



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

**Client:** Extreme Marquees

**Project:** Design check – 5m × 9m Function Standard Tent Structure for 80km/hr Wind  
– 4m × 9m Function Standard Tent Structure for 80km/hr Wind  
– 3m × 9m Function Standard Tent Structure for 80km/hr Wind

**Reference:** Extreme Marquees' data

Report by: KZ  
Checked by: EAB  
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JOB NO: D-11-263557-2



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

### **1 Introduction**

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The report examines the effect of 3s gust wind of 80 km/hr on 5m Span x 3m Bay Function Standard Tent. 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 1664.1:1997 Aluminum limit state design.



## **2 Design Restrictions and Limitations**

- 2.1 The erected structure is for temporary use only and is limited to 6 months maximum at any one site establishment.
- 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 dismantled.
- 2.3 For forecast winds in excess of (**refer to summary**) – all fabric shall be removed from the frames, and 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 Wall Bracing is required at one of the end bays for 5m X 9m tent to resist against lateral movement due to wind direction. However, for multiple tent length, each end bay and every third bay in between must be braced.**

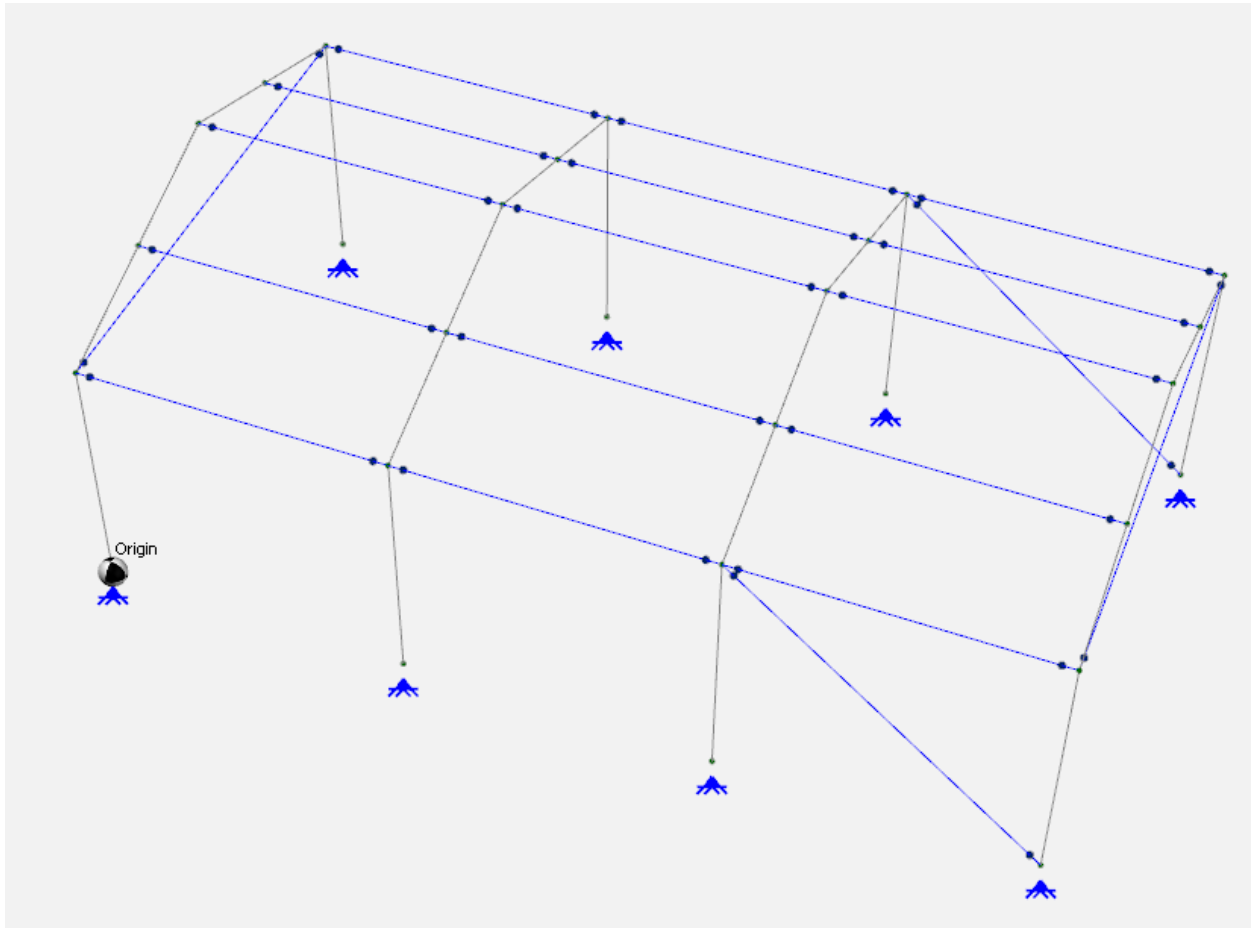


### 3 Specifications

#### 3.1 General

Tent category	
Material	Aluminum 6061-T6

Size	Model
10m x 9m	Function Standard





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### 3.2 Aluminium Properties

Aluminium Properties		
Compressive yield strength	Fcy	241 MPa
Tensile yeild strength	Fty	241 MPa
Tensile ultimate strength	Ftu	262 MPa
Shear yield strength	Fsy	138 MPa
Bearing yeild strength	Fby	386 MPa
Bearing ultimate strength	Fbu	552 MPa
Yield stress (min{Fcy:Fty})	Fy	241 MPa
Elastic modulus	E	70000 MPa
Shear modulus	G	26250 MPa
Value of coefficients	kt	1.00
	kc	1.00
Capacity factor (general yield)	$\phi_y$	0.95
Capacity factor (ultimate)	$\phi_u$	0.85
Capacity factor (bending)	$\phi_b$	0.85
Capacity factor (elastic shear buckling)	$\phi_v$	0.8
Capacity factor (inelastic shear buckling)	$\phi_{vp}$	0.9

### 3.3 Buckling Constants

Type of member and stresses	Intercept, MPa	Slope, MPa	Intersection
Compression in columns and beam flanges	BC= 242.87	Dc= 1.43	Cc= 69.61
Compression in flat plates	Bp= 310.11	Dp= 2.06	Cp= 61.60
Compressive bending stress in solid rectangular bars	Bbr= 459.89	Dbr= 4.57	Cbr= 67.16
Compressive bending stress in round tubes	Btb= 250.32	Dtb= 14.18	Ctb= 183.52
Shear stress in flat plates	Bs= 178.29	Ds= 0.90	Cs= 81.24



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### 3.4 Section Properties

MEMBER(S)	Section	b	d	t	yc	Ag	Zx	Zy	Sx	Sy	Ix	Iy	J	rx	ry
		mm	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	82x48x3	48	82	3	41	744	1.63E+04	1.19E+04	2.00E+04	1.37E+04	6.69E+05	2.86E+05	6.12E+05	30.0	19.6
Upright Support	82x48x3	48	82	3	41	744	1.63E+04	1.19E+04	2.00E+04	1.37E+04	6.69E+05	2.86E+05	6.12E+05	30.0	19.6
Ridge & Eave Purlin	40x40x2	40	40	2	20	304	3.67E+03	3.67E+03	4.34E+03	4.34E+03	7.34E+04	7.34E+04	1.10E+05	15.5	15.5
Gable Beam	40x40x2	40	40	2	20	304	3.67E+03	3.67E+03	4.34E+03	4.34E+03	7.34E+04	7.34E+04	1.10E+05	15.5	15.5
Intermediate Purlin	40x40x2	40	40	2	20	304	3.67E+03	3.67E+03	4.34E+03	4.34E+03	7.34E+04	7.34E+04	1.10E+05	15.5	15.5
Brace	40x40x2	40	40	2	20	304	3.67E+03	3.67E+03	4.34E+03	4.34E+03	7.34E+04	7.34E+04	1.10E+05	15.5	15.5

## 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 80km/hr gust	W	0.245 C <sub>fig</sub>	1.0	0.245 C <sub>fig</sub>

### 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 =  $1.35 \times G$   
=  $1.2 \times G + W_u$   
=  $1.2 \times G + W_u + W_{ls}$

Upward =  $0.9 \times G + W_u$   
=  $0.9 \times G + W_u + W_{IP}$



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### 5 Wind Analysis

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

#### 5.1 Parameters & 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		< 6 months			Table 3.3
Regional gust wind speed		80	Km/hr		Table 3.1 (AS1170.2)
Regional gust wind speed	$V_R$	22.22	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	$V_{Site,\beta}$	20.22	m/s	$V_{Site,\beta} = V_R * M_d * M_{Z,Cat} * M_S * M_t$	
Pitch	$\alpha$	20	Deg		
Pitch	$\alpha$	0.349	rad		
Width	B	5	m		
Width Span	$S_w$	5	m		
Length	D	9	m		
Height	Z	2.95	m		
Bay Span		3	m		
Purlin Spacing		1.33	m		
Number of Intermediate Purlin		1			
	h/d	0.328			
	h/b	0.59			
<b>Wind Pressure</b>					
$\rho_{air}$	$\rho$	1.2	Kg/m <sup>3</sup>		





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dynamic response factor	$C_{dyn}$	1			
Wind Pressure	$\rho/C_{fig}$	0.245	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 (Perpendicular to Length)</b>					
<b>Internal Pressure</b>					
Opening Assumption	<div>With Dominant Opening (C<sub>pi</sub> = nC<sub>pe</sub>)</div>				
Internal Pressure Coefficient (Without Dominant) <b>MIN</b>		-0.1			Table 5.1 A (AS1170.2)
Internal Pressure Coefficient (Without Dominant) <b>MAX</b>		0.2			
Internal Pressure Coefficient (With Dominant) <b>MIN</b>		-0.1			Table 5.1 B (AS1170.2)
Internal Pressure Coefficient (With Dominant) <b>MAX</b>		0.2			
N		0.7			
Combination Factor	$K_{C,i}$	1			
Internal Pressure Coefficient <b>MIN</b>	$C_{p,i}$	0.70			
Internal Pressure Coefficient <b>MAX</b>	$C_{p,i}$	0.70			
<b>External Pressure</b>					
<b>1. Windward Wall</b>					
External Pressure Coefficient	$C_{P,e}$	0.7			Table 5.2 A
Area Reduction Factor	$K_a$	0.8			Table 5.4
combination factor applied to internal pressures	$K_{C,e}$	1			
local pressure factor	$K_l$	1			
porous cladding reduction factor	$K_p$	1			
aerodynamic shape factor	$C_{fig,e}$	0.56			
Wind Wall Pressure	P	0.14	kPa		
Edge Column Force	F	0.21	kN/m		
Intermediate Column Force	F	0.41	kN/m		
<b>2. Leeward Wall</b>					



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External Pressure Coefficient	$C_{P,e}$	-0.4			Table 5.2 B
Area Reduction Factor	$K_a$	0.8			Table 5.4
combination factor applied to internal pressures	$K_{C,e}$	1			
local pressure factor	$K_l$	1			
porous cladding reduction factor	$K_p$	1			
aerodynamic shape factor	$C_{fig,e}$	-0.32			
Lee Wall Pressure	P	-0.08	kPa		
Edge Column Force	F	-0.12	kN/m		
Intermediate Column Force	F	-0.24	kN/m		
<b>3. Side Wall</b>					
Area Reduction Factor	$K_a$	0.8			Table 5.2 C
combination factor applied to internal pressures	$K_{C,e}$	1			Table 5.4
local pressure factor	$K_l$	1			
porous cladding reduction factor	$K_p$	1			
External Pressure Coefficient	$C_{P,e}$	-0.65		0 to 1h	
External Pressure Coefficient	$C_{P,e}$	-0.5		1h to 2h	
External Pressure Coefficient	$C_{P,e}$	-0.3		2h to 3h	
External Pressure Coefficient	$C_{P,e}$	-0.2		>3h	
aerodynamic shape factor	$C_{fig,e}$	-0.52		0 to 1h	
aerodynamic shape factor	$C_{fig,e}$	-0.4		1h to 2h	
aerodynamic shape factor	$C_{fig,e}$	-0.24		2h to 3h	
aerodynamic shape factor	$C_{fig,e}$	-0.16		>3h	
Side Wall Pressure	P	-0.13	kPa	0 to 1h	
Side Wall Pressure	P	-0.10	kPa	1h to 2h	
Side Wall Pressure	P	-0.06	kPa	2h to 3h	
Side Wall Pressure	P	-0.04	kPa	>3h	
<b>4. Roof Up Wind Slop</b>				$\alpha > 10^\circ$	
Area Reduction Factor	$K_a$	0.8			Table 5.3 B
combination factor applied to internal pressures	$K_{C,e}$	1			
local pressure factor	$K_l$	1			



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porous cladding reduction factor	$K_p$	1	
External Pressure Coefficient <b>MIN</b>	$C_{P,e}$	-0.46	
External Pressure Coefficient <b>MAX</b>	$C_{P,e}$	-0.06	
aerodynamic shape factor <b>MIN</b>	$C_{fig,e}$	-0.37	
aerodynamic shape factor <b>MAX</b>	$C_{fig,e}$	-0.05	
Pressure <b>MIN</b>	P	-0.09	kPa
Pressure <b>MAX</b>	P	-0.01	kPa
Edge Rafter Force <b>MIN</b>	F	-0.14	kN/m
Edge Rafter Force <b>Max</b>	F	-0.02	kN/m
Intermediate Rafter Force <b>MIN</b>	F	-0.27	kN/m
Intermediate Rafter Force <b>MAX</b>	F	-0.04	kN/m

### 5. Roof Down Wind Slop

Area Reduction Factor	$K_a$	0.8	
combination factor applied to internal pressures	$K_{C,e}$	1	
local pressure factor	$K_l$	1	
porous cladding reduction factor	$K_p$	1	
External Pressure Coefficient	$C_{P,e}$	-0.6	
aerodynamic shape factor	$C_{fig,e}$	-0.48	
Pressure <b>MIN</b>	P	-0.12	kPa
Pressure <b>MAX</b>	P	-0.12	kPa
Edge Rafter Force <b>MIN</b>	F	-0.18	kN/m
Edge Rafter Force <b>MAX</b>	F	-0.18	kN/m
Intermediate Rafter Force <b>MIN</b>	F	-0.35	kN/m
Intermediate Rafter Force <b>MAX</b>	F	-0.35	kN/m

### WIND DIRECTION 2 (Parallel to Length)

#### Internal Pressure

Opening Assumption

With Dominant Opening ( $C_{pi} = nC_{pe}$ )





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Internal Pressure Coefficient (Without Dominant) <b>MIN</b>		-0.1			Table 5.1 A (AS1170.2)
Internal Pressure Coefficient (Without Dominant) <b>MAX</b>		0.2			
Internal Pressure Coefficient (With Dominant) <b>MIN</b>		-0.1			Table 5.1 B (AS1170.2)
Internal Pressure Coefficient (With Dominant) <b>MAX</b>		0.2			
N		<b>0.7</b>		$C_{pi} = N * C_{pe}$	
Combination Factor	$K_{C,i}$	1			
Internal Pressure Coefficient <b>MIN</b>	$C_{p,i}$	0.70			
Internal Pressure Coefficient <b>MAX</b>	$C_{p,i}$	0.70			
<b>External Pressure</b>					
<b>1. Windward Wall</b>					
External Pressure Coefficient	$C_{P,e}$	0.7			Table 5.2 A
Area Reduction Factor	$K_a$	0.8			Table 5.4
combination factor applied to internal pressures	$K_{C,e}$	1			
local pressure factor	$K_l$	1			
porous cladding reduction factor	$K_p$	1			
aerodynamic shape factor	$C_{fig,e}$	0.56			
Wind Wall Pressure	P	<b>0.14</b>	<b>kPa</b>		
Edge Column Force	F	<b>0.34</b>	<b>kN/m</b>		
Intermediate Column Force	F	<b>0.69</b>	<b>kN/m</b>		
<b>2. Leeward Wall</b>					
External Pressure Coefficient	$C_{P,e}$	-0.4			Table 5.2 B
Area Reduction Factor	$K_a$	0.8			Table 5.4
combination factor applied to internal pressures	$K_{C,e}$	1			
local pressure factor	$K_l$	1			
porous cladding reduction factor	$K_p$	1			
aerodynamic shape factor	$C_{fig,e}$	-0.32			
Lee Wall Pressure	P	<b>-0.08</b>	<b>kPa</b>		



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Edge Column Force	F	-0.20	kN/m
Intermediate Column Force	F	-0.39	kN/m

### 3. Side Wall

Table 5.2 C  
Table 5.4

Area Reduction Factor	K <sub>a</sub>	0.8	
combination factor applied to internal pressures	K <sub>C,e</sub>	1	
local pressure factor	K <sub>l</sub>	1	
porous cladding reduction factor	K <sub>p</sub>	1	
External Pressure Coefficient	C <sub>P,e</sub>	-0.65	0 to 1h
External Pressure Coefficient	C <sub>P,e</sub>	-0.5	1h to 2h
External Pressure Coefficient	C <sub>P,e</sub>	-0.3	2h to 3h
External Pressure Coefficient	C <sub>P,e</sub>	-0.2	>3h
aerodynamic shape factor	C <sub>fig,e</sub>	-0.52	0 to 1h
aerodynamic shape factor	C <sub>fig,e</sub>	-0.4	1h to 2h

Side Wall Pressure	P	-0.13	kPa	0 to 1h
Side Wall Pressure	P	-0.10	kPa	1h to 2h
Side Wall Pressure	P	-0.06	kPa	2h to 3h
Side Wall Pressure	P	-0.04	kPa	>3h

### 4. Roof

$\alpha < 10^\circ$

Table 5.3 A

Area Reduction Factor	K <sub>a</sub>	0.8	
combination factor applied to internal pressures	K <sub>C,e</sub>	1	
local pressure factor	K <sub>l</sub>	1	
porous cladding reduction factor	K <sub>p</sub>	1	
External Pressure Coefficient	C <sub>P,e</sub>	-0.9	0 to 0.5h
MIN			
External Pressure Coefficient	C <sub>P,e</sub>	-0.9	0.5 to 1h
MIN			
External Pressure Coefficient	C <sub>P,e</sub>	-0.50	1h to 2h
MIN			
External Pressure Coefficient	C <sub>P,e</sub>	-0.30	2h to 3h
MIN			
External Pressure Coefficient	C <sub>P,e</sub>	-0.2	>3h
MIN			



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External Pressure Coefficient <b>MAX</b>	$C_{P,e}$	-0.4		0 to 0.5h
External Pressure Coefficient <b>MAX</b>	$C_{P,e}$	-0.4		0.5 to 1h
External Pressure Coefficient <b>MAX</b>	$C_{P,e}$	0		1h to 2h
External Pressure Coefficient <b>MAX</b>	$C_{P,e}$	0.1		2h to 3h
External Pressure Coefficient <b>MAX</b>	$C_{P,e}$	0.2		>3h
aerodynamic shape factor <b>MIN</b>	$C_{fig,e}$	-0.72		0 to 0.5h
aerodynamic shape factor <b>MIN</b>	$C_{fig,e}$	-0.72		0.5 to 1h
aerodynamic shape factor <b>MIN</b>	$C_{fig,e}$	-0.4		1h to 2h
aerodynamic shape factor <b>MIN</b>	$C_{fig,e}$	-0.24		2h to 3h
aerodynamic shape factor <b>MIN</b>	$C_{fig,e}$	-0.16		>3h
aerodynamic shape factor <b>MAX</b>	$C_{fig,e}$	-0.32		0 to 0.5h
aerodynamic shape factor <b>MAX</b>	$C_{fig,e}$	-0.32		0.5 to 1h
aerodynamic shape factor <b>MAX</b>	$C_{fig,e}$	0		1h to 2h
aerodynamic shape factor <b>MAX</b>	$C_{fig,e}$	0.08		2h to 3h
aerodynamic shape factor <b>MAX</b>	$C_{fig,e}$	0.16		>3h
Pressure <b>MIN</b>	<b>P</b>	-0.18	kPa	0 to 0.5h
Pressure <b>MIN</b>	<b>P</b>	-0.18	kPa	0.5 to 1h
Pressure <b>MIN</b>	<b>P</b>	-0.10	kPa	1h to 2h
Pressure <b>MIN</b>	<b>P</b>	-0.06	kPa	2h to 3h
Pressure <b>MIN</b>	<b>P</b>	-0.04	kPa	>3h
Pressure <b>MAX</b>	<b>P</b>	-0.08	kPa	0 to 0.5h
Pressure <b>MAX</b>	<b>P</b>	-0.08	kPa	0.5 to 1h
Pressure <b>MAX</b>	<b>P</b>	0.00	kPa	1h to 2h
Pressure <b>MAX</b>	<b>P</b>	0.02	kPa	2h to 3h
Pressure <b>MAX</b>	<b>P</b>	0.04	kPa	>3h
Edge Purlin Force <b>MIN</b>	<b>F</b>	-0.12	kN/m	0 to 0.5h
Edge Purlin Force <b>MIN</b>	<b>F</b>	-0.12	kN/m	0.5 to 1h
Edge Purlin Force <b>MIN</b>	<b>F</b>	-0.07	kN/m	1h to 2h
Edge Purlin Force <b>MIN</b>	<b>F</b>	-0.04	kN/m	2h to 3h
Edge Purlin Force <b>MIN</b>	<b>F</b>	-0.03	kN/m	>3h



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Edge Purlin Force <b>MAX</b>	F	-0.05	kN/m	0 to 0.5h
Edge Purlin Force <b>MAX</b>	F	-0.05	kN/m	0.5 to 1h
Edge Purlin Force <b>MAX</b>	F	0.00	kN/m	1h to 2h
Edge Purlin Force <b>MAX</b>	F	0.01	kN/m	2h to 3h
Edge Purlin Force <b>MAX</b>	F	0.03	kN/m	>3h
Intermediate Purlin Force <b>MIN</b>	F	-0.23	kN/m	0 to 0.5h
Intermediate Purlin Force <b>MIN</b>	F	-0.23	kN/m	0.5 to 1h
Intermediate Purlin Force <b>MIN</b>	F	-0.13	kN/m	1h to 2h
Intermediate Purlin Force <b>MIN</b>	F	-0.08	kN/m	2h to 3h
Intermediate Purlin Force <b>MIN</b>	F	-0.05	kN/m	>3h
Intermediate Purlin Force <b>MAX</b>	F	-0.10	kN/m	0 to 0.5h
Intermediate Purlin Force <b>MAX</b>	F	-0.10	kN/m	0.5 to 1h
Intermediate Purlin Force <b>MAX</b>	F	0.00	kN/m	1h to 2h
Intermediate Purlin Force <b>MAX</b>	F	0.03	kN/m	2h to 3h
Intermediate Purlin Force <b>MAX</b>	F	0.05	kN/m	>3h



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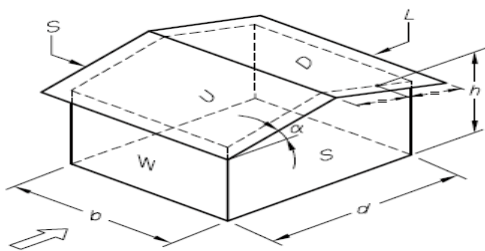
### 5.2 Pressure (P)

$$C_{fig,i} = C_{p,i} k_{c,i}$$

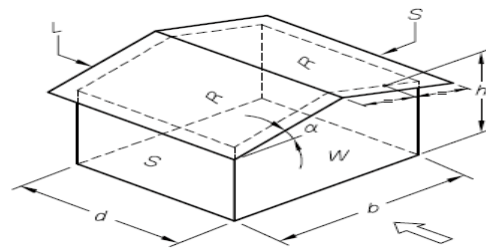
$$C_{fig,e} = C_{p,e} k_a k_{c,e} k_l k_p$$

#### 5.2.1 Pressure summary

WIND EXTERNAL PRESSURE			Direction1		Direction2				
Windward (kPa)			0.14		0.14				
Leeward (kPa)			-0.08		-0.08				
Sidewall (m)	Length	(m)	(m)	(Kpa)	(Kpa)				
	0 - 1h	0	2.95	-0.13	-0.13				
	1h - 2h	2.95	5.9	-0.10	-0.10				
	2h - 3h	5.9	8.85	-0.06	-0.06				
	>3h	8.85	-	-0.04	-0.04				
Roof			Min (Kpa)	Max (Kpa)	Length	(m)	(m)	Min (Kpa)	Max (Kpa)
	Upwind Slope		-0.09	-0.01	0-0.5h	0.00	1.48	-0.18	-0.08
	Downwind Slope		-0.12	-0.12	0.5h-1h	1.48	2.95	-0.18	-0.08
					1h-2h	2.95	5.90	-0.10	0.00
					2h-3h	5.90	8.85	-0.06	0.02
					>3h	8.85	-	-0.04	0.04
Wind Internal Pressure (kPa)			Min (kPa)	Max (kPa)	Min (kPa)			Max (kPa)	
			Proportion of Cpe	Proportion of Cpe	Proportion of Cpe			Proportion of Cpe	



Direction 1



Direction 2

AS1170.2

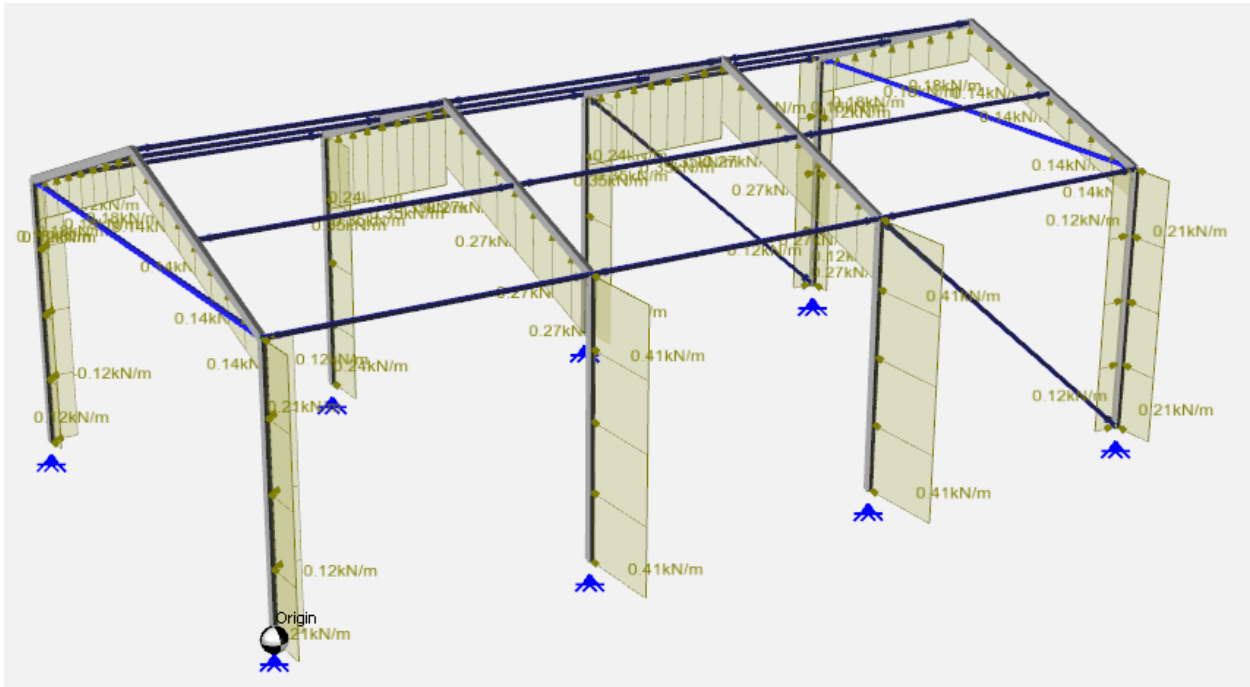




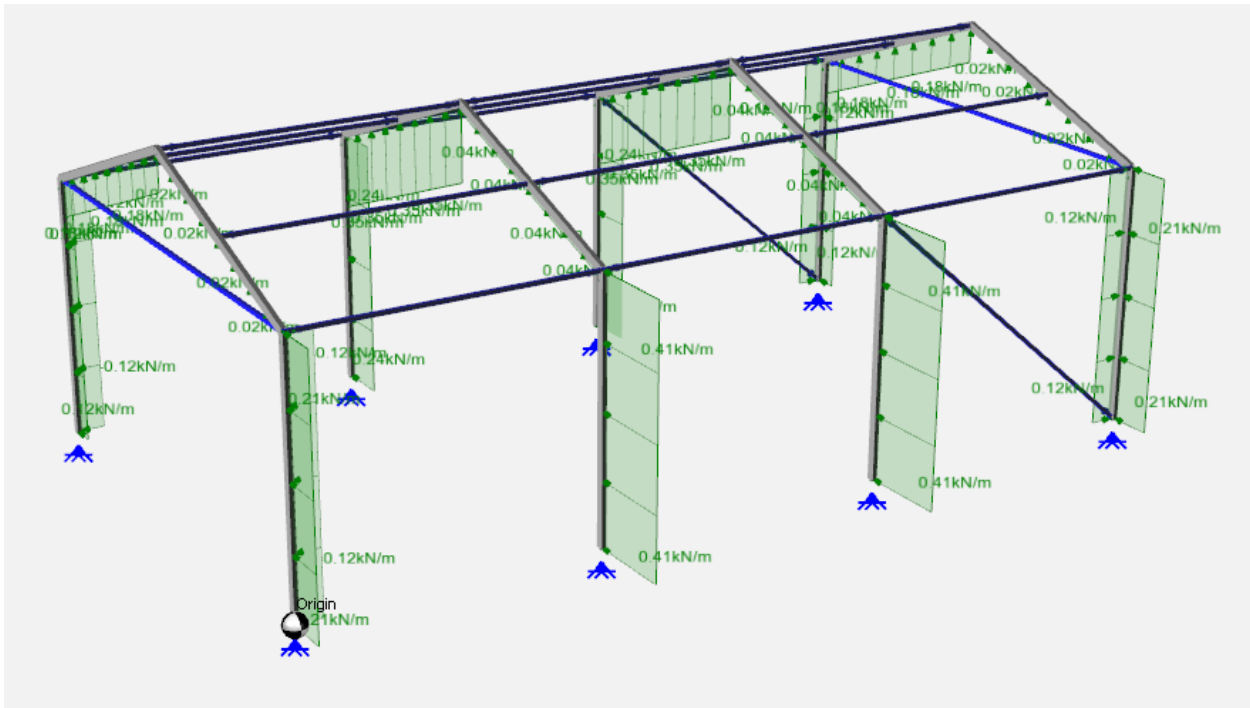
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### 5.3 Wind Load Diagrams

#### 5.3.1 Wind 1(case 1)



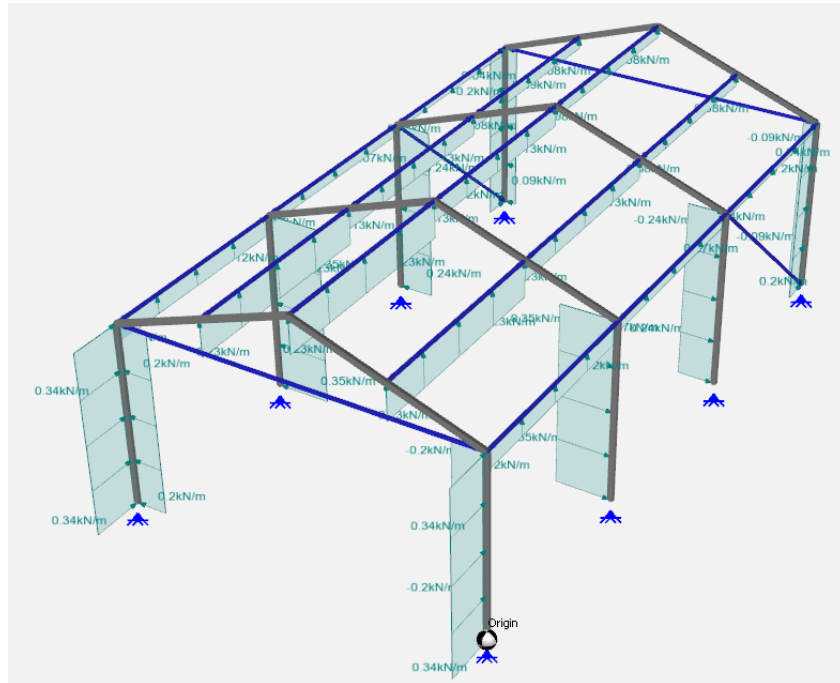
#### 5.3.2 Wind 1(case 2)



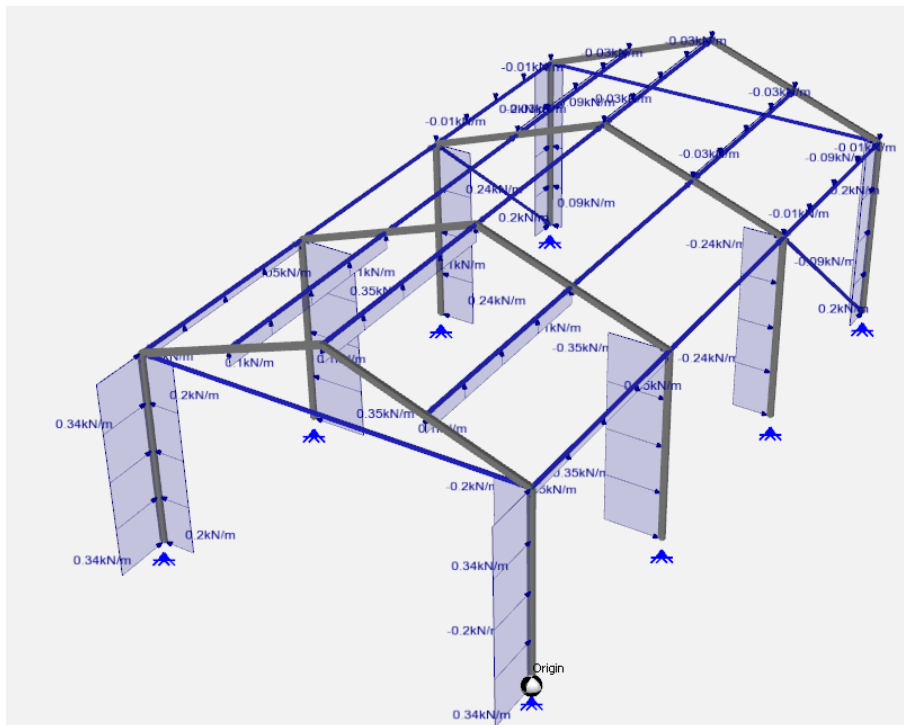


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### 5.3.3 Wind 2(Case1)



### 5.3.4 Wind 2(case 2)



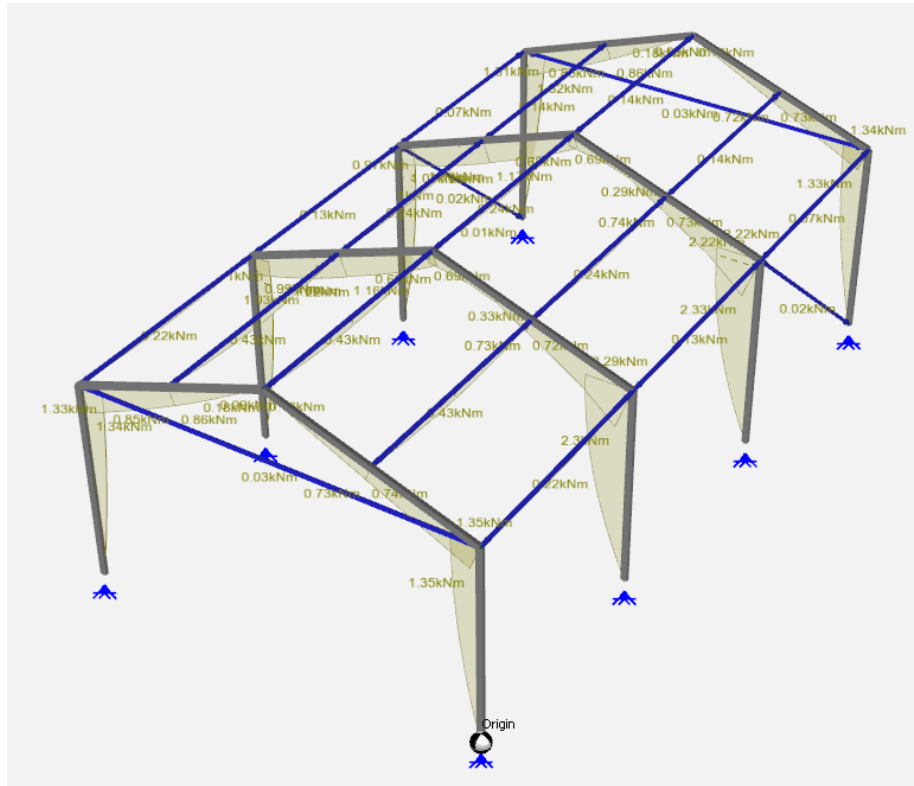
After 3D model analysis, each member is checked based on adverse load combination.

In this regard the maximum bending moment, shear and axial force due to adverse load combinations for each member are presented as below:

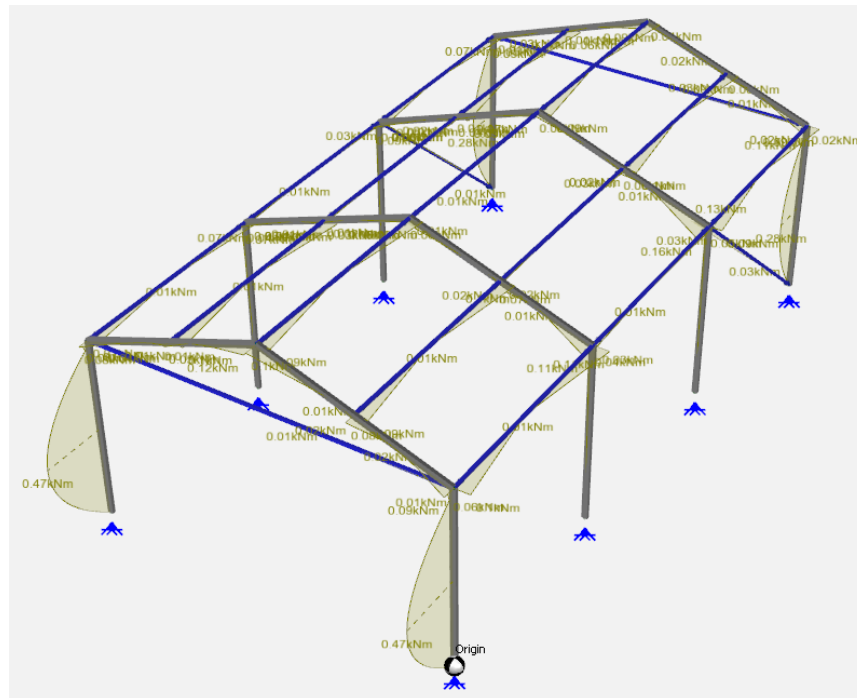


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### 5.3.5 Max Bending Moment due to critical load combination in major axis



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





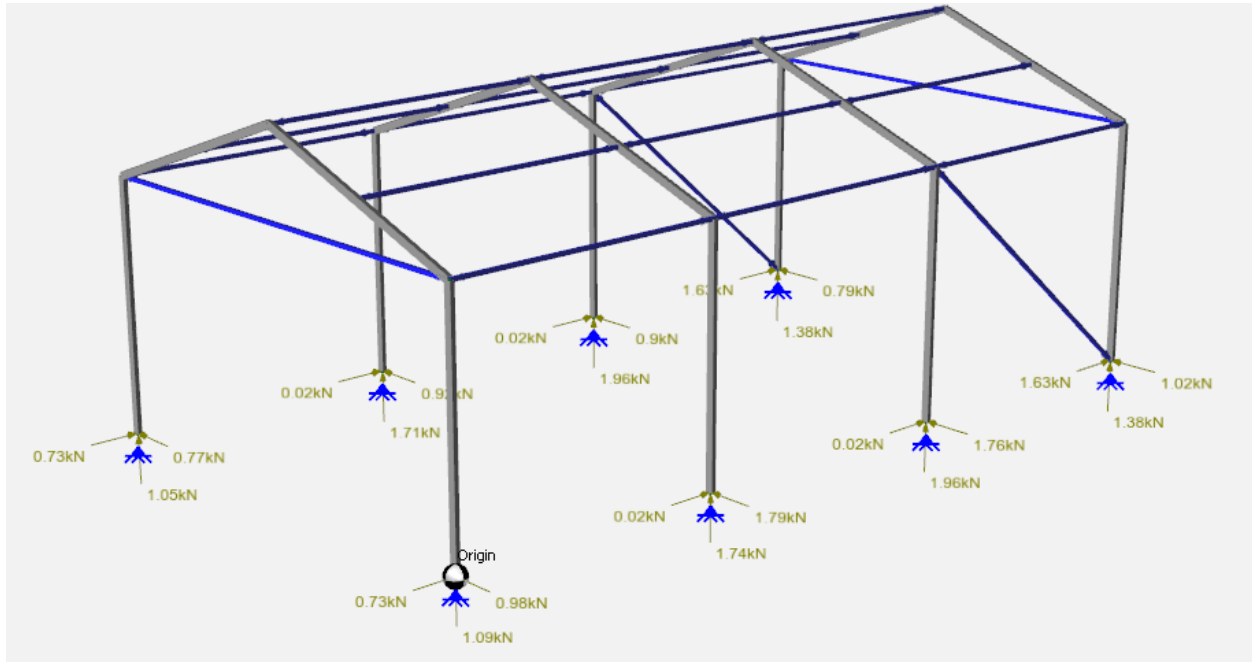
The diagram illustrates a 3D truss structure with internal forces. The structure is composed of blue truss members and yellow triangular plates. Numerous force values in kN are labeled at various joints and along the members. A coordinate system is shown at the bottom center with the origin at (0,0,0).

[illegible]



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### 5.3.9 Max reactions



Max Reaction  $N^* = 2 \text{ kN}$

### 5.3.10 Summary Table:

MEMBER(S)	Section	b	d	t	P	Mx	My
		mm	mm	mm	kN	kN.m	kN.m
Rafter	82x48x3	48	82	3	1.49	2.3	0.16
Upright Support	82x48x3	48	82	3	2	2.22	0.05
Ridge & Eave Purlin	40x40x2	40	40	2	0.82	0.43	0.1
Gable Beam	40x40x2	40	40	2	1.2	0.03	0.02
Intermediate Purlin	40x40x2	40	40	2	0.13	0.43	0.1
Brace	40x40x2	40	40	2	1.6	0.13	0.02



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

#### 6.1 Upright Supports

NAME	SYMBOL	VALUE	UNIT	NOTES	REF
<b>82x48x3</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	
	$k_t$	= 1.0			T3.4(B)
	$k_c$	= 1.0			
<b>FEM ANALYSIS RESULTS</b>					
Axial force	P	= 1.79	kN	compression	
In plane moment	$M_x$	= 1.87	kNm		
Out of plane moment	$M_y$	= 0.49	kNm		
<b>DESIGN STRESSES</b>					
Gross cross section area	$A_g$	= 744	mm <sup>2</sup>		
In-plane elastic section modulus	$Z_x$	= 16318.439	mm <sup>3</sup>		
Out-of-plane elastic section mod.	$Z_y$	= 11937	mm <sup>3</sup>		
Stress from axial force	$f_a$	= $P/A_g$			
		= 2.41	MPa	compression	
Stress from in-plane bending	$f_{bx}$	= $M_x/Z_x$			
		= 114.59	MPa	compression	
Stress from out-of-plane bending	$f_{by}$	= $M_y/Z_y$			
		= 41.05	MPa	compression	
<b>COMPRESSION</b>					
<b>3.4.8 Compression in columns, axial, gross section</b>					
<b>1. General</b>					
					... 3.4.8.1



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Unsupported length of member	L	=	2600	mm		
Effective length factor	k	=	1			
Radius of gyration about buckling axis	r	=	19.62	mm		
Slenderness ratio	kL/r	=	132.50			
Slenderness parameter	$\lambda$	=	2.47			
	$D_c^*$	=	90.3			
	$S_1^*$	=	0.33			
	$S_2^*$	=	1.23			
	$\phi_{cc}$	=	0.926			
Factored limit state stress	$\phi F_L$	=	36.46	MPa		
2. Sections not subject to torsional or torsional-flexural buckling						... 3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	132.50			
<b>3.4.10 Uniform compression in components of columns, gross section - flat plates</b>						
1. Uniform compression in components of columns, gross section - flat plates with both edges supported						... 3.4.10.1 T3.3(D)
	$k_1$	=	0.35			
Max. distance between toes of fillets of supporting elements for plate	$b'$	=	42			
	t	=	3	mm		
Slenderness	b/t	=	14			
Limit 1	$S_1$	=	12.34			
Limit 2	$S_2$	=	32.87		$S_1 < b/t < S_2$	
Factored limit state stress	$\phi F_L$	=	224.30	MPa		
Most adverse compressive limit state stress	$F_a$	=	36.46	MPa		
Most adverse compressive capacity factor	$f_a/F_a$	=	0.07		PASS	
<b>BENDING - IN-PLANE</b>						
<b>3.4.15 Compression in beams, extreme fibre, gross section rectangular tubes, box sections</b>						
Unbraced length for bending	$L_b$	=	2600	mm		



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Second moment of area (weak axis)	$I_y$	=	2.86E+05	mm <sup>4</sup>		
Torsion modulus	J	=	6.12E+05	mm <sup>3</sup>		
Elastic section modulus	Z	=	11937	mm <sup>3</sup>		
Slenderness	S	=	148.30			
Limit 1	S <sub>1</sub>	=	0.39			
Limit 2	S <sub>2</sub>	=	1695.86		S1 < S < S2	
Factored limit state stress	$\phi F_L$	=	202.45	MPa		3.4.15(2)
<b>3.4.17 Compression in components of beams (component under uniform compression), gross section - flat plates with both edges supported</b>						
	k <sub>1</sub>	=	0.5			T3.3(D)
	k <sub>2</sub>	=	2.04			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	b'	=	42	mm		
	t	=	3	mm		
Slenderness	b/t	=	14			
Limit 1	S <sub>1</sub>	=	12.34			
Limit 2	S <sub>2</sub>	=	46.95		S1 < S < S2	
Factored limit state stress	$\phi F_L$	=	224.30	MPa		
Most adverse in-plane bending limit state stress	F <sub>bx</sub>	=	202.45	MPa		
Most adverse in-plane bending capacity factor	f <sub>bx</sub> /F <sub>bx</sub>	=	0.57		PASS	
<b>BENDING - OUT-OF-PLANE</b>						
<b>NOTE: Limit state stresses, <math>\phi F_L</math> are the same for out-of-plane bending (doubly symmetric section)</b>						
Factored limit state stress	$\phi F_L$	=	202.45	MPa		
Most adverse out-of-plane bending limit state stress	F <sub>by</sub>	=	202.45	MPa		
Most adverse out-of-plane bending capacity factor	f <sub>by</sub> /F <sub>by</sub>	=	0.20		PASS	
<b>COMBINED ACTIONS</b>						
<b>4.1.1 Combined compression and bending</b>						
						4.1.1(2)





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$F_a$	=	36.46	MPa		... 3.4.8
$F_{ao}$	=	224.30	MPa		... 3.4.10
$F_{bx}$	=	224.30	MPa		... 3.4.17
$F_{by}$	=	202.45	MPa		... 3.4.17
$f_a/F_a$	=	0.066		Which is <0.15	
Check: $f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					... 4.1.1 (3)
i.e.		0.83	$\leq$	1.0	PASS

### 6.2 Rafter

NAME	SYMBOL	VALUE	UNIT	NOTES	REF
82x48x3	(Rafter)				
Alloy and temper	6061-T6				AS1664.1
Tension	F <sub>tu</sub>	=	262	MPa	T3.3(A)
	F <sub>ty</sub>	=	241	MPa	
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		
	k <sub>c</sub>	=	1.0		T3.4(B)
FEM ANALYSIS RESULTS					
Axial force	P	=	1.63	kN	compression
In plane moment	M <sub>x</sub>	=	1.85	kNm	
Out of plane moment	M <sub>y</sub>	=	0.58	kNm	
DESIGN STRESSES					
Gross cross section area	A <sub>g</sub>	=	744	mm <sup>2</sup>	compression
In-plane elastic section modulus	Z <sub>x</sub>	=	16318.439	mm <sup>3</sup>	
Out-of-plane elastic section mod.	Z <sub>y</sub>	=	11937	mm <sup>3</sup>	
Stress from axial force	f <sub>a</sub>	=	P/A <sub>g</sub>		
		=	2.19	MPa	



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Stress from in-plane bending	$f_{bx}$	=	$M_x/Z_x$			
		=	<b>113.37</b>	<b>MPa</b>	compression	
Stress from out-of-plane bending	$f_{by}$	=	$M_y/Z_y$			
		=	<b>48.59</b>	<b>MPa</b>	compression	
<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	=	5000	mm		
Effective length factor	k	=	1			
Radius of gyration about buckling axis	r	=	19.62	mm		
Slenderness ratio	$kL/r$	=	254.80			
Slenderness parameter	$\lambda$	=	4.759			
	$D_c^*$	=	90.3			
	$S_1^*$	=	0.33			
	$S_2^*$	=	1.23			
	$\phi_{cc}$	=	0.950			
Factored limit state stress	$\phi F_L$	=	<b>10.11</b>	<b>MPa</b>		
<b>2. Sections not subject to torsional or torsional-flexural buckling</b>						... 3.4.8.2
Largest slenderness ratio for flexural buckling	$kL/r$	=	254.80			
<b>3.4.10 Uniform compression in components of columns, gross section - flat plates</b>						
<b>1. Uniform compression in components of columns, gross section - flat plates with both edges supported</b>						... 3.4.10.1
	$k_1$	=	0.35			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	$b'$	=	42			
	t	=	3	mm		
Slenderness	$b/t$	=	14			
Limit 1	$S_1$	=	12.34			
Limit 2	$S_2$	=	32.87		$S_1 < b/t < S_2$	
Factored limit state stress	$\phi F_L$	=	<b>224.30</b>	<b>MPa</b>		
Most adverse compressive limit state stress	$F_a$	=	10.11	MPa		



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Most adverse compressive capacity factor	$f_a/F_a$	=	0.22	PASS	
<b>BENDING - IN-PLANE</b>					
<b>3.4.15</b> Compression in beams, extreme fibre, gross section rectangular tubes, box sections					
Unbraced length for bending	$L_b$	=	1770 mm		
Second moment of area (weak axis)	$I_y$	=	2.86E+05 mm <sup>4</sup>		
Torsion modulus	$J$	=	6.12E+05 mm <sup>3</sup>		
Elastic section modulus	$Z$	=	11937 mm <sup>3</sup>		
Slenderness	$S$	=	100.96		
Limit 1	$S_1$	=	0.39		
Limit 2	$S_2$	=	1695.86	$S_1 < S < S_2$	
Factored limit state stress	$\phi F_L$	=	207.34 MPa		3.4.15(2)
<b>3.4.17</b> Compression in components of beams (component under uniform compression), gross section - flat plates with both edges supported					
	$k_1$	=	0.5		T3.3(D)
	$k_2$	=	2.04		T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	$b'$	=	42 mm		
	$t$	=	3 mm		
Slenderness	$b/t$	=	14		
Limit 1	$S_1$	=	12.34		
Limit 2	$S_2$	=	46.95	$S_1 < S < S_2$	
Factored limit state stress	$\phi F_L$	=	224.30 MPa		
Most adverse in-plane bending limit state stress	$F_{bx}$	=	207.34 MPa		
Most adverse in-plane bending capacity factor	$f_{bx}/F_{bx}$	=	0.55	PASS	
<b>BENDING - OUT-OF-PLANE</b>					
NOTE: Limit state stresses, $\phi F_L$ are the same for out-of-plane bending (doubly symmetric section)					
Factored limit state stress	$\phi F_L$	=	207.34 MPa		



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Most adverse out-of-plane bending limit state stress	$F_{by}$	=	207.34	MPa		
Most adverse out-of-plane bending capacity factor	$f_{by}/F_{by}$	=	0.23		PASS	
COMBINED ACTIONS						
<b>4.1.1 Combined compression and bending</b>						
	$F_a$	=	10.11	MPa		4.1.1(2)
	$F_{ao}$	=	224.30	MPa		... 3.4.8
	$F_{bx}$	=	224.30	MPa		... 3.4.10
	$F_{by}$	=	207.34	MPa		... 3.4.17
	$f_a/F_a$	=	0.217		Which is <0.15	
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					... 4.1.1 (3)
i.e.	1.00	≤	1.0		PASS	

### 6.3 Gable Pole

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
82x48x3	(Gable pole)					
Alloy and temper	6061-T6					AS1664.1
Tension	F <sub>tu</sub>	=	262	MPa	Ultimate	T3.3(A)
	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)
	k <sub>c</sub>	=	1.0			
FEM ANALYSIS RESULTS						
Axial force	P	=	1.17	kN	compression	
In plane moment	M <sub>x</sub>	=	0.96	kNm		
Out of plane moment	M <sub>y</sub>	=	1.03	kNm		



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DESIGN STRESSES					
Gross cross section area	$A_g$	=	744 mm <sup>2</sup>		
In-plane elastic section modulus	$Z_x$	=	16318.439 mm <sup>3</sup>		
Out-of-plane elastic section mod.	$Z_y$	=	11937 mm <sup>3</sup>		
Stress from axial force	$f_a$	=	$P/A_g$		
		=	1.57 MPa	compression	
Stress from in-plane bending	$f_{bx}$	=	$M_x/Z_x$		
		=	58.83 MPa	compression	
Stress from out-of-plane bending	$f_{by}$	=	$M_y/Z_y$		
		=	86.29 MPa	compression	
COMPRESSION					
<b>3.4.8</b> Compression in columns, axial, gross section					
1. General					... 3.4.8.1
Unsupported length of member	$L$	=	4420 mm		
Effective length factor	$k$	=	1		
Radius of gyration about buckling axis	$r$	=	19.62 mm		
Slenderness ratio	$kL/r$	=	225.25		
Slenderness parameter	$\lambda$	=	4.21		
	$D_c^*$	=	90.3		
	$S_1^*$	=	0.33		
	$S_2^*$	=	1.23		
	$\phi_{cc}$	=	0.950		
Factored limit state stress	$\phi F_L$	=	12.94 MPa		
2. Sections not subject to torsional or torsional-flexural buckling					... 3.4.8.2
Largest slenderness ratio for flexural buckling	$kL/r$	=	225.25		
<b>3.4.10</b> Uniform compression in components of columns, gross section - flat plates					
1. Uniform compression in components of columns, gross section - flat plates with both edges supported					... 3.4.10.1
	$k_1$	=	0.35		T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	$b'$	=	42		



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Slenderness	$t$	=	3	mm		
Limit 1	$b/t$	=	14			
Limit 2	$S_1$	=	12.34		$S1 < b/t < S2$	
Factored limit state stress	$S_2$	=	32.87			
Most adverse compressive limit state stress	$\phi F_L$	=	224.30	MPa		
Most adverse compressive capacity factor	$F_a$	=	12.94	MPa		
	$f_a/F_a$	=	0.12		PASS	
<b>BENDING - IN-PLANE</b>						
<b>3.4.15 Compression in beams, extreme fibre, gross section rectangular tubes, box sections</b>						
Unbraced length for bending	$L_b$	=	2600	mm		
Second moment of area (weak axis)	$I_y$	=	286488	mm <sup>4</sup>		
Torsion modulus	$J$	=	611517.34	mm <sup>3</sup>		
Elastic section modulus	$Z$	=	11937	mm <sup>3</sup>		
Slenderness	$S$	=	148.30			
Limit 1	$S_1$	=	0.39		$S1 < S < S2$	
Limit 2	$S_2$	=	1695.86			
Factored limit state stress	$\phi F_L$	=	202.45	MPa		3.4.15(2)
<b>3.4.17 Compression in components of beams (component under uniform compression), gross section - flat plates with both edges supported</b>						
	$k_1$	=	0.5			T3.3(D)
	$k_2$	=	2.04			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	$b'$	=	42	mm		
Slenderness	$t$	=	3	mm		
Limit 1	$b/t$	=	14			
Limit 2	$S_1$	=	12.34		$S1 < S < S2$	
Factored limit state stress	$S_2$	=	46.95			
	$\phi F_L$	=	224.30	MPa		



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Most adverse in-plane bending limit state stress	$F_{bx}$	=	202.45	MPa		
Most adverse in-plane bending capacity factor	$f_{bx}/F_{bx}$	=	0.29		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	$\phi F_L$	=	202.45	MPa		
Most adverse out-of-plane bending limit state stress	$F_{by}$	=	202.45	MPa		
Most adverse out-of-plane bending capacity factor	$f_{by}/F_{by}$	=	0.43		PASS	
<b>COMBINED ACTIONS</b>						
<b>4.1.1 Combined compression and bending</b>						
	$F_a$	=	12.94	MPa		4.1.1(2)
	$F_{ao}$	=	224.30	MPa		... 3.4.8
	$F_{bx}$	=	224.30	MPa		... 3.4.10
	$F_{by}$	=	202.45	MPa		... 3.4.17
	$f_a/F_a$	=	0.122		Which is <0.15	... 3.4.17
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					... 4.1.1 (3)
i.e.	0.84	≤	1.0		PASS	

### 6.4 Ridge & Eave Purlin

NAME	SYMBOL	VALUE	UNIT	NOTES	REF
<b>40x40x2</b>	<b>(Ridge &amp; Eave Purlin)</b>				
Alloy and temper	6061-T6				AS1664.1
Tension	$F_{tu}$	=	262	MPa	T3.3(A)
	$F_{ty}$	=	241	MPa	
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



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Modulus of elasticity	E	=	70000	MPa	Compressive	
	$k_t$	=	1.0			T3.4(B)
	$k_c$	=	1.0			
<b>FEM ANALYSIS RESULTS</b>						
Axial force	P	=	0.82	kN	compression	
In plane moment	$M_x$	=	0.15	kNm		
Out of plane moment	$M_y$	=	0.39	kNm		
<b>DESIGN STRESSES</b>						
Gross cross section area	$A_g$	=	304	mm <sup>2</sup>		
In-plane elastic section modulus	$Z_x$	=	3668.266 7	mm <sup>3</sup>		
Out-of-plane elastic section mod.	$Z_y$	=	3668.266 7	mm <sup>3</sup>		
Stress from axial force	$f_a$	=	P/ $A_g$ <b>2.70</b>	<b>MPa</b>	compression	
Stress from in-plane bending	$f_{bx}$	=	$M_x/Z_x$ <b>40.89</b>	<b>MPa</b>	compression	
Stress from out-of-plane bending	$f_{by}$	=	$M_y/Z_y$ <b>106.32</b>	<b>MPa</b>	compression	
<b>COMPRESSION</b>						
<b>3.4.8 Compression in columns, axial, gross section</b>						
<b>1. General</b>						
Unsupported length of member	L	=	3000	mm		
Effective length factor	k	=	1			
Radius of gyration about buckling axis	r	=	15.53	mm		
Slenderness ratio	$kL/r$	=	193.11			
Slenderness parameter	$\lambda$	=	3.61			
	$D_c^*$	=	90.3			
	$S_1^*$	=	0.33			
	$S_2^*$	=	1.23			
	$\phi_{cc}$	=	0.950			
Factored limit state stress	$\phi F_L$	=	17.60	MPa		





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2. Sections not subject to torsional or torsional-flexural buckling					... 3.4.8.2
Largest slenderness ratio for flexural buckling	$kL/r$	=	193.11		
<b>3.4.10 Uniform compression in components of columns, gross section - flat plates</b>					
1. Uniform compression in components of columns, gross section - flat plates with both edges supported					... 3.4.10.1
	$k_1$	=	0.35		T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	$b'$	=	36		
	$t$	=	2 mm		
Slenderness	$b/t$	=	18		
Limit 1	$S_1$	=	12.34		
Limit 2	$S_2$	=	32.87	$S_1 < b/t < S_2$	
Factored limit state stress	$\phi F_L$	=	213.07 MPa		
Most adverse compressive limit state stress	$F_a$	=	17.60 MPa		
Most adverse compressive capacity factor	$f_a/F_a$	=	0.15	PASS	
<b>BENDING - IN-PLANE</b>					
<b>3.4.15 Compression in beams, extreme fibre, gross section rectangular tubes, box sections</b>					
Unbraced length for bending	$L_b$	=	3000 mm		
Second moment of area (weak axis)	$I_y$	=	73365.33 mm <sup>4</sup>		
Torsion modulus	$J$	=	109744 mm <sup>3</sup>		
Elastic section modulus	$Z$	=	3668.266 mm <sup>3</sup>		
Slenderness	$S$	=	245.29		
Limit 1	$S_1$	=	0.39		
Limit 2	$S_2$	=	1695.86	$S_1 < S < S_2$	
Factored limit state stress	$\phi F_L$	=	194.46 MPa		... 3.4.15(2)
<b>3.4.17 Compression in components of beams (component under uniform compression), gross section - flat plates with both edges supported</b>					



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	$k_1$	=	0.5			T3.3(D)
	$k_2$	=	2.04			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	$b'$	=	36	mm		
	$t$	=	2	mm		
Slenderness	$b/t$	=	18			
Limit 1	$S_1$	=	12.34			
Limit 2	$S_2$	=	46.95		$S1 < S < S2$	
Factored limit state stress	$\phi F_L$	=	213.07	MPa		
Most adverse in-plane bending limit state stress	$F_{bx}$	=	194.46	MPa		
Most adverse in-plane bending capacity factor	$f_{bx}/F_{bx}$	=	0.21		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	$\phi F_L$	=	194.46	MPa		
Most adverse out-of-plane bending limit state stress	$F_{by}$	=	194.46	MPa		
Most adverse out-of-plane bending capacity factor	$f_{by}/F_{by}$	=	0.55		PASS	
<b>COMBINED ACTIONS</b>						
<b>4.1.1 Combined compression and bending</b>						4.1.1(2)
	$F_a$	=	17.60	MPa		... 3.4.8
	$F_{ao}$	=	213.07	MPa		... 3.4.10
	$F_{bx}$	=	213.07	MPa		... 3.4.17
	$F_{by}$	=	194.46	MPa		... 3.4.17
	$f_a/F_a$	=	0.153		Which is <0.15	... 4.1.1 (3)
Check: $f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$						
i.e.	0.91	$\leq$	1.0		PASS	



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### 6.5 Gable Beam

NAME	SYMBOL	VALUE	UNIT	NOTES	REF
<b>40x40x2</b>	<b>(Gable Beam)</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	
	$k_t$	= 1.0			T3.4(B)
	$k_c$	= 1.0			
<b>FEM ANALYSIS RESULTS</b>					
Axial force	P	= 0.44	kN	compression	
In plane moment	$M_x$	= 0.03	kNm		
Out of plane moment	$M_y$	= 0.18	kNm		
<b>DESIGN STRESSES</b>					
Gross cross section area	$A_g$	= 304	mm <sup>2</sup>		
In-plane elastic section modulus	$Z_x$	= 3668.2667	mm <sup>3</sup>		
Out-of-plane elastic section mod.	$Z_y$	= 3668.2667	mm <sup>3</sup>		
Stress from axial force	$f_a$	= $P/A_g$			
		= 1.45	MPa	compression	
Stress from in-plane bending	$f_{bx}$	= $M_x/Z_x$			
		= 8.18	MPa	compression	
Stress from out-of-plane bending	$f_{by}$	= $M_y/Z_y$			
		= 49.07	MPa	compression	
<b>COMPRESSION</b>					
<b>3.4.8 Compression in columns, axial, gross section</b>					
<b>1. General</b>					
Unsupported length of	L	= 5000	mm		... 3.4.8.1



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member						
Effective length factor	$k$	=	1			
Radius of gyration about buckling axis	$r$	=	15.53	mm		
Slenderness ratio	$kL/r$	=	321.86			
Slenderness parameter	$\lambda$	=	6.01			
	$D_c^*$	=	90.3			
	$S_1^*$	=	0.33			
	$S_2^*$	=	1.23			
	$\phi_{cc}$	=	0.950			
Factored limit state stress	$\phi F_L$	=	6.34	MPa		
2. Sections not subject to torsional or torsional-flexural buckling						... 3.4.8.2
Largest slenderness ratio for flexural buckling	$kL/r$	=	321.86			
<b>3.4.10 Uniform compression in components of columns, gross section - flat plates</b>						
1. Uniform compression in components of columns, gross section - flat plates with both edges supported						... 3.4.10.1
	$k_1$	=	0.35			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	$b'$	=	36			
	$t$	=	2	mm		
Slenderness	$b/t$	=	18			
Limit 1	$S_1$	=	12.34			
Limit 2	$S_2$	=	32.87		$S_1 < b/t < S_2$	
Factored limit state stress	$\phi F_L$	=	213.07	MPa		
Most adverse compressive limit state stress	$F_a$	=	6.34	MPa		
Most adverse compressive capacity factor	$f_d/F_a$	=	0.23		PASS	
<b>BENDING - IN-PLANE</b>						
<b>3.4.15 Compression in beams, extreme fibre, gross section rectangular tubes, box sections</b>						
Unbraced length for bending	$L_b$	=	5000	mm		
Second moment of area (weak axis)	$I_y$	=	73365.333	mm <sup>4</sup>		



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Torsion modulus	J	=	109744	mm <sup>3</sup>		
Elastic section modulus	Z	=	3668.2667	mm <sup>3</sup>		
Slenderness	S	=	408.81			
Limit 1	S <sub>1</sub>	=	0.39			
Limit 2	S <sub>2</sub>	=	1695.86		S1 < S < S2	
Factored limit state stress	$\phi F_L$	=	184.01	MPa		3.4.15(2)
<b>3.4.17 Compression in components of beams (component under uniform compression), gross section - flat plates with both edges supported</b>						
	k <sub>1</sub>	=	0.5			T3.3(D)
	k <sub>2</sub>	=	2.04			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	b'	=	36	mm		
	t	=	2	mm		
Slenderness	b/t	=	18			
Limit 1	S <sub>1</sub>	=	12.34			
Limit 2	S <sub>2</sub>	=	46.95		S1 < S < S2	
Factored limit state stress	$\phi F_L$	=	213.07	MPa		
Most adverse in-plane bending limit state stress	F <sub>bx</sub>	=	184.01	MPa		
Most adverse in-plane bending capacity factor	f <sub>bx</sub> /F <sub>bx</sub>	=	0.04		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	$\phi F_L$	=	184.01	MPa		
Most adverse out-of-plane bending limit state stress	F <sub>by</sub>	=	184.01	MPa		
Most adverse out-of-plane bending capacity factor	f <sub>by</sub> /F <sub>by</sub>	=	0.27		PASS	
<b>COMBINED ACTIONS</b>						
<b>4.1.1 Combined compression and bending</b>						
						4.1.1(2)



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$F_a$	=	6.34	MPa		... 3.4.8
$F_{ao}$	=	213.07	MPa		... 3.4.10
$F_{bx}$	=	213.07	MPa		... 3.4.17
$F_{by}$	=	184.01	MPa		... 3.4.17
$f_a/F_a$	=	0.228		Which is <0.15	
Check: $f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					... 4.1.1 (3)
i.e.	0.54	≤	1.0	PASS	

### 6.6 Intermediate Purlin

NAME	SYMBOL	VALUE	UNIT	NOTES	REF
<b>40x40x2</b>	<b>(Intermediate Purlin)</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	
	$k_t$	= 1.0			T3.4(B)
	$k_c$	= 1.0			
<b>FEM ANALYSIS RESULTS</b>					
Axial force	P	= 0.49	kN	compression	
In plane moment	$M_x$	= 0.31	kNm		
Out of plane moment	$M_y$	= 0.3	kNm		
<b>DESIGN STRESSES</b>					
Gross cross section area	$A_g$	= 304	mm <sup>2</sup>		
In-plane elastic section modulus	$Z_x$	= 3668.266	mm <sup>3</sup>		
Out-of-plane elastic section mod.	$Z_y$	= 3668.266	mm <sup>3</sup>		
Stress from axial force	$f_a$	= $P/A_g$			



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Stress from in-plane bending	$f_{bx}$	=	1.61	MPa	compression	
		=	$M_x/Z_x$			
Stress from out-of-plane bending	$f_{by}$	=	84.51	MPa	compression	
		=	$M_y/Z_y$			
		=	81.78	MPa	compression	
<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	=	3000	mm		
Effective length factor	k	=	1			
Radius of gyration about buckling axis	r	=	15.53	mm		
Slenderness ratio	$kL/r$	=	193.11			
Slenderness parameter	$\lambda$	=	3.61			
	$D_c^*$	=	90.3			
	$S_1^*$	=	0.33			
	$S_2^*$	=	1.23			
	$\phi_{cc}$	=	0.950			
Factored limit state stress	$\phi F_L$	=	17.60	MPa		
<b>2. Sections not subject to torsional or torsional-flexural buckling</b>						... 3.4.8.2
Largest slenderness ratio for flexural buckling	$kL/r$	=	193.11			
<b>3.4.10 Uniform compression in components of columns, gross section - flat plates</b>						
<b>1. Uniform compression in components of columns, gross section - flat plates with both edges supported</b>						... 3.4.10.1
	$k_1$	=	0.35			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	$b'$	=	36			
	t	=	2	mm		
Slenderness	$b/t$	=	18			
Limit 1	$S_1$	=	12.34			
Limit 2	$S_2$	=	32.87		$S1 < b/t < S2$	
Factored limit state stress	$\phi F_L$	=	213.07	MPa		



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Most adverse compressive limit state stress	$F_a$	=	17.60	MPa		
Most adverse compressive capacity factor	$f_a/F_a$	=	0.09		PASS	
<b>BENDING - IN-PLANE</b>						
<b>3.4.15 Compression in beams, extreme fibre, gross section rectangular tubes, box sections</b>						
Unbraced length for bending	$L_b$	=	3000	mm		
Second moment of area (weak axis)	$I_y$	=	73365.33	mm <sup>4</sup>		
Torsion modulus	$J$	=	109744	mm <sup>3</sup>		
Elastic section modulus	$Z$	=	3668.266	mm <sup>3</sup>		
Slenderness	$S$	=	245.29			
Limit 1	$S_1$	=	0.39			
Limit 2	$S_2$	=	1695.86		$S_1 < S < S_2$	
Factored limit state stress	$\phi F_L$	=	194.46	MPa		3.4.15(2)
<b>3.4.17 Compression in components of beams (component under uniform compression), gross section - flat plates with both edges supported</b>						
	$k_1$	=	0.5			T3.3(D)
	$k_2$	=	2.04			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	$b'$	=	36	mm		
	$t$	=	2	mm		
Slenderness	$b/t$	=	18			
Limit 1	$S_1$	=	12.34			
Limit 2	$S_2$	=	46.95		$S_1 < S < S_2$	
Factored limit state stress	$\phi F_L$	=	213.07	MPa		
Most adverse in-plane bending limit state stress	$F_{bx}$	=	194.46	MPa		
Most adverse in-plane bending capacity factor	$f_{bx}/F_{bx}$	=	0.43		PASS	
<b>BENDING - OUT-OF-PLANE</b>						





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NOTE: Limit state stresses,  $\phi F_L$  are the same for out-of-plane bending (doubly symmetric section)

Factored limit state stress  $\phi F_L = 194.46 \text{ MPa}$

Most adverse out-of-plane bending limit state stress  $F_{by} = 194.46 \text{ MPa}$

Most adverse out-of-plane bending capacity factor  $f_{by}/F_{by} = 0.42$

PASS

### COMBINED ACTIONS

#### 4.1.1 Combined compression and bending

$F_a = 17.60 \text{ MPa}$

$F_{ao} = 213.07 \text{ MPa}$

$F_{bx} = 213.07 \text{ MPa}$

$F_{by} = 194.46 \text{ MPa}$

$f_a/F_a = 0.092$

Check:  $f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$

i.e.  $0.95 \leq 1.0$

Which is  $< 0.15$

PASS

... 4.1.1(2)

... 3.4.8

... 3.4.10

... 3.4.17

... 3.4.17

... 4.1.1 (3)

### 6.7 Cross Brace

NAME	SYMBOL	VALUE	UNIT	NOTES	REF
<b>40x40x2</b>	<b>(Brace)</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	
	$k_t$	= 1.0			T3.4(B)
	$k_c$	= 1.0			
FEM ANALYSIS RESULTS					



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Axial force	$P$	=	1.78	kN	compression	
In plane moment	$M_x$	=	0.06	kNm		
Out of plane moment	$M_y$	=	0.06	kNm		
<b>DESIGN STRESSES</b>						
Gross cross section area	$A_g$	=	304	mm <sup>2</sup>		
In-plane elastic section modulus	$Z_x$	=	3668.2667	mm <sup>3</sup>		
Out-of-plane elastic section mod.	$Z_y$	=	3668.2667	mm <sup>3</sup>		
Stress from axial force	$f_a$	=	$P/A_g$		compression	
		=	<b>5.86</b>	<b>MPa</b>		
Stress from in-plane bending	$f_{bx}$	=	$M_x/Z_x$		compression	
		=	<b>16.36</b>	<b>MPa</b>		
Stress from out-of-plane bending	$f_{by}$	=	$M_y/Z_y$		compression	
		=	<b>16.36</b>	<b>MPa</b>		
<b>COMPRESSION</b>						
<b>3.4.8 Compression in columns, axial, gross section</b>						
<b>1. General</b>						
Unsupported length of member	$L$	=	4000	mm		... 3.4.8.1
Effective length factor	$k$	=	1			
Radius of gyration about buckling axis	$r$	=	15.53	mm		
Slenderness ratio	$kL/r$	=	257.48			
Slenderness parameter	$\lambda$	=	4.81			
	$D_c^*$	=	90.3			
	$S_1^*$	=	0.33			
	$S_2^*$	=	1.23			
	$\phi_{cc}$	=	0.950			
Factored limit state stress	$\phi F_L$	=	<b>9.90</b>	<b>MPa</b>		
<b>2. Sections not subject to torsional or torsional-flexural buckling</b>						
Largest slenderness ratio for flexural buckling	$kL/r$	=	257.48			... 3.4.8.2
<b>3.4.10 Uniform compression in components of columns, gross section - flat plates</b>						
<b>1. Uniform compression in components of columns, gross section - flat plates with both edges supported</b>						
						... 3.4.10.1



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	$k_1$	=	0.35			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	$b'$	=	36			
	$t$	=	2	mm		
Slenderness	$b/t$	=	18			
Limit 1	$S_1$	=	12.34			
Limit 2	$S_2$	=	32.87		$S1 < b/t < S2$	
Factored limit state stress	$\phi F_L$	=	213.07	MPa		
Most adverse compressive limit state stress	$F_a$	=	9.90	MPa		
Most adverse compressive capacity factor	$f_a/F_a$	=	0.59		PASS	
<b>BENDING - IN-PLANE</b>						
<b>3.4.15 Compression in beams, extreme fibre, gross section rectangular tubes, box sections</b>						
Unbraced length for bending	$L_b$	=	4000	mm		
Second moment of area (weak axis)	$I_y$	=	73365.333	mm <sup>4</sup>		
Torsion modulus	$J$	=	109744	mm <sup>3</sup>		
Elastic section modulus	$Z$	=	3668.2667	mm <sup>3</sup>		
Slenderness	$S$	=	327.05			
Limit 1	$S_1$	=	0.39			
Limit 2	$S_2$	=	1695.86		$S1 < S < S2$	
Factored limit state stress	$\phi F_L$	=	188.90	MPa		3.4.15(2)
<b>3.4.17 Compression in components of beams (component under uniform compression), gross section - flat plates with both edges supported</b>						
	$k_1$	=	0.5			T3.3(D)
	$k_2$	=	2.04			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	$b'$	=	36	mm		
	$t$	=	2	mm		
Slenderness	$b/t$	=	18			
Limit 1	$S_1$	=	12.34			
Limit 2	$S_2$	=	46.95		$S1 < S < S2$	



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Factored limit state stress	$\phi F_L$	=	213.07	MPa		
Most adverse in-plane bending limit state stress	$F_{bx}$	=	188.90	MPa		
Most adverse in-plane bending capacity factor	$f_{bx}/F_{bx}$	=	0.09		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	$\phi F_L$	=	188.90	MPa		
Most adverse out-of-plane bending limit state stress	$F_{by}$	=	188.90	MPa		
Most adverse out-of-plane bending capacity factor	$f_{by}/F_{by}$	=	0.09		PASS	
<b>COMBINED ACTIONS</b>						
<b>4.1.1 Combined compression and bending</b>						
	$F_a$	=	9.90	MPa		... 4.1.1(2)
	$F_{ao}$	=	213.07	MPa		... 3.4.8
	$F_{bx}$	=	213.07	MPa		... 3.4.10
	$F_{by}$	=	188.90	MPa		... 3.4.17
	$f_a/F_a$	=	0.591		Which is <0.15	... 3.4.17
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					... 4.1.1(3)
i.e.	0.76	≤	1.0		PASS	



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

### 7 Summary

#### 7.1 Conclusions

- The 5m Span x 3m Bay Function Standard Tent structure as specified has been analyzed with a conclusion that it has the capacity to withstand wind speeds up to and including **80km/hr**.
- For forecast winds in excess of **80km/hr** – all fabric shall be removed from the frames, and the structure should be completely dismantled.
- Wall Bracing is required at one of the end bays for 5m X 9m tent to resist against lateral movement due to wind direction<sup>2</sup>. However, for multiple tent length, each end bay and every third bay in between must be braced. (Refer to detail drawing)
- For uplift due to 80km/hr, 3 kN (300Kg) holding down weight/per leg is required.
- The bearing pressure of soil should be clarified and checked by an engineer prior to any construction for considering foundation and base plate.
- Required weight per leg for smaller tents:

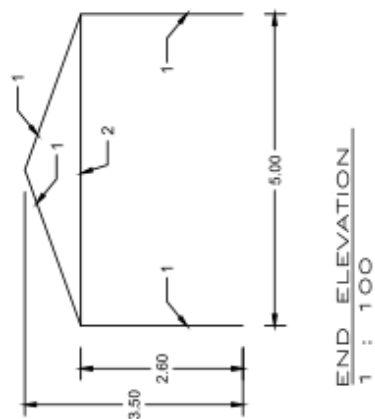
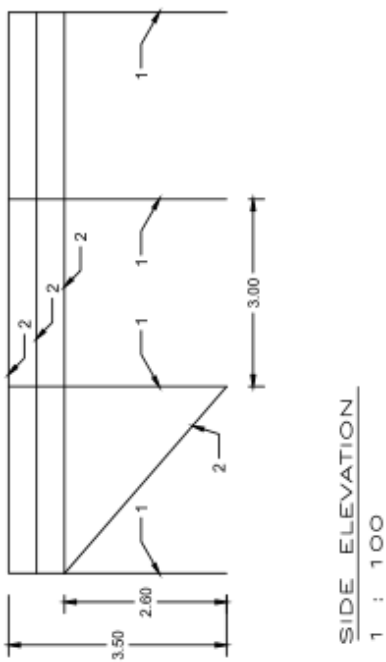
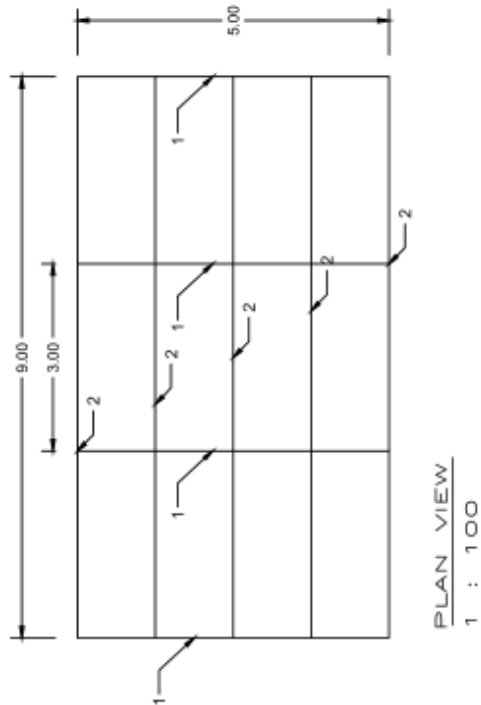
Span Width	Required Weight Per Leg	
	(kN)	(Kg)
5	3	300
4	2.75	275
3	2	200

Yours faithfully,

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



8 Appendix A – 5m x 9m Function Standard Tent:



ALUMINUM PROFILE SCHEDULE		
1	RAFTER, UPRIGHT SUPPORT	82X48X3
2	EAVE, RIDGE & INTERMEDIATE PURLIN GABLE BEAM, CROSS BRACE	40X40X2