Civil & Structural Engineering Design Services Pty. Ltd.

Client: **Extreme Marquees Pty Ltd**
Project: Design check – 3m × 3m Pavilion Marquees Structure for 60km/hr Wind Spead
Reference: Extreme Marquees Technical Data

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

JOB NO: E-11-265231-4

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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 60 km/hr on 3m x 3m 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.

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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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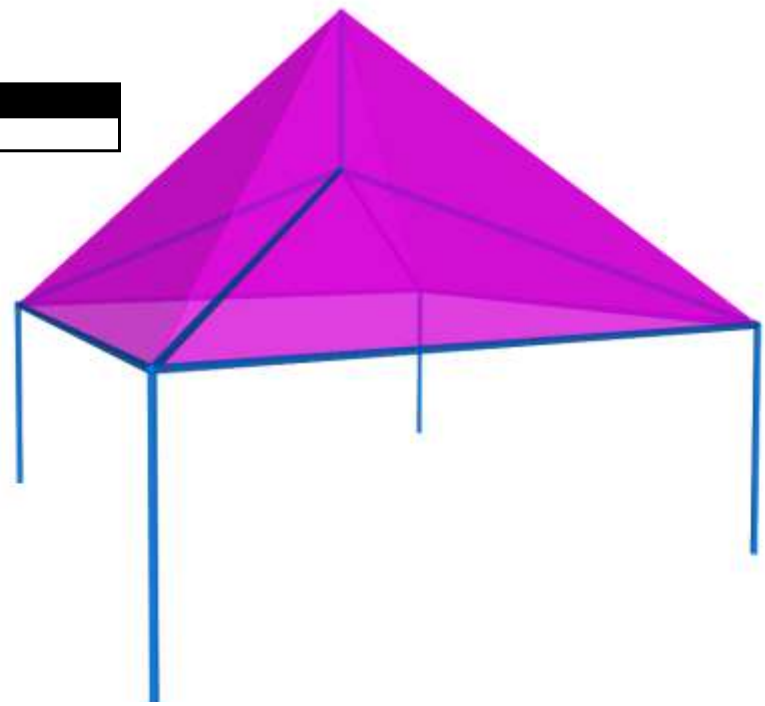
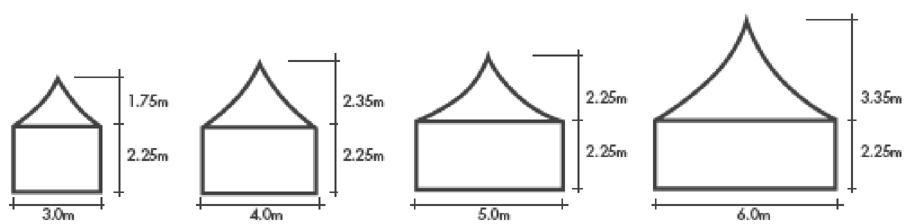
3 Specifications

3.1 General

Tent category	
Material	Aluminum 6061 – T6



Size	Model
3m x 3m	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			

3.2 Section Properties

MEMBER(S)	Section	d	t	y_c	A_g	Z_x	Z_y	S_x	S_y	I_x	I_y	J	r_x	r_y
		mm	*mm*	*mm*	*mm²*	*mm³*	*mm³*	*mm³*	*mm³*	*mm⁴*	*mm⁴*	*mm⁴*	*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 60km/hr gust	W	0.138 C_{fig}	1.0	0.138

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 = 16.67m/s (60 km/hr) *(regional 3 s gust wind speed)*
M_d = 1

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$M_s = 1$
$M_t = 1$
$M_{z,cat} = 0.91$ *(Table 4.1(B) AS1170.2)*
$V_{sit,\beta} = 15.17$ m/s

Height of structure (h) = 3.3 m *(mid of peak and eave)*
Width of structure (w) = 3 m
Length of structure (l) = 3 m
Pressure (P) = $0.5\rho_{air} (V_{sit,\beta})^2 C_{fig} C_{dyn}$
= $0.138C_{fig}$ kPa

5.2 Pressure Coefficients (C_{fig})

Name	Symbol	Value	Unit	*Notes*	*Ref.*
		Input			
Importance level		2			*Table 3.1 - Table 3.2 (AS1170.0)*
Annual probability of exceedance		Temporary			*Table 3.3*
Regional gust wind speed		**60**	Km/hr		*Table 3.1 (AS1170.2)*
Regional gust wind speed	V_R	**16.67**	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	$V_{Site,\beta}$	**15.17**	m/s	$V_{Site,\beta}=V_R*M_d*M_{z,cat}*M_S,M_t$	
Pitch	α	45	Deg		
Pitch	α	0.79	rad		
Width	B	3	m		
Length	D	3	m		
Height	Z	3.3	m		
		Wind Pressure			
ρair	ρ	1.2	Kg/m^3		
dynamic response factor	C_{dyn}	1			
Wind Pressure	$\rho*C_{fig}$	**0.138**	Kg/m^2	$\rho=0.5\rho_{air}*(V_{des,\beta})^2*C_{fig}*C_{dyn}$	*2.4 (AS1170.2)*
		WIND DIRECTION 1 & 2			

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4. Free Roof

				$\alpha = 0^o$	
Area Reduction Factor	K_a	1			*D7*
local pressure factor	K_l	1			
porous cladding reduction factor	K_p	1			
External Pressure Coefficient **MIN**	$C_{P,w}$	-0.3			
External Pressure Coefficient **MAX**	$C_{P,w}$	0.8			
External Pressure Coefficient **MIN**	$C_{P,l}$	-0.7			
External Pressure Coefficient **MAX**	$C_{P,l}$	0			
aerodynamic shape factor **MIN**	$C_{fig,w}$	-0.30			
aerodynamic shape factor **MAX**	$C_{fig,w}$	0.80			
aerodynamic shape factor **MIN**	$C_{fig,l}$	-0.70			
aerodynamic shape factor **MAX**	$C_{fig,l}$	0.00			
Pressure Windward **MIN**	P	**-0.04**	**kPa**		
Pressure Windward **MAX**	P	**0.11**	**kPa**		
Pressure Leeward **MIN**	P	**-0.10**	**kPa**		
Pressure Leeward **MAX**	P	**0.00**	**kPa**		

5.2.1 Pressure summary

WIND EXTERNAL PRESSURE	Direction1&2	
	Min (Kpa)	**Max (Kpa)**
W	-0.041	0.110
L	-0.097	0.000

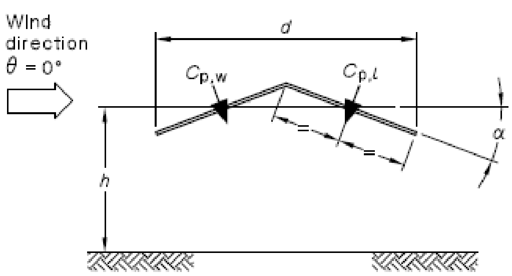
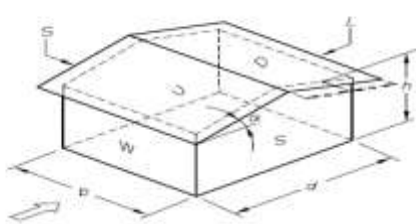
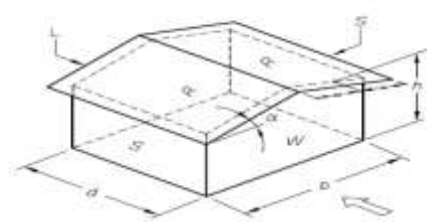


FIGURE D3 PITCHED FREE ROOFS



AS1170.2

Direction 1



Direction 2

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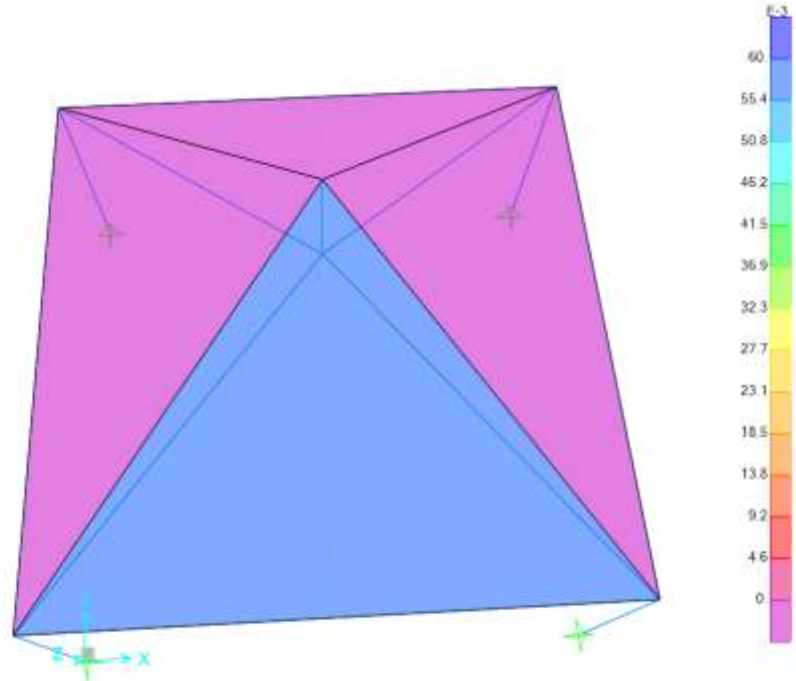
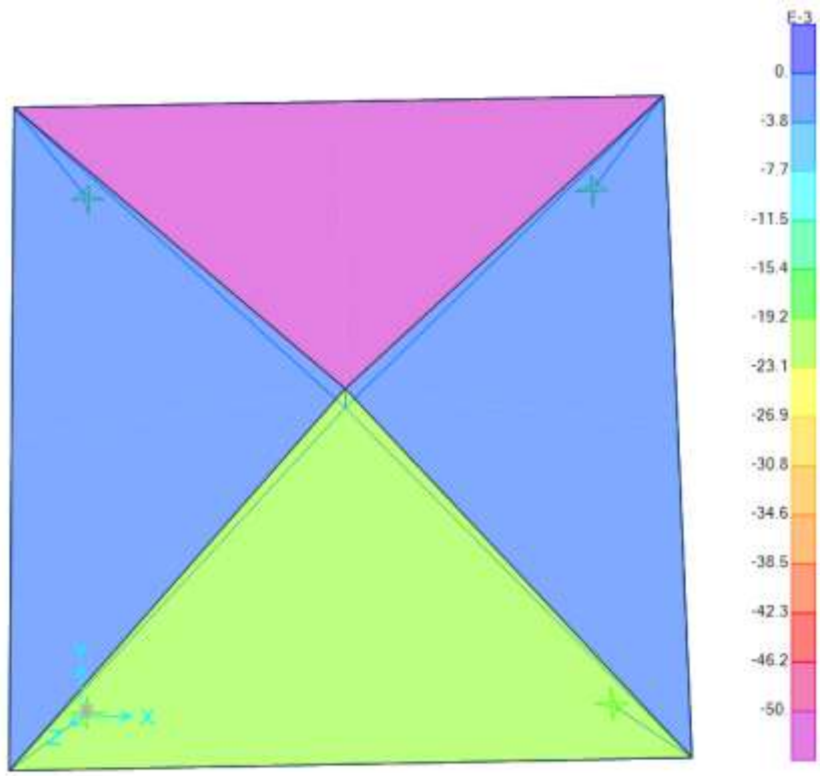
5.3 Wind Load Diagrams

5.3.1 Wind 1(case 1)



5.3.2 Wind 1(case 2)



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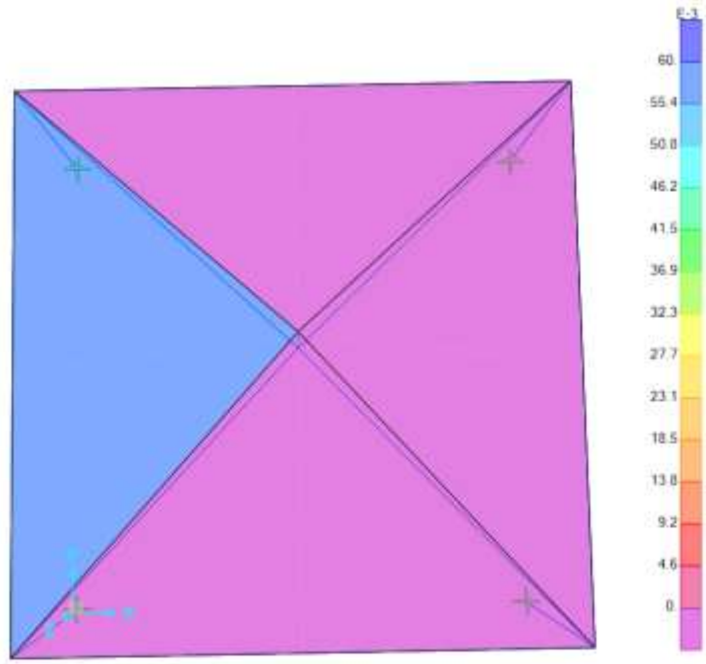
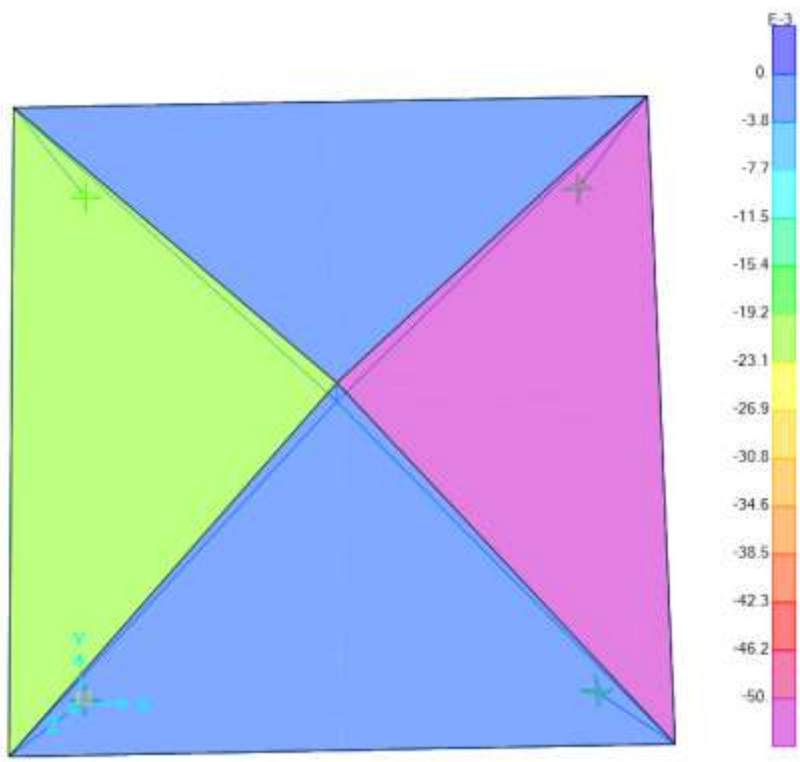
5.3.3 Wind 2(Case1)



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:

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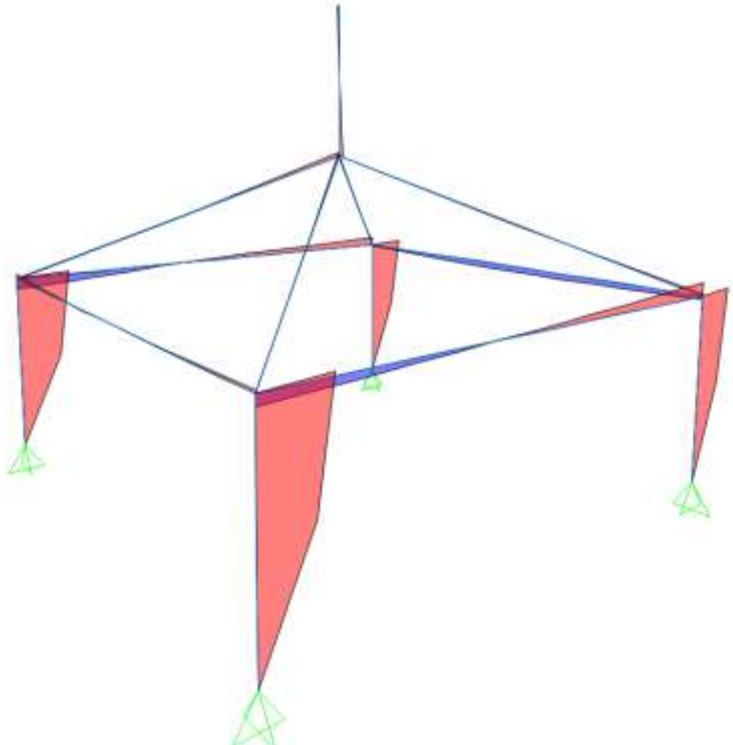
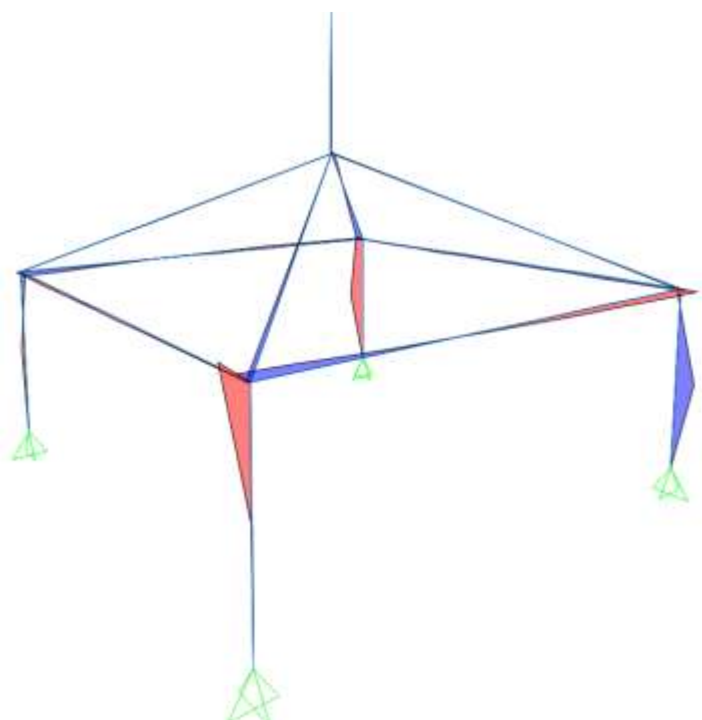
5.3.5 Max Bending Moment due to critical load combination in major axis



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



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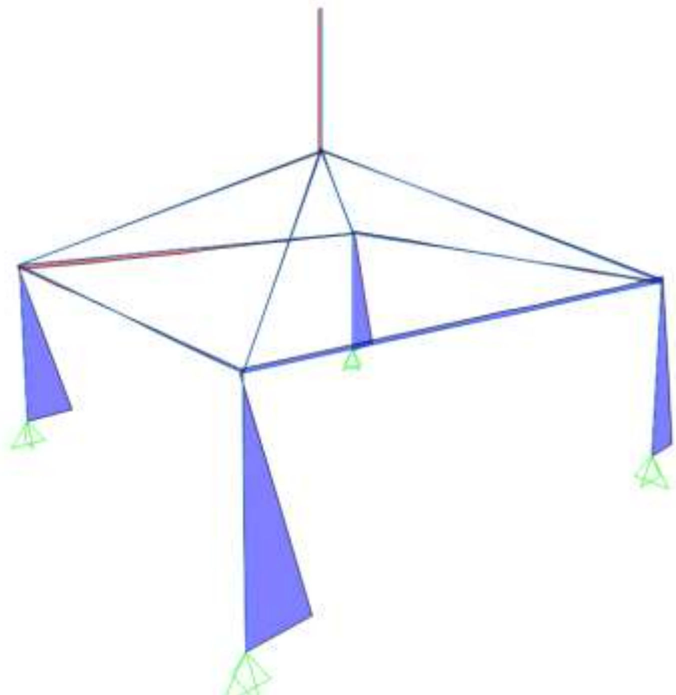
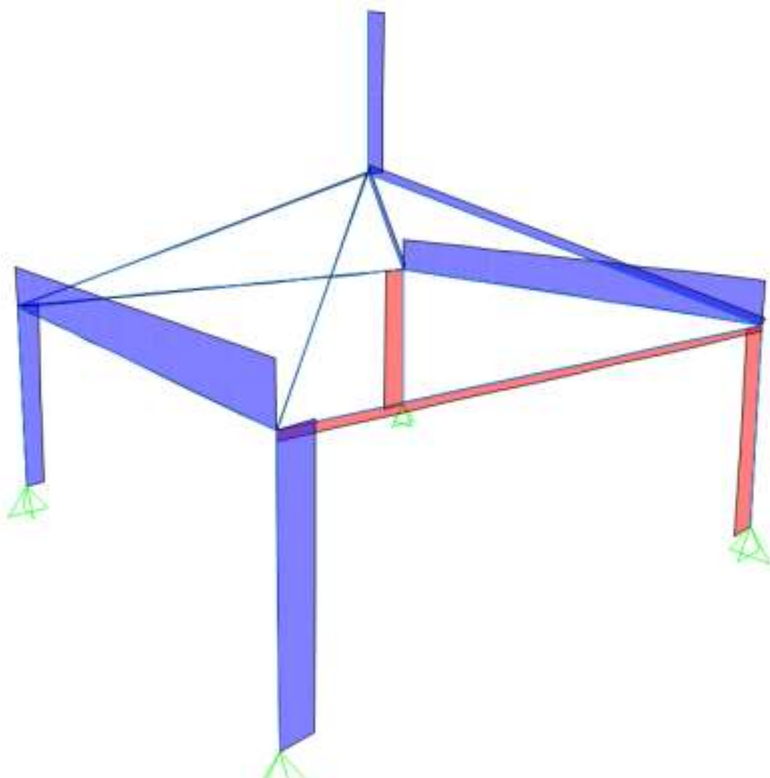
5.3.7 Max Shear in due to critical load combination



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



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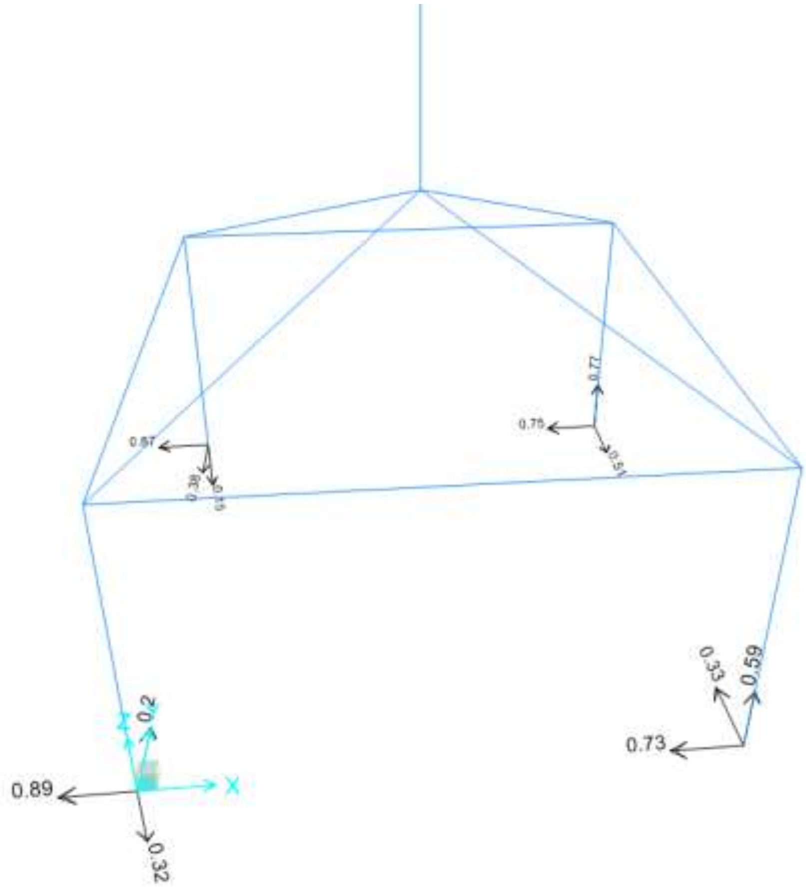
5.3.9 Max reactions



Max Reaction $N^* = 0.91kN$

6 Checking Members Based on AS1664.1 ALUMINIUM LSD

6.1 Upright Support

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
D63x2.5	**Upright Support**					
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*	
	k_t	=	1.0			T3.4(B)
	k_c	=	1.0			
FEM ANALYSIS RESULTS						
Axial force	P	=	0	kN	*compression*	
	P	=	0.606	kN	*Tension*	
In plane moment	M_x	=	0.9187	kNm		
Out of plane moment	M_y	=	0.4713	kNm		
DESIGN STRESSES						
Gross cross section area	A_g	**=**	475.16589	mm^2		
In-plane elastic section modulus	Z_x	**=**	6913.4751	mm^3		
Out-of-plane elastic section mod.	Z_y	**=**	6913.4751	mm^3		
Stress from axial force	$\mathbf{f_a}$	**=**	P/A_g			
		=	**0.00**	**MPa**	*compression*	
		=	**1.28**	**MPa**	*Tension*	
Stress from in-plane bending	$\mathbf{f_{bx}}$	**=**	M_x/Z_x			
		=	**132.89**	**MPa**	*compression*	
Stress from out-of-plane bending	$\mathbf{f_{by}}$	**=**	M_y/Z_y			
		=	**68.17**	**MPa**	*compression*	
Tension						
3.4.3 *Tension in round or oval tubes*						3.4.3
	$\boldsymbol{\phi F_L}$	**=**	**267.87**	**MPa**		
		OR				
	$\boldsymbol{\phi F_L}$	**=**	**276.15**	**MPa**		
COMPRESSION						
3.4.8 *Compression in columns, axial, gross section*						
1. General						3.4.8.1
Unsupported length of member	L	=	2250	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/ry	=	105.10			
Slenderness ratio	kL/rx	=	105.10			

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Slenderness parameter	λ	=	1.96			
	D_c*	=	90.3			
	S_1*	=	0.33			
	S_2*	=	1.23			
	ϕ_{cc}	=	0.855			
Factored limit state stress	**ϕF_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	**ϕF_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^4		
Torsion modulus	J	=	4.36E+05	mm^3		
Elastic section modulus	Z	=	6913.4751	mm^3		
	R_b/t	=	12.10			

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Limit 1	S_1	=	44.07			
Limit 2	S_2	=	78.23			
Factored limit state stress	**ϕF_L**	=	**267.87**	**MPa**		3.4.13
***3.4.18** Compression in components of beams - curverd plates with both edges supported*						
	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	**ϕF_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}	=	0.60		PASS	
BENDING - OUT-OF-PLANE						
NOTE: Limit state stresses, ϕF_L are the same for out-of-plane bending (doubly symmetric section)						
Factored limit state stress	**ϕF_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}**	=	0.31		PASS	
COMBINED ACTIONS						
***4.1.1** Combined compression and bending*						4.1.1
	F_a	=	53.46	MPa		3.4.11
	F_{ao}	=	221.14	MPa		3.4.11
	F_{bx}	=	221.14	MPa		3.4.18
	F_{by}	=	221.14	MPa		3.4.18

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	f_a/F_a	=	0.005			
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \le 1.0$					4.1.1
i.e.	0.91	≤	1.0		PASS	
SHEAR						
***3.4.24** Shear in webs (Major Axis)*						3.4.24
	R	=	31.5	mm		
	t	=	2.5	mm		
Equivalent h/t	h/t	=	41.08			
Limit 1	S_1	=	29.01			
Limit 2	S_2	=	59.31			
Factored limit state stress	**ϕF_L**	=	**118.88**	**MPa**		
Stress From Shear force	**f_{sx}**	=	V/A_w			
			0.27	**MPa**		
***3.4.25** Shear in webs (Minor Axis)*						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	**ϕF_L**	=	**118.88**	**MPa**		
Stress From Shear force	**f_{sy}**	=	V/A_w			
			0.33	**MPa**		

6.2 Rafter

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
D63x2.5	**Rafter**					
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			T3.4(B)
	k_c	=	1.0			
FEM ANALYSIS RESULTS						
Axial force	P	=	0	kN	*compression*	
	P	=	0.06	kN	*Tension*	
In plane moment	M_x	=	0.0664	kNm		
Out of plane moment	M_y	=	0.1231	kNm		
DESIGN STRESSES						
Gross cross section area	A_g	**=**	475.1658 9	mm^2		
In-plane elastic section modulus	Z_x	**=**	6913.475 1	mm^3		
Out-of-plane elastic section mod.	Z_y	**=**	6913.475 1	mm^3		
Stress from axial force	$\mathbf{f_a}$	**=**	P/A_g			
		=	**0.00**	**MPa**	*compression*	
		=	**0.13**	**MPa**	*Tension*	
Stress from in-plane bending	$\mathbf{f_{bx}}$	**=**	M_x/Z_x			
		=	**9.60**	**MPa**	*compression*	
Stress from out-of-plane bending	$\mathbf{f_{by}}$	**=**	M_y/Z_y			
		=	**17.81**	**MPa**	*compression*	
Tension						
3.4.3 *Tension in rectangular tubes*						3.4.3
	$\mathbf{\phi F_L}$	**=**	**267.87**	**MPa**		
		OR				
	$\mathbf{\phi F_L}$	**=**	**276.15**	**MPa**		
COMPRESSION						
3.4.8 *Compression in columns, axial, gross section*						
1. General						3.4.8.1
Unsupported length of member	L	=	3000	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/ry	=	140.13			
Slenderness ratio	kL/rx	=	140.13			

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Slenderness parameter	λ	=	2.617			
	D_c*	=	90.3			
	S_1*	=	0.33			
	S_2*	=	1.23			
	ϕ_{cc}	=	0.946			
Factored limit state stress	**ϕF_L**	**=**	**33.30**	**MPa**		
2. Sections not subject to torsional or torsional-flexural buckling						3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	140.13			
3.4.11 *Uniform compression in components of columns, gross section - flat plates*						
Uniform compression in components of columns, gross section - curved plates with both edges, walls of round or oval tube						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	**ϕF_L**	**=**	**229.63**	**MPa**		
Most adverse compressive limit state stress	F_a	=	33.30	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	=	3000	mm		
Second moment of area (weak axis)	I_y	=	2.18E+05	mm^4		
Torsion modulus	J	=	4.36E+05	mm^3		
Elastic section modulus	Z	=	6913.475 1	mm^3		
	R_b/t	=	12.10			

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Limit 1	S_1	=	44.07			
Limit 2	S_2	=	78.23			
Factored limit state stress	**ϕF_L**	=	**267.87**	**MPa**		3.4.13
***3.4.18** Compression in components of beams - curverd plates with both edges supported*						
	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	**ϕF_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}	=	0.04		PASS	
BENDING - OUT-OF-PLANE						
NOTE: Limit state stresses, ϕF_L are the same for out-of-plane bending (doubly symmetric section)						
Factored limit state stress	**ϕF_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}**	=	0.08		PASS	
COMBINED ACTIONS						
***4.1.1** Combined compression and bending*						4.1.1
	F_a	=	33.30	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	=	0.000			

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Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					4.1.1
i.e.	0.12	≤	1.0		PASS	
SHEAR						
***3.4.24** Shear in webs (Major Axis)*						3.4.24
	R	=	31.5	mm		
	t	=	2.5	mm		
Equivalent h/t	h/t	=	44.14			
Limit 1	S_1	=	29.01			
Limit 2	S_2	=	59.31			
Factored limit state stress	ϕF_L	=	**115.78**	**MPa**		
Stress From Shear force	f_{sx}	=	V/A_w			
			0.27	**MPa**		
***3.4.25** Shear in webs (Minor Axis)*						3.4.24
Clear web height	R	=	31.5	mm		
	t	=	2.5	mm		
Equivalent h/t	h/t	=	44.14			
Factored limit state stress	ϕF_L	=	**115.78**	**MPa**		
Stress From Shear force	f_{sy}	=	V/A_w			
			0.33	**MPa**		

6.3 Gable Beam

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
D63x2.9	**Gable Beam**					
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*	
	k_t	=	1.0			T3.4(B)

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	k_c	=	1.0			
FEM ANALYSIS RESULTS						
Axial force	P	=	0.047	kN	*compression*	
	P	=	0	kN	*Tension*	
In plane moment	M_x	=	0.2844	kNm		
Out of plane moment	M_y	=	0.2743	kNm		
DESIGN STRESSES						
Gross cross section area	A_g	**=**	475.16589	mm^2		
In-plane elastic section modulus	Z_x	**=**	6913.4751	mm^3		
Out-of-plane elastic section mod.	Z_y	**=**	6913.4751	mm^3		
Stress from axial force	$\mathbf{f_a}$	**=**	P/A_g			
		=	**0.10**	**MPa**	*compression*	
		=	**0.00**	**MPa**	*Tension*	
Stress from in-plane bending	$\mathbf{f_{bx}}$	**=**	M_x/Z_x			
		=	**41.14**	**MPa**	*compression*	
Stress from out-of-plane bending	$\mathbf{f_{by}}$	**=**	M_y/Z_y			
		=	**39.68**	**MPa**	*compression*	
Tension						
3.4.3 *Tension in rectangular tubes*						3.4.3
	$\boldsymbol{\phi F_L}$	**=**	**267.87**	**MPa**		
		OR				
	$\boldsymbol{\phi F_L}$	**=**	**276.15**	**MPa**		
COMPRESSION						
3.4.8 *Compression in columns, axial, gross section*						
1. General						3.4.8.1
Unsupported length of member	L	=	4000	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/ry	=	186.84			
Slenderness ratio	kL/rx	=	186.84			
Slenderness parameter	λ	=	3.49			
	D_c*	=	90.3			

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	S_1*	=	0.33			
	S_2*	=	1.23			
	ϕ_{cc}	=	0.950			
Factored limit state stress	**ϕF_L**	**=**	**18.80**	**MPa**		
2. Sections not subject to torsional or torsional-flexural buckling						3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	186.84			
***3.4.11** Uniform compression in components of columns, gross section - flat plates*						
Uniform compression in components of columns, gross section - curved plates with both edges, walls of round or oval tube						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	**ϕF_L**	**=**	**229.63**	**MPa**		
Most adverse compressive limit state stress	F_a	=	18.80	MPa		
Most adverse tensile limit state stress	F_a	=	267.87	MPa		
Most adverse compressive & Tensile capacity factor	f_a/F_a	=	0.01		PASS	
BENDING - IN-PLANE						
***3.4.13** Compression in beams, extreme fibre, gross section round or oval tubes*						
Unbraced length for bending	L_b	=	4000	mm		
Second moment of area (weak axis)	I_y	=	217774.47	mm^4		
Torsion modulus	J	=	435548.93	mm^3		
Elastic section modulus	Z	=	6913.4751	mm^3		
	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	**ϕF_L**	=	**267.87**	**MPa**		3.4.13
***3.4.18** Compression in components of beams - curverd plates with both edges supported*						
	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	**ϕF_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}	=	0.19		PASS	
BENDING - OUT-OF-PLANE						
NOTE: Limit state stresses, ϕF_L are the same for out-of-plane bending (doubly symmetric section)						
Factored limit state stress	**ϕF_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	
COMBINED ACTIONS						
***4.1.1** Combined compression and bending*						4.1.1
	F_a	=	18.80	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

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	f_a/F_a	=	0.005			
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					4.1.1
i.e.	0.37	≤	1.0		PASS	
SHEAR						
***3.4.24** Shear in webs (Major Axis)*						3.4.24
	R	=	31.5	mm		
	t	=	2.5	mm		
Equivalent h/t	h/t	=	47.43			
Limit 1	S_1	=	29.01			
Limit 2	S_2	=	59.31			
Factored limit state stress	**ϕF_L**	=	**112.45**	**MPa**		
Stress From Shear force	**f_{sx}**	=	V/A_w			
			0.27	**MPa**		
***3.4.25** Shear in webs (Minor Axis)*						3.4.25
Clear web height	R	=	31.5	mm		
	t	=	2.5	mm		
Equivalent h/t	h/t	=	47.43			
Factored limit state stress	**ϕF_L**	=	**112.45**	**MPa**		
Stress From Shear force	**f_{sy}**	=	V/A_w			
			0.33	**MPa**		

6.4 Summary Forces

MEMBER(S)	Section	d	t	Vx	Vy	P (Axial) Negative -> Compression Positive -> Tension	Mx	My
		mm	mm	kN	kN	kN	kN.m	kN.m
Rafter	D63x2.5	63	2.5	0.063	-0.079	0.06	-0.0664	0.1231
Upright Support	D63x2.5	63	2.5	-0.06	0.648	0.606	-0.9187	-0.4713
Gable Beam	D63x2.9	63	2.5	0.214	0.192	-0.047	-0.2844	-0.2743

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7 Summary

7.1 Conclusions

a. The 3m x 3m Pavilion Marquees as specified has been analyzed with a conclusion that it has the capacity to withstand wind speeds up to and including **60km/hr.**

b. For forecast winds in excess of **60km/hr** – the structure should be completely dismantled.

c. For uplift due to 60km/hr, 1.4 kN (140kg) 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 <u>unbraced</u> Pavilion Marquees due to the lack of bracing within the system and insufficient out-of-plane stiffness of framing.**

Yours faithfully,

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8 Appendix A – Base Anchorage Requirements

3m x 3m Pavilion Marquees:

Tent Span	Sile Type	Required Weight Per Leg
3 m	A	140kg
	B	140kg
	C	140kg
	D	140kg
	E	140kg

<u>Definition of Soil Types:</u>

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 .

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9 Appendix "B" – Hold Down Method Details