



## Civil & Structural Engineering Design Services Pty. Ltd.

**Client:** Extreme Marquees Pty Ltd  
**Project:** Design check – 5m × 5m Pavilion Marquees Structure for 45km/hr Wind Speed  
**Reference:** Extreme Marquees Technical Data

Report by: KZ  
Checked by: EAB  
Date: 22/03/2017

JOB NO: E-11-265231-2



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### Table of Contents

1	Introduction.....	3
2	Design Restrictions and Limitations.....	4
3	Specifications.....	5
3.1	General.....	5
3.2	Section Properties.....	6
4	Design Loads.....	6
4.1	Ultimate.....	6
4.2	Load Combinations.....	6
4.2.1	Serviceability .....	6
4.2.2	Ultimate .....	6
5	Wind Analysis.....	6
5.1	Parameters .....	6
5.2	Pressure Coefficients ( $C_{fig}$ ).....	7
5.2.1	Pressure summary.....	8
5.3	Wind Load Diagrams.....	9
5.3.1	Wind 1(case 1) .....	9
5.3.2	Wind 1(case 2) .....	9
5.3.3	Wind 2(Case1) .....	10
5.3.4	Wind 2(case 2) .....	10
5.3.5	Max Bending Moment due to critical load combination in major axis .....	11
5.3.6	Max Bending Moment in minor axis due to critical load combination .....	11
5.3.7	Max Shear in due to critical load combination.....	12
5.3.8	Max Axial force in upright support and roof beam due to critical load combination.....	12
5.3.9	Max reactions .....	13
6	Checking Members Based on AS1664.1 ALUMINIUM LSD.....	13
6.1	Upright Support.....	13
6.2	Rafter .....	17
6.3	Gable Beam.....	21
6.4	Summary Forces .....	25
7	Summary.....	26
7.1	Conclusions .....	26
8	Appendix A – Base Anchorage Requirements .....	27
9	Appendix "B" – Hold Down Method Details.....	28



## Civil & Structural Engineering Design Services Pty. Ltd.

### 1 Introduction

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The following structural drawings and calculations are for the applicable transportable tents supplied by Extreme Marquees Pty Ltd.

The report examines the effect of 3s gust wind of 45 km/hr on 5m x 5m Pavilion Marquees as the worst case scenario.

The relevant Australian Standards AS1170.0:2002 General principles, AS1170.1:2002 Permanent, imposed and other actions and AS1170.2:2011 Wind actions are used. The design check is in accordance with AS/NZS AS1664.1

ALUMINIUM LIMIT STATE DESIGN.



## **2 Design Restrictions and Limitations**

- 2.1 The erected structure is for temporary use only.
- 2.2 It should be noted that if high gust wind speeds are anticipated or forecast in the locality of the tent, the temporary erected structure should be folded.
- 2.3 For forecast winds in excess of **(refer to summary)** the structure should be completely dismantled.  
(Please note that the locality squall or gust wind speed is affected by factors such as terrain exposure and site elevations.)
- 2.4 The structure may only be erected in regions with wind classifications no greater than the limits specified on the attached wind analysis.
- 2.5 The wind classifications are based upon category 2 in AS. Considerations have also been made to the regional wind terrain category, topographical location and site shielding from adjacent structures. Please note that in many instances topographical factors such as a location on the crest of a hill or on top of an escarpment may yield a higher wind speed classification than that derived for a higher wind terrain category in a level topographical region. For this reason, particular regard shall be paid to the topographical location of the structure. For localities which do not conform to the standard prescribed descriptions for wind classes as defined above, a qualified Structural Engineer may be employed to determine an appropriate wind class for that the particular site.
- 2.6 The structures in no circumstances shall ever be erected in tropical or severe tropical cyclonic condition.
- 2.7 The tent structure has not been designed to withstand snow and ice loadings such as when erected in alpine regions.
- 2.8 For the projects, where the site conditions approach the design limits, extra consideration should be given to pullout tests of the stakes and professional assessment of the appropriate wind classification for the site.
- 2.9 Design of fabric by others.
- 2.10 No Fabrics or doors should be used for covering the sides of unbraced Pavilion Marquees due to the lack of bracing within the system and insufficient out-of-plane stiffness of framing.**



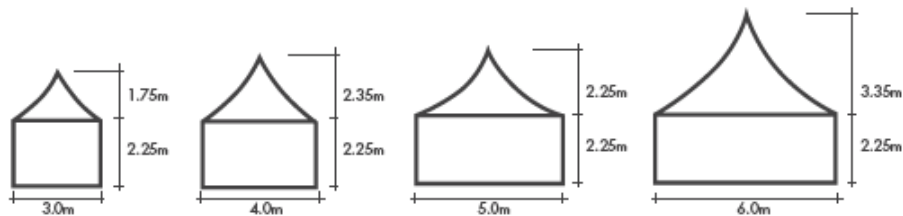
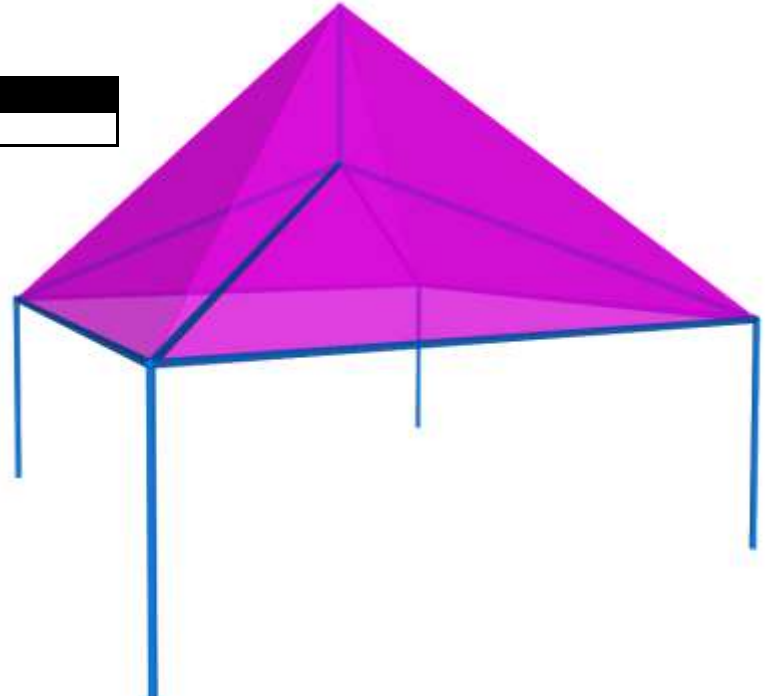
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### 3 Specifications

#### 3.1 General

Tent category	
Material	Aluminum 6061 – T6

Size	Model
5m x 5m	Pavilion Marquees



Size	3x3m	4x4m	5x5m	6x6m
Height	4m	4.6m	4.5m	5.6m
Clearance	2.25m			
Roof Tension System	Turn buckle tension system			
Main Profile	Dia. 63mm, 2.5mm Thickness Aluminium			
Feet	Aluminium			
Connectors	Steel			
Framework Material	Aluminium - 6063 T5			
Cover Material	580GSM Imported Belgian PVC			
Engineer Certification	Engineer Structural Certificate, Resistance of Fabrics to Water Penetration Test, Ultra Violet Protection Test, Fire Action Analysis			



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### 3.2 Section Properties

MEMBER(S)	Section	d	t	y <sub>c</sub>	A <sub>g</sub>	Z <sub>x</sub>	Z <sub>y</sub>	S <sub>x</sub>	S <sub>y</sub>	I <sub>x</sub>	I <sub>y</sub>	J	r <sub>x</sub>	r <sub>y</sub>
		mm	mm	mm	mm <sup>2</sup>	mm <sup>3</sup>	mm <sup>3</sup>	mm <sup>3</sup>	mm <sup>3</sup>	mm <sup>4</sup>	mm <sup>4</sup>	mm <sup>4</sup>	mm	mm
Rafter	D63x2.5	63	2.5	31.5	475.2	6913.5	6913.5	9155.8	9155.8	217774.5	217774.5	435548.9	21.4	21.4
Upright Support	D63x2.5	63	2.5	31.5	475.2	6913.5	6913.5	9155.8	9155.8	217774.5	217774.5	435548.9	21.4	21.4
Gable Beam	D63x2.5	63	2.5	31.5	475.2	6913.5	6913.5	9155.8	9155.8	217774.5	217774.5	435548.9	21.4	21.4

## 4 Design Loads

### 4.1 Ultimate

		Distributed load (kPa)	Design load factor (-)	Factored imposed load (kPa)
Live	Q	-	1.5	-
Self weight	G	self weight	1.35, 1.2, 0.9	1.2 self weight, 0.9 self weight
3s 45km/hr gust	W	0.078 C <sub>fig</sub>	1.0	0.078

### 4.2 Load Combinations

#### 4.2.1 Serviceability

Gravity =  $1.0 \times G$

Wind =  $1.0 \times G + 1.0 \times W$

#### 4.2.2 Ultimate

Downward =  $1.35 \times G$   
=  $1.2 \times G + W_u$

Upward =  $0.9 \times G + W_u$

## 5 Wind Analysis

Wind towards surface (+ve), away from surface (-ve)

### 5.1 Parameters

Terrain category = 2

Site wind speed ( $V_{sit,\beta}$ ) =  $V_R M_d (M_{z,cat} M_s M_t)$

$V_R = 12.50\text{m/s}$  (45 km/hr)

(regional 3 s gust wind speed)

$M_d = 1$



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$$M_s = 1$$

$$M_t = 1$$

$$M_{z,cat} = 0.91$$

$$V_{sit,\beta} = 11.38 \text{ m/s}$$

(Table 4.1(B) AS1170.2)

$$\text{Height of structure (h)} = 3.4 \text{ m}$$

$$\text{Width of structure (w)} = 5 \text{ m}$$

$$\text{Length of structure (l)} = 5 \text{ m}$$

$$\text{Pressure (P)} = 0.5 \rho_{air} (V_{sit,\beta})^2 C_{fig} C_{dyn}$$

$$= 0.078 C_{fig} \text{ kPa}$$

(mid of peak and eave)

## 5.2 Pressure Coefficients ( $C_{fig}$ )

Name	Symbol	Value	Unit	Notes	Ref.
<b>Input</b>					
Importance level		2			Table 3.1 - Table 3.2 (AS1170.0)
Annual probability of exceedance		Temporary			Table 3.3
Regional gust wind speed		45	Km/hr		Table 3.1 (AS1170.2)
Regional gust wind speed	$V_R$	12.50	m/s		
Wind Direction Multipliers	$M_d$	1			Table 3.2 (AS1170.2)
Terrain Category Multiplier	$M_{Z,Cat}$	0.91			Table 4.1 (AS1170.2)
Shield Multiplier	$M_s$	1			4.3 (AS1170.2)
Topographic Multiplier	$M_t$	1			4.4 (AS1170.2)
Site Wind Speed	$V_{Site,\beta}$	11.38	m/s	$V_{Site,\beta} = V_R * M_d * M_{Z,Cat} * M_s * M_t$	
Pitch	$\alpha$	45	Deg		
Pitch	$\alpha$	0.79	rad		
Width	B	5	m		
Length	D	5	m		
Height	Z	3.4	m		
<b>Wind Pressure</b>					
$\rho_{air}$	$\rho$	1.2	Kg/m <sup>3</sup>		
dynamic response factor	$C_{dyn}$	1			
Wind Pressure	$\rho * C_{fig}$	0.078	Kg/m <sup>2</sup>	$\rho = 0.5 \rho_{air} * (V_{des,\beta})^2 * C_{fig} * C_{dyn}$	2.4 (AS1170.2)
<b>WIND DIRECTION 1&amp;2</b>					



#### 4. Free Roof

Area Reduction Factor	$K_a$	1	
local pressure factor	$K_l$	1	
porous cladding reduction factor	$K_p$	1	
External Pressure Coefficient <b>MIN</b>	$C_{P,w}$	-0.3	
External Pressure Coefficient <b>MAX</b>	$C_{P,w}$	0.8	
External Pressure Coefficient <b>MIN</b>	$C_{P,l}$	-0.7	
External Pressure Coefficient <b>MAX</b>	$C_{P,l}$	0	
aerodynamic shape factor <b>MIN</b>	$C_{fig,w}$	-0.30	
aerodynamic shape factor <b>MAX</b>	$C_{fig,w}$	0.80	
aerodynamic shape factor <b>MIN</b>	$C_{fig,l}$	-0.70	
aerodynamic shape factor <b>MAX</b>	$C_{fig,l}$	0.00	
Pressure Windward <b>MIN</b>	P	-0.02	kPa
Pressure Windward <b>MAX</b>	P	0.06	kPa
Pressure Leeward <b>MIN</b>	P	-0.05	kPa
Pressure Leeward <b>MAX</b>	P	0.00	kPa

$\alpha = 0^\circ$

D7

#### 5.2.1 Pressure summary

WIND EXTERNAL PRESSURE	Direction1	
	Min (Kpa)	Max (Kpa)
W	-0.023	0.062
L	-0.054	0.000

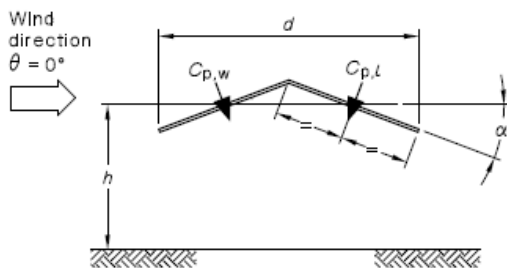
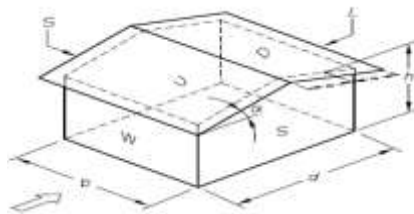
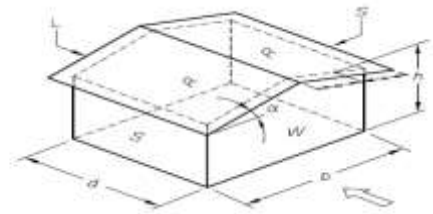


FIGURE D3 PITCHED FREE ROOFS



AS1170.2

Direction 1



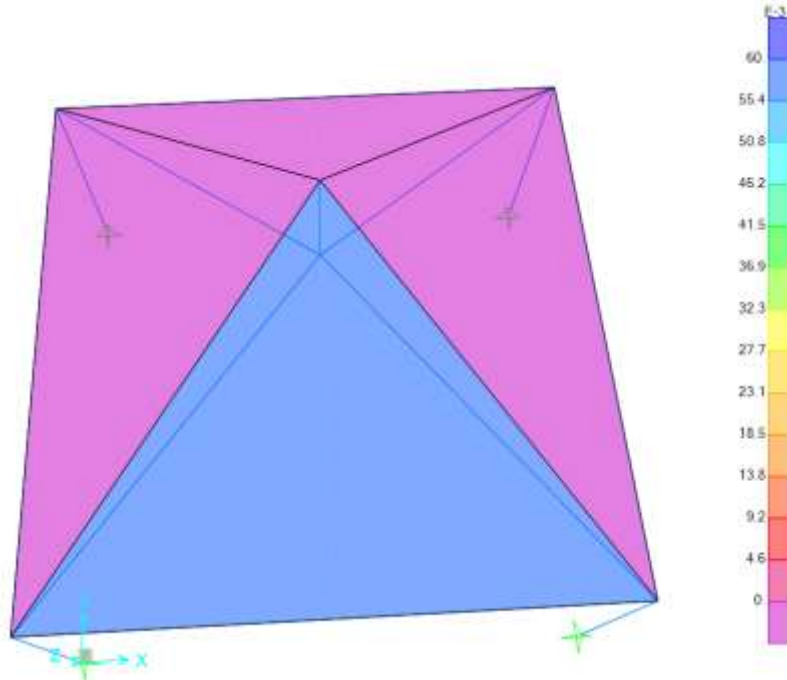
Direction 2



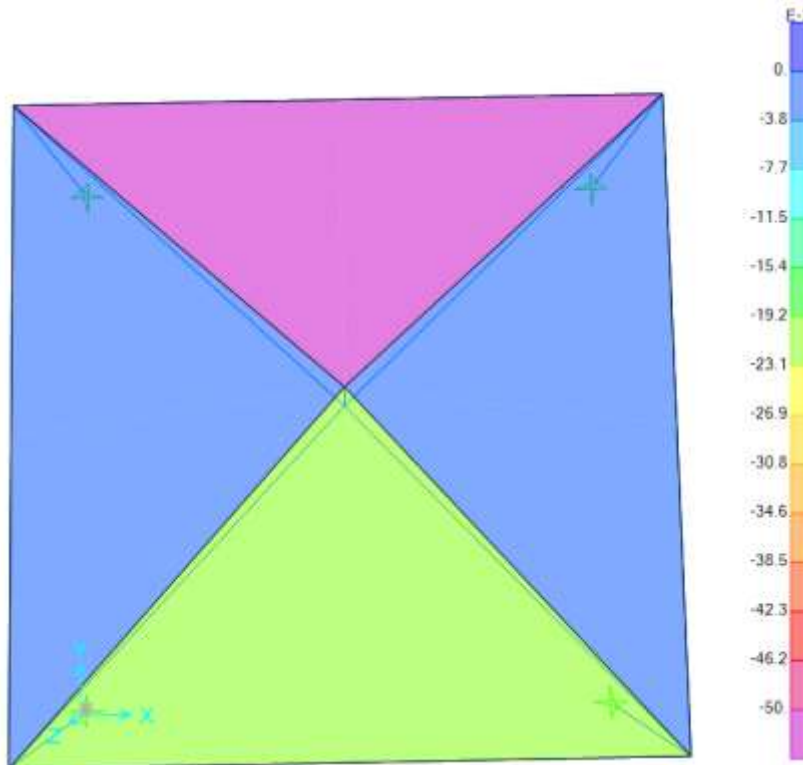


### 5.3 Wind Load Diagrams

#### 5.3.1 Wind 1(case 1)



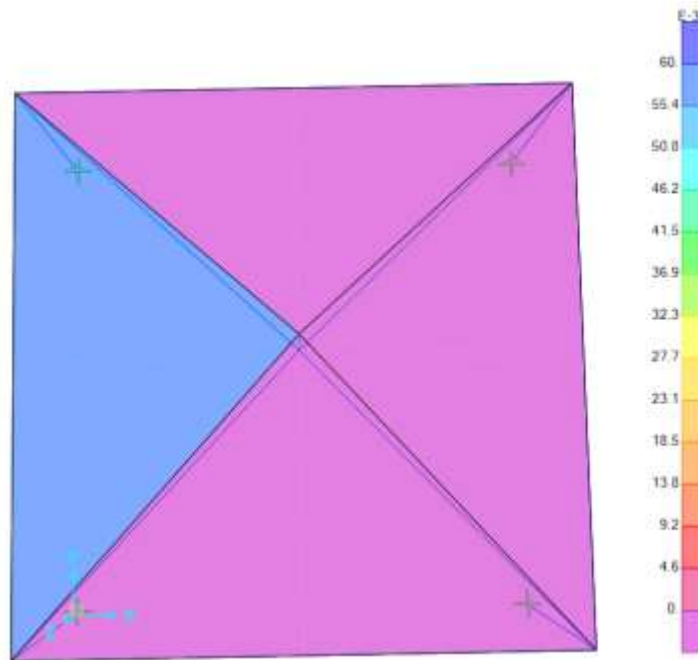
#### 5.3.2 Wind 1(case 2)



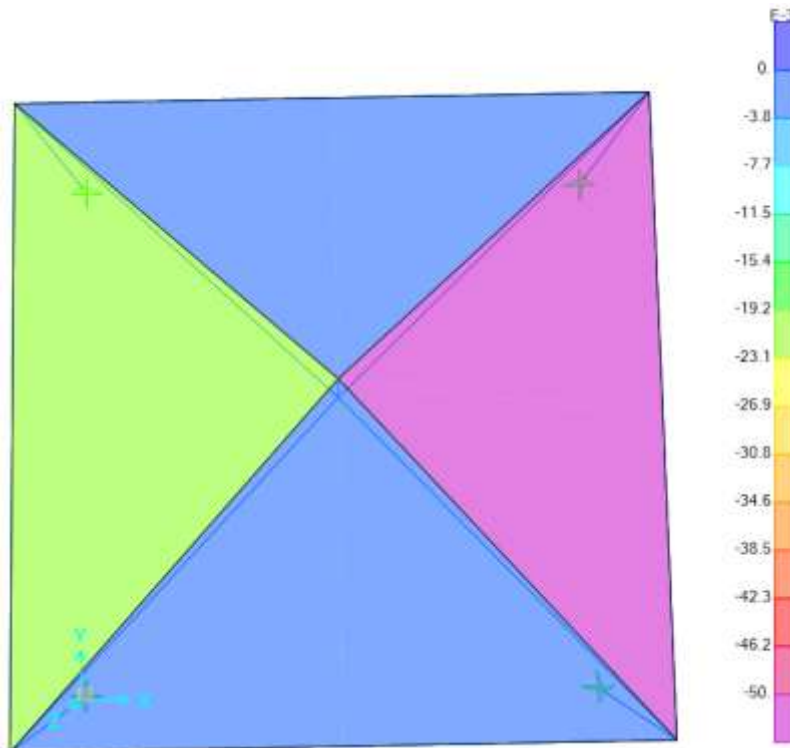


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### 5.3.3 Wind 2(Case1)



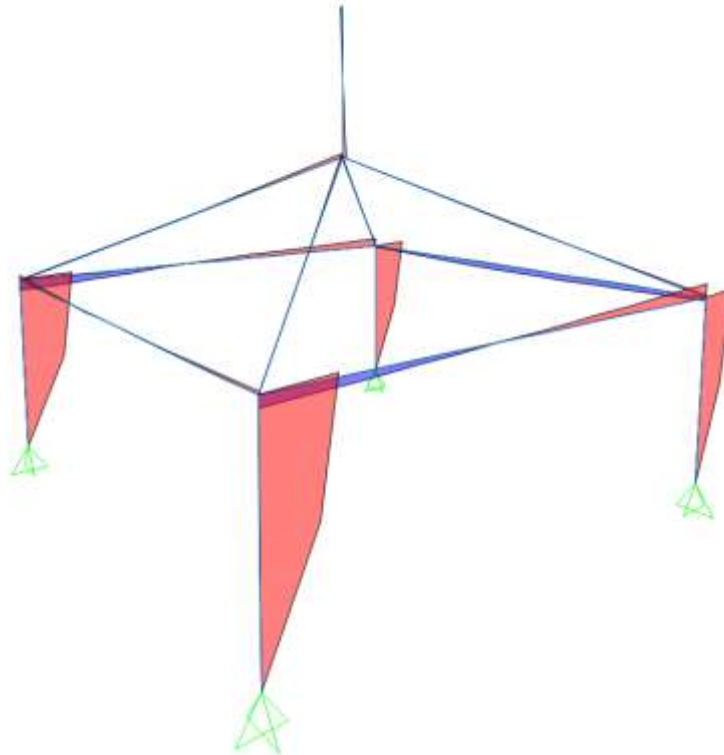
### 5.3.4 Wind 2(case 2)



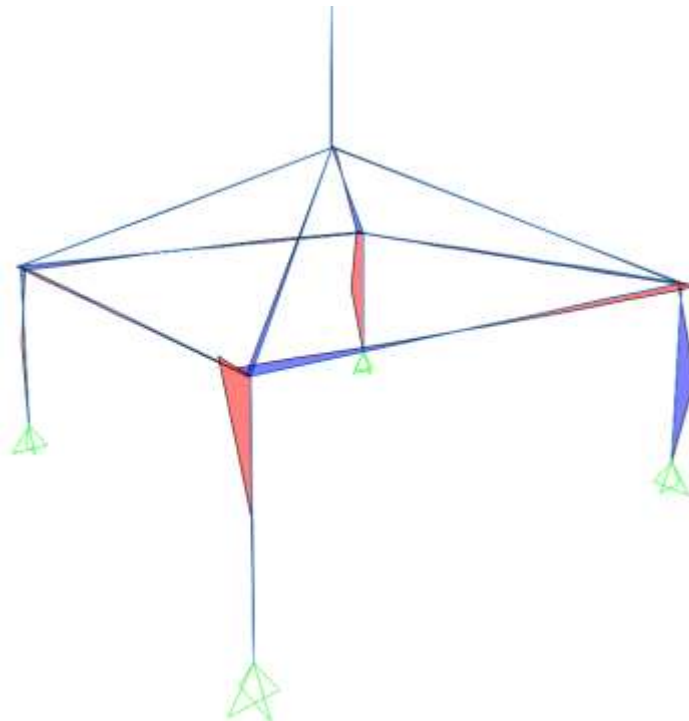
After 3D model analysis, each member is checked based on adverse load combination. In this regard the maximum bending moment, shear and axial force due to adverse load combinations for each member are presented as below:



5.3.5 Max Bending Moment due to critical load combination in major axis



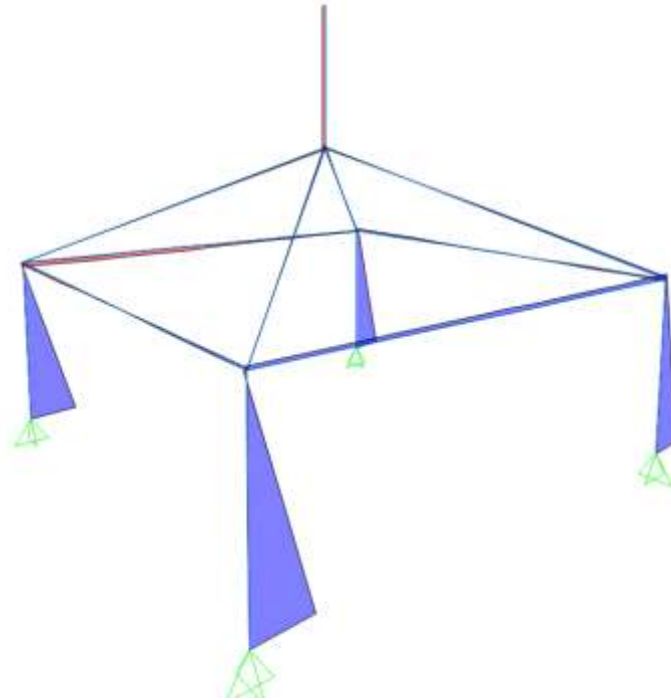
5.3.6 Max Bending Moment in minor axis due to critical load combination



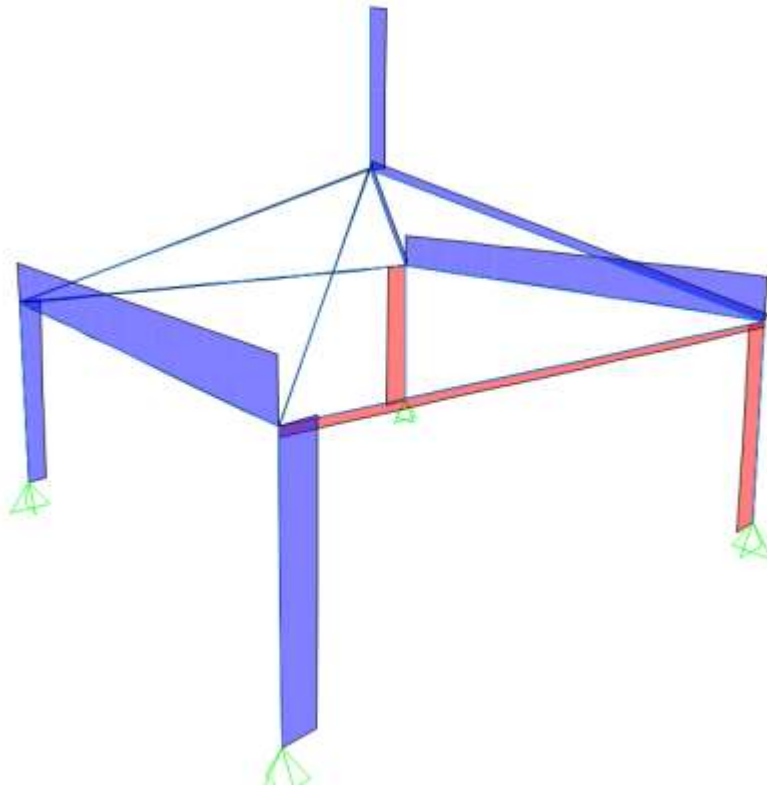


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### 5.3.7 Max Shear in due to critical load combination



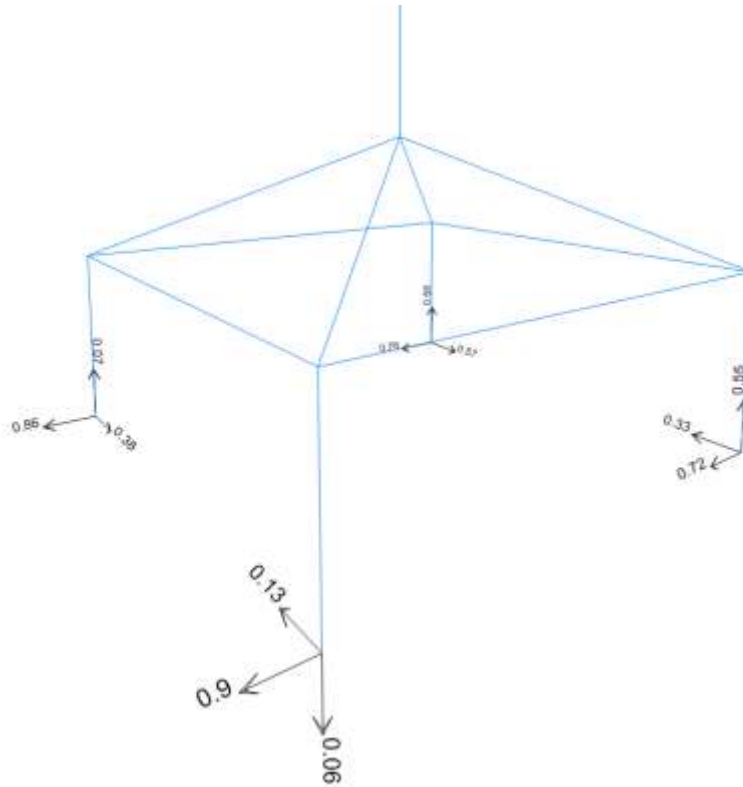
### 5.3.8 Max Axial force in upright support and roof beam due to critical load combination





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### 5.3.9 Max reactions



Max Reaction  $N^* = 0.68\text{kN}$

## 6 Checking Members Based on AS1664.1 ALUMINIUM LSD

### 6.1 Upright Support

NAME	SYMBOL	VALUE	UNIT	NOTES	REF
<b>D63x2.5</b>	<b>Upright Support</b>				
Alloy and temper	6061-T6				AS1664.1
Tension	$F_{tu}$	= 262	MPa	Ultimate	T3.3(A)
	$F_{ty}$	= 241	MPa	Yield	
Compression	$F_{cy}$	= 241	MPa		
Shear	$F_{su}$	= 165	MPa	Ultimate	
	$F_{sy}$	= 138	MPa	Yield	
Bearing	$F_{bu}$	= 551	MPa	Ultimate	
	$F_{by}$	= 386	MPa	Yield	
Modulus of elasticity	E	= 70000	MPa	Compressive	



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	$k_t$	=	1.0			
	$k_c$	=	1.0			T3.4(B)
<b>FEM ANALYSIS RESULTS</b>						
Axial force	$P$	=	0	kN	<i>compression</i>	
	$P$	=	0.21	kN	<i>Tension</i>	
In plane moment	$M_x$	=	0.9522	kNm		
Out of plane moment	$M_y$	=	0.57	kNm		
<b>DESIGN STRESSES</b>						
Gross cross section area	$A_g$	=	475.1658	mm <sup>2</sup>		
			9			
In-plane elastic section modulus	$Z_x$	=	6913.475	mm <sup>3</sup>		
			1			
Out-of-plane elastic section mod.	$Z_y$	=	6913.475	mm <sup>3</sup>		
			1			
Stress from axial force	$f_a$	=	$P/A_g$		<i>compression</i>	
		=	0.00	MPa	<i>Tension</i>	
		=	0.44	MPa		
Stress from in-plane bending	$f_{bx}$	=	$M_x/Z_x$		<i>compression</i>	
		=	137.73	MPa		
Stress from out-of-plane bending	$f_{by}$	=	$M_y/Z_y$		<i>compression</i>	
		=	82.45	MPa		
<b>Tension</b>						
<b>3.4.3 Tension in round or oval tubes</b>						
	$\phi F_L$	=	267.87	MPa		3.4.3
		O				
	$\phi F_L$	=	276.15	MPa		
<b>COMPRESSION</b>						
<b>3.4.8 Compression in columns, axial, gross section</b>						
<b>1. General</b>						
Unsupported length of member	$L$	=	2250	mm		3.4.8.1
Effective length factor	$k$	=	1			
Radius of gyration about buckling axis (Y)	$r_y$	=	21.41	mm		
Radius of gyration about buckling axis (X)	$r_x$	=	21.41	mm		
Slenderness ratio	$kLb/r_y$	=	105.10			
Slenderness ratio	$kL/r_x$	=	105.10			
Slenderness parameter	$\lambda$	=	1.96			



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	$D_c^*$	=	90.3			
	$S_1^*$	=	0.33			
	$S_2^*$	=	1.23			
	$\phi_{cc}$	=	0.855			
Factored limit state stress	$\phi F_L$	=	53.46	MPa		
2. Sections not subject to torsional or torsional-flexural buckling						3.4.8.2
Largest slenderness ratio for flexural buckling	$kL/r$	=	105.10			
3.4.11 Uniform compression in components of columns, gross section						
Uniform compression in components of columns, gross section - curved plates with both edges, walls of round or oval tube						3.4.11
						T3.3(D)
mid-thickness radius of round tubular column or maximum mid-thickness radius	$R_m$	=	30.25			
	$t$	=	2.5	mm		
Slenderness	$R_m/t$	=	12.1			
Limit 1	$S_1$	=	0.24			
Limit 2	$S_2$	=	672.46			
Factored limit state stress	$\phi F_L$	=	221.14	MPa		
Most adverse compressive limit state stress	$F_a$	=	53.46	MPa		
Most adverse tensile limit state stress	$F_a$	=	267.87	MPa		
Most adverse compressive & Tensile capacity factor	$f_a/F_a$	=	0.00		PASS	
BENDING - IN-PLANE						
3.4.13 Compression in beams, extreme fibre, gross section round or oval tubes						
Unbraced length for bending	$L_b$	=	2250	mm		
Second moment of area (weak axis)	$I_y$	=	2.18E+05	mm <sup>4</sup>		
Torsion modulus	$J$	=	4.36E+05	mm <sup>3</sup>		
Elastic section modulus	$Z$	=	6913.475	mm <sup>3</sup>		
			1			
	$R_b/t$	=	12.10			
Limit 1	$S_1$	=	44.07			



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Limit 2	$S_2$	=	78.23		
Factored limit state stress	$\phi F_L$	=	<b>267.87</b>	MPa	3.4.13
<b>3.4.18 Compression in components of beams - curved plates with both edges supported</b>					
	$k_1$	=	0.5		T3.3(D)
	$k_2$	=	2.04		T3.3(D)
mid-thickness radius of round tubular column or maximum mid-thickness radius	$R_b$	=	30.25	mm	
	$t$	=	2.5	mm	
Slenderness	$R_b/t$	=	12.1		
Limit 1	$S_1$	=	2.75		
Limit 2	$S_2$	=	78.23		
Factored limit state stress	$\phi F_L$	=	<b>221.14</b>	MPa	
Most adverse in-plane bending limit state stress	$F_{bx}$	=	221.14	MPa	
Most adverse in-plane bending capacity factor	$f_{bx}/F_{bx}$	=	0.62		PASS
<b>BENDING - OUT-OF-PLANE</b>					
<i>NOTE: Limit state stresses, <math>\phi F_L</math> are the same for out-of-plane bending (doubly symmetric section)</i>					
Factored limit state stress	$\phi F_L$	=	<b>221.14</b>	MPa	
Most adverse out-of-plane bending limit state stress	$F_{by}$	=	221.14	MPa	
Most adverse out-of-plane bending capacity factor	$f_{by}/F_{by}$	=	0.37		PASS
<b>COMBINED ACTIONS</b>					
<b>4.1.1 Combined compression and bending</b>					
	$F_a$	=	53.46	MPa	4.1.1
	$F_{ao}$	=	221.14	MPa	3.4.11
	$F_{bx}$	=	221.14	MPa	3.4.11
	$F_{by}$	=	221.14	MPa	3.4.18
	$f_a/F_a$	=	0.002		3.4.18
Check: $f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					4.1.1





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i.e.		1.00	≤	1.0	PASS	
<b>SHEAR</b>						
<b>3.4.24 Shear in webs (Major Axis)</b>						3.4.24
	R	=	31.5	mm		
	t	=	2.5	mm		
Equivalent h/t	h/t	=	41.08			
Limit 1	S <sub>1</sub>	=	29.01			
Limit 2	S <sub>2</sub>	=	59.31			
Factored limit state stress	$\phi F_L$	=	118.88	MPa		
Stress From Shear force	$f_{sx}$	=	V/A <sub>w</sub>			
			0.21	MPa		
<b>3.4.25 Shear in webs (Minor Axis)</b>						3.4.25
Clear web height	R	=	31.5	mm		
	t	=	2.5	mm		
Equivalent h/t	h/t	=	41.08			
Factored limit state stress	$\phi F_L$	=	118.88	MPa		
Stress From Shear force	$f_{sy}$	=	V/A <sub>w</sub>			
			0.17	MPa		

### 6.2 Rafter

NAME	SYMBOL	VALUE	UNIT	NOTES	REF
<b>D63x2.5</b>	<b>Rafter</b>				
Alloy and temper	6061-T6				AS1664.1
Tension	F <sub>tu</sub>	=	262	MPa	Ultimate
	F <sub>ty</sub>	=	241	MPa	Yield
Compression	F <sub>cy</sub>	=	241	MPa	
Shear	F <sub>su</sub>	=	165	MPa	Ultimate
	F <sub>sy</sub>	=	138	MPa	Yield
Bearing	F <sub>bu</sub>	=	551	MPa	Ultimate
	F <sub>by</sub>	=	386	MPa	Yield
Modulus of elasticity	E	=	70000	MPa	Compressive
	k <sub>t</sub>	=	1.0		T3.4(B)



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	$k_c$	=	1.0		
<b>FEM ANALYSIS RESULTS</b>					
Axial force	$P$	=	0 kN	compression	
	$P$	=	0.094 kN	Tension	
In plane moment	$M_x$	=	0.0431 kNm		
Out of plane moment	$M_y$	=	0.1029 kNm		
<b>DESIGN STRESSES</b>					
Gross cross section area	$A_g$	=	475.1658 mm <sup>2</sup>		
In-plane elastic section modulus	$Z_x$	=	6913.475 mm <sup>3</sup>		
Out-of-plane elastic section mod.	$Z_y$	=	6913.475 mm <sup>3</sup>		
Stress from axial force	$f_a$	=	$P/A_g$		
		=	0.00 MPa	compression	
		=	0.20 MPa	Tension	
Stress from in-plane bending	$f_{bx}$	=	$M_x/Z_x$		
		=	6.23 MPa	compression	
Stress from out-of-plane bending	$f_{by}$	=	$M_y/Z_y$		
		=	14.88 MPa	compression	
<b>Tension</b>					
<b>3.4.3 Tension in rectangular tubes</b>					3.4.3
	$\phi F_L$	=	267.87 MPa		
		O R			
	$\phi F_L$	=	276.15 MPa		
<b>COMPRESSION</b>					
<b>3.4.8 Compression in columns, axial, gross section</b>					
<b>1. General</b>					3.4.8.1
Unsupported length of member	$L$	=	3750 mm		
Effective length factor	$k$	=	1		
Radius of gyration about buckling axis (Y)	$r_y$	=	21.41 mm		
Radius of gyration about buckling axis (X)	$r_x$	=	21.41 mm		
Slenderness ratio	$kLb/r_y$	=	175.17		
Slenderness ratio	$kL/r_x$	=	175.17		
Slenderness parameter	$\lambda$	=	3.272		
	$D_c^*$	=	90.3		



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	$S_1^*$	=	0.33		
	$S_2^*$	=	1.23		
	$\phi_{cc}$	=	0.950		
Factored limit state stress	$\phi F_L$	=	<b>21.39</b>	<b>MPa</b>	
<i>2. Sections not subject to torsional or torsional-flexural buckling</i>					3.4.8.2
Largest slenderness ratio for flexural buckling	$kL/r$	=	175.17		
<b>3.4.11</b> <i>Uniform compression in components of columns, gross section - flat plates</i>					
<i>Uniform compression in components of columns, gross section - curved plates with both edges, walls of round or oval tube</i>					3.4.11
	$k_1$	=	0.35		T3.3(D)
mid-thickness radius of round tubular column or maximum mid-thickness radius	$R_m$	=	30.25		
	$t$	=	2.5	mm	
Slenderness	$R_m/t$	=	12.1		
Limit 1	$S_1$	=	0.24		
Limit 2	$S_2$	=	672.46		
Factored limit state stress	$\phi F_L$	=	<b>229.63</b>	<b>MPa</b>	
Most adverse compressive limit state stress	$F_a$	=	21.39	MPa	
Most adverse tensile limit state stress	$F_a$	=	267.87	MPa	
Most adverse compressive & Tensile capacity factor	$f_a/F_a$	=	0.00		PASS
<b>BENDING - IN-PLANE</b>					
<b>3.4.13</b> <i>Compression in beams, extreme fibre, gross section round or oval tubes</i>					
Unbraced length for bending	$L_b$	=	3750	mm	
Second moment of area (weak axis)	$I_y$	=	2.18E+05	mm <sup>4</sup>	
Torsion modulus	$J$	=	4.36E+05	mm <sup>3</sup>	
Elastic section modulus	$Z$	=	6913.475	mm <sup>3</sup>	
	$R_b/t$	=	12.10		
Limit 1	$S_1$	=	44.07		
Limit 2	$S_2$	=	78.23		



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Factored limit state stress	$\phi F_L$	=	267.87	MPa		3.4.13
<b>3.4.18 Compression in components of beams - curved plates with both edges supported</b>						
	$k_1$	=	0.5			T3.3(D)
	$k_2$	=	2.04			T3.3(D)
mid-thickness radius of round tubular column or maximum mid-thickness radius	$R_b$	=	30.25	mm		
	$t$	=	2.5	mm		
Slenderness	$R_b/t$	=	12.1			
Limit 1	$S_1$	=	2.75			
Limit 2	$S_2$	=	78.23			
Factored limit state stress	$\phi F_L$	=	221.14	MPa		
Most adverse in-plane bending limit state stress	$F_{bx}$	=	221.14	MPa		
Most adverse in-plane bending capacity factor	$f_{bx}/F_{bx}$	=	0.03		PASS	
<b>BENDING - OUT-OF-PLANE</b>						
<i>NOTE: Limit state stresses, <math>\phi F_L</math> are the same for out-of-plane bending (doubly symmetric section)</i>						
Factored limit state stress	$\phi F_L$	=	221.14	MPa		
Most adverse out-of-plane bending limit state stress	$F_{by}$	=	221.14	MPa		
Most adverse out-of-plane bending capacity factor	$f_{by}/F_{by}$	=	0.07		PASS	
<b>COMBINED ACTIONS</b>						
<b>4.1.1 Combined compression and bending</b>						
	$F_a$	=	21.39	MPa		4.1.1
	$F_{ao}$	=	229.63	MPa		3.4.11
	$F_{bx}$	=	221.14	MPa		3.4.18
	$F_{by}$	=	221.14	MPa		3.4.18
	$f_a/F_a$	=	0.001			
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by}$	$\leq$	1.0			4.1.1
i.e.	0.10	$\leq$	1.0		PASS	



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SHEAR						
<b>3.4.24 Shear in webs (Major Axis)</b>						3.4.24
	R	=	31.5	mm		
	t	=	2.5	mm		
Equivalent h/t	h/t	=	46.67			
Limit 1	S <sub>1</sub>	=	29.01			
Limit 2	S <sub>2</sub>	=	59.31			
Factored limit state stress	$\phi F_L$	=	113.22	MPa		
Stress From Shear force	$f_{sx}$	=	V/A <sub>w</sub>			
			0.17	MPa		
<b>3.4.25 Shear in webs (Minor Axis)</b>						3.4.24
Clear web height	R	=	31.5	mm		
	t	=	2.5	mm		
Equivalent h/t	h/t	=	46.67			
Factored limit state stress	$\phi F_L$	=	113.22	MPa		
Stress From Shear force	$f_{sy}$	=	V/A <sub>w</sub>			
			0.17	MPa		

### 6.3 Gable Beam

NAME	SYMBOL	VALUE	UNIT	NOTES	REF
<b>D63x2.9</b>	<b>Gable Beam</b>				
Alloy and temper	6061-T6				AS1664.1
Tension	$F_{tu}$	=	262	MPa	Ultimate
	$F_{ty}$	=	241	MPa	Yield
Compression	$F_{cy}$	=	241	MPa	
Shear	$F_{su}$	=	165	MPa	Ultimate
	$F_{sy}$	=	138	MPa	Yield
Bearing	$F_{bu}$	=	551	MPa	Ultimate
	$F_{by}$	=	386	MPa	Yield
Modulus of elasticity	E	=	70000	MPa	Compressive
	$k_t$	=	1.0		
	$k_c$	=	1.0		



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FEM ANALYSIS RESULTS						
Axial force	P	=	0.02	kN	compression	
	P	=	0	kN	Tension	
In plane moment	M <sub>x</sub>	=	0.3615	kNm		
Out of plane moment	M <sub>y</sub>	=	0.2782	kNm		
DESIGN STRESSES						
Gross cross section area	A <sub>g</sub>	=	475.16589	mm <sup>2</sup>		
In-plane elastic section modulus	Z <sub>x</sub>	=	6913.4751	mm <sup>3</sup>		
Out-of-plane elastic section mod.	Z <sub>y</sub>	=	6913.4751	mm <sup>3</sup>		
Stress from axial force	f <sub>a</sub>	=	P/A <sub>g</sub>		compression	
		=	0.04	MPa	Tension	
		=	0.00	MPa		
Stress from in-plane bending	f <sub>bx</sub>	=	M <sub>x</sub> /Z <sub>x</sub>		compression	
		=	52.29	MPa		
Stress from out-of-plane bending	f <sub>by</sub>	=	M <sub>y</sub> /Z <sub>y</sub>		compression	
		=	40.24	MPa		
Tension						
3.4.3 Tension in rectangular tubes						3.4.3
	φF <sub>L</sub>	=	267.87	MPa		
		OR				
	φF <sub>L</sub>	=	276.15	MPa		
COMPRESSION						
3.4.8 Compression in columns, axial, gross section						
1. General						3.4.8.1
Unsupported length of member	L	=	5000	mm		
Effective length factor	k	=	1			
Radius of gyration about buckling axis (Y)	r <sub>y</sub>	=	21.41	mm		
Radius of gyration about buckling axis (X)	r <sub>x</sub>	=	21.41	mm		
Slenderness ratio	kLb/r <sub>y</sub>	=	233.55			
Slenderness ratio	kL/r <sub>x</sub>	=	233.55			
Slenderness parameter	λ	=	4.36			
	D <sub>c</sub> *	=	90.3			
	S <sub>1</sub> *	=	0.33			
	S <sub>2</sub> *	=	1.23			



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	$\phi_{cc}$	=	0.950		
Factored limit state stress	$\phi F_L$	=	12.03	MPa	
<i>2. Sections not subject to torsional or torsional-flexural buckling</i>					3.4.8.2
Largest slenderness ratio for flexural buckling	$kL/r$	=	233.55		
<b>3.4.11</b> <i>Uniform compression in components of columns, gross section - flat plates</i>					
<i>Uniform compression in components of columns, gross section - curved plates with both edges, walls of round or oval tube</i>					3.4.11
	$k_1$	=	0.35		T3.3(D)
mid-thickness radius of round tubular column or maximum mid-thickness radius	$R_m$	=	30.25		
	$t$	=	2.5	mm	
Slenderness	$R_m/t$	=	12.1		
Limit 1	$S_1$	=	0.24		
Limit 2	$S_2$	=	672.46		
Factored limit state stress	$\phi F_L$	=	229.63	MPa	
Most adverse compressive limit state stress	$F_a$	=	12.03	MPa	
Most adverse tensile limit state stress	$F_a$	=	267.87	MPa	
Most adverse compressive & Tensile capacity factor	$f_a/F_a$	=	0.00		PASS
<b>BENDING - IN-PLANE</b>					
<b>3.4.13</b> <i>Compression in beams, extreme fibre, gross section round or oval tubes</i>					
Unbraced length for bending	$L_b$	=	5000	mm	
Second moment of area (weak axis)	$I_y$	=	217774.47	mm <sup>4</sup>	
Torsion modulus	$J$	=	435548.93	mm <sup>3</sup>	
Elastic section modulus	$Z$	=	6913.4751	mm <sup>3</sup>	
	$R_b/t$	=	12.10		
Limit 1	$S_1$	=	44.07		
Limit 2	$S_2$	=	78.23		
Factored limit state stress	$\phi F_L$	=	267.87	MPa	3.4.13



<b>3.4.18 Compression in components of beams - curved plates with both edges supported</b>					
	$k_1$	=	0.5		T3.3(D)
	$k_2$	=	2.04		T3.3(D)
mid-thickness radius of round tubular column or maximum mid-thickness radius	$R_b$	=	30.25	mm	
	$t$	=	2.5	mm	
Slenderness	$R_b/t$	=	12.1		
Limit 1	$S_1$	=	2.75		
Limit 2	$S_2$	=	78.23		
Factored limit state stress	$\phi F_L$	=	221.14	MPa	
Most adverse in-plane bending limit state stress	$F_{bx}$	=	221.14	MPa	
Most adverse in-plane bending capacity factor	$f_{bx}/F_{bx}$	=	0.24		PASS
<b>BENDING - OUT-OF-PLANE</b>					
<i>NOTE: Limit state stresses, <math>\phi F_L</math> are the same for out-of-plane bending (doubly symmetric section)</i>					
Factored limit state stress	$\phi F_L$	=	221.14	MPa	
Most adverse out-of-plane bending limit state stress	$F_{by}$	=	221.14	MPa	
Most adverse out-of-plane bending capacity factor	$f_{by}/F_{by}$	=	0.18		PASS
<b>COMBINED ACTIONS</b>					
<b>4.1.1 Combined compression and bending</b>					4.1.1
	$F_a$	=	12.03	MPa	3.4.11
	$F_{ao}$	=	229.63	MPa	3.4.11
	$F_{bx}$	=	221.14	MPa	3.4.18
	$F_{by}$	=	221.14	MPa	3.4.18
	$f_a/F_a$	=	0.003		
Check: $f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					4.1.1
i.e. 0.42	$\leq$	1.0		PASS	





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SHEAR							
<b>3.4.24 Shear in webs (Major Axis)</b>							3.4.24
	R	=	31.5	mm			
	t	=	2.5	mm			
Equivalent h/t	h/t	=	50.15				
Limit 1	S <sub>1</sub>	=	29.01				
Limit 2	S <sub>2</sub>	=	59.31				
Factored limit state stress	$\phi F_L$	=	109.69	MPa			
Stress From Shear force	$f_{sx}$	=	V/A <sub>w</sub>				
			0.17	MPa			
<b>3.4.25 Shear in webs (Minor Axis)</b>							3.4.25
Clear web height	R	=	31.5	mm			
	t	=	2.5	mm			
Equivalent h/t	h/t	=	50.15				
Factored limit state stress	$\phi F_L$	=	109.69	MPa			
Stress From Shear force	$f_{sy}$	=	V/A <sub>w</sub>				
			0.17	MPa			

### 6.4 Summary Forces

MEMBER(S)	Section	d	t	V <sub>x</sub>	V <sub>y</sub>	P (Axial) Negative -> Compression Positive -> Tension	M <sub>x</sub>	M <sub>y</sub>
		mm	mm	kN	kN	kN	kN.m	kN.m
Rafter	D63x2.5	63	2.5	0.041	0.04	0.094	-0.0431	-0.1029
Upright Support	D63x2.5	63	2.5	-0.05	0.692	0.21	-0.9522	-0.57
Gable Beam	D63x2.9	63	2.5	0.197	0.134	-0.02	-0.3615	-0.2782



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### 7 Summary

#### 7.1 Conclusions

- a. The 5m x 5m Pavilion Marquees as specified has been analyzed with a conclusion that it has the capacity to withstand wind speeds up to and including **45km/hr**.
- b. For forecast winds in excess of **45km/hr** – the structure should be completely dismantled.
- c. For uplift due to 45km/hr, 1.5 kN (150kg) holding down weight/per leg for upright support is required.
- d. The bearing pressure of soil should be clarified and checked by an engineer prior to any construction for considering foundation and base plate.
- e. **No Fabrics or doors should be used for covering the sides of unbraced Pavilion Marquees due to the lack of bracing within the system and insufficient out-of-plane stiffness of framing.**

Yours faithfully,

E.A. Bennett M.I.E. Aust. NPER 198230



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### 8 Appendix A – Base Anchorage Requirements

5m x 5m Pavilion Marquees:

Tent Span	Sile Type	Required Weight Per Leg
5 m	A	150kg
	B	150kg
	C	150kg
	D	150kg
	E	150kg

#### Definition of Soil Types:

Type A : Loose sand such as dunal sand. Uncompacted site filling may also be included in this soil type.

Type B : Medium to stiff clays or silty clays

Type C: Moderately compact sand or gravel eg. of alluvial origin.

Type D : Compact sand and gravel eg. Weathered sandstone or compacted quarry rubble hardstand

Type E : Concrete slab on ground .



9 Appendix "B" – Hold Down Method Details

