



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

**Client:** Hercules Instant Shelter Australia Pty Ltd

**Project:** Design check –3m × 3m, 3m × 4.5m & 3m × 6m PRO57 Folding Marquee Structures for 80km/hr Wind Speed.

**Reference:** Hercules Instant Shelter Australia's Technical Data

Report by: KZ  
Checked by: EAB  
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## Civil & Structural Engineering Design Services Pty. Ltd.

### 1 Introduction

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The following structural drawings and calculations are for the applicable transportable marquees supplied by Hercules Instant Shelter Australia Pty Ltd.

The report examines the effect of 3s gust wind of 80 km/hr on 3m x 6m PRO57 Folding Marquee 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 1664.1:1997 Aluminum Structures 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 marquee, the temporary erected structure should be dismantled.
- 2.3 For forecast winds in excess of (**refer to summary**) the structure should be completely folded.  
(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/NZS1170.2. 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 marquee 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 No Fabrics or doors should be used for covering the sides of unbraced Folding Marquees due to the lack of bracing within the system and insufficient out-of-plane stiffness of framing.

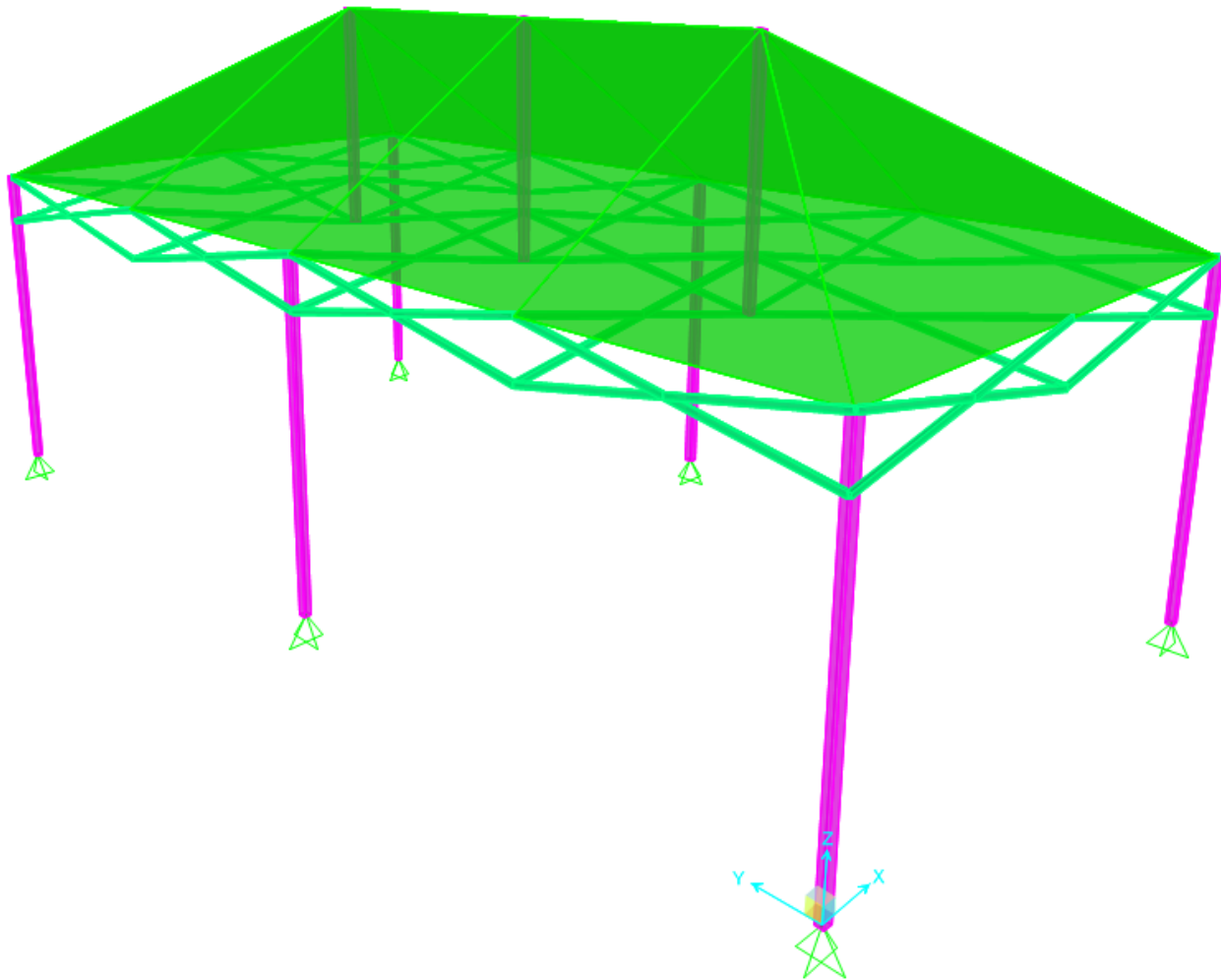


### 3 Specifications

#### 3.1 General

Marquee category	
Material	Aluminum 6005-T5

Size	Model
3m x 6m	Folding Marquees – PRO57





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### 3.2 Section Properties

- Legs: 57mm Hexagonal profile
- Thickness: 2.0mm
- Truss bars: 35x18x2.0



MEMBER(S)	Section	b	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	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
Legs	Hex 57x2	50	50	2	25.0	328.1	3593.2	3593.2	5183.0	5183.0	102399.0	102399.0	186517.0	17.7	17.7
Centre Pole	Hex 57x2	50	50	2	25.0	328.1	3593.2	3593.2	5183.0	5183.0	102399.0	102399.0	186517.0	17.7	17.7
Truss Bar	35x18x2	18	35	2	17.5	196.0	1688.9	1102.4	2149.0	1316.0	29556.3	9921.3	22757.9	12.3	7.1

## 4 Buckling Constant

**TABLE 3.3(D)  
BUCKLING CONSTANTS FOR ALLOY 6005-T5**

Type of member and stress	Intercept, MPa		Slope, MPa		Intersection	
Compression in columns and beam flanges	<b>B<sub>c</sub></b>	271.04	<b>D<sub>c</sub></b>	1.69	<b>C<sub>c</sub></b>	65.89
Compression in flat plates	<b>B<sub>p</sub></b>	310.11	<b>D<sub>p</sub></b>	2.06	<b>C<sub>p</sub></b>	61.60
Compression in round tubes under axial end load	<b>B<sub>t</sub></b>	297.39	<b>D<sub>t</sub></b>	10.70	<b>C<sub>t</sub></b>	*
Compressive bending stress in rectangular bars	<b>B<sub>br</sub></b>	459.89	<b>D<sub>br</sub></b>	4.57	<b>C<sub>br</sub></b>	67.16
Compressive bending stress in round tubes	<b>B<sub>tb</sub></b>	653.34	<b>D<sub>tb</sub></b>	50.95	<b>C<sub>tb</sub></b>	78.23
Shear stress in flat plates	<b>B<sub>s</sub></b>	178.29	<b>D<sub>s</sub></b>	0.90	<b>C<sub>s</sub></b>	81.24
Ultimate strength of flat plates in compression	<i>k<sub>1</sub></i>	0.35	<i>k<sub>2</sub></i>	2.27		
Ultimate strength of flat plates in bending	<i>k<sub>1</sub></i>	0.5	<i>k<sub>2</sub></i>	2.04		

\* C<sub>t</sub> shall be determined using a plot of curves of limit state stress based on elastic and inelastic buckling or by trial and error solution



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### 5 Design Loads

#### 5.1 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>

#### 5.2 Load Combinations

##### 5.2.1 Serviceability

$$\text{Gravity} = 1.0 \times G$$

$$\text{Wind} = 1.0 \times G + 1.0 \times W$$

##### 5.2.2 Ultimate

$$\begin{aligned} \text{Downward} &= 1.35 \times G \\ &= 1.2 \times G + W_u \end{aligned}$$

$$\text{Upward} = 0.9 \times G + W_u$$

### 6 Wind Analysis

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

#### 6.1 Parameters

Terrain category = 2

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

$V_R = 22.22 \text{ m/s (80 km/hr)}$

*(regional 3 s gust wind speed)*

$M_d = 1$

$M_s = 1$

$M_t = 1$

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

*(Table 4.1(B) AS1170.2)*

$V_{\text{sit},\beta} = 20.22 \text{ m/s}$

Height of structure (h) = 2.83 m

*(mid of peak and eave)*

Width of structure (w) = 3 m

Length of structure (l) = 6 m

Pressure (P) =  $0.5 \rho_{\text{air}} (V_{\text{sit},\beta})^2 C_{\text{fig}} C_{\text{dyn}}$   
 = 0.245 C<sub>fig</sub> kPa



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## 6.2 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		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	$\alpha$	30	Deg		
Pitch	$\alpha$	0.52	rad		
Width	B	3	m		
Length	D	6	m		
Height	Z	2.83	m		
<b>Wind Pressure</b>					
$\rho_{air}$	$\rho$	1.2	Kg/m <sup>3</sup>		
dynamic response factor	$C_{dyn}$	1			
Wind Pressure	$\rho * C_{fig}$	0.245	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 (<math>\theta=0,180</math>)</b>					
<b>4. Free Roof</b>				$\alpha = 0^\circ$	
Area Reduction Factor	$K_a$	1			D7
local pressure factor	$K_l$	1			
porous cladding reduction factor	$K_p$	1			
External Pressure Coefficient <b>MIN</b>	$C_{P,w}$	-0.3			





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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	-0.07	kPa
Pressure Windward <b>MAX</b>	P	0.20	kPa
Pressure Leeward <b>MIN</b>	P	-0.17	kPa
Pressure Leeward <b>MAX</b>	P	0.00	kPa

### WIND DIRECTION 2 ( $\theta=90,270$ )

#### 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>	$C_{P,w}$	0.4	
External Pressure Coefficient <b>MIN</b>	$C_{P,l}$	-0.4	
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>	$C_{fig,w}$	0.40	
aerodynamic shape factor <b>MIN</b>	$C_{fig,l}$	-0.40	
aerodynamic shape factor <b>MAX</b>	$C_{fig,l}$	0.00	
Pressure <b>MIN (Windward Side)</b>	P	-0.07	kPa
Pressure <b>MAX (Windward Side)</b>	P	0.10	kPa
Pressure <b>MIN (Leeward Side)</b>	P	-0.10	kPa
Pressure <b>MAX (Leeward Side)</b>	P	0.00	kPa

$\alpha=180^\circ$

D7



6.2.1 Pressure summary

WIND EXTERNAL PRESSURE	Direction1		Direction2		
	Min (Kpa)	Max (Kpa)		Min (Kpa)	Max (Kpa)
W	-0.07	0.20	W	-0.07	0.10
L	-0.17	0.00	L	-0.10	0.00

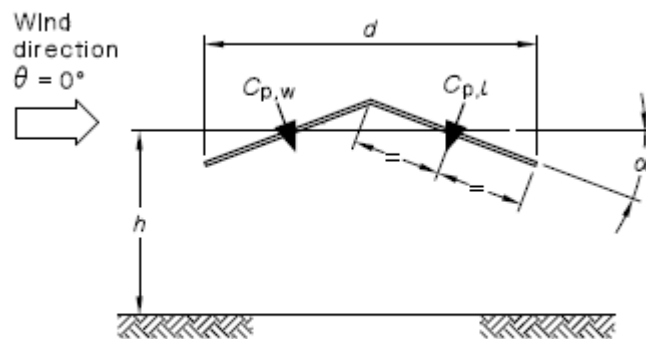
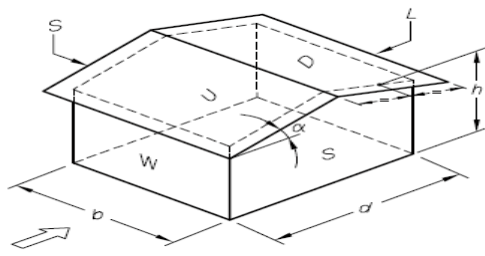
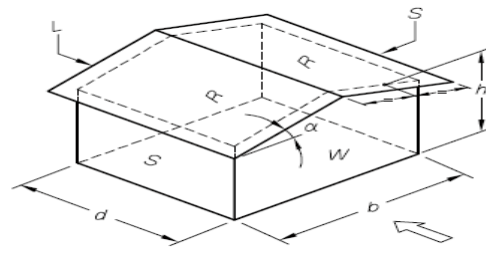


FIGURE D3 PITCHED FREE ROOFS



Direction 1



Direction 2

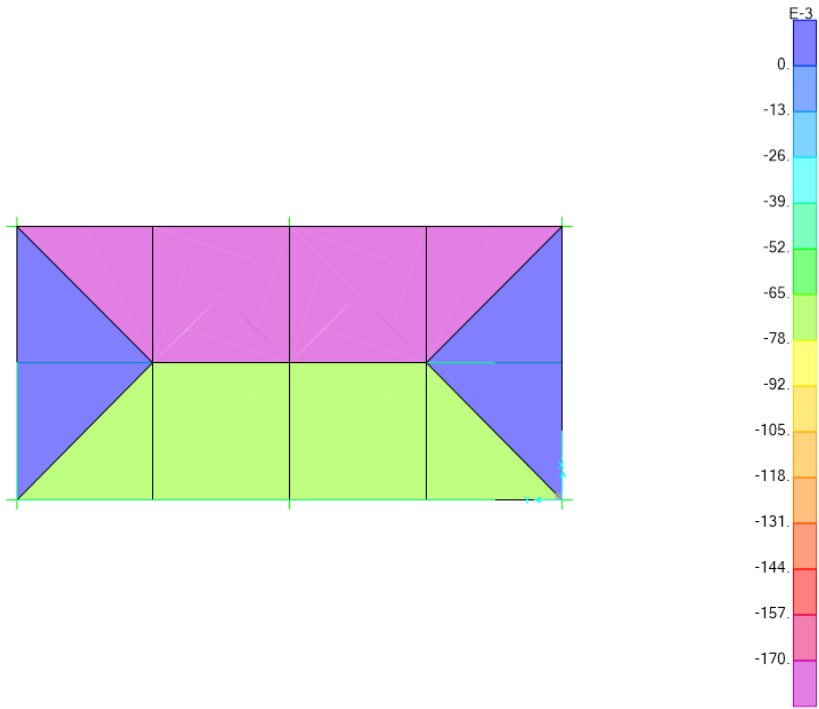
AS1170.2



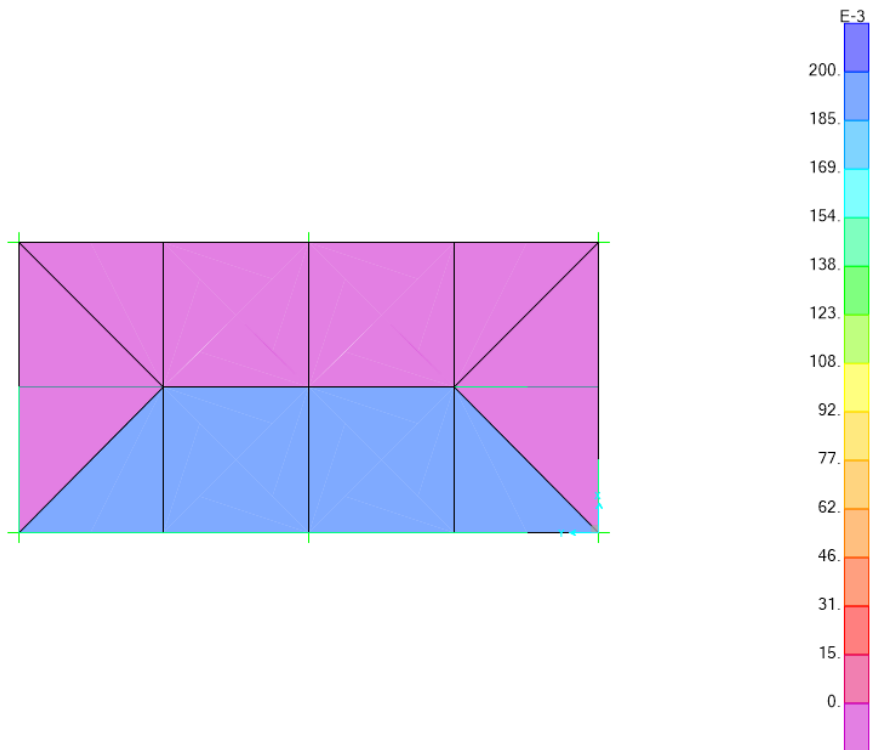
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## 6.3 Wind Load Diagrams

### 6.3.1 Wind 1(case 1)



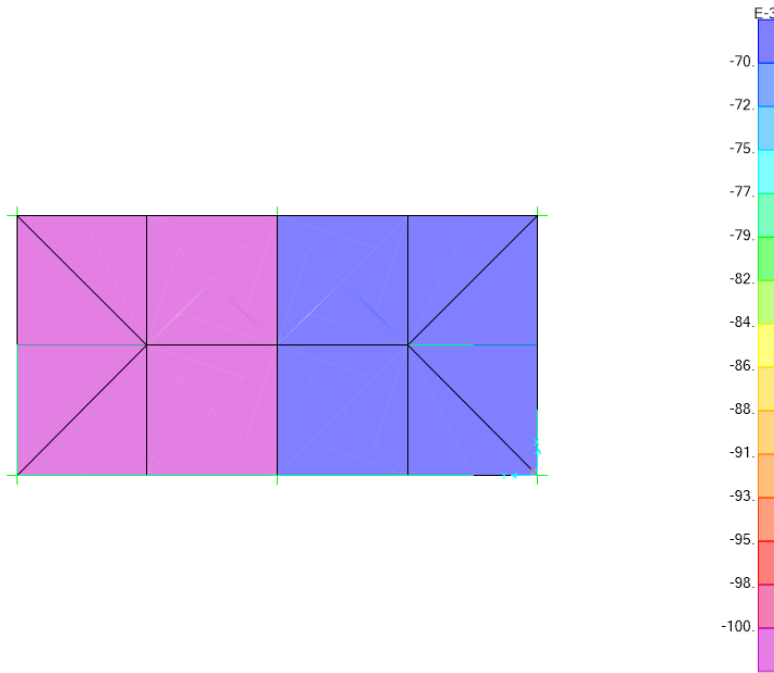
### 6.3.2 Wind 1(case 2)



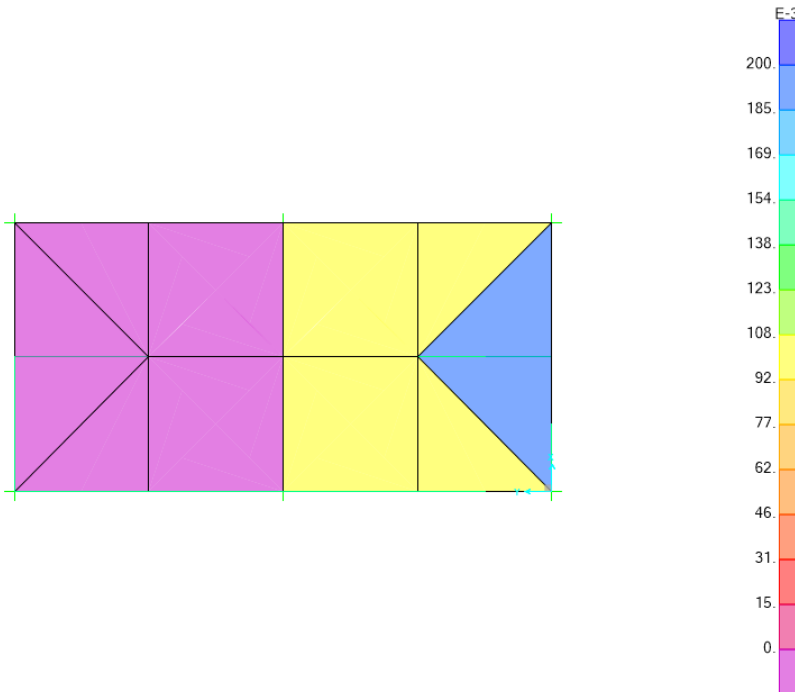


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## 6.3.3 Wind 2(Case1)



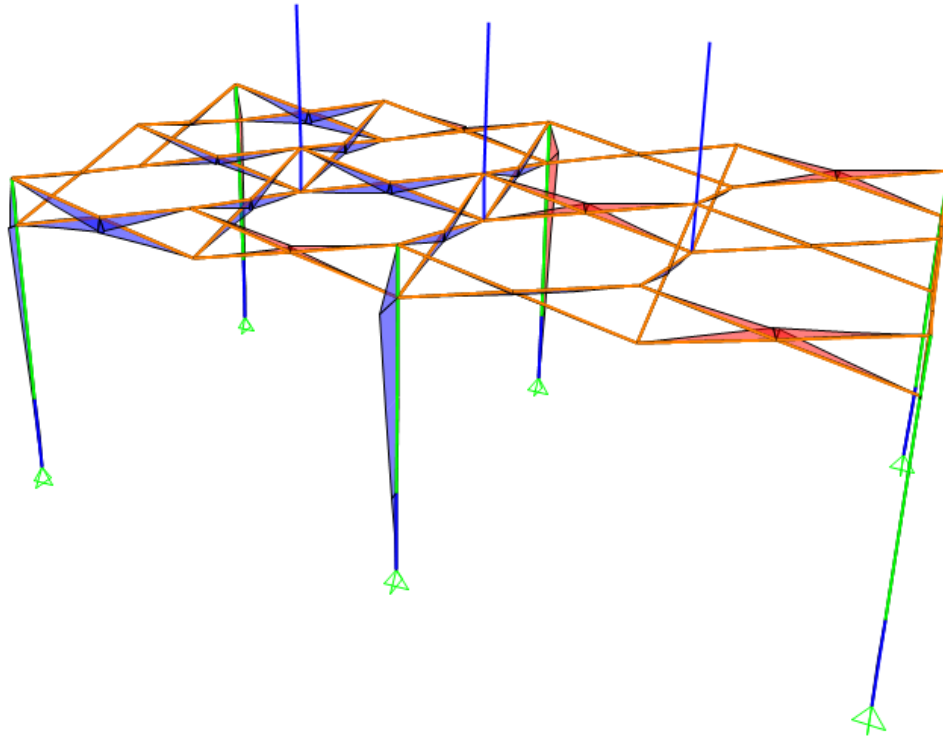
## 6.3.4 Wind 2(case 2)



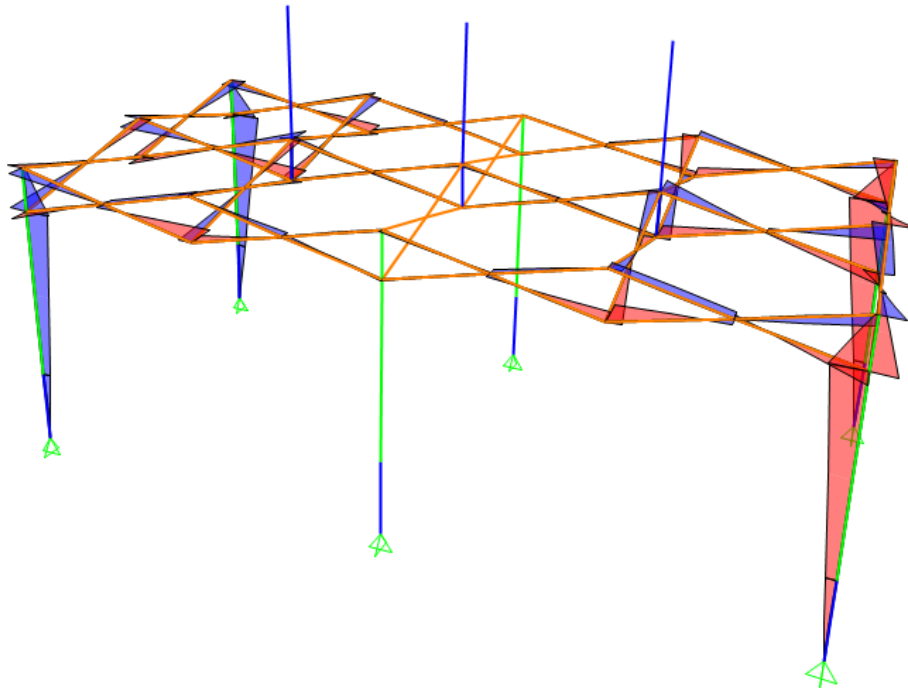
After 3D model analysis, each member is checked based on adverse load combination. In this regard the maximum bending moment, shear and axial force due to adverse load combinations for each member are presented as below:



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

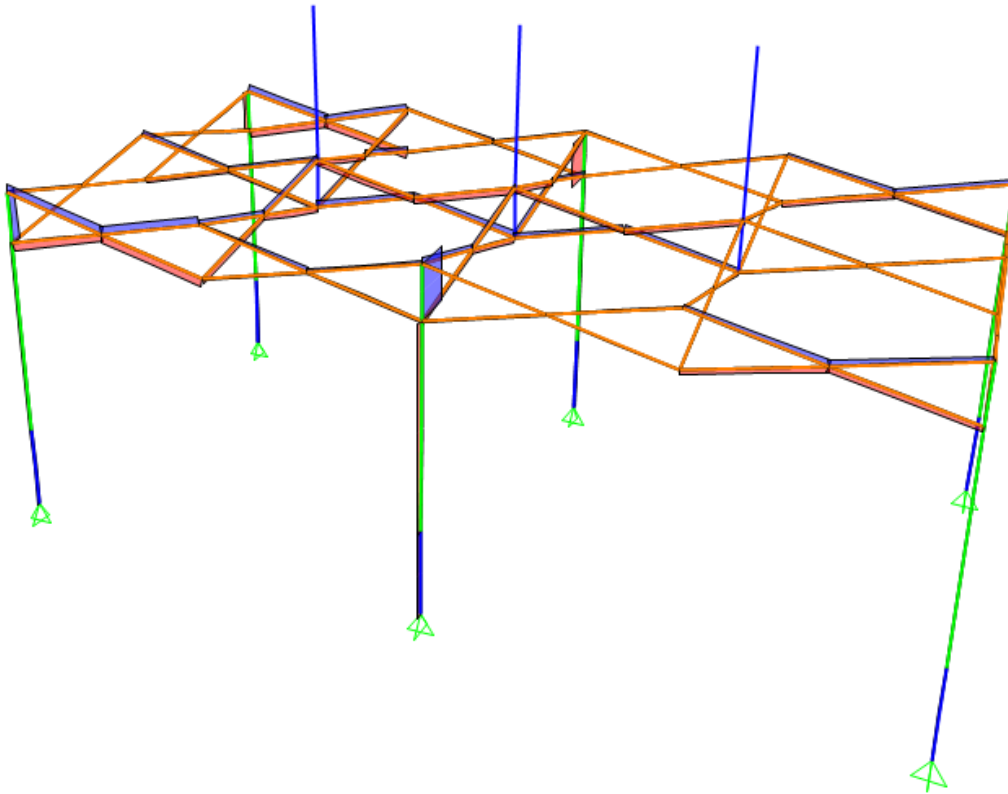


6.3.6 Max Bending Moment in minor axis due to critical load combination

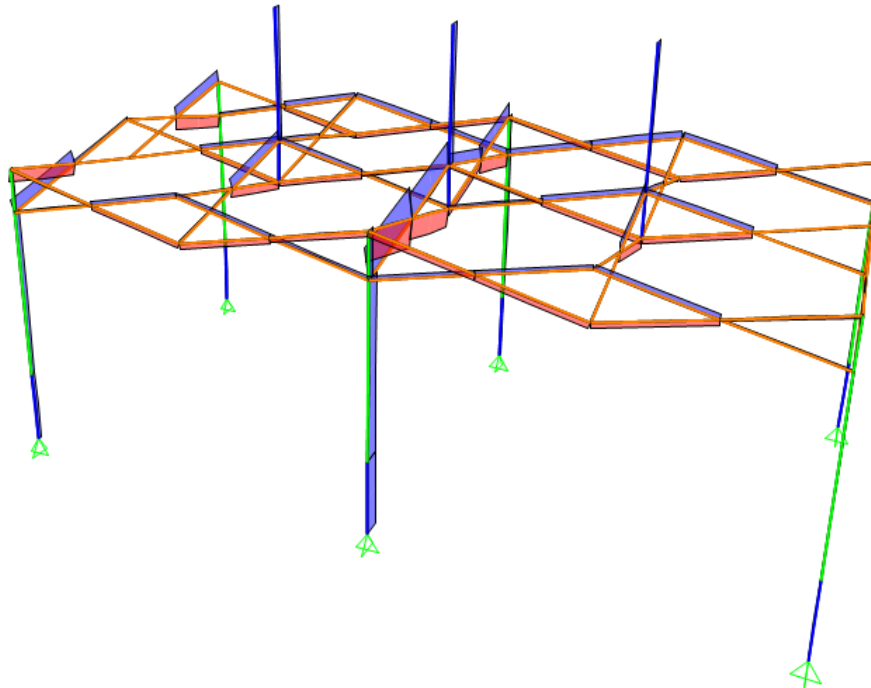




6.3.7 Max Shear in due to critical load combination



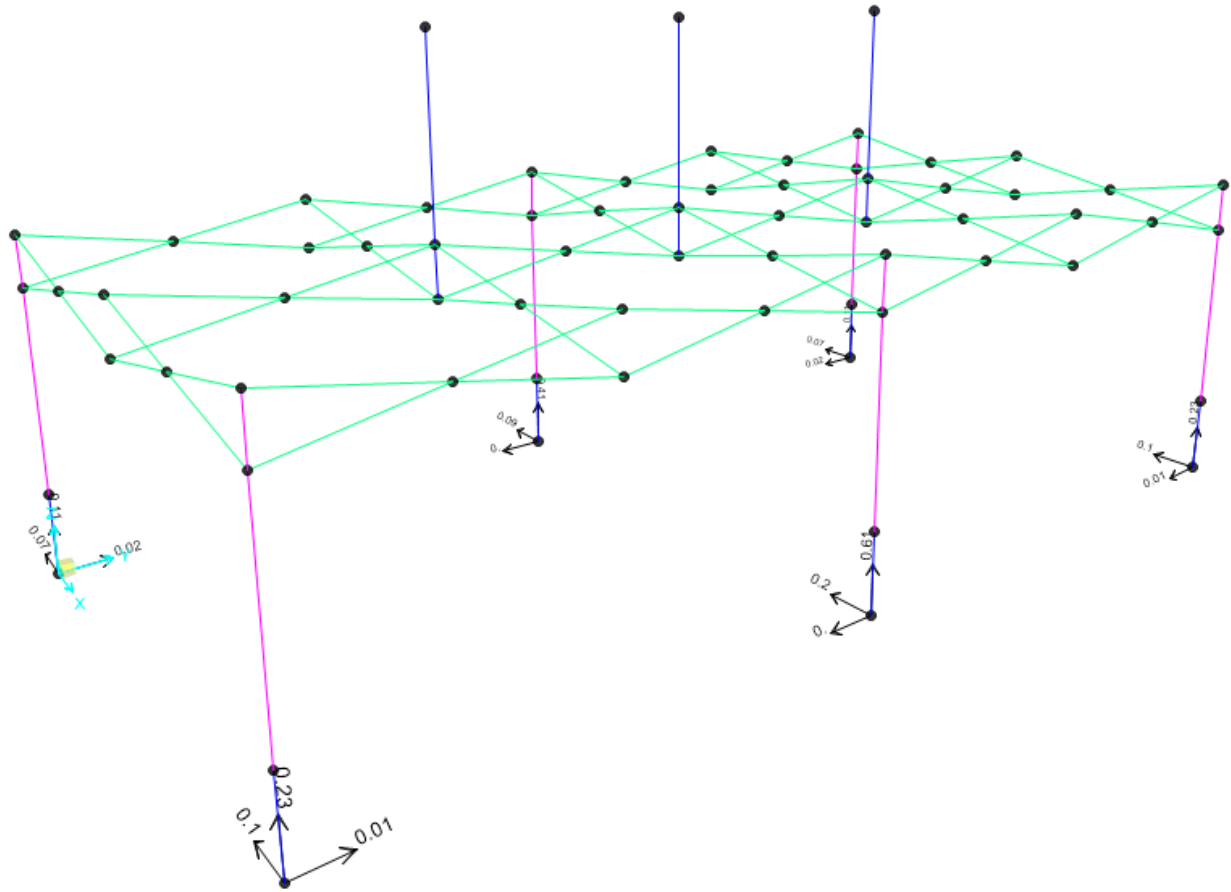
6.3.8 Max Axial force in upright support and roof beam due to critical load combination





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## 6.3.9 Max reactions



Max Uplift  $N^* = 0.78\text{kN}$

## 6.4 Summary Forces

MEMBER(S)	Section	b	d	t	Vx	Vy	P (Axial)	Mx	My
		mm	mm	mm	kN	kN	kN	kN.m	kN.m
Legs	Hex 57x2	50	50	2	0.305	3E-13	-1.008	-0.6314	-6.188E-13
Centre Pole	Hex 57x2	50	50	2	0.199	-4.9E-17	-0.334	0.1828	-8.565E-17
Truss Bar	35x18x2	18	35	2	0.2	1.4E-13	-1.178	0.1565	-2.681E-15



7 Checking Members Based on 1664.1:1997 Aluminum Structures Limit State Design

7.1 Truss Bars

NAME	SYMBOL	VALUE	UNIT	NOTES	REF
<b>35x18x2</b>	<b>Truss Bar</b>				
Alloy and temper	6005-T5				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	$F_{bu}$	= 138	MPa	Ultimate	
	$F_{by}$	= 386	MPa	Yield	
Modulus of elasticity	E	= 70000	MPa	Compressive	
	$k_t$	= 1			T3.4(B)
	$k_c$	= 1			
<b>FEM ANALYSIS RESULTS</b>					
Axial force	P	= 1.178	kN	compression	
	P	= 0	kN	Tension	
In plane moment	$M_x$	= 0.1565	kNm		
Out of plane moment	$M_y$	= 2.681E-15	kNm		
<b>DESIGN STRESSES</b>					
Gross cross section area	$A_g$	= 196	mm <sup>2</sup>		
In-plane elastic section modulus	$Z_x$	= 1688.933	mm <sup>3</sup>		
Out-of-plane elastic section mod.	$Z_y$	= 1102.370	mm <sup>3</sup>		
Stress from axial force	$f_a$	= $P/A_g$			
		= 6.01	MPa	compression	
		= 0.00	MPa	Tension	
Stress from in-plane bending	$f_{bx}$	= $M_x/Z_x$			





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		=	<b>92.66</b>	<b>MPa</b>	<i>compression</i>	
Stress from out-of-plane bending	$f_{by}$	=	$M_y/Z_y$			
		=	<b>0.00</b>	<b>MPa</b>	<i>compression</i>	
<i>Tension</i>						
<b>3.4.3 Tension in rectangular tubes</b>						
	$\phi F_L$	=	<b>228.95</b>	<b>MPa</b>		
			<b>O</b>			
			<b>R</b>			
	$\phi F_L$	=	<b>222.70</b>	<b>MPa</b>		
<b>COMPRESSION</b>						
<b>3.4.8 Compression in columns, axial, gross section</b>						
1. General						
						... 3.4.8.1
Unsupported length of member	L	=	1544	mm		
Effective length factor	k	=	1.00			
Radius of gyration about buckling axis (Y)	$r_y$	=	7.11	mm		
Radius of gyration about buckling axis (X)	$r_x$	=	12.28	mm		
Slenderness ratio	$kLb/r_y$	=	108.51			
Slenderness ratio	$kL/r_x$	=	125.73			
Slenderness parameter	$\lambda$	=	2.35			
	$D_c^*$	=	90.3			
	$S_1^*$	=	0.33			
	$S_2^*$	=	1.23			
	$\phi_{cc}$	=	0.909			
Factored limit state stress	$\phi F_L$	=	<b>39.71</b>	<b>MPa</b>		
2. Sections not subject to torsional or torsional-flexural buckling						
						... 3.4.8.2
Largest slenderness ratio for flexural buckling	$kL/r$	=	125.73			
<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	$b'$	=	14			
	t	=	2	mm		



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Slenderness	b/t	=	7		
Limit 1	S <sub>1</sub>	=	12.34		
Limit 2	S <sub>2</sub>	=	32.87		
Factored limit state stress	$\phi F_L$	=	<b>228.95</b>	<b>MPa</b>	
Most adverse compressive limit state stress	F <sub>a</sub>	=	39.71	MPa	
Most adverse tensile limit state stress	F <sub>a</sub>	=	222.70	MPa	
Most adverse compressive & Tensile capacity factor	f <sub>a</sub> /F <sub>a</sub>	=	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 <sub>b</sub>	=	772	mm	
Second moment of area (weak axis)	I <sub>y</sub>	=	9921.333 3	mm <sup>4</sup>	
Torsion modulus	J	=	22757.87 8	mm <sup>3</sup>	
Elastic section modulus	Z	=	1688.933 3	mm <sup>3</sup>	
Slenderness	S	=	173.54		
Limit 1	S <sub>1</sub>	=	0.39		
Limit 2	S <sub>2</sub>	=	1695.86		
Factored limit state stress	$\phi F_L$	=	<b>200.17</b>	<b>MPa</b>	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'	=	14	mm	
	t	=	2	mm	
Slenderness	b/t	=	7		
Limit 1	S <sub>1</sub>	=	12.34		
Limit 2	S <sub>2</sub>	=	46.95		
Factored limit state stress	$\phi F_L$	=	<b>228.95</b>	<b>MPa</b>	



Most adverse in-plane bending limit state stress	$F_{bx}$	=	200.17	MPa		
Most adverse in-plane bending capacity factor	$f_{bx}/F_{bx}$	=	0.46		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	$\phi F_L$	=	200.17	MPa		
Most adverse out-of-plane bending limit state stress	$F_{by}$	=	200.17	MPa		
Most adverse out-of-plane bending capacity factor	$f_{by}/F_{by}$	=	0.00		PASS	
<b>COMBINED ACTIONS</b>						
<b>4.1.1 Combined compression and bending</b>						
	$F_a$	=	39.71	MPa		... 4.1.1(2)
	$F_{ao}$	=	228.95	MPa		... 3.4.8
	$F_{bx}$	=	200.17	MPa		... 3.4.10
	$F_{by}$	=	200.17	MPa		... 3.4.17
	$f_a/F_a$	=	0.151			... 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. 0.61	$\leq$	1.0		PASS	
<b>SHEAR</b>						
<b>3.4.24 Shear in webs (Major Axis)</b>						
						... 4.1.1(2)
Clear web height	$h$	=	31	mm		
	$t$	=	2	mm		
Slenderness	$h/t$	=	15.5			
Limit 1	$S_1$	=	29.01			
Limit 2	$S_2$	=	59.31			
Factored limit state stress	$\phi F_L$	=	131.10	MPa		
Stress From Shear force	$f_{sx}$	=	$V/A_w$			
			1.22	MPa		
<b>3.4.25 Shear in webs (Minor</b>						



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Axis)					
Clear web height	b	=	14	mm	
	t	=	2	mm	
Slenderness	b/t	=	7		
Factored limit state stress	$\phi F_L$	=	131.10	MPa	
Stress From Shear force	$f_{sy}$	=	V/A <sub>w</sub>		
			0.00	MPa	

### 7.2 Legs

NAME	SYMBOL	VALUE	UNIT	NOTES	REF
<b>Hex 57x2</b>	<b>Legs</b>				
Alloy and temper	6005-T5				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	$F_{bu}$	=	138	MPa	Ultimate
	$F_{by}$	=	386	MPa	Yield
Modulus of elasticity	E	=	70000	MPa	Compressive
	$k_t$	=	1		
	$k_c$	=	1		T3.4(B)
<b>FEM ANALYSIS RESULTS</b>					
Axial force	P	=	1.008	kN	compression
	P	=	0	kN	Tension
In plane moment	$M_x$	=	0.6314	kNm	
Out of plane moment	$M_y$	=	6.188E-13	kNm	
<b>DESIGN STRESSES</b>					
Gross cross section area	$A_g$	=	328.12	mm <sup>2</sup>	
In-plane elastic section modulus	$Z_x$	=	3593.2	mm <sup>3</sup>	
Out-of-plane elastic section mod.	$Z_y$	=	3593.2	mm <sup>3</sup>	



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Stress from axial force	$f_a$	=	$P/A_g$			
		=	<b>3.07</b>	<b>MPa</b>	<i>compression</i>	
		=	<b>0.00</b>	<b>MPa</b>	<i>Tension</i>	
Stress from in-plane bending	$f_{bx}$	=	$M_x/Z_x$			
		=	<b>175.72</b>	<b>MPa</b>	<i>compression</i>	
Stress from out-of-plane bending	$f_{by}$	=	$M_y/Z_y$			
		=	<b>0.00</b>	<b>MPa</b>	<i>compression</i>	
<i>Tension</i>						
<b>3.4.3 Tension in rectangular tubes</b>						
	$\phi F_L$	=	<b>228.95</b>	<b>MPa</b>		
		OR				
	$\phi F_L$	=	<b>222.70</b>	<b>MPa</b>		
<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	=	2440	mm		
Effective length factor	k	=	1.00			
Radius of gyration about buckling axis (Y)	$r_y$	=	17.67	mm		
Radius of gyration about buckling axis (X)	$r_x$	=	17.67	mm		
Slenderness ratio	$kLb/r_y$	=	117.15			
Slenderness ratio	$kL/r_x$	=	138.09			
Slenderness parameter	$\lambda$	=	2.579			
	$D_c^*$	=	90.3			
	$S_1^*$	=	0.33			
	$S_2^*$	=	1.23			
	$\phi_{cc}$	=	0.941			
Factored limit state stress	$\phi F_L$	=	<b>34.10</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	$kL/r$	=	138.09			
<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)



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Max. distance between toes of fillets of supporting elements for plate	$b'$	=	46		
	$t$	=	2	mm	
Slenderness	$b/t$	=	23		
Limit 1	$S_1$	=	12.34		
Limit 2	$S_2$	=	32.87		
Factored limit state stress	$\phi F_L$	=	<b>199.03</b>	<b>MPa</b>	
Most adverse compressive limit state stress	$F_a$	=	34.10	MPa	
Most adverse tensile limit state stress	$F_a$	=	222.70	MPa	
Most adverse compressive & Tensile 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	$L_b$	=	2070	mm	
Second moment of area (weak axis)	$I_y$	=	1.02E+05	mm <sup>4</sup>	
Torsion modulus	$J$	=	1.87E+05	mm <sup>3</sup>	
Elastic section modulus	$Z$	=	3593.2	mm <sup>3</sup>	
Slenderness	$S$	=	107.64		
Limit 1	$S_1$	=	0.39		
Limit 2	$S_2$	=	1695.86		
Factored limit state stress	$\phi F_L$	=	<b>206.59</b>	<b>MPa</b>	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	$b'$	=	46	mm	
	$t$	=	2	mm	
Slenderness	$b/t$	=	23		
Limit 1	$S_1$	=	12.34		
Limit 2	$S_2$	=	46.95		



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Factored limit state stress	$\phi F_L$	=	199.03	MPa		
Most adverse in-plane bending limit state stress	$F_{bx}$	=	199.03	MPa		
Most adverse in-plane bending capacity factor	$f_{bx}/F_{bx}$	=	0.88		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	$\phi F_L$	=	199.03	MPa		
Most adverse out-of-plane bending limit state stress	$F_{by}$	=	199.03	MPa		
Most adverse out-of-plane bending capacity factor	$f_{by}/F_{by}$	=	0.00		PASS	
<b>COMBINED ACTIONS</b>						
<b>4.1.1 Combined compression and bending</b>						
						...
	$F_a$	=	34.10	MPa		4.1.1(2)
	$F_{ao}$	=	199.03	MPa		... 3.4.8
	$F_{bx}$	=	199.03	MPa		... 3.4.10
	$F_{by}$	=	199.03	MPa		... 3.4.17
	$f_a/F_a$	=	0.090			... 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. 0.97	$\leq$	1.0		PASS	
<b>SHEAR</b>						
<b>3.4.24 Shear in webs (Major Axis)</b>						
						...
Clear web height	$h$	=	46	mm		4.1.1(2)
	$t$	=	2	mm		
Slenderness	$h/t$	=	23			
Limit 1	$S_1$	=	29.01			
Limit 2	$S_2$	=	59.31			
Factored limit state stress	$\phi F_L$	=	131.10	MPa		
Stress From Shear force	$f_{sx}$	=	$V/A_w$			
			1.12	MPa		



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### 3.4.25 Shear in webs (Minor Axis)

Clear web height	b	=	46	mm
	t	=	2	mm
Slenderness	b/t	=	23	
Factored limit state stress	$\phi F_L$	=	131.10	MPa
Stress From Shear force	$f_{sy}$	=	V/A <sub>w</sub>	
			0.00	MPa

### 7.3 Centre Pole

NAME	SYMBOL	VALUE	UNIT	NOTES	REF
<b>Hex 57x2</b>	<b>Centre Pole</b>				
Alloy and temper	6005-T5				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>	=	138	MPa	Ultimate
	F <sub>by</sub>	=	386	MPa	Yield
Modulus of elasticity	E	=	70000	MPa	Compressive
	k <sub>t</sub>	=	1		
	k <sub>c</sub>	=	1		
<b>FEM ANALYSIS RESULTS</b>					
Axial force	P	=	0.334	kN	compression
	P	=	0	kN	Tension
In plane moment	M <sub>x</sub>	=	0.1828	kNm	
Out of plane moment	M <sub>y</sub>	=	8.565E-17	kNm	
<b>DESIGN STRESSES</b>					
Gross cross section area	A <sub>g</sub>	=	328.12	mm <sup>2</sup>	
In-plane elastic section modulus	Z <sub>x</sub>	=	3593.2	mm <sup>3</sup>	





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Out-of-plane elastic section mod.	$Z_y$	=	3593.2	mm <sup>3</sup>		
Stress from axial force	$f_a$	=	$P/A_g$			
		=	<b>1.02</b>	<b>MPa</b>	<i>compression</i>	
		=	<b>0.00</b>	<b>MPa</b>	<i>Tension</i>	
Stress from in-plane bending	$f_{bx}$	=	$M_x/Z_x$			
		=	<b>50.87</b>	<b>MPa</b>	<i>compression</i>	
Stress from out-of-plane bending	$f_{by}$	=	$M_y/Z_y$			
		=	<b>0.00</b>	<b>MPa</b>	<i>compression</i>	
<i>Tension</i>						
<b>3.4.3 Tension in rectangular tubes</b>						
	$\phi F_L$	=	<b>228.95</b>	<b>MPa</b>		
		<b>O</b>				
		<b>R</b>				
	$\phi F_L$	=	<b>222.70</b>	<b>MPa</b>		
<b>COMPRESSION</b>						
<b>3.4.8 Compression in columns, axial, gross section</b>						
1. General						
						...
						3.4.8.1
Unsupported length of member	$L$	=	1290	mm		
Effective length factor	$k$	=	1.00			
Radius of gyration about buckling axis (Y)	$r_y$	=	17.67	mm		
Radius of gyration about buckling axis (X)	$r_x$	=	17.67	mm		
Slenderness ratio	$kLb/r_y$	=	52.07			
Slenderness ratio	$kL/r_x$	=	73.01			
Slenderness parameter	$\lambda$	=	1.36			
	$D_c^*$	=	90.3			
	$S_1^*$	=	0.33			
	$S_2^*$	=	1.23			
	$\phi_{cc}$	=	0.771			
Factored limit state stress	$\phi F_L$	=	<b>99.93</b>	<b>MPa</b>		
2. Sections not subject to torsional or torsional-flexural buckling						
						...
						3.4.8.2
Largest slenderness ratio for flexural buckling	$kL/r$	=	73.01			
<b>3.4.10 Uniform compression in components of columns, gross section - flat plates</b>						



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<i>1. Uniform compression in components of columns, gross section - flat plates with both edges supported</i>				...
	$k_1$	=	0.35	3.4.10.1
Max. distance between toes of fillets of supporting elements for plate	$b'$	=	46	T3.3(D)
	$t$	=	2 mm	
Slenderness	$b/t$	=	23	
Limit 1	$S_1$	=	12.34	
Limit 2	$S_2$	=	32.87	
Factored limit state stress	$\phi F_L$	=	<b>199.03 MPa</b>	
Most adverse compressive limit state stress	$F_a$	=	99.93 MPa	
Most adverse tensile limit state stress	$F_a$	=	222.70 MPa	
Most adverse compressive & Tensile capacity factor	$f_a/F_a$	=	0.01	PASS
<b>BENDING - IN-PLANE</b>				
<i>3.4.15 Compression in beams, extreme fibre, gross section rectangular tubes, box sections</i>				
Unbraced length for bending	$L_b$	=	920 mm	
Second moment of area (weak axis)	$I_y$	=	1.02E+05 mm <sup>4</sup>	
Torsion modulus	$J$	=	1.87E+05 mm <sup>3</sup>	
Elastic section modulus	$Z$	=	3593.2 mm <sup>3</sup>	
Slenderness	$S$	=	47.84	
Limit 1	$S_1$	=	0.39	
Limit 2	$S_2$	=	1695.86	
Factored limit state stress	$\phi F_L$	=	<b>214.52 MPa</b>	3.4.15(2)
<i>3.4.17 Compression in components of beams (component under uniform compression), gross section - flat plates with both edges supported</i>				
	$k_1$	=	0.5	T3.3(D)
	$k_2$	=	2.04	T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	$b'$	=	46 mm	
	$t$	=	2 mm	
Slenderness	$b/t$	=	23	



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Limit 1	$S_1$	=	12.34		
Limit 2	$S_2$	=	46.95		
Factored limit state stress	$\phi F_L$	=	<b>199.03</b>	<b>MPa</b>	
Most adverse in-plane bending limit state stress	$F_{bx}$	=	199.03	MPa	
Most adverse in-plane bending capacity factor	$f_{bx}/F_{bx}$	=	0.26		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>199.03</b>	<b>MPa</b>	
Most adverse out-of-plane bending limit state stress	$F_{by}$	=	199.03	MPa	
Most adverse out-of-plane bending capacity factor	$f_{by}/F_{by}$	=	0.00		PASS
<b>COMBINED ACTIONS</b>					
<b>4.1.1 Combined compression and bending</b>					
					...
					4.1.1(2)
	$F_a$	=	99.93	MPa	... 3.4.8
	$F_{ao}$	=	199.03	MPa	... 3.4.10
	$F_{bx}$	=	199.03	MPa	... 3.4.17
	$F_{by}$	=	199.03	MPa	... 3.4.17
	$f_a/F_a$	=	0.010		
	Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$			... 4.1.1 (3)
	i.e.	0.27	$\leq$	1.0	PASS
<b>SHEAR</b>					
<b>3.4.24 Shear in webs (Major Axis)</b>					
					...
					4.1.1(2)
Clear web height	$h$	=	46	mm	
	$t$	=	2	mm	
Slenderness	$h/t$	=	23		
Limit 1	$S_1$	=	29.01		
Limit 2	$S_2$	=	59.31		



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Factored limit state stress	$\phi F_L$	=	131.10	MPa		
Stress From Shear force	$f_{sx}$	=	$V/A_w$			
			0.73	MPa		
<b>3.4.25 Shear in webs (Minor Axis)</b>						
Clear web height	b	=	46	mm		
	t	=	2	mm		
Slenderness	b/t	=	23			
Factored limit state stress	$\phi F_L$	=	131.10	MPa		
Stress From Shear force	$f_{sy}$	=	$V/A_w$			
			0.00	MPa		



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

### 8 Summary

#### 8.1 Conclusions

- a. The 3m × 3m, 3m × 4.5m & 3m × 6m PRO57 Folding Marquees as specified have been analyzed with a conclusion that they have the capacity to withstand wind speeds up to and including **80km/hr**.
- b. For forecast winds in excess of **80km/hr** – the structure should be completely folded.
- c. For uplift due to 80km/hr, 0.8 kN (80kg) holding down weight/per leg for middle legs and 40kg for corner legs are required.
- d. No Fabrics or doors should be used for covering the sides of unbraced Folding 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



Civil & Structural Engineering Design Services Pty. Ltd.



C & SITE-IT

# Civil & Structural Engineering Design Services Pty. Ltd.

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05<sup>th</sup> April 2021

Hercules Instant Shelter Australias  
17/256 Musgrave Road  
Coopers Plains QLD 4108

Dear Sir/Madam,

## Certificate of Adequacy for Design of Temporary Structures Folding Marquee - PRO57

I, Edward A. Bennett, practicing structural Engineer, hereby certify that I have carried out computations in accordance with proper design principles for the purpose of certifying the structural adequacy of the above marquees to be erected as a temporary structure at various Sites throughout Australia that meet the Design Restrictions and Limitations within the computations (Copy of Report attached).

I am able to confirm that these Temporary Structures will be erected with weights/tie downs in accordance with the BCA Section B, "Structural Provisions", AS 1170.0 & 1-2002, "Structural Design Actions" and AS 1170.2, 2011 "Wind Actions", such that I am able to issue this "Certificate of Adequacy - Design".

Full Name of Designer:	Edward Arthur Bennett
Qualifications:	M.I.E. Aust. CPE NPER 198230
Address of Designer:	3 Wanniti Road, Belrose NSW 2085
Business Telephone No.:	Phone: (02) 9975 3899 Fax: 9974 1943
Name of Employer:	Civil & Structural Engineering Design Services Pty. Ltd.

Yours faithfully,

E.A. Bennett M.I.E. Aust. NPER 198230, BPB NSW-0282, BPB VIC – EC 25923 & RPEQ 4541



## PRO 57 OUR BEST ALLOY MODEL

Offering extreme strength & durability all year round, the Aluminium Pro 57 is the strongest commercial folding marquee. Unbeatable for its outstanding performance in all situation. It's built to last and withstand most weather conditions.

### Main Features

- 1 Minute set up. No loose parts, no tools are required!
- 57mm Hexagonal alloy outer legs, 2mm gauge.
- 35 x 18mm Multi-ribbed extruded truss bars.
- All legs and truss bars are made from high strength 6005 T6 aluminium, substantially strengthened and never rust.
- All joints upgraded to casting aluminium.
- Galvanised Steel Foot plates & Stainless Screws.
- Unique 75mm Stainless Steel Spring Tension System.



### Specification



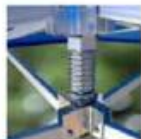
**Waterproof & UV Treated Fabric**, the standard package comes with the thick 500D PVC coated polyester fabric.



**All Seam Points Are Double Stitched** for added strength and durability.



**Sturdy Center Pole** ensures proper top up-right.



**Center Stainless Steel Spring Tension System** ensures proper top fit.



**Central Pivot Design** ensures lifetime of durability.



**Supported Buckled Strap.** The canopy is secured to the frame with additional buckled strap at 4 sides.



**Protective Layer At Corners**, a double lining reinforcement for extra protection.



**Casting Aluminium Brackets** with rounded ABS plastic caps to provide extra protection to the roof from general tear and wear.



**35x18mm Truss bar** features inner structure.



**Pull-pin Quick Lock Release Button** with 5 height levels adjustment to reach maximum of 2.1 meters.



**Stainless Steel Thick Footplates** with holes provided for pegs.



**50mm Wide Velcro Strap.** Sidewalls can be easier attached to the canopy.

WON'T BE BEATEN ON PRICE & QUALITY + NATIONWIDE FAST DELIVERY

### Warranty



The PRO 57 Marquee is covered by 10 years framework warranty.

### Sizes

- 3m x 3m – 31kg
- 3m x 4.5m – 41kg
- 3m x 6m – 57kg
- 4m x 4m – 41kg
- 4m x 6m – 59kg
- 4m x 8m – 67kg

### Colors

9 Standard colors available:  

 Black, White, Grey, Red, Blue, Green, Navy, Maroon, Yellow.

### Accessories

- Solid full wall/door wall
- Half wall/Window wall
- PVC clear wall/Mesh wall
- Sandbag/Steel leg weight
- Carry bag/Wheelie bag
- Rain Gutter

Phone: 1300 810 910 | Email: [sales@herculesinstantshelter.com.au](mailto:sales@herculesinstantshelter.com.au) | [www.herculesinstantshelter.com.au](http://www.herculesinstantshelter.com.au)