Civil & Structural Engineering Design Services Pty. Ltd.

Client: **EXTREME MARQUEES PTY. LTD.**

Project: Design check – 2m, 3m & 4m Café Umbrella for **112km/hr** Wind Speed.

Reference: Extreme Marquees Pty Ltd Technical Data

Report by: KZ
Checked by: EAB
Date: 14/11/2017
Amendment: -

JOB NO: E-11-265815

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ABN: 62 051 307 852
3 Wanniti Road BELROSE NSW 2085
Tel: 02 9975 3899 Fax: 02 99751943
Email: hited@bigpond.net.au
Web: https://cseds.com.au/

1 Introduction

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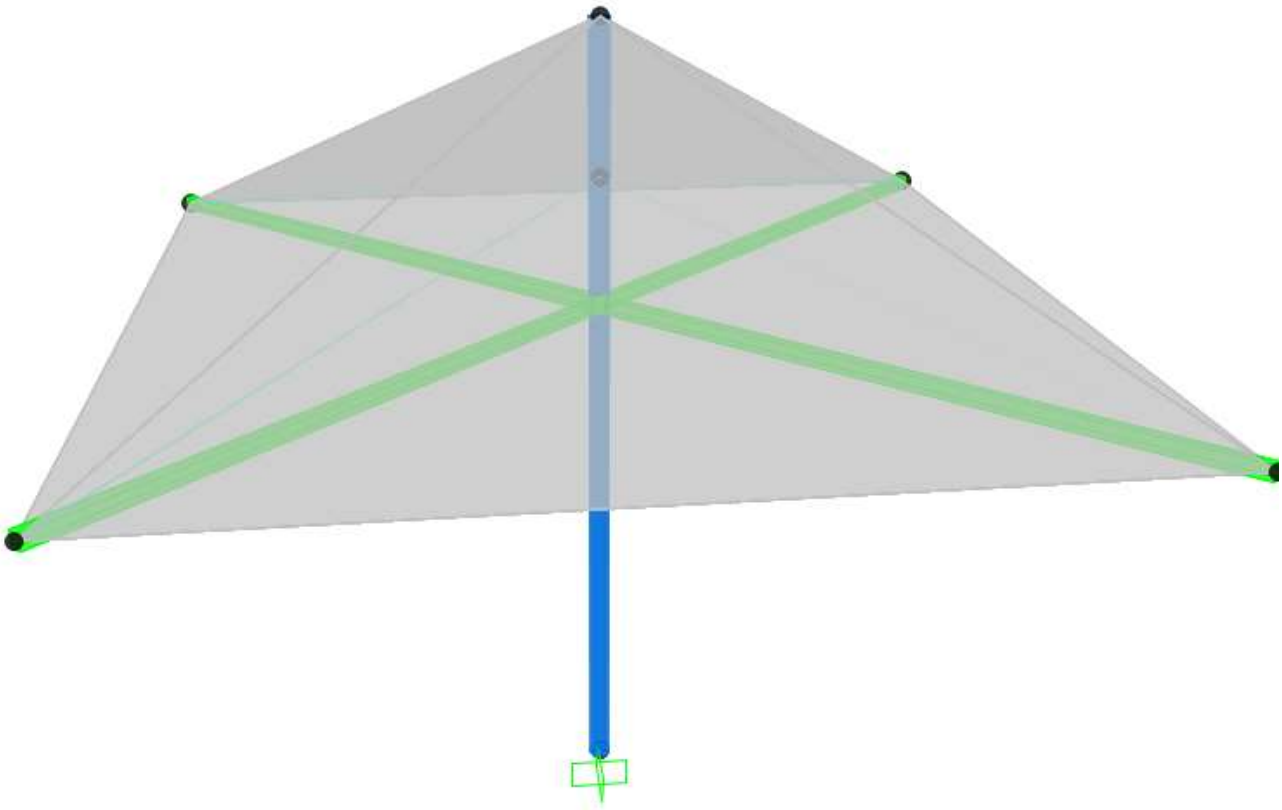
The following structural drawings and calculations are for the transportable 2m, 3m & 4m Café Umbrellas supplied by Extreme Marquees.

The frame consists principally of extruded '6061-T6' aluminum components with hot dipped galvanized steel base plate.

The report examines the effect of 3s gust wind of 112 km/hr on 2m, 3m & 4m Café Umbrellas 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 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 umbrella should be closed.

2.3 For forecast winds in excess of **(refer to summary)** – the umbrella should be completely closed.

(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 Terrain Category 2.5. 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 as defined on the Map of Australia in AS 1170.2-2011, Figure 3.1.

2.7 The structure has not been designed to withstand snow and ice loadings such as when erected in alpine regions.

2.8 For the purpose of the analysis it is assumed that the umbrella is fully opened with the empty under condition. (as per AS1170.2 Cl. D3.1 " 'empty under' implies that any goods or materials stored under the roof, block less than 50% of the cross-section exposed to the wind").

2.9 Design of fabric is by others.

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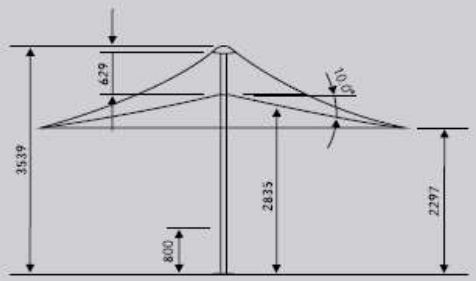
3 Specifications

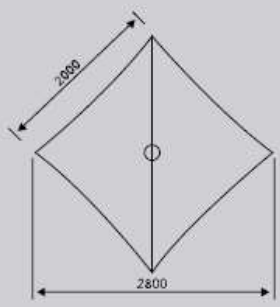
3.1 General

Tent category	
Material	Aluminum 6061-T6

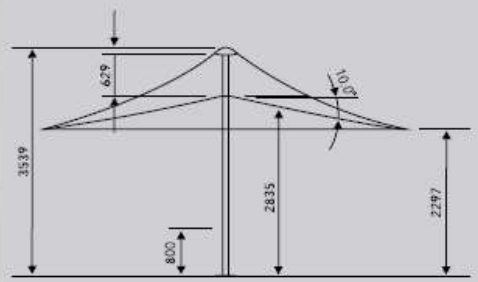
Size	Model
2m, 3m & 4m	Café Umbrellas

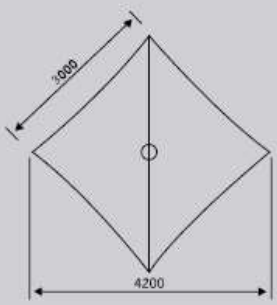
2m Cafe Umbrella



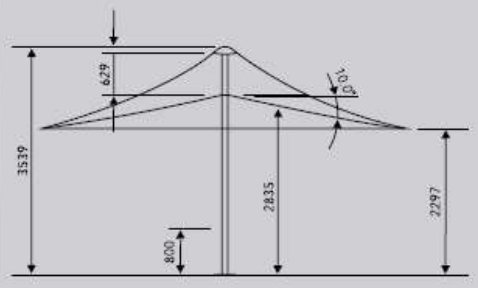


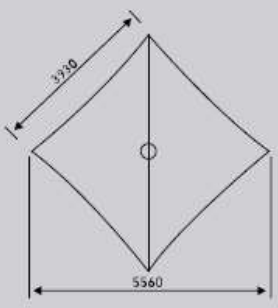
3m Cafe Umbrella





4m Cafe Umbrella





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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)	φy	0.95
Capacity factor (ultimate)	φu	0.85
Capacity factor (bending)	φb	0.85
Capacity factor (elastic shear buckling)	φv	0.8
Capacity factor (inelastic shear buckling)	φvp	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	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*
Beams	60.5x44.4x4	44.4	4	30.3	636.1	8112.8	7079.6	11142.1	9144.4	245291.0	157168.0	377798.0	19.6	15.7
Upright Support	D90x3.5	90	3.5	45.0	951.1	19800.4	19800.4	26202.2	26202.2	891018.5	891018.5	1782036.9	30.6	30.6

Refer Appendix 'C' for detail drawings

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 112km/hr gust	W	0.44 C_{fig}	1.0	0.44 C_{fig}

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 = 2.5
Site wind speed ($V_{sit,\beta}$) = $V_R M_d (M_{z,cat} M_s M_t)$
V_R = 31.11 m/s (112 km/hr) *(regional 3 s gust wind speed)*
M_d = 1
M_s = 1
M_t = 1

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$M_{z,cat}$ = 0.87 *(Table 4.1(B) AS1170.2)*

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

Height of structure (h) = 2.9 m *(mid of peak and eave)*
Width of structure (w) = 4 m
Length of structure (l) = 4 m

Pressure (P) = $0.5\rho_{air} (V_{sit,\beta})^2 C_{fig} C_{dyn}$
= $0.44C_{fig}$ 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		-			*Table 3.3*
Regional gust wind speed		**112**	Km/hr		*Table 3.1 (AS1170.2)*
Regional gust wind speed	V_R	**31.11**	m/s		
Wind Direction Multipliers	M_d	1			*Table 3.2 (AS1170.2)*
Terrain Category Multiplier	$M_{Z,Cat}$	0.87			*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	$V_{Site,\beta}$	**27.07**	m/s	$V_{Site,\beta}=V_R*M_d*M_{z,cat}*M_S,M_t$	
Pitch	α	23	Deg		
Pitch	α	-	rad		
Width	B	4	m		
Length	D	4	m		
Height	Z	2.9	m		
Wind Pressure					
ρair	ρ	1.2	Kg/m^3		
dynamic response factor	C_{dyn}	1			
Wind Pressure	$\rho*C_{fig}$	**0.440**	Kg/m^2	$\rho=0.5\rho_{air}*(V_{des,\beta})^2*C_{fig}*C_{dyn}$	*2.4 (AS1170.2)*
WIND DIRECTION 1 (θ=0) Empty Under					

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External Pressure					
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**	$C_{P,w}$	0.6			
External Pressure Coefficient **MIN**	$C_{P,l}$	-0.6			
External Pressure Coefficient **MAX**	$C_{P,l}$	0			
aerodynamic shape factor **MIN**	$C_{fig,w}$	-0.30			
aerodynamic shape factor **MAX**	$C_{fig,w}$	0.60			
aerodynamic shape factor **MIN**	$C_{fig,l}$	-0.60			
aerodynamic shape factor **MAX**	$C_{fig,l}$	0.00			
Pressure Windward **MIN**	P	**-0.13**	**kPa**		
Pressure Windward **MAX**	P	**0.26**	**kPa**		
Pressure Leeward **MIN**	P	**-0.26**	**kPa**		
Pressure Leeward **MAX**	P	**0.00**	**kPa**		

5.2.1 Pressure summary

WIND EXTERNAL PRESSURE	Direction1	
	Min (Kpa)	**Max (Kpa)**
W	-0.13	0.26
L	-0.26	0.00

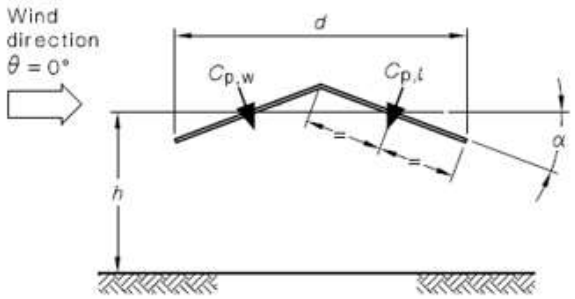

FIGURE D3 PITCHED FREE ROOFS

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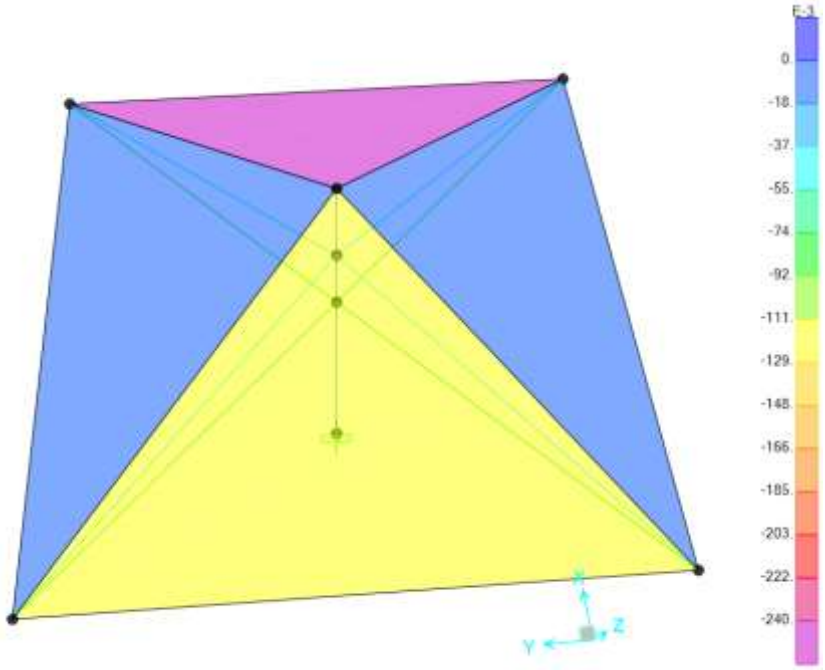
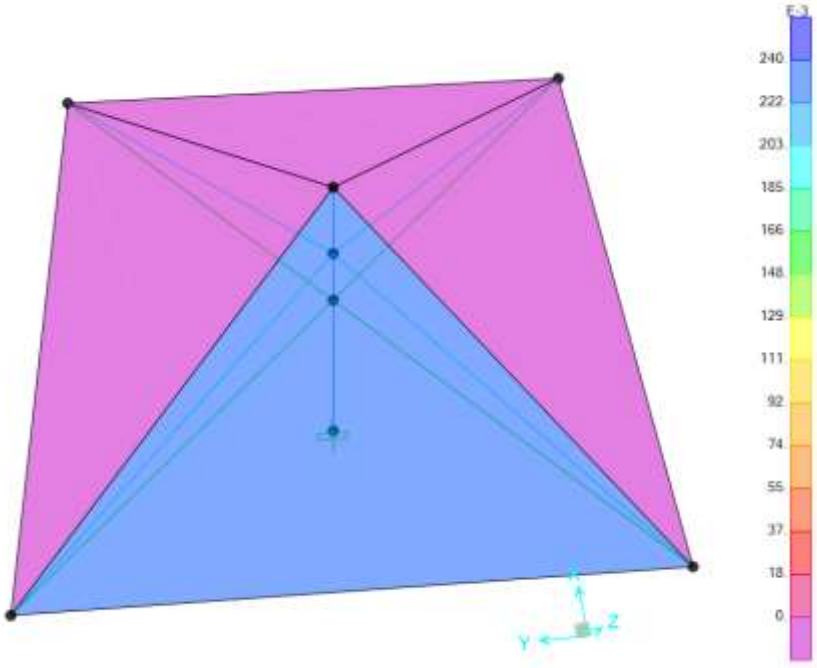
5.3 Wind Load Diagrams

5.3.1 Wind 1(case 1)



5.3.2 Wind 1(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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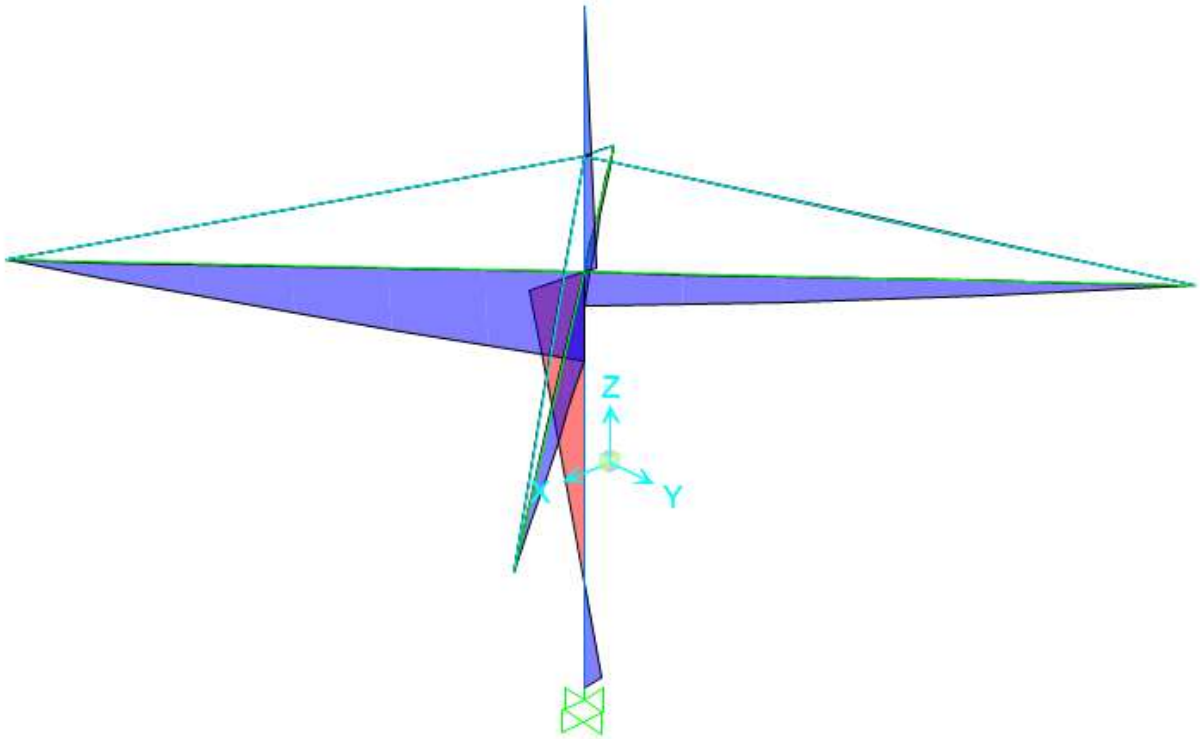
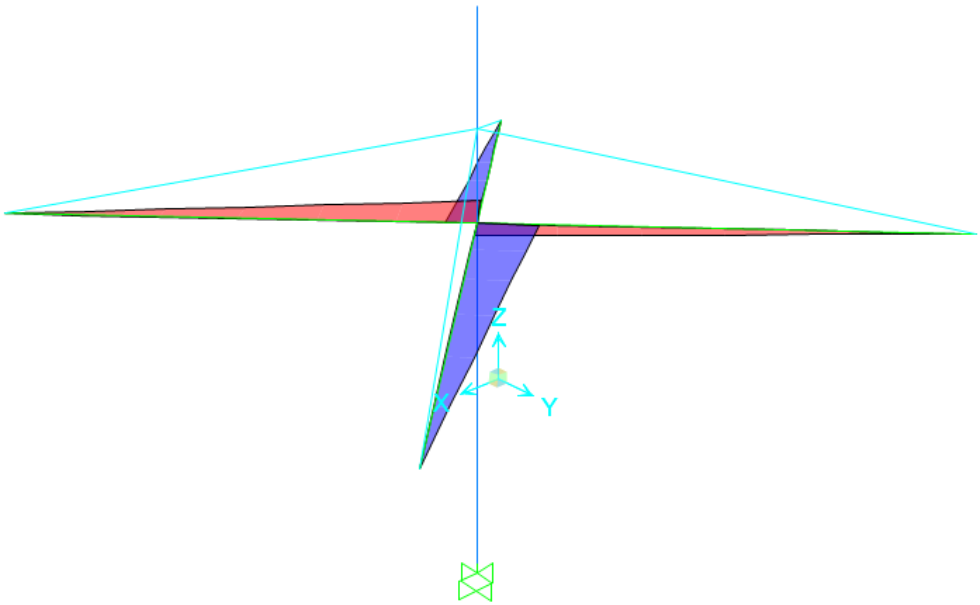
5.3.3 Max Bending Moment due to critical load combination in major axis



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



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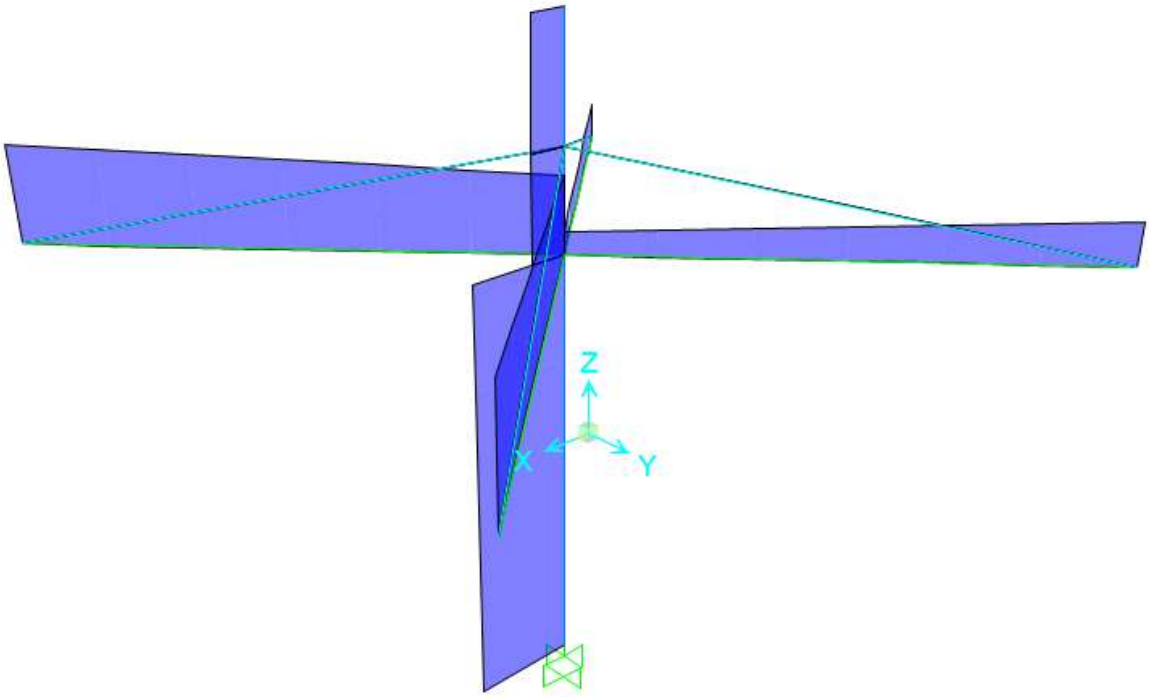
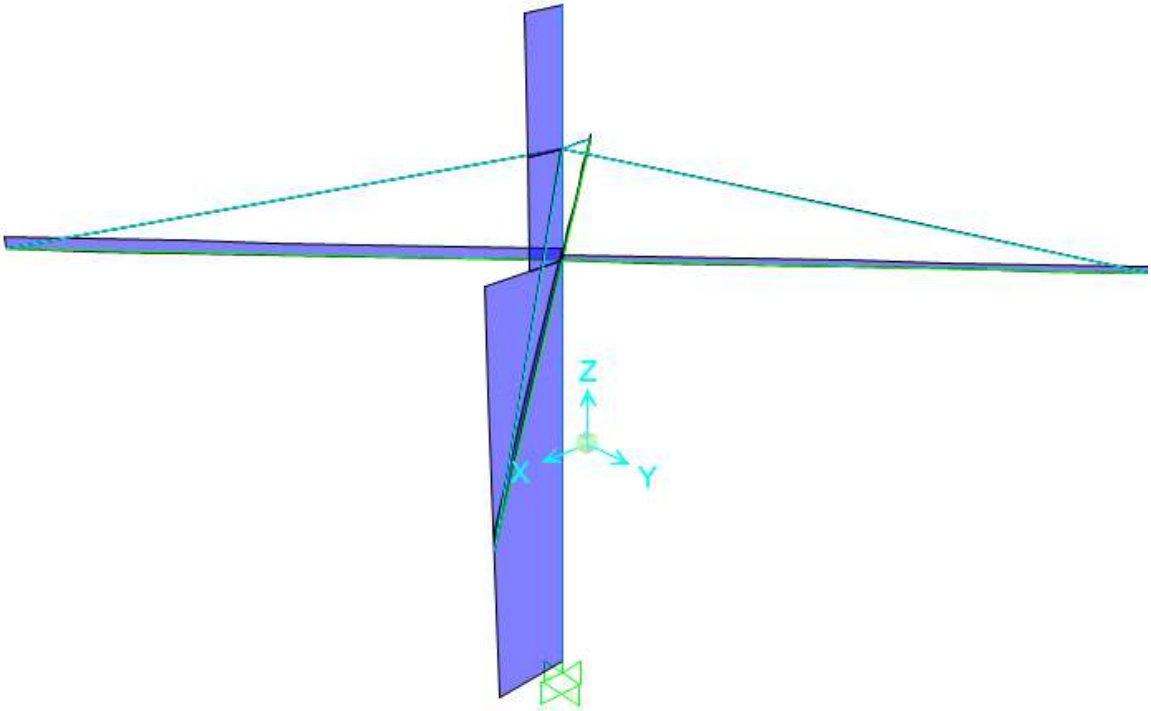
5.3.5 Max Shear in due to critical load combination



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



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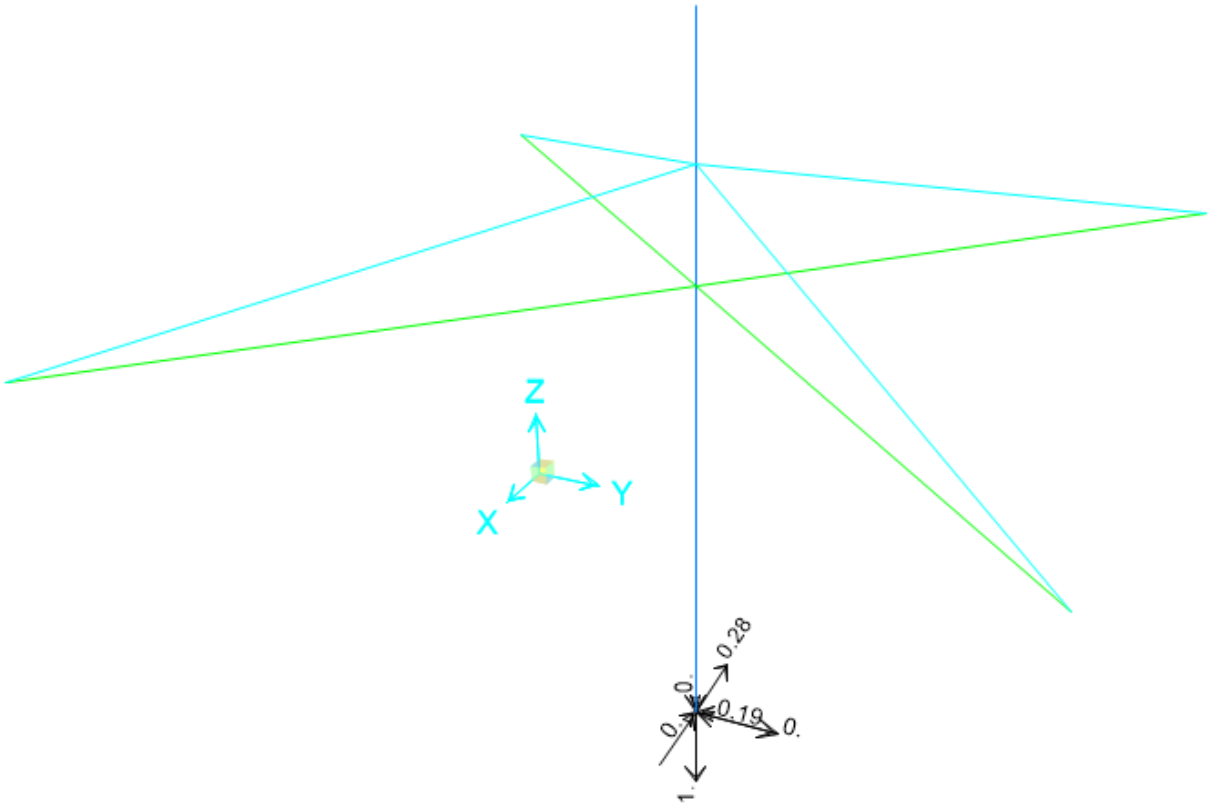
5.3.7 Max reactions



Max Reaction (Uplift) N^* = 1.3 kN

5.3.8 Summary Table:

6 Checking Members Based on AS1664.1 ALUMINIUM LSD

6.1 Beams

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
60.5x44.4x4	**Beams**					
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*	

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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	=	0.128	kN	*compression*	
	P	=	0	kN	*Tension*	
In plane moment	M_x	=	0.983	kNm		
Out of plane moment	M_y	=	0.3566	kNm		
DESIGN STRESSES						
Gross cross section area	A_g	=	636.11	mm^2		
In-plane elastic section modulus	Z_x	=	8112.8	mm^3		
Out-of-plane elastic section mod.	Z_y	=	7079.63	mm^3		
Stress from axial force	f_a	=	P/A_g			
		=	**0.20**	**MPa**	*compression*	
		=	**0.00**	**MPa**	*Tension*	
Stress from in-plane bending	f_{bx}	=	M_x/Z_x			
		=	**121.17**	**MPa**	*compression*	
Stress from out-of-plane bending	f_{by}	=	M_y/Z_y			
		=	**50.37**	**MPa**	*compression*	
Tension						
3.4.3 *Tension in rectangular tubes*						3.4.3
	ϕF_L	=	**267.87**	**MPa**		
		OR				
	ϕF_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	=	2780	mm		
Effective length factor	k	=	2.2			
Radius of gyration about buckling axis (Y)	r_y	=	15.72	mm		

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Radius of gyration about buckling axis (X)	r_x	=	19.64	mm		
Slenderness ratio	kLb/ry	=	389.06			
Slenderness ratio	kL/rx	=	311.41			
Slenderness parameter	λ	=	7.266			
	D_c*	=	90.3			
	S_1*	=	0.33			
	S_2*	=	1.23			
	ϕ_{cc}	=	0.950			
Factored limit state stress	**ϕF_L**	**=**	**4.34**	**MPa**		
2. Sections not subject to torsional or torsional-flexural buckling						3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	389.06			
***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	=	20.2			
	t	=	4	mm		
Slenderness	R_m/t	=	5.05			
Limit 1	S_1	=	0.24			
Limit 2	S_2	=	672.46			
Factored limit state stress	**ϕF_L**	**=**	**249.42**	**MPa**		
Most adverse compressive limit state stress	F_a	=	4.34	MPa		
Most adverse tensile limit state stress	F_a	=	267.87	MPa		
Most adverse compressive & Tensile capacity factor	f_a/F_a	=	0.05		PASS	
BENDING - IN-PLANE						
***3.4.13** Compression in beams, extreme fibre, gross section round or oval tubes*						
Unbraced length for bending	L_b	=	2780	mm		

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Second moment of area (weak axis)	I_y	=	1.57E+05	mm^4		
Torsion modulus	J	=	3.78E+05	mm^3		
Elastic section modulus	Z	=	8112.8	mm^3		
	R_b/t	=	5.05			
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	**=**	20.2	mm		
	t	**=**	4	mm		
Slenderness	R_b/t	**=**	5.05			
Limit 1	S_1	=	2.75			
Limit 2	S_2	=	78.23			
Factored limit state stress	**ϕF_L**	=	**232.34**	**MPa**		
Most adverse in-plane bending limit state stress	F_{bx}	=	232.34	MPa		
Most adverse in-plane bending capacity factor	f_{bx}/F_{bx}	**=**	0.52		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**	=	**232.34**	**MPa**		
Most adverse out-of-plane bending limit state stress	**F_{by}**	=	232.34	MPa		
Most adverse out-of-plane bending capacity factor	**f_{by}/F_{by}**	**=**	0.22		PASS	
COMBINED ACTIONS						
***4.1.1** Combined compression and bending*						4.1.1

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	F_a	=	4.34	MPa		3.4.11
	F_{ao}	=	249.42	MPa		3.4.11
	F_{bx}	=	232.34	MPa		3.4.18
	F_{by}	=	232.34	MPa		3.4.18
	f_a/F_a	=	0.046			
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					4.1.1
i.e.	0.78	≤	1.0		PASS	
SHEAR						
3.4.24 *Shear in webs (Major Axis)*						3.4.24
	R	=	22.2	mm		
	t	=	4	mm		
Equivalent h/t	h/t	=	28.31			
Limit 1	S_1	=	29.01			
Limit 2	S_2	=	59.31			
Factored limit state stress	ϕF_L	=	**131.10**	**MPa**		
Stress From Shear force	f_{sx}	=	V/A_w			
			1.20	**MPa**		
3.4.25 *Shear in webs (Minor Axis)*						3.4.24
Clear web height	R	=	22.2	mm		
	t	=	4	mm		
Equivalent h/t	h/t	=	28.31			
Factored limit state stress	ϕF_L	=	**131.10**	**MPa**		
Stress From Shear force	f_{sy}	=	V/A_w			
			0.40	**MPa**		

6.2 Upright Supports

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
D90x3.5	**Upright Support**					
Alloy and temper	6061-T6					AS1664.1
Tension	F_{tu}	=	262	MPa	*Ultimate*	T3.3(A)
	F_{ty}	=	241	MPa	*Yield*	

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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	=	1.436	kN	*compression*	
	P	=	0	kN	*Tension*	
In plane moment	M_x	=	0.9241	kNm		
Out of plane moment	M_y	=	2.46E-15	kNm		
DESIGN STRESSES						
Gross cross section area	A_g	=	951.11718	mm^2		
In-plane elastic section modulus	Z_x	=	19800.41	mm^3		
Out-of-plane elastic section mod.	Z_y	=	19800.41	mm^3		
Stress from axial force	f_a	=	P/A_g			
		=	**1.51**	**MPa**	*compression*	
		=	**0.00**	**MPa**	*Tension*	
Stress from in-plane bending	f_{bx}	=	M_x/Z_x			
		=	**46.67**	**MPa**	*compression*	
Stress from out-of-plane bending	f_{by}	=	M_y/Z_y			
		=	**0.00**	**MPa**	*compression*	
Tension						
3.4.3 *Tension in round or oval tubes*						3.4.3
	ϕF_L	=	**267.87**	**MPa**		
		OR				
	ϕF_L	=	**276.15**	**MPa**		
COMPRESSION						
3.4.8 *Compression in columns, axial, gross section*						
1. General						3.4.8.1
Unsupported length of	L	=	3500	mm		

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member						
Effective length factor	k	=	2.2			
Radius of gyration about buckling axis (Y)	r_y	=	30.61	mm		
Radius of gyration about buckling axis (X)	r_x	=	30.61	mm		
Slenderness ratio	kLb/ry	=	165.32			
Slenderness ratio	kL/rx	=	251.57			
Slenderness parameter	λ	=	4.70			
	D_c*	=	90.3			
	S_1*	=	0.33			
	S_2*	=	1.23			
	ϕ_{cc}	=	0.950			
Factored limit state stress	**ϕF_L**	**=**	**10.37**	**MPa**		
2. Sections not subject to torsional or torsional-flexural buckling						3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	251.57			
***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	=	43.25			
	t	=	3.5	mm		
Slenderness	R_m/t	=	12.357143			
Limit 1	S_1	=	0.24			
Limit 2	S_2	=	672.46			
Factored limit state stress	**ϕF_L**	**=**	**220.80**	**MPa**		
Most adverse compressive limit state stress	F_a	=	10.37	MPa		
Most adverse tensile limit state stress	F_a	=	267.87	MPa		
Most adverse compressive & Tensile capacity factor	f_a/F_a	=	0.15		PASS	
BENDING - IN-PLANE						

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3.4.13 *Compression in beams, extreme fibre, gross section round or oval tubes*						
Unbraced length for bending	L_b	=	2300	mm		
Second moment of area (weak axis)	I_y	=	8.91E+05	mm^4		
Torsion modulus	J	=	1.78E+06	mm^3		
Elastic section modulus	Z	=	19800.41	mm^3		
	R_b/t	=	12.36			
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	=	43.25	mm		
	t	=	3.5	mm		
Slenderness	R_b/t	=	12.357143			
Limit 1	S_1	=	2.75			
Limit 2	S_2	=	78.23			
Factored limit state stress	ϕF_L	=	**220.80**	**MPa**		
Most adverse in-plane bending limit state stress	F_{bx}	=	220.80	MPa		
Most adverse in-plane bending capacity factor	f_{bx}/F_{bx}	=	0.21		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	=	**220.80**	**MPa**		
Most adverse out-of-plane bending limit state stress	F_{by}	=	220.80	MPa		
Most adverse out-of-plane bending capacity factor	f_{by}/F_{by}	=	0.00		PASS	

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COMBINED ACTIONS						
4.1.1 *Combined compression and bending*						4.1.1
	F_a	=	10.37	MPa		3.4.11
	F_{ao}	=	220.80	MPa		3.4.11
	F_{bx}	=	220.80	MPa		3.4.18
	F_{by}	=	220.80	MPa		3.4.18
	f_a/F_a	=	0.146			
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq$		1.0			4.1.1
i.e.	0.36	≤	1.0		PASS	
SHEAR						
3.4.24 *Shear in webs (Major Axis)*						3.4.24
	R	=	45	mm		
	t	=	3.5	mm		
Equivalent h/t	h/t	=	42.49			
Limit 1	S_1	=	29.01			
Limit 2	S_2	=	59.31			
Factored limit state stress	ϕF_L	=	**117.45**	**MPa**		
Stress From Shear force	f_{sx}	=	V/A_w			
			1.19	**MPa**		
3.4.25 *Shear in webs (Minor Axis)*						3.4.25
Clear web height	R	=	45	mm		
	t	=	3.5	mm		
Equivalent h/t	h/t	=	42.49			
Factored limit state stress	ϕF_L	=	**117.45**	**MPa**		
Stress From Shear force	f_{sy}	=	V/A_w			
			0.27	**MPa**		

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7 Summary

7.1 Conclusions

a. The 2m, 3m & 4m Café Umbrellas structure as specified has been analyzed with a conclusion that it has the capacity to withstand wind speeds up to and including **112km/hr** when opened & **148km/hr** when closed**.**
b. For forecast winds in excess of **100km/hr** – the structure should be completely closed.
c. For uplift due to 112km/hr, 3.2 kN (320kg) holding down weight/per post is required for the 4m umbrella. Refer appendix 'A' for weight requirements for the other umbrella sizes.
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. For the purpose of the analysis it is assumed that the umbrella is fully opened with the empty under condition. (as per AS1170.2 Cl. D3.1 " 'empty under' implies that any goods or materials stored under the roof, block less than 50% of the cross-section exposed to the wind")
f. Design of fabric is by others.

Yours faithfully,

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

ABN: 62 051 307 852
3 Wanniti Road BELROSE NSW 2085
Email: hited@bigpond.net.au
Tel: 02 9975 3899 Fax: 02 99751943
Web: https://cseds.com.au/

8 Appendix A – Base Anchorage Requirements

2m, 3m & 4m Café Umbrellas:

Tent Span	Sile Type	Required Weight Per Leg
4 m	A	320kg
	B	320kg
	C	320kg
	D	320kg
	E	320kg
3 m	A	250kg
	B	250kg
	C	250kg
	D	250kg
	E	250kg
2 m	A	150kg
	B	150kg
	C	150kg
	D	150kg
	E	150kg

Definition of Soil Types:

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

Type B : Medium to stiff clays or silty clays

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

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

Type E : Concrete slab on ground. Number of dyna bolts and slab thickness to be designed.

Please note, it is assumed the base plate is 445mm diameter

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9 Appendix B – Dina Bolt Anchorage Requirements

7 DynaBolt™ Sleeve Anchors

Installation and Performance Details

Anchor size, d_h (mm)	Installation details				Minimum Dimensions*			Reduced Characteristic Capacity			
	Drilled hole Ø, d_h (mm)	Fixture hole Ø, d_f (mm)	Anchor effective depth, h (mm)	Tightening torque, T_r (Nm)	Edge distance, e_c (mm)	Anchor spacing, a_c (mm)	Substrate thickness, b_m (mm)	Shear V_a (kN)	Tension N_a (kN)		
								Concrete compressive strength (MPa)			
								20 MPa	20 MPa	32 MPa	40 MPa
M6	6	8	20	10	30	60	40	3.4	3.0	3.7	4.2
			30		55	105	70	3.4	5.4	5.4	5.4
M8	8	10	30	15	50	95	65	6.0	5.4	6.9	7.7
			40		75	150	100	6.0	8.3	9.6	9.6
M10	10	12	35	35	50	100	70	10.9	6.8	8.6	9.7
			50		85	165	110	10.9	11.7	14.8	16.5
M12	12	15	40	55	65	125	85	15.8	8.3	10.6	11.8
			50		90	180	120	15.8	11.7	14.8	16.5
			60		105	210	140	15.8	15.3	19.4	21.7
M16	16	19	55	85	75	145	95	20.9	13.5	17.0	19.0
			70		105	210	140	20.9	19.3	24.4	27.3
			80		135	270	180	20.9	23.6	29.9	33.4
M20	20	24	70	165	90	180	120	31.1	19.3	24.4	27.3
			85		130	255	170	31.1	25.9	32.7	36.6
			100		195	390	260	31.1	33.0	41.7	46.7

* For shear loads acting towards an edge or where these minimum dimensions are not achievable, please use the simplified strength limit state design process to verify capacity.

Reduced Characteristic

For 2m, 3m & 4m Café Umbrellas use 4/M10 DynaBolt with specifications highlighted yellow above

Please note, it is assumed the base plate is 445mm diameter with 4 bolt holes spaced 270mm apart.

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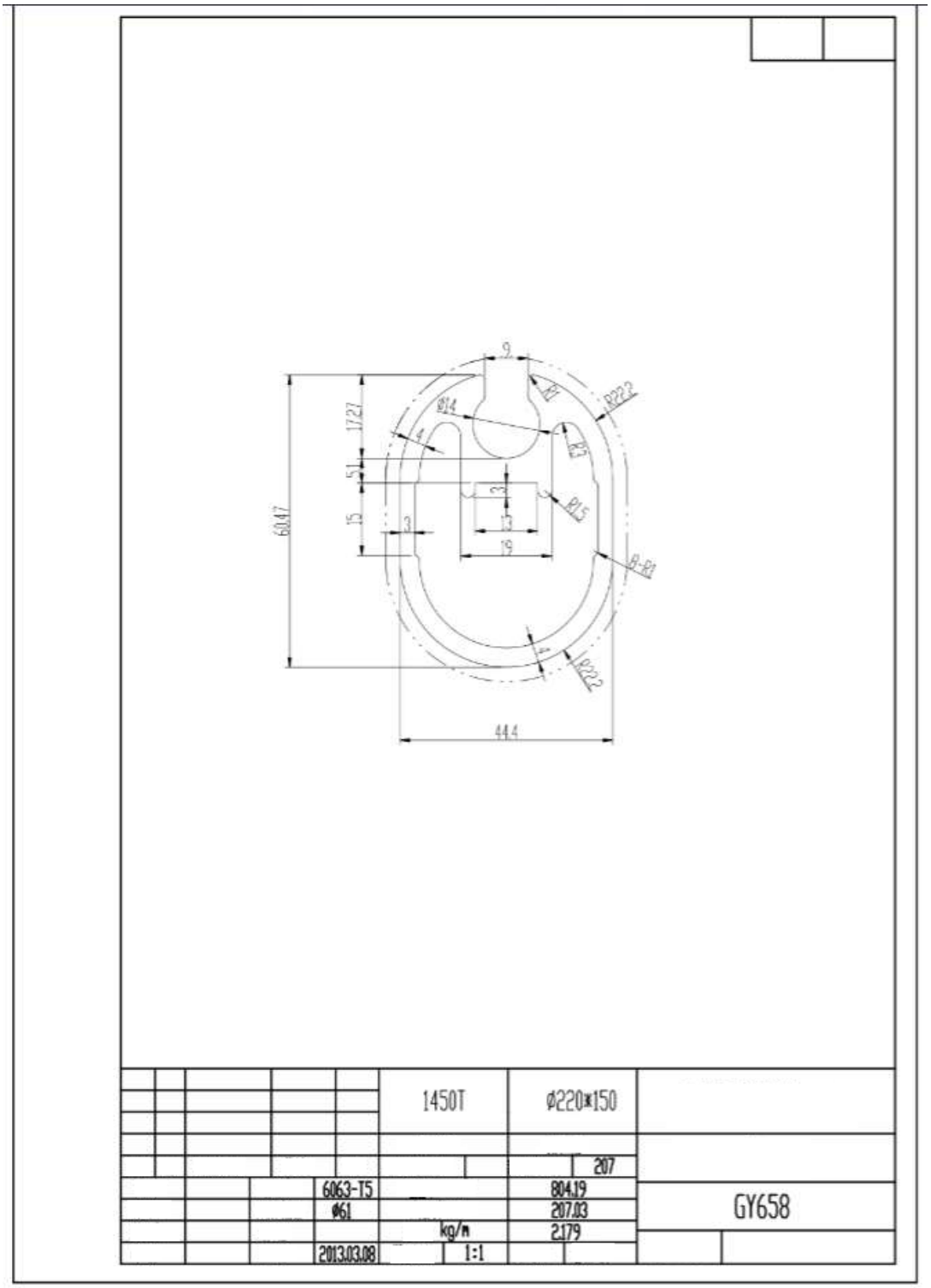
10 Appendix C – Detail Drawings



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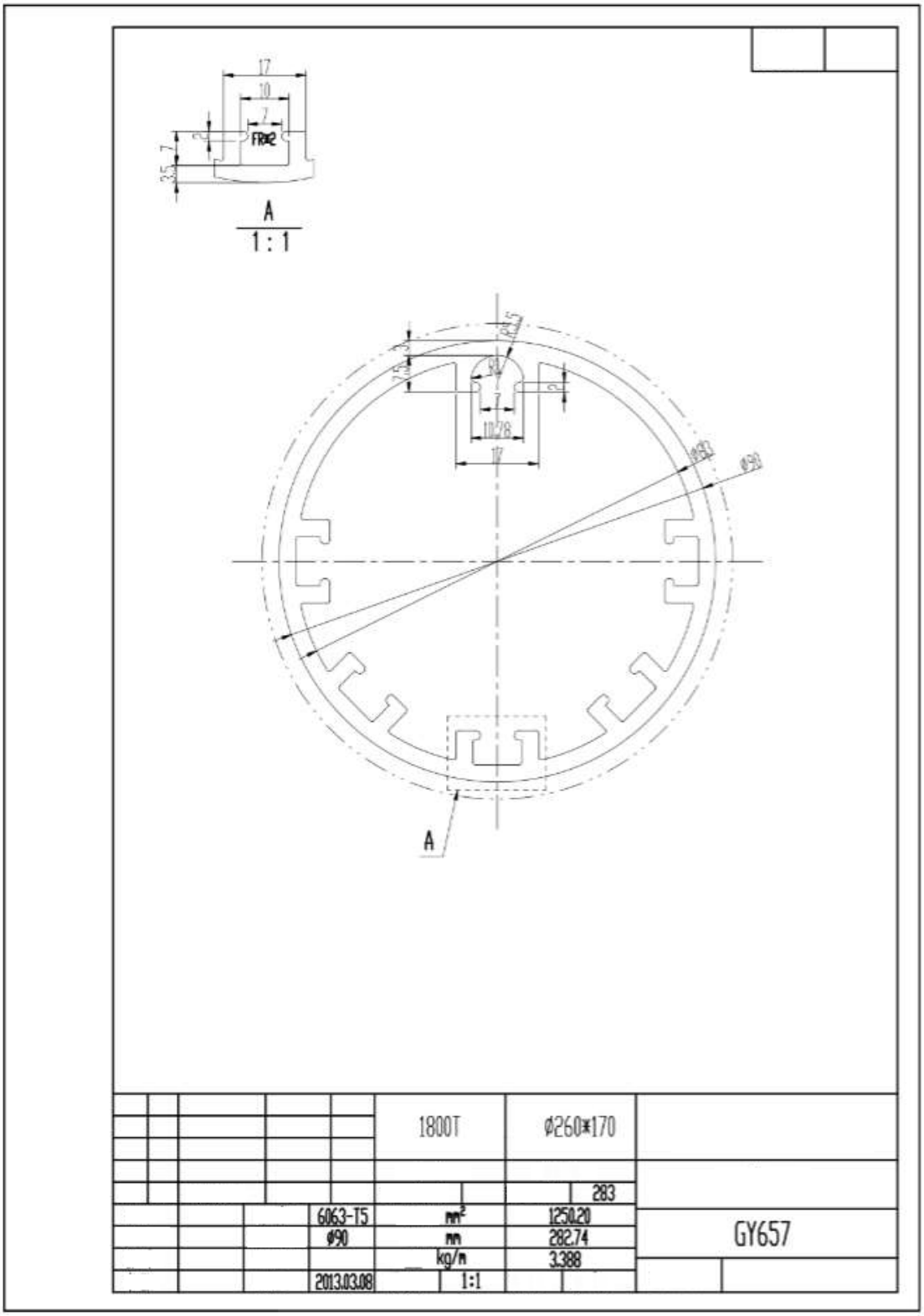

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