supporting wall ledger to the centerline of the supporting box beam or inner face of the gutter beam.

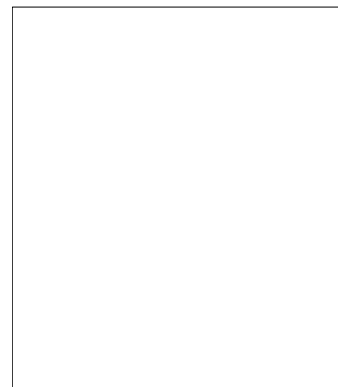
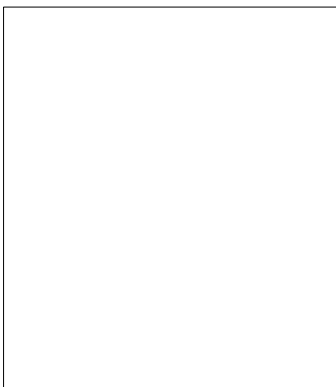
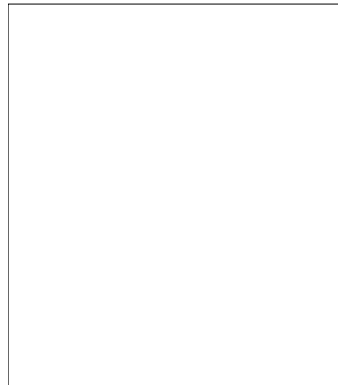
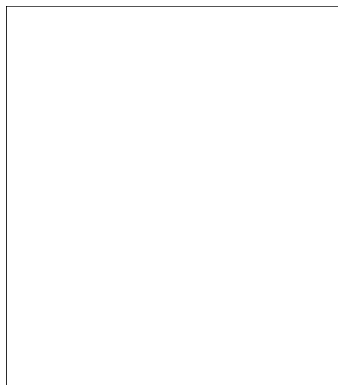
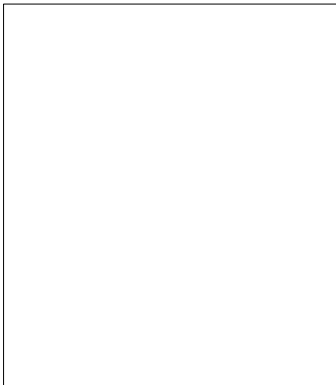
The canopy may be installed as a mono-slope free standing roof as shown in the attached calculations.

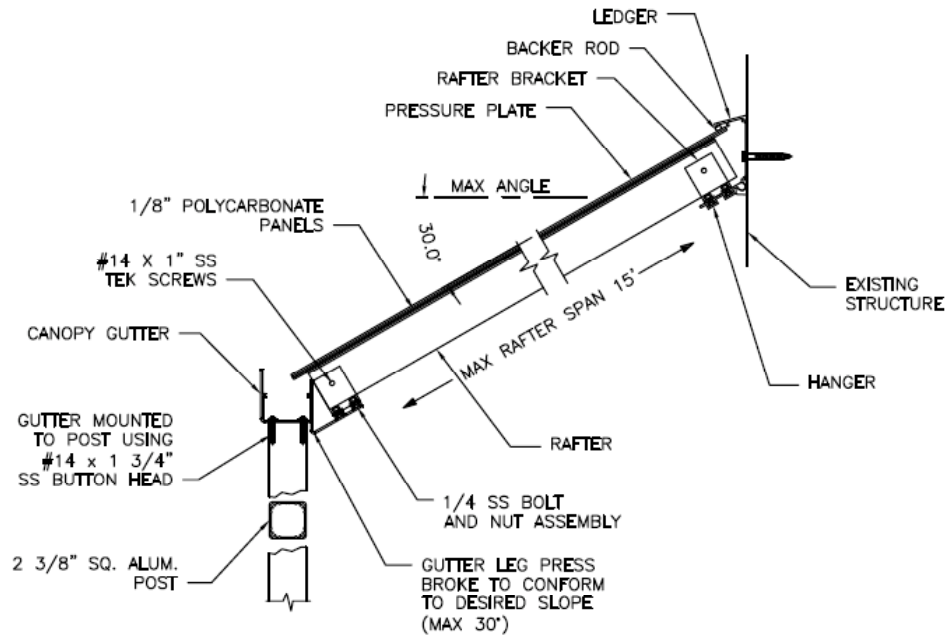
Material type for rafters and posts shall be Aluminum alloy type 6005 T5 or 6061 T6. Beams, ledgers and other extrusions may be these alloys or 6063 T6. All screws and bolts shall be either 304 or 316 stainless steel or hot dipped galvanized.

Refer to following Structural Calculations for additional information.

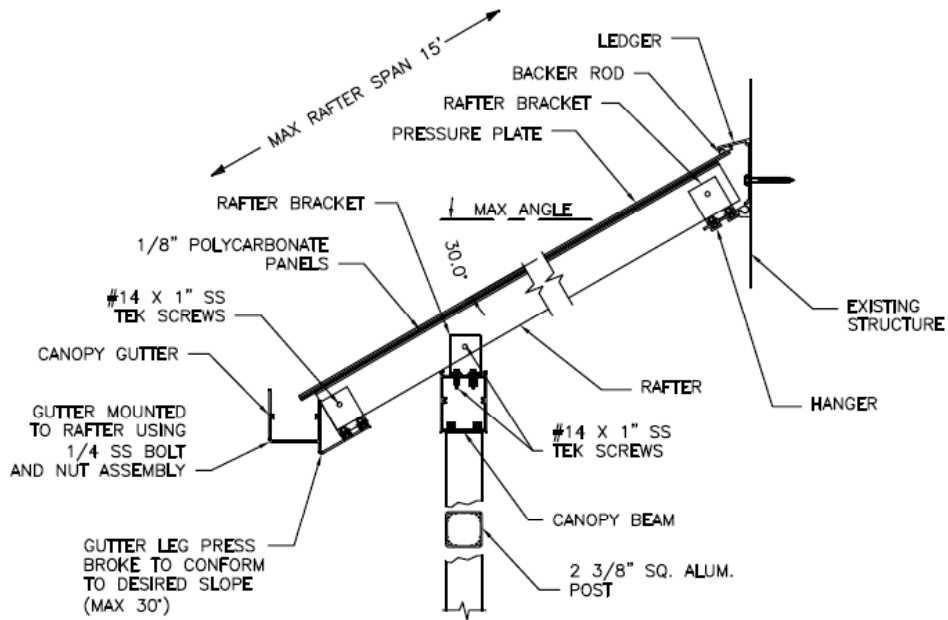
Edward Robison, P.E.

Stamped 08/12/2008





A GUTTER SUPPORT CANOPY DETAIL  
3/4" = 1'



B BEAM SUPPORT CANOPY DETAIL  
3/4" = 1'

**ROOF PANELS:**

0.118" Polycarbonate panels (Lexan® or equivalent)

Allowable deflection: L/60

Allowable bending stress = (13,500 psi/1.6) = 8,437 psi

$$S = 12'' * 0.118^2 / 6 = 0.0278 \text{ in}^3/\text{ft}$$

$$M_a = 0.0278 \text{ in}^3/\text{ft} * 8,437 \text{ psi} = 235\#'' = 19.58\#'$$

Determine allowable span based on 50psf load on panel.

$$M = (wL^2/8) < M_a$$

Solving for L with w = 50 psf:

$$L = \sqrt{(19.58\#'' * 8 / 50\#')} = 1.77'$$

Use 20" for rafter spacing

$$D = 0.74 \text{ psf}$$

Check panel deflection:

Deflection will be resisted by shell forces as panel deflects.

Check stress at L/60 = 20"/60 = 0.333"

$$C_t = \frac{WL^2}{8\Delta} = \frac{50/12 * 20^2}{8 * 0.333''} = 626 \text{ plf}$$

$$f_T = 626 \text{ plf} / (12'' * 0.118'') = 442 \text{ psi}$$

Panel anchorage to rafters:

Panel is secured with pressure plate screwed to rafter. Tension strength of #14 Tek screw:

5/8" thread into rafter screw channel

$$P_{not} = 0.5 * 0.58 * A_{sn} * t * F_{tu}$$

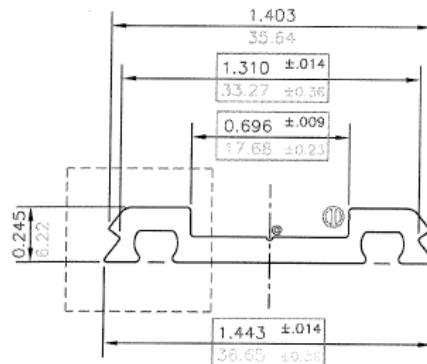
$$= 0.5 * 0.58 * 0.539'' * 0.625'' * 30 \text{ ksi} = 2,930\#$$

$$P_{st} = 2,930 / 3 = 977\# \text{ controls}$$

For screw strength

$$T_s = 0.75 * 56 \text{ ksi} * 0.0318 \text{ in}^2 = 1,334\#$$

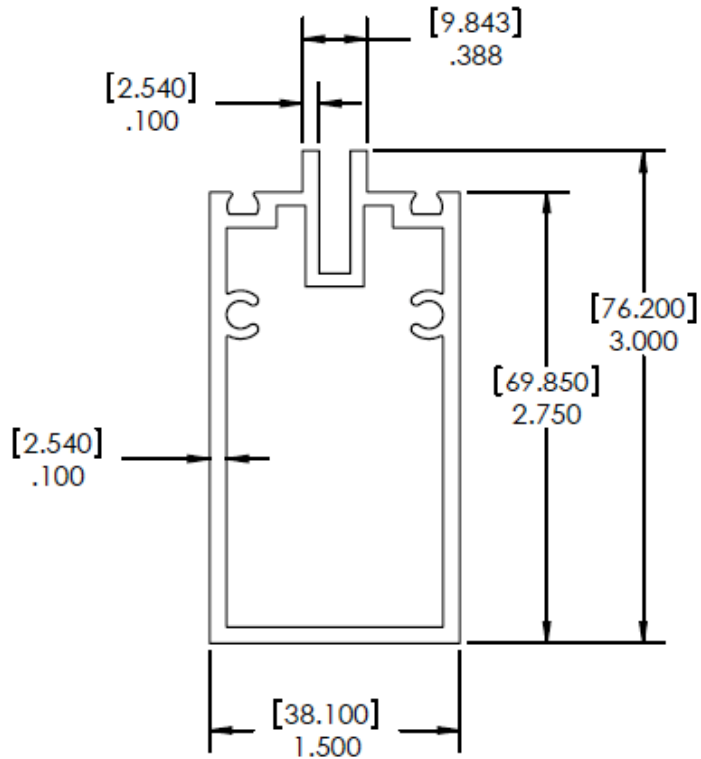
Screw spacing = 977#/626# = 1.56' use 18" on center.



**RAFTER**

**Section Properties:**

- A = 1.01 in<sup>2</sup>
- Centroid: 0.75", 1.57"
- I<sub>xx</sub> = 0.98 in<sup>4</sup>
- I<sub>yy</sub> = 0.33 in<sup>4</sup>
- S<sub>xx</sub> = 0.62 in<sup>3</sup>
- S<sub>yy</sub> = 0.44 in<sup>3</sup>
- J = 1.31 in<sup>4</sup>
- D = 1.2 plf



Calculate bending strength of rafter:

From ADM Table 2-20 or Table 2-22 6061-T6 or 6005-T5

F<sub>t</sub> = 19 ksi (line 2)

For compression:

Tubular shape:

$$S_R = 2L_b S_c / [C_b \sqrt{I_y J}]$$

$$S_R = 2L_b 0.44 / [1.25 \sqrt{(0.33 * 1.31)}]$$

$$S_R = 1.07 * \sqrt{L_b} \leq 123$$

L<sub>b</sub> = (123/1.07) = 115"

For L ≤ 115" F<sub>c</sub> = 21 ksi

Determine length for F<sub>c</sub> = F<sub>t</sub> = 19 ksi

$$23.9 - 0.238 * \sqrt{L * 1.07} = 19$$

$$L = [(23.9 - 19) / 0.238]^2 / 1.07 = 396" = 33'$$

Since this is longer than longest rafter length to be used the F<sub>t</sub> = 19 ksi will control rafter stresses.

$$M_a = F_b * S_{xx} = 19 \text{ ksi} * 0.62 \text{ in}^3 = 11,780 \text{ #"} = 981.7 \text{ #'}$$

Rafter spans for 20" on center spacing for given uniform load:

$$L = \sqrt{[M_a * 8 / (1.667 * w)]} = \sqrt{[981.7 \text{ #'} * 8 / (1.667 * w)]} = \sqrt{[4,711 / w]}$$

$$w = 4,711 / L^2$$

w = D+S or D+W where D = 0.74psf+1.2plf/1.667 = 1.46 psf

For deflection limit = L/120

$$\delta = 5wL^4 / (384EI) = L/120 \text{ solving for w:}$$

$$w = 384EI / (5 * 120 * L^3) = 384 * 10,100,000 * 0.98 / (600 * L^3) = 6334720 / L^3 \text{ lb/(inxft)}$$

**GUTTER BEAM**

Section Properties:

$A = 2.02 \text{ in}^2$

Centroid:  $x = 3.12''$ ,

$y = 3.96''$

$I_{xx} = 2.95 \text{ in}^4$

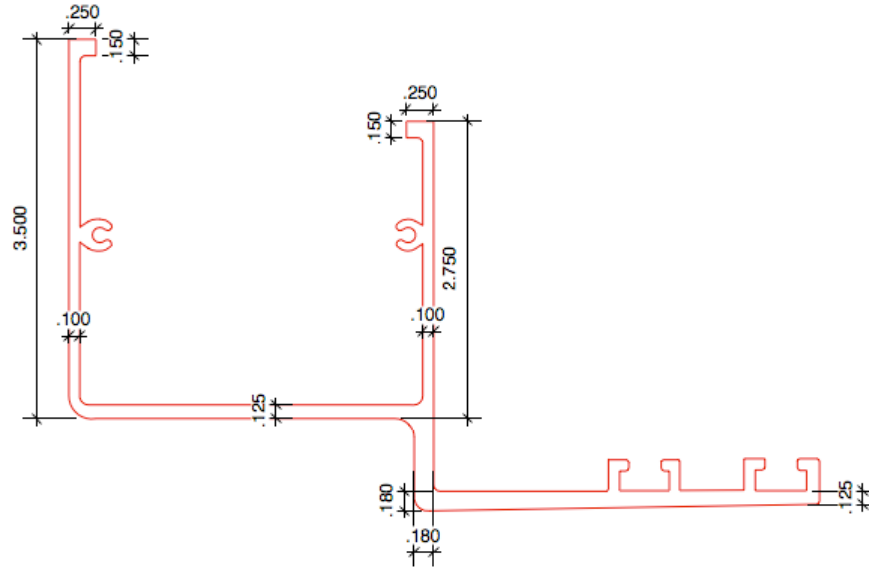
$I_{yy} = 9.05 \text{ in}^4$

$S_{xx} = 0.946 \text{ in}^3$

$S_{yy} = 2.29 \text{ in}^3$

$r_{xx} = 1.207 \text{ in}$

$r_{yy} = 2.116 \text{ in}$



Use stiffeners at top of gutter legs:

$A_s = b \cdot t / 2 =$

$(1.675'' -$

$.1875) \cdot 0.1 / 4 = 0.037 \text{ in}^2$

$I_s = A_s / t_s = 0.037 / 0.15 = 0.25''$

From ADM Table 2-24 6063-T6

Table 2-24  $F_T = 15 \text{ ksi}$  line 2 (bottom)

Check allowable compression stress:

$b/t = 0.25 / .15 = 1.67 < 7.2$  ADM Sec 3.4.15

$h/t = 3.125 / .1 = 31.25 < 53$  ADM Sec 3.4.18

$F_c = 15 \text{ ksi}$

$M_a = 15 \text{ ksi} \cdot 0.946 \text{ in}^3 = 14,190 \#'' = 1,182.5 \#'$

Gutter Beam Span to load relationship:

$L = \sqrt{[M_a \cdot 8 / (w)]} = \sqrt{[1,182.5 \# \cdot 8 / (w)]} = \sqrt{[9,460 / w]}$

$w = 9,460 / L^2$

$w = D + S$  or  $D + W$

For deflection limit =  $L / 72$

$\delta = 5wL^4 / (384EI) = L / 72$  solving for  $w$ :

$w = 384EI / (5 \cdot 72 \cdot L^3) = 384 \cdot 10,100,000 \cdot 2.95 / (600 \cdot L^3) = 19068800 / L^3 \text{ lb/in}$

**Gutter Section:**

Rafter is supported by leg on gutter extrusion. Load is transferred from rafter to leg by connection bracket which is screwed to leg- Determine length of leg that supports rafter:

Design concentrated load:  
 $7.5' \times 2' \times 30 \text{ psf} = 450\#$

Bracket length = 1.813"  
 Screw chase rib stiffness:

$$I_{yy} = 0.0155 \text{ in}^4$$

$$S_{xx} = 0.0445 \text{ in}^3$$

Length that will resist concentrated load based on  $\delta = 2t = 2 \times 1/8" = 1/4"$

$$\delta = P \cdot l^4 / (48EI) \text{ solve for } l$$

$$l = [\delta \cdot 48EI / P]^{1/4} =$$

$$l = [0.25 \cdot 48 \cdot 10,100,000 \cdot 0.0155 / 450]^{1/4} =$$

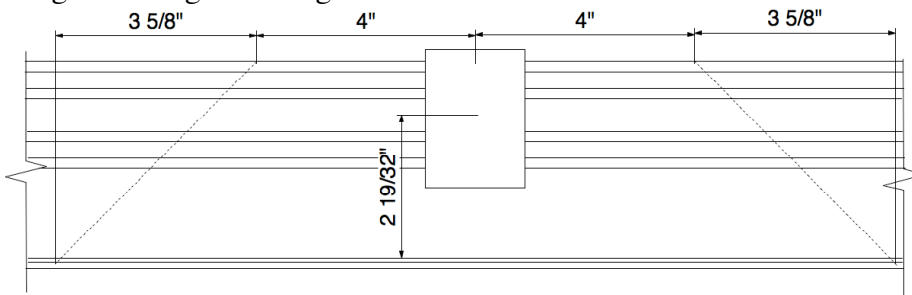
$$l = 8.04"$$

Check stress:

$$f_b = (450\# \cdot 8.04/4) / 0.0445 = 20,326 \text{ psi}$$

$F_t = 20 \text{ ksi close}$  - use 8" tributary length for stiffened section

Length of flange resisting concentrated load =  $8" + 2 \cdot 3.625" = 15.25"$



Calculate strength of flange:

$$S = 15.25" \cdot 0.125"{}^2 / 6 = 0.0397 \text{ in}^3$$

$$M = 450\# \cdot 2 - 19/32" = 1167\#"$$

$$f_b = 1167\# / 0.0397 = 29,400 \text{ psi}$$

$$F_t = 20 \text{ ksi}$$

Need to increase flange thickness

$$S_{req} = 1,167 / 20,000 = 0.0584 \text{ in}^3$$

$$t_{min} = \sqrt{(0.0584 \cdot 6 / 15.25)} = 0.152"$$

$$t_{req} = 0.152 / 0.85 = 0.1788"$$

Use 0.18" for flange thickness, can taper.

Determine Allowable spans/loads:

Allowable loads based on previously derived formula:

Table A: ALLOWABLE LOADS ON RAFTERS

ALLOWABLE RAFTER LOADS:			20" on center rafter spacing	Allowable load in psf, wind/snow
SPAN	W(stress)	$\delta = l/120$	W(deflection)	$W_{all} - D$
6	130.9	0.6	122.2	120.7
7	96.1	0.7	76.9	75.5
8	73.6	0.8	51.5	50.1
9	58.2	0.9	36.2	34.7
10	47.1	1	26.4	24.9
11	38.9	1.1	19.8	18.4
12	32.7	1.2	15.3	13.8
13	27.9	1.3	12.0	10.6
14	24.0	1.4	9.6	8.2
15	20.9	1.5	7.8	6.4

Table B: ALLOWABLE LOADS ON GUTTER BEAM:

SPAN	W(stress)	$\delta = l/72$	W(deflection)	Allowable load in plf, wind/snow $W_{all} - D$
6	262.8	1.00	613.1	261.3
7	193.1	1.17	386.1	191.6
8	147.8	1.33	258.6	146.4
9	116.8	1.50	181.6	115.3
10	94.6	1.67	132.4	93.1

Load per rafter is based on 20" on center spacing.

For closer spacing use  $W_{all} - D$  which is allowable imposed load per foot.

Table C: ALLOWABLE LOADS FOR GIVEN RAFTER AND BEAM SPAN

RAFTER SPAN FT	GUTTER SPAN FT	ALLOWABLE LOAD PSF
8	8	31.4
8	10	23
8	12	16
10	8	24.9
10	10	18
10	12	12.8
12	12	13.8*
12	13	9.6
13	10	10.6*
13	12	9.9
14	12	8.2*
15	12	6.3*

Allowable load is snow or wind load in psf.

\*Rafter strength controls allowable load.

4"X3" TUBE BEAM

Area = 2.18 in<sup>2</sup>

Weight = 2.52 plf

I<sub>xx</sub> = 4.52 in<sup>4</sup>

I<sub>yy</sub> = 2.93 in<sup>4</sup>

r<sub>xx</sub> = 1.44 in

r<sub>yy</sub> = 1.16 in

Location of centroid:

C<sub>xx</sub> = 2.097"

C<sub>yy</sub> = 1.525"

S<sub>xx</sub> = 2.157 in<sup>3</sup>

S<sub>yy</sub> = 1.924 in<sup>3</sup>

J = 4.60 in<sup>4</sup>

Aluminum 6063-T6

Allowable stress from ADM

Table 2-24

F<sub>t</sub> = 15 ksi Sec 3.4.2

Compression:

Based on L<sub>b</sub> = 10' max

(cantilevered beam or continuous multiple span applications)

$$2L_b S_c / \sqrt{I_y J} = 2 * 120'' * 1.924 \text{ in}^3 / \sqrt{(2.93 \text{ in}^4 * 4.60 \text{ in}^4)} = 125.8 < 130$$

F<sub>c</sub> = 15 ksi Sec 3.4.14

Allowable moment on beam:

$$M_a = 2.157 \text{ in}^3 * 15 \text{ ksi} = 32,355 \text{ #''} = 2,696 \text{ #'}$$

Gutter Beam Span to load relationship:

$$L = \sqrt{[M_a * 8 / (w)]} = \sqrt{[2,696 \text{ #''} * 8 / (w)]} = \sqrt{[21,568 / w]}$$

$$w = 21,568 / L^2$$

$$w = D + S \text{ or } D + W$$

For deflection limit = L/72

$$\delta = 5wL^4 / (384EI) = L/72 \text{ solving for } w:$$

$$w = 384EI / (5 * 72 * L^3) = 384 * 10,100,000 * 4.52 / (600 * L^3) = 29217280 / L^3 \text{ lb/in}$$

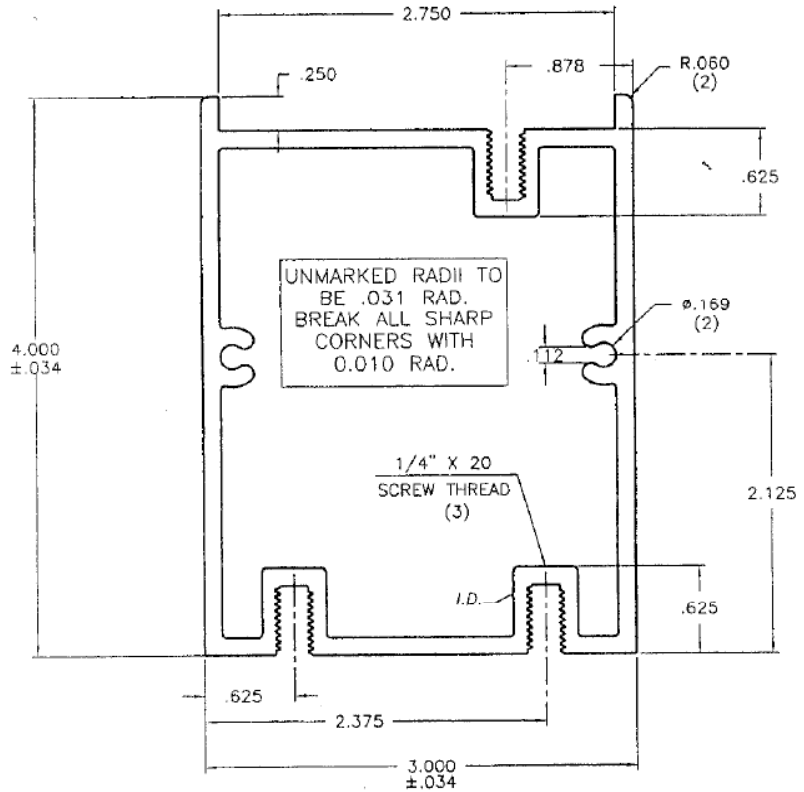


TABLE D: ALLOWABLE BOX BEAM LOADS:

SPAN	W(stress)	$\delta = l/72$	W(deflection)	Allowable load in plf, wind/snow $W_{all-D}$	LOAD/RAFTER
8	337.0	1.33	396.3	335.5	559.3
9	266.3	1.50	278.3	264.8	441.4
10	215.7	1.67	202.9	201.4	335.8
11	178.2	1.83	152.4	151.0	251.7
12	149.8	2.00	117.4	116.0	193.3
13	127.6	2.17	92.4	90.9	151.5
14	110.0	2.33	73.9	72.5	120.8
15	95.9	2.50	60.1	58.7	97.8
16	84.3	2.67	49.5	48.1	80.1
17	74.6	2.83	41.3	39.8	66.4
18	66.6	3.00	34.8	33.3	55.6
19	59.7	3.17	29.6	28.1	46.9
20	53.9	3.33	25.4	23.9	39.8

Load per rafter is based on 20" on center spacing.

For closer spacing use  $W_{all-D}$  which is allowable imposed load per foot.

Table E: ALLOWABLE LOADS FOR GIVEN RAFTER AND BEAM SPAN

2' overhang

RAFTER SPAN FT	BOX BEAM SPAN FT	ALLOWABLE LOAD PSF
8	8	50.1*
8	10	33.6
8	12	19.3
8	14	12.1
10	10	24.9*
10	12	16.6
10	14	10.4
12	12	13.8*
12	14	9.1
13	13	10.6*
14	13.75	8.2*
15	14.75	6.4

Based on 2' overhang measured from centerline of box beam, and main rafter span as shown.

\*Indicates that rafter strength controls allowable load, wind or snow.

Box beams may cantilever up to 1/4 the main span length past the posts using the allowable loads shown in tables B, C, D or E

Post strength:

6005-TS or 6061T6

Post

-Area 0.995"

$$I_{xx} = I_{yy} = 0.863 \text{ in}^4$$

$$S = 0.726 \text{ in}^3$$

$$r = 0.923 \text{ in}$$

$$J = 0.98 \text{ in}$$

$k \leq 1$  for all applications

Allowable bending stress ADM Table 2-21

$$S_1 = \frac{L_B S_C}{0.5\sqrt{I_y J}} = \frac{L_B \cdot 0.726}{0.5\sqrt{0.863 \cdot 0.98}} = 1.58 L_B$$

for  $L_B \leq \frac{146}{1.58} = 92'' \rightarrow F_{CB} = 21 \text{ ksi}$

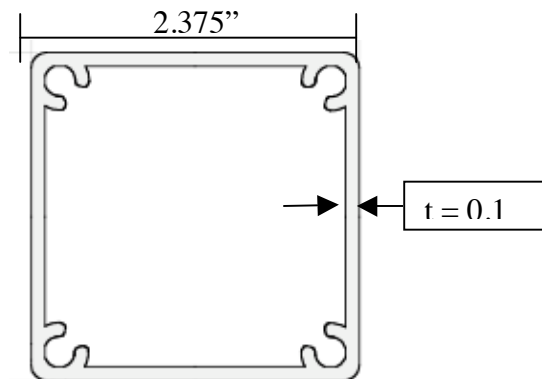
158

for  $L_B > 92'' F_{CB} = 2.39 - 0.24(1.58 L_B)^{1/2}$

$M_{all} = 0.726 \cdot 19^{ksi} = 13,794 \text{ #''} = 1,149 \text{ #''}$  LATERAL LOAD CAUSED MOMENT PER POST, REQUIRES CORE MOUNTED POST TO ACHIEVE FULL MOMENT STRENGTH.

When 1/3 stress increase is allowed IBC 1607.7.1.3

$$M_{incr} = 1 \frac{1}{3} \cdot 13,794 = 18,346 \text{ #''} = 1,149 \text{ ft-lb}$$



Determine allowable axial load for given post height:

For  $L_B \leq S_1/r$ :

$$S_1 = L_B S_C / [0.5\sqrt{(I_y J)}] = L_B 0.726 \text{ in}^3 / [0.5\sqrt{(0.863 \text{ in}^4 * 0.98)}] = 1.58 L_B$$

Limit for  $F_a = F_c = 21 \text{ ksi}$ :  $L_B \leq 146 / 1.58 = 92''$

For greater post heights:

$$F_a = 51,000 / (kl/r)^2 \text{ ksi}$$

for  $k = 1.33$  and  $l = 120''$

$$F_a = 51,000 / (1.33 * 120 / 0.923)^2 = 1.7 \text{ ksi}$$

Allowable post load =  $0.995 \text{ in}^2 * 1.7 \text{ ksi} = 1.7 \text{ k}$

Connection to base plate

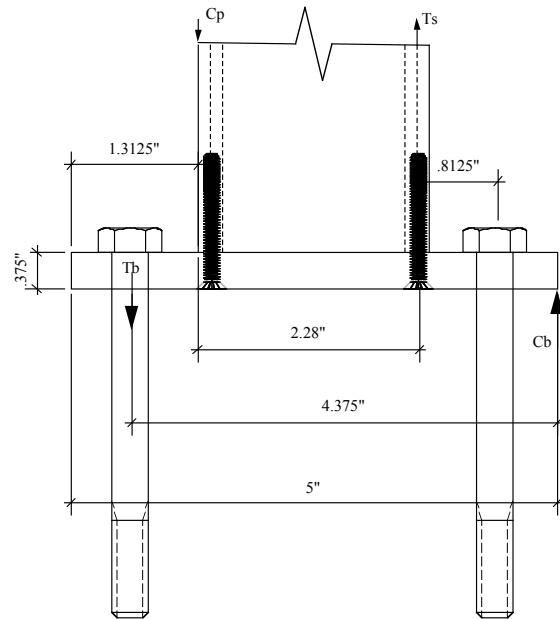
- Failure modes → screw tension
- screw shear
- screw withdrawal

For screw withdrawal  
**See ADM 5.4**

$$W = 2.3 \cdot e \cdot d \cdot \pi \cdot F_{sy}$$

e = full thread engagement = 1"  
 d = max root diameter = 0.248"  
 minor = 0.185"

Base plate to post screws are AISI 4037 steel alloy fabricated in accordance with SAE J429 Grade 8 and coated with Magni 550 corrosion protection.



$$F_{sy} = 20 \text{ ksi}$$

$$W = 2/3 \cdot 1'' \cdot 0.248'' \cdot \pi \cdot 20^{\text{ksi}}$$

$$W = 10.39^{\text{k}}$$

$$W' = \frac{10.39}{3.0}$$

Safety factor

$$= 3.46^{\text{k}}$$

Major root area

Screw tension →  $T_y = 0.0483 \text{ in}^2 \cdot 110 \text{ ksi} = 5314^{\#}$

$$V_u = 0.0483 \cdot 45 \text{ ksi} = 2,174^{\#}$$

average root area

$$F_{tU} = 0.0376 \cdot 150 \text{ ksi} = 5640^{\#}$$

Safety factors for screws calculated from SEI/ASCE 8-02 Section 5 LRFD factors

For yielding  $SF = 1.6/0.75 = 2.13 \rightarrow 5,314^{\#}/2.13 = 2,495^{\#}$

For fracture  $SF = 1.6/0.65 = 2.46 \rightarrow 5640/2.46 = 2,293^{\#}$

Shear strength

For fracture  $SF = 1.6/(0.9 \cdot 0.75) = 2.37 \rightarrow 5,640/2.37 = 2,380^{\#}$

Base plate bending stress

$$F_t = 24 \text{ ksi} \rightarrow S_{\text{min}} = \frac{5'' \cdot 3/8^2}{6} = 0.117 \text{ in}^3$$

Base plate allowable moment

$$M_{all} = 24 \text{ ksi} \cdot 0.117 \text{ in}^3 = 2,812 \text{ \#"}^{\prime\prime}$$

→ Base plate bending stress

$$T_B = C$$

$$M = 0.8125'' \cdot T_B \cdot 2$$

$$T_{all} = \frac{2,812}{2 \cdot 0.8125} = 1,730^{\#}$$

Maximum post moment for base plate strength

$$M_{all} = 2 \cdot 1730 \cdot 4.375'' = 15,142^{\#"}^{\prime\prime}$$

Limiting factor = screws to post

$$M_{ult} = 2 \cdot 5,314^{\#} \cdot 2.28'' = 24,232^{\#"}^{\prime\prime}$$

$$M_{all} = 2 \cdot 2,380^{\#} \cdot 2.28'' = 10,853^{\#"}^{\prime\prime}$$

When 1/3 stress increase is allowed

IBC 1607.7.1.3

$$M_{1/3} = 10,853 \cdot 4/3 = 14,470^{\#"}^{\prime\prime}$$

For factors of safety refer to Aluminum Design Manual Section 5.3.2.1 and SEI/ASCE 8-02 section 5

#### BASE PLATE ANCHORAGE

$$T_{Des} = \frac{10,853}{2 \cdot 4.375''} = 1,240^{\#}$$

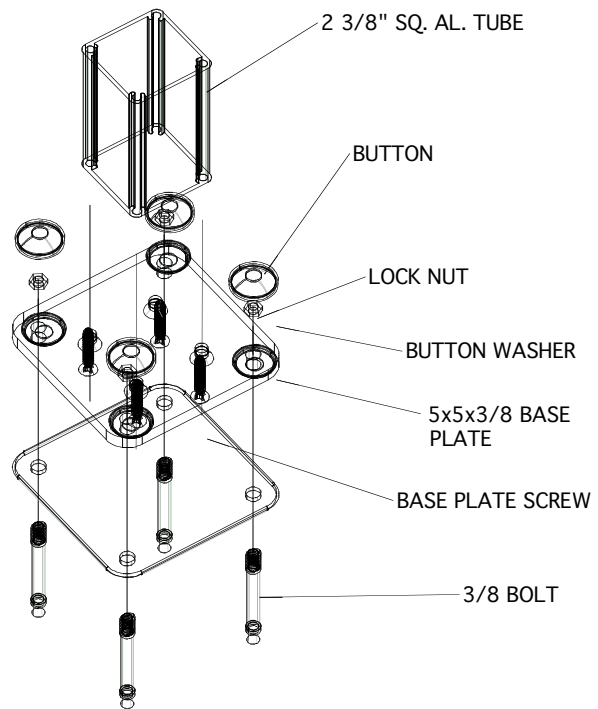
adjustment for concrete bearing pressure:

$$a = 2 \cdot 1240 / (2 \cdot 3000 \text{ psi} \cdot 4.75'') = 0.087''$$

$$T'_{Des} = \frac{10,853}{2 \cdot (4.375'' - 0.087/2)} = 1,253^{\#}$$

For 96'' post height the maximum live load at the top of the post is:

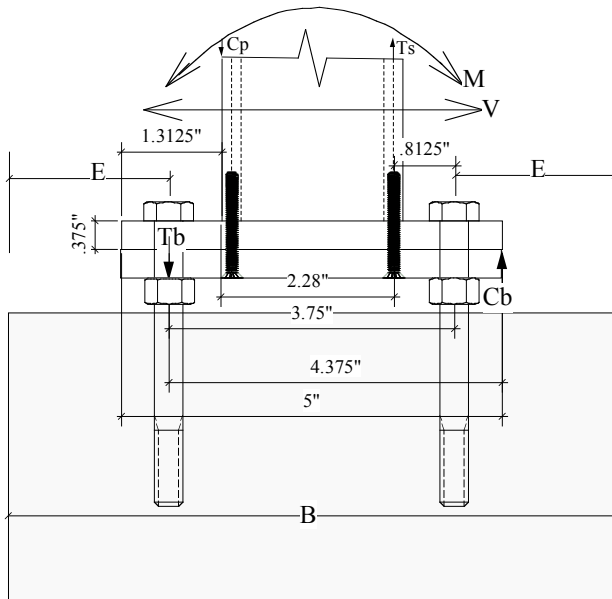
$$P_{max} = 10,853^{\#} / 96'' = 113^{\#} \text{ lateral load}$$



**BASEPLATE DESIGN AND ANCHORAGE –**

Baseplates are raised up and bear on nuts installed on epoxy anchored threaded rod.  
 Maximum allowable moment = 10,500#”, vertical load = 1.7k

Design anchorage for 10,500#” moment.



Bolt tension for typical design

$$T = 10,500 / (2 * 3.75) = 1,400\#$$

Anchor to concrete:

1/2” x 5” all-thread embedment depth = 3.5” and 4,000 psi concrete strength.  
 Allowable loads taken from ER-5560,

T = 2,700# Adjustment for anchor spacing = 3.75”

$$Cs@ 3.75” = 1 - 0.20[(5.625 - 3.75) / 4.5] = 0.917$$

Adjustment for edge distance = 2-1/8”

$$Ce = 1 - 0.30[(3.375 - 2.125) / 2.25] = 0.833$$

$$T' = 2,700\# * 0.917 * 0.833 = 2,062\#$$

Check base plate strength: Bending is biaxial because it sits on bearing nuts:

$$M = (3.75” - 2.28”) / 2 * 1,400\# * 2 * \sqrt{2} = 2,910”\#$$

Bending stress in plate

The effective width at the post screws: 3.86”

$$S = 2 * 3.86” * 0.375^2 / 6 = 0.181 \text{ in}^3$$

$$fb = 2,910 / 0.181 = 16,080 \text{ psi}$$

Allowable = 19 ksi

Bearing on nut:

$$\text{Area} = (0.8^2 - 0.5625^2) \pi = 1.0 \text{ in}^2$$

$$fb = 1,400\# / 1.0 = 1,400 \text{ psi} - \text{Okay}$$

Screws to post – okay based on standard base plate design

Posts okay based on standard post design

**OFFSET BASE PLATE**

Offset base plate will have same allowable loads as the standard base plate.

Anchors to concrete are same as for standard base plate.

**ALLOWABLE LATERAL LOADS ON CANOPY**

Determine the maximum allowable lateral load per post.

$$M_1 = H \cdot h \text{ where:}$$

$M_1$  = moment from lateral load

H = horizontal load (wind or seismic)

h = post height

$$w = H/a \text{ where:}$$

a = tributary vertical projected area to each post

For base plate mounted posts with gutter beam:

$$10,500\#'' = H \cdot h$$

$$H = 10,500\#''/h$$

$$h = 10,500\#''/H$$

For base plate mounted posts with box beam:

$$10,500\#'' = H \cdot (h/2)$$

$$H = 21,000\#''/h$$

$$h = 21,000\#''/H$$

For core mounted posts with gutter beam:

$$13,794\#'' = H \cdot h$$

$$H = 13,794\#''/h$$

$$h = 13,794\#''/H$$

For core mounted posts with box beam:

$$13,794\#'' = H \cdot (h/2)$$

$$H = 27,588\#''/h$$

$$h = 27,588\#''/H$$

Example of how to apply equations to determine maximum allowable wind load:

For a typical canopy 8' post height (h = 96'') and width = 10' and 2:12 pitch.

Lateral loading occurs from wind load on edge of canopy roof,  $A = 10' \cdot 0.43' = 4.3 \text{ sf}$ .

1/2 of lateral load is tributary to the front posts of the canopy. For two posts 1/2 of this is tributary to each post so 1/4 of full lateral load is tributary to each post.

Determine allowable wind loads for this canopy:

For base plate mounted posts with gutter beam:

$$w = (10,500\#''/96'')/(4.3\text{sf}/4) = 101.7 \text{ psf}$$

For base plate mounted posts with box beam:

$$w = (21,000\#''/96'')/(4.3\text{sf}/4) = 203.4 \text{ psf}$$

Therefore horizontal loads from wind will rarely control the canopy design.

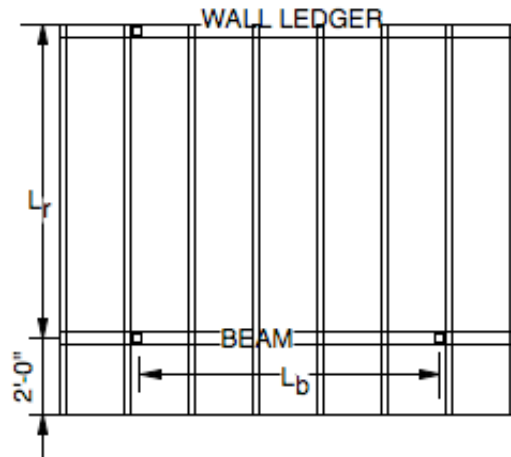
**Example 1:**

Determine the maximum canopy size that can be constructed using the box beam option with 2' cantilever on the box beam each end and 2' rafter overhang.

Wind load = 21.5 psf (85 mph exp B)

From Table E the maximum beam span:

RAFTER	BOX BEAM	ALLOWABLE
SPAN FT	SPAN FT	LOAD PSF
8	8	50.1*
8	10	33.6
8	12	19.3
8	14	12.1
<u>10</u>	<u>10</u>	<u>24.9*</u>
10	12	16.6
10	14	10.4
12	12	13.8*
12	14	9.1
13	13	10.6*
14	13.75	8.2*
15	14.75	6.4



Rafter span can be up to 10' with 10' box beam span for total canopy size of: 10' + 2' = 12' rafters and 10' + 2\*2' = 14' box beam length.

Or by using the individual rafter and box beam tables:

To determine maximum rafter length allowable for the wind load check table A:

ALLOWABLE RAFTER LOADS:			20" on center rafter spacing	Allowable load in psf, wind/snow
SPAN	W(stress)	$\delta = l/120$	W(deflection)	$W_{all.-D}$
6	130.9	0.6	122.2	120.7
7	96.1	0.7	76.9	75.5
8	73.6	0.8	51.5	50.1
9	58.2	0.9	36.2	34.7
<u>10</u>	<u>47.1</u>	<u>1</u>	<u>26.4</u>	<u>24.9</u>
11	38.9	1.1	19.8	18.4

Maximum rafter span is 10'

The maximum beam span for the 10' rafter span:  $W = (2' + 10/2) * 21.5 = 150.5$  plf.

From Table D the maximum beam span = 11'

Maximum canopy size is:

10' + 2' = 12' rafters and 11' + 2\*2' = 15' box beam length.

Snow loads shall be checked similarly.

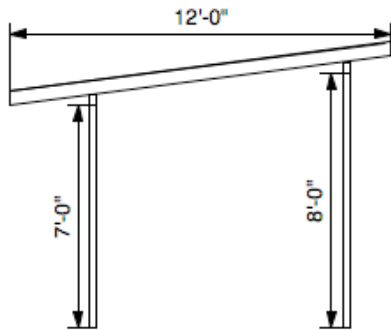
Free standing mono-slope roof:

The canopy components may be used to construct a free standing mono-slope roof. The free standing roof is constructed using box beam at the upper side and either a box beam or gutter beam at the lower side. Roof pitch can vary from 1/4" per foot to 6" per foot.

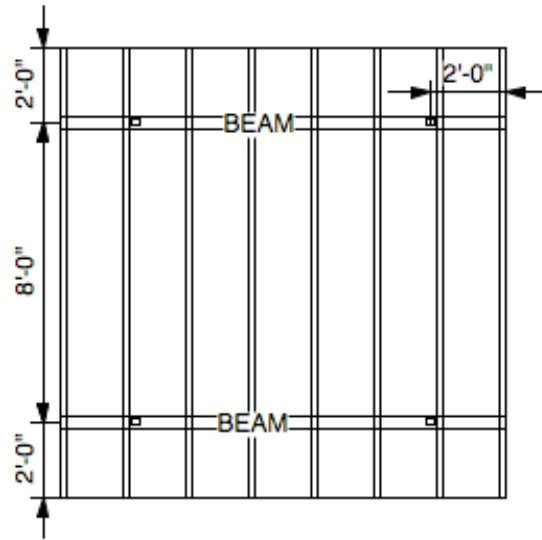
The allowable rafter and beam spans are the same as for the attached canopy.

Allowable lateral loads shall be calculated the same as previously shown using the tallest post height for h.

Example: Determine allowable loading on a 12' x 12' canopy constructed with box beams and 2' overhang all around.



Rafter span = 8' and box beam span = 8'  
From Table E the allowable load = 50.1 psf



For posts mounted to concrete with base plates determine allowable lateral load:

$$a_1 = 12' * 0.46' = 5.52 \text{ sf or}$$

$$a_1 = 12' * (0.33 + 0.25 + 1.5') = 24.96 \text{ sf}$$

For base plate mounted posts with box beam:

$$w = (21,000\# / 96) / (24.96\text{sf} / 4) = 35.0 \text{ psf}$$

Therefore lateral load will only control when wind load exceeds 35.0 psf.