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Prime Consulting Engineers Pty. Ltd.

Design Report:

2.5m, 3m, 3.5m and 4m Diameter Octagonal

Premium Café SAVILLE Umbrella Structures

For

60km/hr Wind speed (Open Condition)

For

EXTREME MARQUEES

Ref: R-24-954-4

Date: 31/07/2024

Amendment: -

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Document Control

Should you have any queries relating to any technical aspects of this report please contact our office on (02) 8964 1818.

Document Authorization

RECIPIENT(S):	Mitchell Taverner
Document Issued Date:	31/07/2024

Rev.	Date	Issue for	Prepared by	Checked by
0	31/07/2024	Client's Review	AK	BG

Summary of Amendments

Rev.	Section(s)	Description
0	-	-

CONTENTS

1 Introduction and Scope:

The report and certification are the sole property of Prime Consulting Engineers Pty. Ltd.

Prime Consulting Engineers have been engaged by Extreme Marquees Pty. Ltd. to carry out a structural analysis of 2.5m, 3m, 3.5m and 4m Diameter Octagonal Premium Café SAVILLE Umbrella Structures for **60km/hr** wind speed in open condition. It should be noted that the outcome of our analysis is limited to the selected items as outlined in this report.

This report shall be read in conjunction with the documents listed in the references (Cl. 1.2)

1.1 Project Description

The report examines the effect of the peak gust wind that an equivalent moving average time of approximately 0.2S **16.67m/s (60 km/hr)** positioned for the worst effect, in open condition respectively, on 2.5m, 3m, 3.5m and 4m Diameter Octagonal Premium Café SAVILLE Umbrella Structures as the worst-case scenario. The relevant Australian Standards AS1170.0:2002 General principles, AS1170.1:2002 Permanent, imposed, and other actions and AS1170.2:2021 Wind actions are used. The design check is in accordance with AS1664.1 Aluminium Structures.

1.2 References

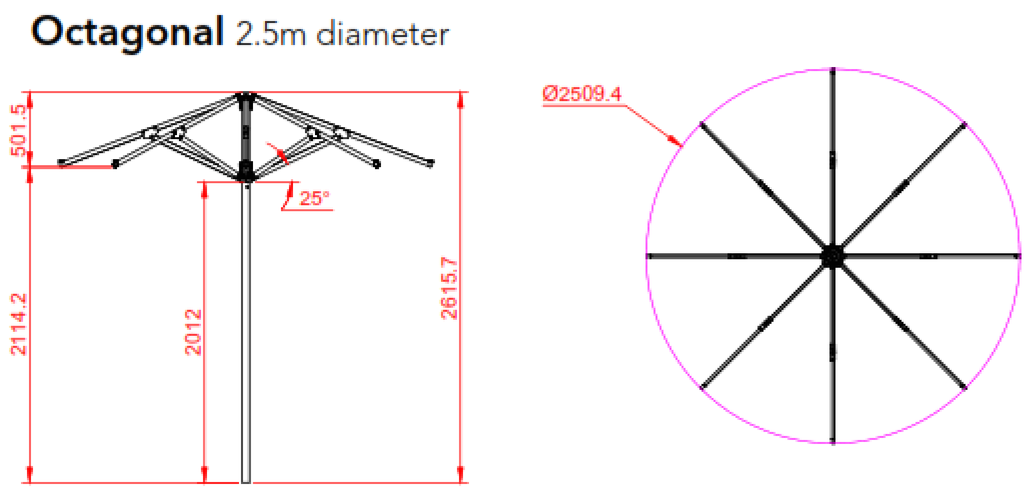
- The documents referred to in this report are as follows:
    - Report on results produced through SAP2000 V24 software & excel spreadsheets.
- The basic standards used in this report are as follows:
    - AS 1170.0:2002 – Structural Design Actions (Part 0: General principles)
    - AS 1170.1:2002 – Structural Design Actions (Part 1: Permanent, imposed, and other actions)
    - AS 1170.2:2021 – Structural Design Actions (Part 2: Wind Actions)
    - AS1664.1:1997 Aluminium Structures.
- Section Properties of Aluminium Section provided by the client.
- The program(s) used for this analysis are as follows:
    - SAP2000 V24
    - Microsoft Excel

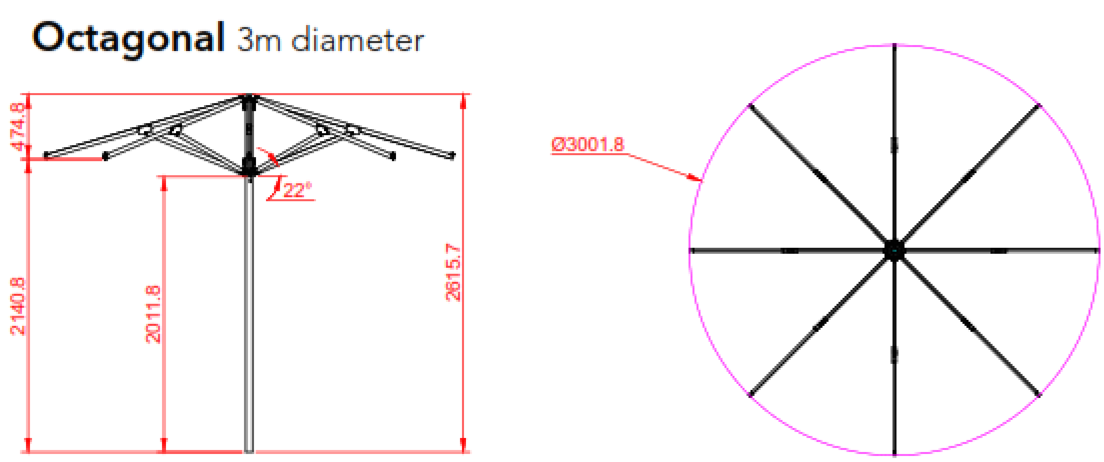
1.3 Notation

AS/NZS	Australian Standard/New Zealand Standard
FEM/FEA	Finite Element Method/Finite Element Analysis
SLS	Serviceability Limit State
ULS	Ultimate Limit State

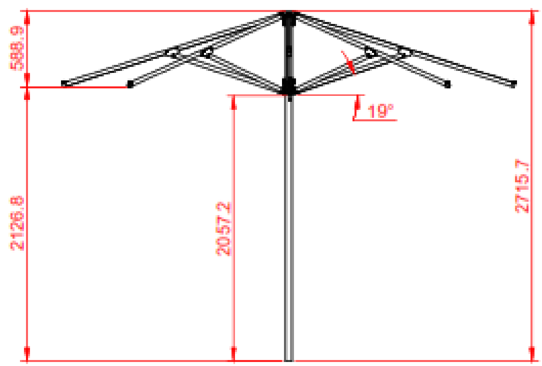
2 Design Overview

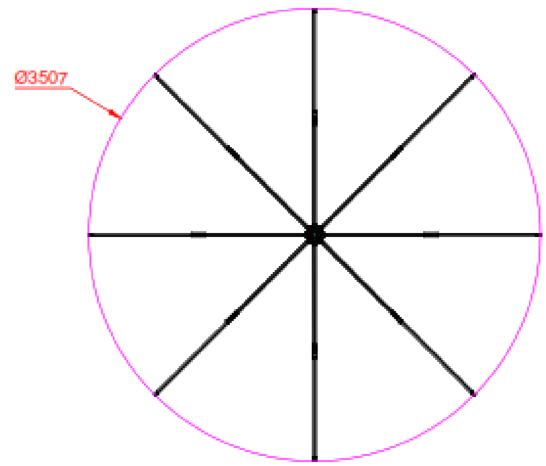
2.1 Geometry Data



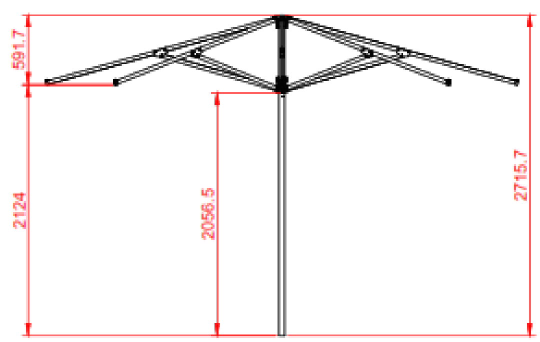


Octagonal 3.5m diameter





Octagonal 4m diameter



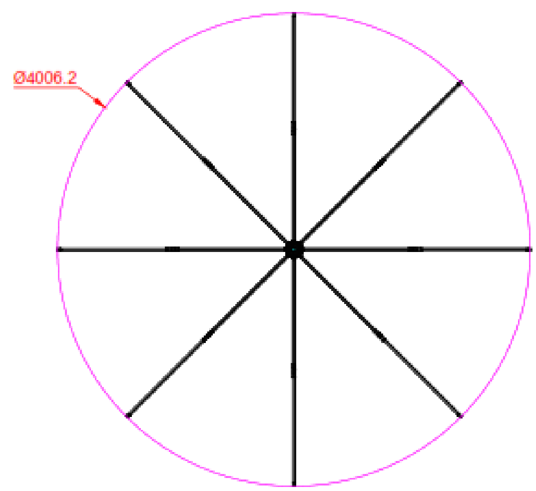


Figure 1: 2.5m, 3m, 3.5m and 4m Diameter Octagonal Premium Café SAVILLE Umbrella Structures

Size	2.5m dia	3m dia.	3.5m dia.	4m dia.
Canopy Diameter	2.5m	3m	3.5m	4m
Height	2.6m		2.7m	
Clearance	2.1m			
Fabric Weight	3kg	3kg	3kg	3.5kg
Frame Weight	11kg	11kg	12kg	13kg
Frame Box Dimensions	30 x 30 x 262cm			
Main Profile Dia.	50mm diameter x 2.8mm thick			
Framework	Aluminium (Black or Silver)			
Pole Connectors	Extruded Aluminium			
Lifting	4x Pulley System			
Fabric	Spanish Recasens			
Printing	UV Digital Print Screen Printing (4 colours)			
Manufacturer's Warranty	Frame 3 Years Recasens Fabric: 5 Years Printed Fabric: 2 Years			
Weight Plates	Optional accessory			

2.2 Assumptions & Limitations

- For forecast winds in excess of **60km/hr,** the umbrella structure should be closed.
- The umbrella with temporary anchorage system must be stored in an enclosed building when forecast wind exceeds **60km/hr**.
- The structure is design for wind parameters as below:
  - Wind Region A
  - TC2
  - M_s, M_t & M_d = 1
- Shall the site conditions/wind parameters exceed prescribed design wind actions (refer to Cl.4), Prime Consulting Engineers Pty. Ltd. should be informed to determine appropriate wind classifications and amend computations accordingly.
- It is assumed that the fabric weighs 500gr/m^2.

- Aluminium alloy is to be 6061-T6.
- It is assumed that the umbrella is "empty under" for calculating wind loads. As per AS1170.2:2021, empty under is defined "Any goods or materials stored under the roof block less than 50% of the cross-section exposed to the wind".

2.3 Exclusions

- Design of fabric.
- Wind actions due to tropical or severe tropical cyclonic areas.
- Snow and ice loads.

2.4 Design Parameters and Inputs

2.4.1 Load Cases

1.	G	Permanent actions (Dead load)
2.	Wu	Ultimate wind action (ULS)
3.	Ws	Serviceability wind action (SLS)

2.4.2 Load Combinations

Strength (ULS):

1.	1.35G	Permanent action only
2.	$0.9G+W_u$	Permanent and wind actions
3.	$1.2G+W_u$	Permanent and wind actions

Serviceability (SLS):

1.	$G+W_s$	Wind service actions

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3 Specifications

3.1 Material Properties

Material Properties										
6061-T6	F_{tu}	F_{ty}	F_{cy}	F_{su}	F_{sy}	F_{bu}	F_{by}	E	k_t	k_c
	262	241	241	165	138	551	386	70000	1	1.12

3.2 Buckling Constants

TABLE 3.3(D)
BUCKLING CONSTANTS FOR ALLOY 6061-T6

Type of member and stress	Intercept, MPa		Slope, MPa		Intersection	
Compression in columns and beam flanges	B_c	271.04	D_c	1.69	C_c	65.89
Compression in flat plates	B_p	310.11	Dp	2.06	C_p	61.60
Compression in round tubes under axial end load	B_t	297.39	D_t	10.70	C_t	*
Compressive bending stress in rectangular bars	B_{br}	459.89	D_{br}	4.57	C_{br}	67.16
Compressive bending stress in round tubes	B_{tb}	653.34	D_{tb}	50.95	C_{tb}	78.23
Shear stress in flat plates	B_s	178.29	D_s	0.90	C_s	81.24
Ultimate strength of flat plates in compression	k_1	0.35	k_2	2.27		
Ultimate strength of flat plates in bending	k_1	0.5	k_2	2.04		

** C_t shall be determined using a plot of curves of limit state stress based on elastic and inelastic buckling or by trial-and-error solution.*

3.3 Member Sizes & 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*
Main pole	D50x2.8	50	2.8	25.0	415.2	4641.2	4641.2	6245.3	6245.3	116029.8	116030	232059.6	16.7	16.7

MEMBER(S)	Section	b	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*	*mm*	*mm²*	*mm³*	*mm³*	*mm³*	*mm³*	*mm⁴*	*mm⁴*	*mm⁴*	*mm*	*mm*
Long Rib 1	17x32x1.8	17	32	1.8	16.0	163.4	1302.7	871.4	1650.0	1037.1	20842.6	7406.9	16708.9	11.3	6.7
Short Rib 1	17x32x1.8	17	32	1.8	16.0	163.4	1302.7	871.4	1650.0	1037.1	20842.6	7406.9	16708.9	11.3	6.7

4 Wind Analysis

4.1 Wind calculations

PRIME CONSULTING ENGINEERS PTY. LTD

Project: EXTREME MARUQEES

Job no. 24-954 ***Designer:*** AK

Date: 19/07/2024 ***Amendment:***

Name	Symbol	Value	Unit	Notes	Ref.
Input					
Importance level		2			*Table 3.1 - Table 3.2 (AS1170.0)*
Annual probability of exceedance		1/500			*Table 3.3*
Regional gust wind speed		**60.012**	Km/hr		
Regional gust wind speed	V_R	16.67	m/s		
Wind Direction Multipliers	M_d	1			*Table 3.2 (AS1170.2)*
Terrain Category	TC	2			
Terrain Category Multiplier	$M_{Z,Cat}$	0.91			
Shield Multiplier	M_S	1			*4.3 (AS1170.2)*
Topographic Multiplier	M_t	1			*4.4 (AS1170.2)*
Site Wind Speed	$V_{Site,\beta}$	**15.17**	m/s	$V_{Site,\beta}=V_R*M_d*M_{z,cat}*M_S,M_t$	
Pitch	α	16.5	Deg		
Pitch	α	-	rad		
Width	B	4	m		
Length	D	4	m		
Height	Z	2.4	m		
Porosity Ratio	δ	1		*ratio of solid area to total area*	
Wind Pressure					
ρair	ρ	1.2	Kg/m^3		

dynamic response factor	C_{dyn}	1			
Wind Pressure	ρ*C_{fig}	**0.138**	Kg/m^2	$\rho=0.5\rho_{air}*(V_{des,\beta})^2*C_{fig}*C_{dyn}$	*2.4 (AS1170.2)*
WIND DIRECTION 1 (θ=0) ***External Pressure***					
1. Free Roof				$\alpha=0^o$	
Area Reduction Factor	K_a	1			*D7*
local pressure factor	K_l	1			
porous cladding reduction factor	K_p	1.00			
External Pressure Coefficient **MIN**	$C_{P,w}$	-0.3			
External Pressure Coefficient **MAX**	$C_{P,w}$	0.44			
External Pressure Coefficient **MIN**	$C_{P,l}$	-0.44			
External Pressure Coefficient **MAX**	$C_{P,l}$	0			
aerodynamic shape factor **MIN**	$C_{fig,w}$	-0.30			
aerodynamic shape factor **MAX**	$C_{fig,w}$	0.44			
aerodynamic shape factor **MIN**	$C_{fig,l}$	-0.44			
aerodynamic shape factor **MAX**	$C_{fig,l}$	0.00			
Pressure Windward **MIN**	P	**-0.04**	**kPa**		
Pressure Windward **MAX**	P	**0.06**	**kPa**		
Pressure Leeward **MIN**	P	**-0.06**	**kPa**		
Pressure Leeward **MAX**	P	**0.00**	**kPa**		
WIND DIRECTION 2 (θ=90) ***External Pressure***					
4. Free Roof				$\alpha=180^o$	*D7*
Area Reduction Factor	K_a	1			
local pressure factor	K_l	1			
porous cladding reduction factor	K_p	1.00			
External Pressure Coefficient **MIN**	$C_{P,w}$	-0.3			
External Pressure Coefficient **MAX**	$C_{P,w}$	0.4			
External Pressure Coefficient **MIN**	$C_{P,l}$	-0.4			

External Pressure Coefficient **MAX**	$C_{P,l}$	0	
aerodynamic shape factor **MIN**	$C_{fig,w}$	-0.30	
aerodynamic shape factor **MAX**	$C_{fig,w}$	0.40	
aerodynamic shape factor **MIN**	$C_{fig,l}$	-0.40	
aerodynamic shape factor **MAX**	$C_{fig,l}$	0.00	
Pressure **MIN (Windward Side)**	P	**-0.04**	**kPa**
Pressure **MAX (Windward Side)**	P	**0.06**	**kPa**
Pressure **MIN (Leeward Side)**	P	**-0.06**	**kPa**
Pressure **MAX (Leeward Side)**	P	**0.00**	**kPa**

4.1.1 Summary

WIND EXTERNAL PRESSURE	Direction1		Direction2	
	Min (Kpa)	Max (Kpa)	Min (Kpa)	Max (Kpa)
Windward	-0.041	0.061	-0.041	0.055
Leeward	-0.061	0.000	-0.055	0.000

4.2 Wind Load Diagrams

4.2.1 Wind Load Ultimate (W_{min}) _ Opened Condition

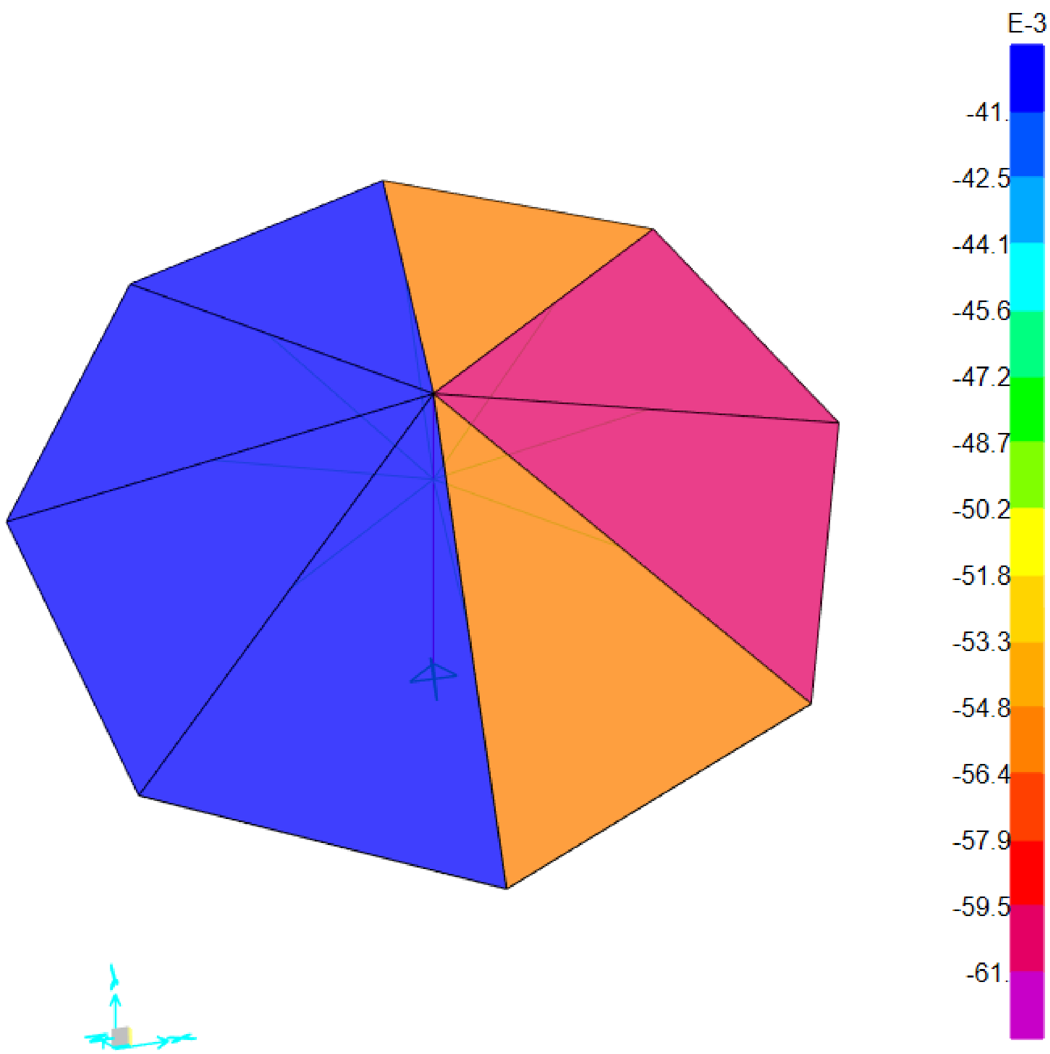


Figure 2 Wind Min

4.2.2 Wind Load Ultimate (W_{max}) _Opened Condition

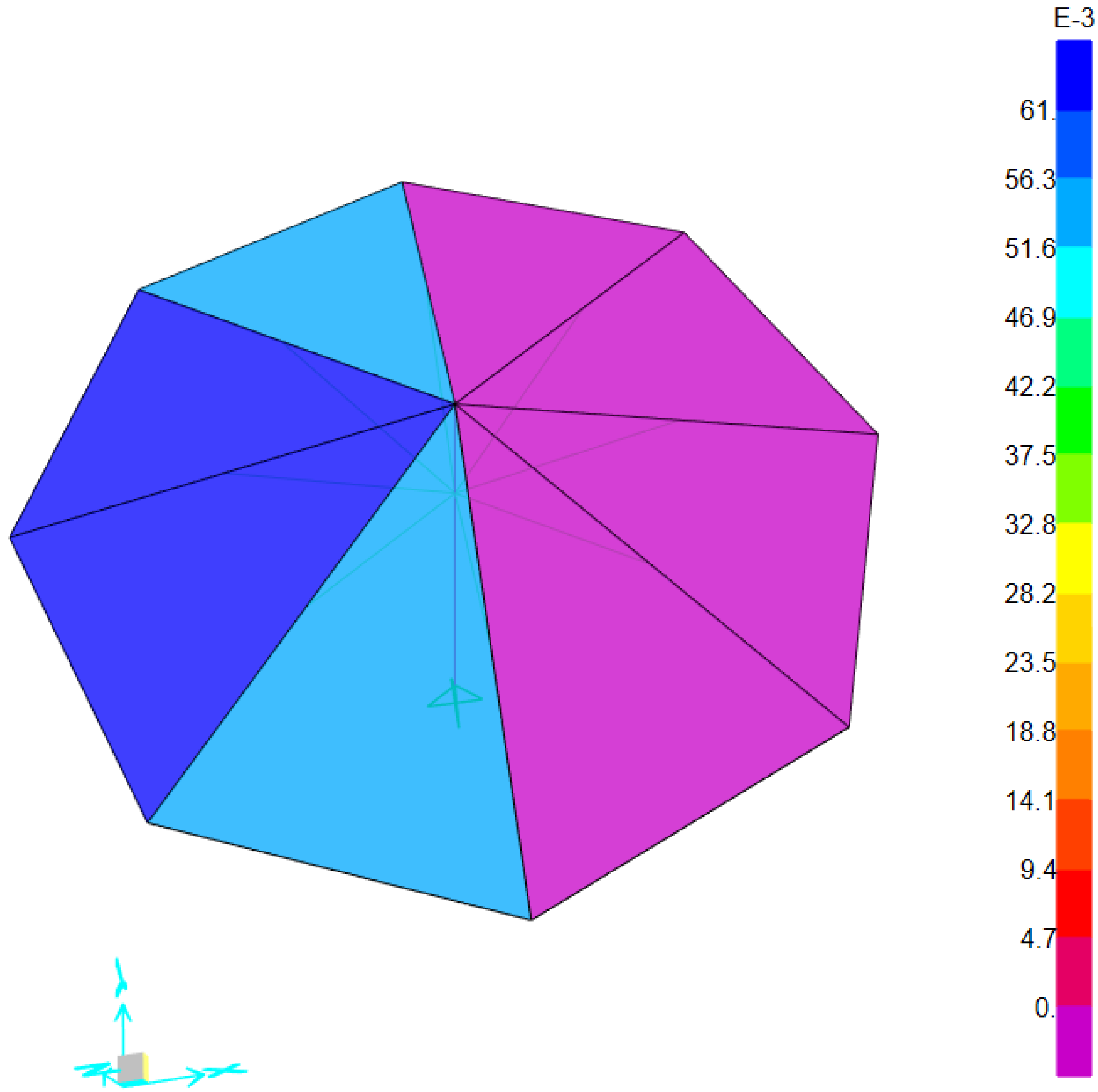


Figure 3 Wind Max

5 Analysis

5.1 Results

5.1.1 Maximum Bending Moment in Major Axis

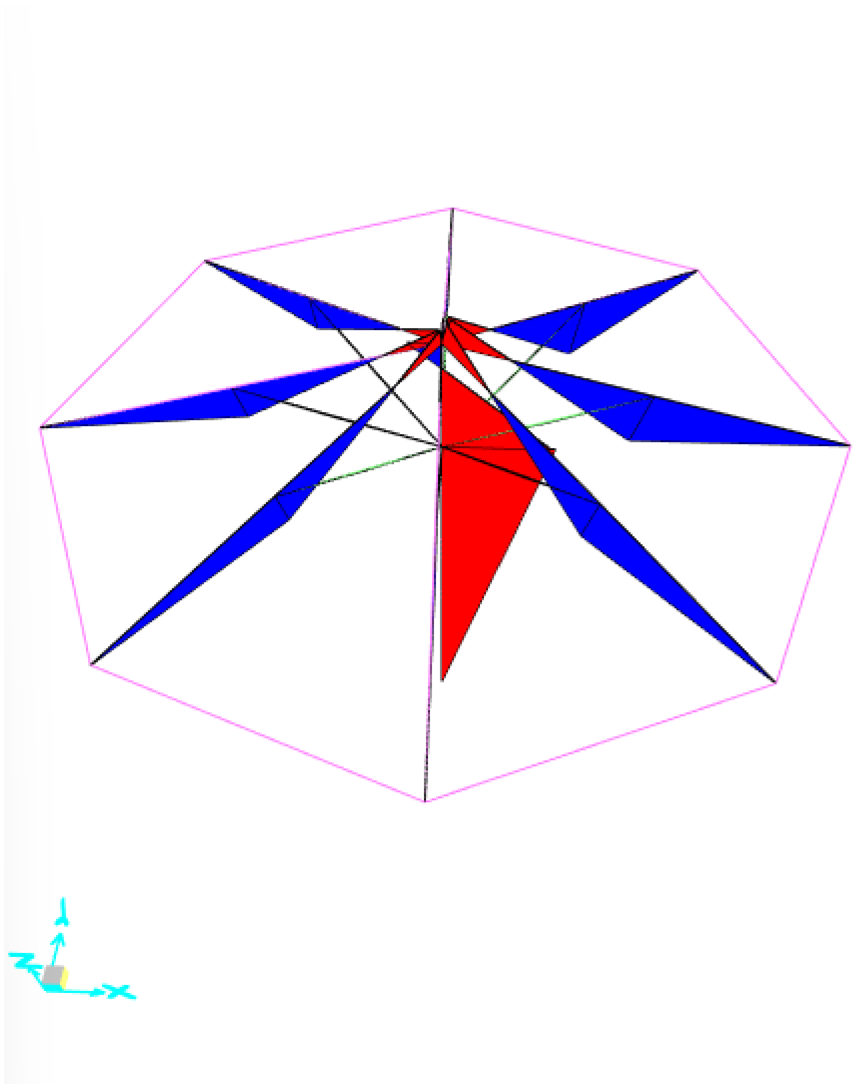


Figure 4 Maximum Bending Moment - Major

5.1.2 Maximum Bending Moment in Minor Axis

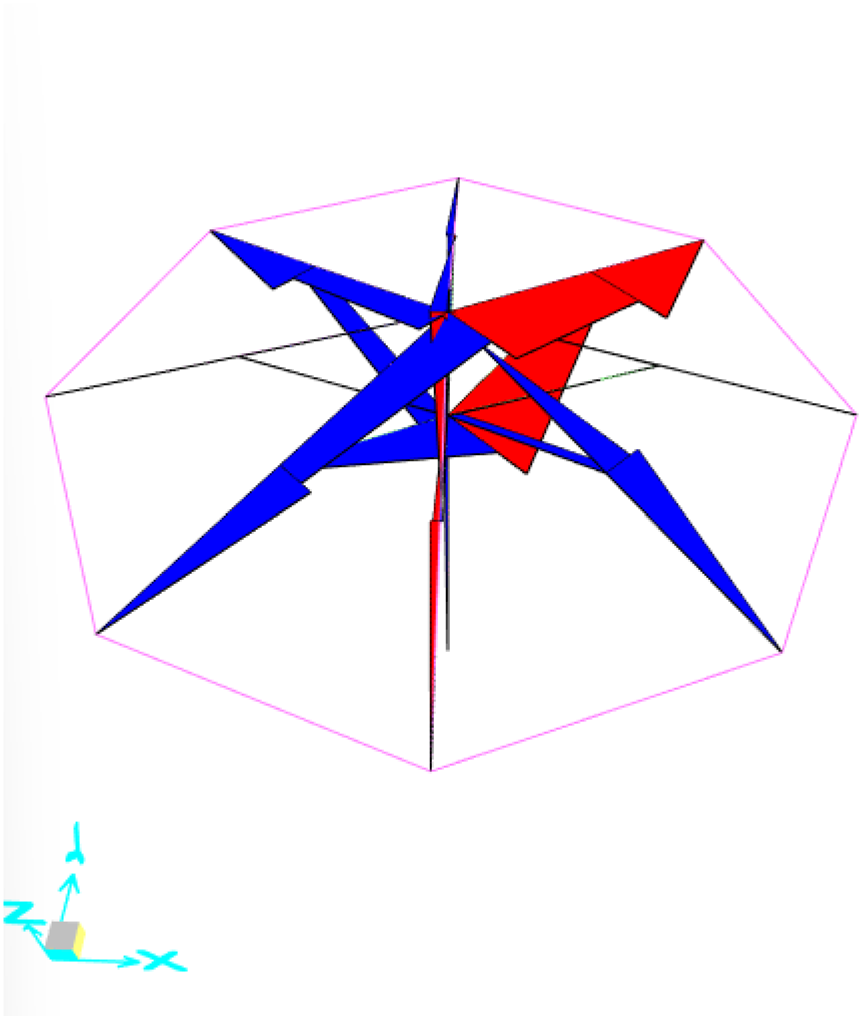


Figure 5: Maximum Bending Moment - Minor

5.1.3 Maximum Shear

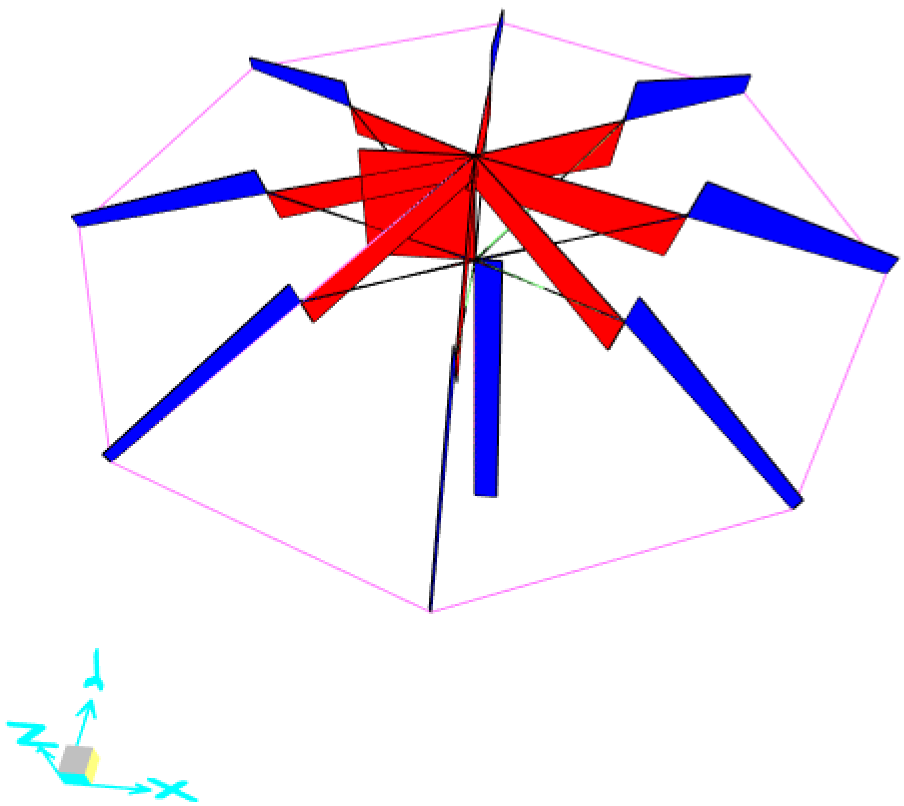


Figure 6 Maximum Shear

5.1.4 Maximum Axial Force

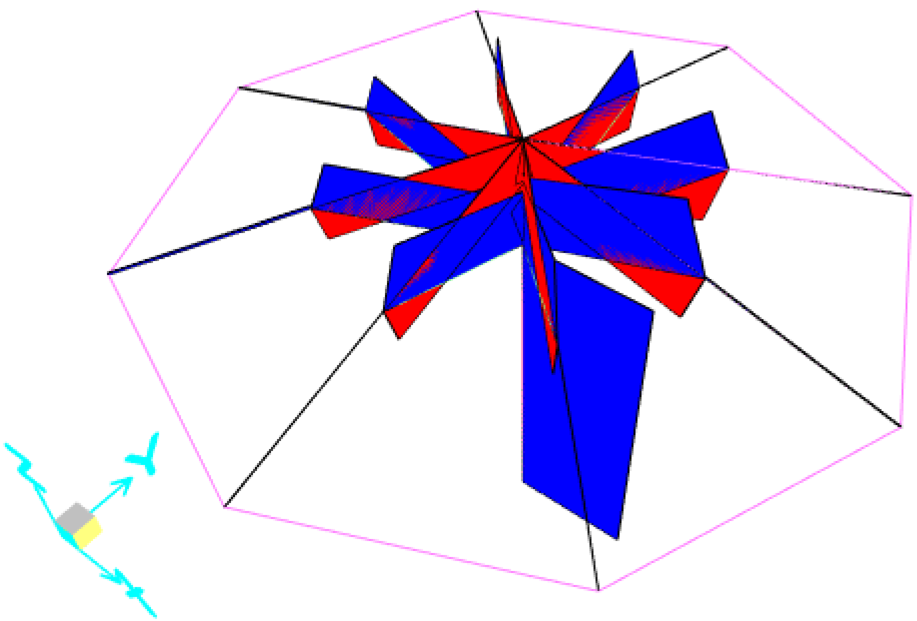


Figure 7 Maximum Axial Force

5.1.5 Maximum Reactions – Opened

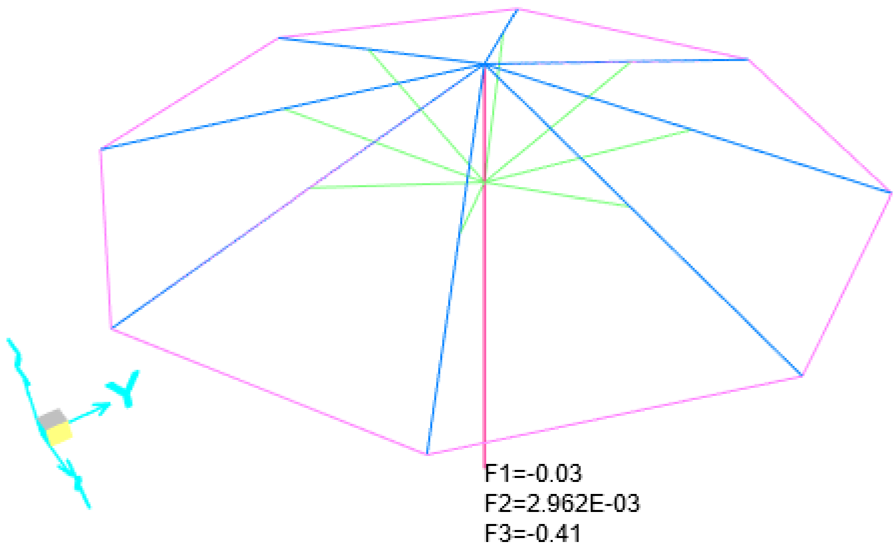


Figure 8 Maximum Reactions (opened)

$Fx = -0.11$ kN
$Fy = 0.01$ kN
$F_{z\ (up\ lift)} = 0.41$ kN
$F_{z\ (Bearing)} = 0.54$ kN

6 Aluminium Member Design

All Aluminium members passed. The summary results are tabulated below. Refer to Appendix 'A' for details.

MEMBER(S)	Section	d	t	Vx	Vy	P (Axial) Compression (-) Tension (+)	Mx	My
		mm	mm	kN	kN	kN	kN.m	kN.m
Main Pole	D50x2.8	50	2.8	0.111	-0.00964	-0.515	-0.2277	0.0198

MEMBER(S)	Section	b	d	t	Vx	Vy	P (Axial)	Mx	My
		mm	mm	mm	kN	kN	kN	kN.m	kN.m
Long Rib 1	17x32x1.8	17	32	1.8	-0.07	0.013	-0.007813	-0.0513	0.0129
Short Rib 1	17x32x1.8	17	32	1.8	-0.07	0.013	-0.007813	-0.0513	0.0129

6.1 Temporary Installation with 500 x 500x15 Base Plate

Umbrella Structure	Uplift Force (KN)	Self-Weight of the base plate(kg)	Additional weight to counteract Uplift (kg)
2.5m Dia	0.12	25	10
3m Dia	0.19	25	15
3.5m Dia	0.31	25	35
4m Dia	0.41	25	55

7 Summary and Recommendations

- The 2.5m, 3m, 3.5m and 4m Diameter Octagonal Premium Café SAVILLE Umbrella Structures as specified are capable of withstanding **60 m/s Wind Loads when open.**
- For forecast winds in excess of **60km/hr** the umbrella structure should be completely folded. The umbrella with temporary anchorage system must be stored in an enclosed building.

Yours faithfully,
Prime Consulting Engineers Pty. Ltd.
Bijaya Giri, MEng, MIEAust, CPEng, NER, APEC, IntPE (Aus), PE Vic

8 Appendix A – Aluminium Design Based on AS1664.1

8.1 Main Pole

PRIME CONSULTING ENGINEERS PTY. LTD

Job no. 24-954-5 **Date:** 31/07/2024

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
D50x2.8	**Main Pole**					
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	=	1.1			
FEM ANALYSIS RESULTS						
Axial force	P	=	0.515	kN	*compression*	
	P	=	0	kN	*Tension*	
In plane moment	M_x	=	0.2277	kNm		
Out of plane moment	M_y	=	0.0198	kNm		
DESIGN STRESSES						
Gross cross section area	A_g	**=**	415.19289	mm^2		
In-plane elastic section modulus	Z_x	**=**	4641.1921	mm^3		
Out-of-plane elastic section mod.	Z_y	**=**	4641.1921	mm^3		
Stress from axial force	$\mathbf{f_a}$	=	P/A_g			
		=	**1.24**	**MPa**	*compression*	
		=	**0.00**	**MPa**	*Tension*	

Stress from in-plane bending	**f_{bx}**	**=**	M_x/Z_x			
		=	**49.06**	**MPa**	*compression*	
Stress from out-of-plane bending	**f_{by}**	**=**	M_y/Z_y			
		=	**4.27**	**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	=	2700	mm		
Effective length factor	k	=	1.00			
Radius of gyration about buckling axis (Y)	r_y	=	16.72	mm		
Radius of gyration about buckling axis (X)	r_x	=	16.72	mm		
Slenderness ratio	kLb/ry	=	123.05			
Slenderness ratio	kL/rx	=	161.51			
Slenderness parameter	λ	=	3.017			
	D_c*	=	90.3			
	S_1*	=	0.62			
	S_2*	=	1.23			
	ϕ_{cc}	=	0.950			
Factored limit state stress	**ϕF_L**	**=**	**25.16**	**MPa**		
2. Sections not subject to torsional or torsional-flexural buckling						3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	**=**	161.51			
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	=	23.6			
	t	**=**	2.8	mm		
Slenderness	R_m/t	**=**	8.4285714			

Limit 1	S_1	=	0.50				
Limit 2	S_2	=	672.46				
Factored limit state stress	**ϕF_L**	=	**239.94**	**MPa**			
Most adverse compressive limit state stress	F_a	=	25.16	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	=	2057	mm			
Second moment of area (weak axis)	I_y	=	1.16E+05	mm^4			
Torsion modulus	J	=	2.32E+05	mm^3			
Elastic section modulus	Z	=	4641.1921	mm^3			
	R_b/t	=	8.43				
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	=	23.6	mm			
	t	=	2.8	mm			
Slenderness	R_b/t	=	8.4285714				
Limit 1	S_1	=	2.75				
Limit 2	S_2	=	78.23				
Factored limit state stress	**ϕF_L**	=	**226.37**	**MPa**			
Most adverse in-plane bending limit state stress	F_{bx}	=	226.37	MPa			

Most adverse in-plane bending capacity factor	f_{bx}/F_{bx}	=	0.22		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	$\boldsymbol{\phi F_L}$	=	**226.37**	**MPa**		
Most adverse out-of-plane bending limit state stress	$\boldsymbol{F_{by}}$	=	226.37	MPa		
Most adverse out-of-plane bending capacity factor	$\boldsymbol{f_{by}/F_{by}}$	=	0.02		PASS	
COMBINED ACTIONS						
4.1.1 *Combined compression and bending*						4.1.1
	F_a	=	25.16	MPa		3.4.11
	F_{ao}	=	239.94	MPa		3.4.11
	F_{bx}	=	226.37	MPa		3.4.18
	F_{by}	=	226.37	MPa		3.4.18
	f_a/F_a	=	0.049			
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					4.1.1
i.e.	0.28	$\leq$	1.0		PASS	
SHEAR						
3.4.24 *Shear in webs (Major Axis)*						3.4.24
	R	=	25	mm		
	t	=	2.8	mm		
Equivalent h/t	h/t	=	36.73			
Limit 1	S_1	=	29.01			
Limit 2	S_2	=	59.31			
Factored limit state stress	$\boldsymbol{\phi F_L}$	=	**123.28**	**MPa**		
Stress From Shear force	$\boldsymbol{f_{sx}}$	=	V/A_w			
			0.53	**MPa**		
3.4.25 *Shear in webs (Minor Axis)*						3.4.24
Clear web height	R	=	25	mm		
	t	=	2.8	mm		
Equivalent h/t	h/t	=	36.73			

Prime Consulting Engineers Pty. Ltd.
Email: info@primeengineers.com.au

Address: Level M 394 Lane Cove Rd
Macquarie Park NSW 2113
Phone: (02) 8964 1818

Factored limit state stress	ϕF_L	=	**123.28**	**MPa**		
Stress From Shear force	f_{sy}	=	V/A_w			
			0.05	**MPa**		
Most adverseshear capacity factor (Major Axis)	f_{sx}/F_{sx}	=	0.00	**MPa**		
Most adverseshear capacity factor (Minor Axis)	f_{sy}/F_{sy}	=	0.00	**Mpa**	PASS	
COMBINED ACTIONS						
***4.4** Combined Shear, Compresion and bending*						4.4
Check:	$f_a/F_a + f_b/F_b + (f_s/F_s)^2 \le 1.0$					
i.e.	0.27	≤	1.0		PASS	

8.2 Long Rib 1

Job no. 24-954-5 **Date:** 31/07/2024

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
17x32x1.8	**Long Rib 1**					
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			T3.4(B)

	k_c	=	1			
FEM ANALYSIS RESULTS						
Axial force	P	=	0.007813	kN	*compression*	
	P	=	0	kN	*Tension*	
In plane moment	M_x	=	0.0513	kNm		
Out of plane moment	M_y	=	0.0129	kNm		
DESIGN STRESSES						
Gross cross section area	A_g	**=**	163.44	mm^2		
In-plane elastic section modulus	Z_x	**=**	1302.6642	mm^3		
Out-of-plane elastic section mod.	Z_y	**=**	871.39849	mm^3		
Stress from axial force	$\mathbf{f_a}$	**=**	P/A_g			
		=	**0.05**	**MPa**	*compression*	
		=	**0.00**	**MPa**	*Tension*	
Stress from in-plane bending	$\mathbf{f_{bx}}$	**=**	M_x/Z_x			
		=	**39.38**	**MPa**	*compression*	
Stress from out-of-plane bending	$\mathbf{f_{by}}$	**=**	M_y/Z_y			
		=	**14.80**	**MPa**	*compression*	
Tension						
***3.4.3** Tension in rectangular tubes*						
	$\mathbf{\phi F_L}$	**=**	**228.95**	**MPa**		
		OR				
	$\mathbf{\phi F_L}$	**=**	**222.70**	**MPa**		
COMPRESSION						
***3.4.8** Compression in columns, axial, gross section*						
1. General						… 3.4.8.1
Unsupported length of member	L	=	2080	mm		
Effective length factor	k	=	1.00			
Radius of gyration about buckling axis (Y)	r_y	=	6.73	mm		
Radius of gyration about buckling axis (X)	r_x	=	11.29	mm		
Slenderness ratio	kLb/ry	=	154.49			
Slenderness ratio	kL/rx	=	184.19			
Slenderness parameter	λ	=	3.44			
	D_c*	=	90.3			
	S_1*	=	0.33			

	S_2*	=	1.23			
	ϕ_{cc}	=	0.950			
Factored limit state stress	ϕF_L	**=**	**19.35**	**MPa**		
2. Sections not subject to torsional or torsional-flexural buckling						… 3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	184.19			
***3.4.10** 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'	=	13.4			
	t	=	1.8	mm		
Slenderness	b/t	=	7.4444444			
Limit 1	S_1	=	12.34			
Limit 2	S_2	=	32.87			
Factored limit state stress	ϕF_L	**=**	**228.95**	**MPa**		
Most adverse compressive limit state stress	F_a	=	19.35	MPa		
Most adverse tensile limit state stress	F_a	=	222.70	MPa		
Most adverse compressive & Tensile capacity factor	f_a/F_a	=	0.00		PASS	
BENDING - IN-PLANE						
***3.4.15** Compression in beams, extreme fibre, gross section rectangular tubes, box sections*						
Unbraced length for bending	L_b	=	1040	mm		
Second moment of area (weak axis)	I_y	=	7.41E+03	mm^4		
Torsion modulus	J	=	1.67E+04	mm^3		
Elastic section modulus	Z	=	1302.6642	mm^3		
Slenderness	S	=	243.56			
Limit 1	S_1	=	0.39			
Limit 2	S_2	=	1695.86			

Factored limit state stress	**ϕF_L**	=	**194.59**	**MPa**		… 3.4.15(2)
***3.4.17** 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'	=	13.4	mm		
	t	=	1.8	mm		
Slenderness	b/t	=	7.444444 4			
Limit 1	S_1	=	12.34			
Limit 2	S_2	=	46.95			
Factored limit state stress	**ϕF_L**	=	**228.95**	**MPa**		
Most adverse in-plane bending limit state stress	F_{bx}	=	194.59	MPa		
Most adverse in-plane bending capacity factor	f_{bx}/F_{bx}	=	0.20		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**	=	**194.59**	**MPa**		
Most adverse out-of-plane bending limit state stress	**F_{by}**	=	194.59	MPa		
Most adverse out-of-plane bending capacity factor	**f_{by}/F_{by}**	=	0.08		PASS	
COMBINED ACTIONS						
***4.1.1** Combined compression and bending*						… 4.1.1(2)
	F_a	=	19.35	MPa		… 3.4.8
	F_{ao}	=	228.95	MPa		… 3.4.10
	F_{bx}	=	194.59	MPa		… 3.4.17
	F_{by}	=	194.59	MPa		… 3.4.17
	f_a/F_a	=	0.002			
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					… 4.1.1 (3)

i.e.	0.28	≤	1.0		PASS	
SHEAR						
***3.4.24** Shear in webs (Major Axis)*						… 4.1.1(2)
Clear web height	h	=	28.4	mm		
	t	=	1.8	mm		
Slenderness	h/t	=	15.777778			
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			
			0.54	**MPa**		
***3.4.25** Shear in webs (Minor Axis)*						
Clear web height	b	=	13.4	mm		
	t	=	1.8	mm		
Slenderness	b/t	=	7.4444444			
Factored limit state stress	**ϕF_L**	=	**131.10**	**MPa**		
Stress From Shear force	**f_{sy}**	=	V/A_w			
			0.10	**MPa**		
Most adverseshear capacity factor (Major Axis)	f_{sx}/F_{sx}	=	0.00	**MPa**		
Most adverseshear capacity factor (Minor Axis)	f_{sy}/F_{sy}	=	0.00	**Mpa**	PASS	
COMBINED ACTIONS						
***4.4** Combined Shear, Compresion and bending*						
Check:	$f_a/F_a + f_b/F_b + (f_s/F_s)^2 \leq 1.0$					
i.e.	0.20	≤	1.0		PASS	

8.3 Short Rib 1

PRIME CONSULTING ENGINEERS PTY. LTD

Job no. 24-954-5 **Date:** 31/07/2024

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
17x32x1.8	**Short Rib 1**					
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			T3.4(B)
	k_c	=	1			
FEM ANALYSIS RESULTS						
Axial force	P	=	0.007813	kN	*compression*	
	P	=	0	kN	*Tension*	
In plane moment	M_x	=	0.0513	kNm		
Out of plane moment	M_y	=	0.0129	kNm		
DESIGN STRESSES						
Gross cross section area	A_g	**=**	163.44	mm^2		
In-plane elastic section modulus	Z_x	**=**	1302.6642	mm^3		
Out-of-plane elastic section mod.	Z_y	**=**	871.39849	mm^3		
Stress from axial force	$\mathbf{f_a}$	**=**	P/A_g			
		=	**0.05**	**MPa**	*compression*	
		=	**0.00**	**MPa**	*Tension*	
Stress from in-plane bending	$\mathbf{f_{bx}}$	**=**	M_x/Z_x			

		=	**39.38**	**MPa**	*compression*	
Stress from out-of-plane bending	**f_{by}**	=	M_y/Z_y			
		=	**14.80**	**MPa**	*compression*	
Tension						
***3.4.3** Tension in rectangular tubes*						
	ϕF_L	=	**228.95**	**MPa**		
		OR				
	ϕF_L	=	**222.70**	**MPa**		
COMPRESSION						
***3.4.8** Compression in columns, axial, gross section*						
1. General						… 3.4.8.1
Unsupported length of member	L	=	1060	mm		
Effective length factor	k	=	1.00			
Radius of gyration about buckling axis (Y)	r_y	=	6.73	mm		
Radius of gyration about buckling axis (X)	r_x	=	11.29	mm		
Slenderness ratio	kLb/ry	=	157.46			
Slenderness ratio	kL/rx	=	93.87			
Slenderness parameter	λ	=	2.94			
	D_c*	=	90.3			
	S_1*	=	0.33			
	S_2*	=	1.23			
	ϕ_{cc}	=	0.950			
Factored limit state stress	**ϕF_L**	=	**26.47**	**MPa**		
2. Sections not subject to torsional or torsional-flexural buckling						… 3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	157.46			
***3.4.10** 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'	=	13.4			
	t	=	1.8	mm		
Slenderness	b/t	=	7.4444444			

Limit 1	S_1	=	12.34			
Limit 2	S_2	=	32.87			
Factored limit state stress	**ϕF_L**	=	**228.95**	**MPa**		
Most adverse compressive limit state stress	F_a	=	26.47	MPa		
Most adverse tensile limit state stress	F_a	=	222.70	MPa		
Most adverse compressive & Tensile capacity factor	f_a/F_a	=	0.00		PASS	
BENDING - IN-PLANE						
3.4.15 *Compression in beams, extreme fibre, gross section rectangular tubes, box sections*						
Unbraced length for bending	L_b	=	1060	mm		
Second moment of area (weak axis)	I_y	=	7406.8872	mm^4		
Torsion modulus	J	=	16708.894	mm^3		
Elastic section modulus	Z	=	1302.6642	mm^3		
Slenderness	S	=	248.24			
Limit 1	S_1	=	0.39			
Limit 2	S_2	=	1695.86			
Factored limit state stress	**ϕF_L**	=	**194.25**	**MPa**		... 3.4.15(2)
3.4.17 *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'	=	13.4	mm		
	t	=	1.8	mm		
Slenderness	b/t	=	7.4444444			
Limit 1	S_1	=	12.34			
Limit 2	S_2	=	46.95			
Factored limit state stress	**ϕF_L**	=	**228.95**	**MPa**		

Most adverse in-plane bending limit state stress	F_{bx}	=	194.25	MPa		
Most adverse in-plane bending capacity factor	f_{bx}/F_{bx}	=	0.20		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	$\boldsymbol{\phi F_L}$	=	**194.25**	**MPa**		
Most adverse out-of-plane bending limit state stress	$\mathbf{F_{by}}$	=	194.25	MPa		
Most adverse out-of-plane bending capacity factor	$\mathbf{f_{by}/F_{by}}$	=	0.08		PASS	
COMBINED ACTIONS						
4.1.1 *Combined compression and bending*						… 4.1.1(2)
	F_a	=	26.47	MPa		… 3.4.8
	F_{ao}	=	228.95	MPa		… 3.4.10
	F_{bx}	=	194.25	MPa		… 3.4.17
	F_{by}	=	194.25	MPa		… 3.4.17
	f_a/F_a	=	0.002			
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					… 4.1.1 (3)
i.e.	0.28	$\leq$	1.0		PASS	
SHEAR						
3.4.24 *Shear in webs (Major Axis)*						… 4.1.1(2)
Clear web height	h	=	28.4	mm		
	t	=	1.8	mm		
Slenderness	h/t	=	15.777778			
Limit 1	S_1	=	29.01			
Limit 2	S_2	=	59.31			
Factored limit state stress	$\boldsymbol{\phi F_L}$	=	**131.10**	**MPa**		
Stress From Shear force	$\mathbf{f_{sx}}$	=	V/A_w			
			0.54	**MPa**		
3.4.25 *Shear in webs (Minor Axis)*						

Clear web height	b	=	13.4	mm	
	t	=	1.8	mm	
Slenderness	b/t	=	7.4444444		
Factored limit state stress	**ϕF_L**	=	**131.10**	**MPa**	
Stress From Shear force	**f_{sy}**	=	V/A_w		
			0.10	**MPa**	
Most adverseshear capacity factor (Major Axis)	f_{sx}/F_{sx}	=	0.00	**MPa**	
Most adverseshear capacity factor (Minor Axis)	f_{sy}/F_{sy}	=	0.00	**Mpa**	PASS

COMBINED ACTIONS

***4.4** Combined Shear, Compresion and bending*

Check: $f_a/F_a + f_b/F_b + (f_s/F_s)^2 \leq 1.0$

i.e. 0.20 ≤ 1.0 PASS

9 Appendix B – Technical Data Sheet

FLARE SHADE | EXTREME MARQUEES

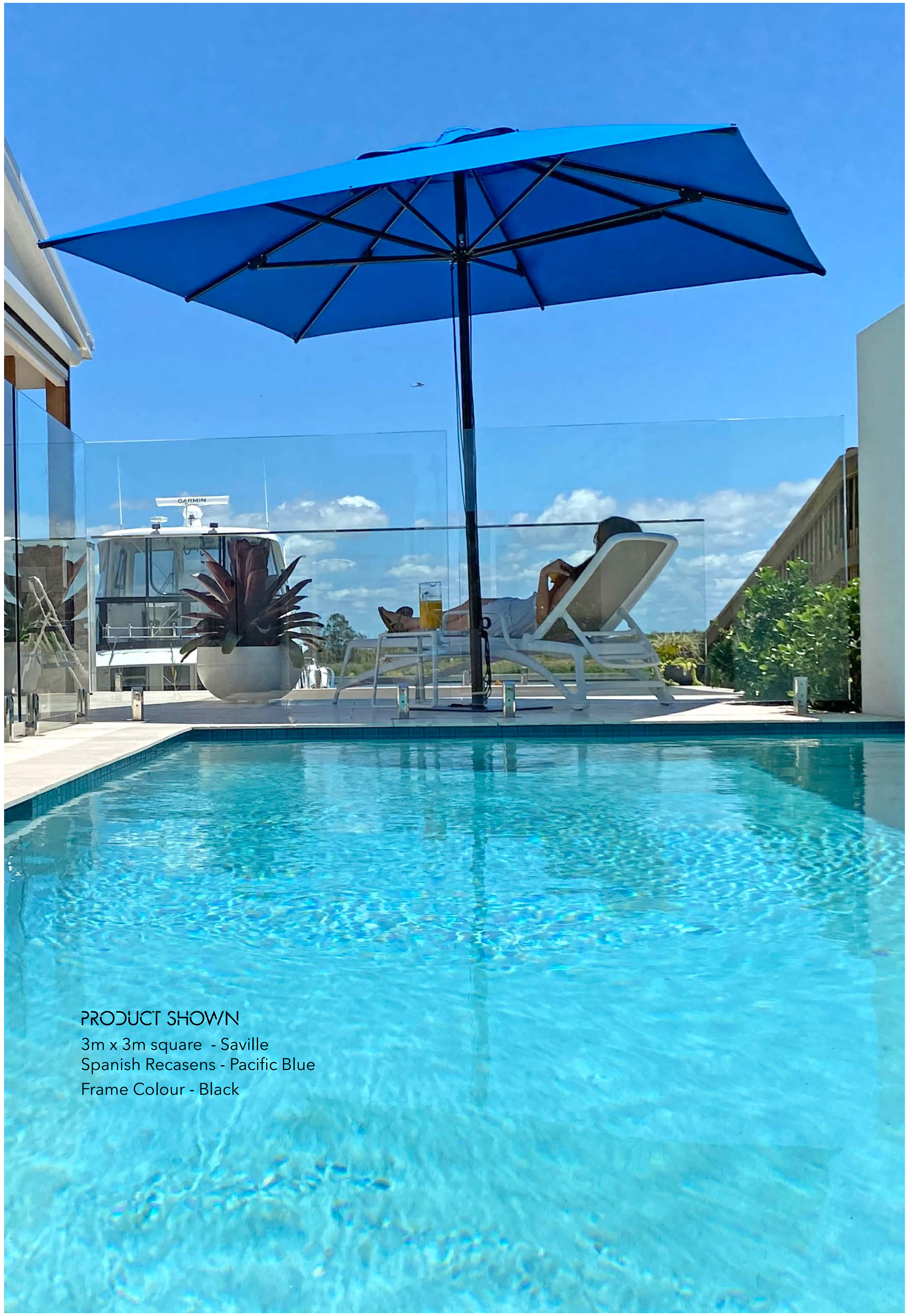
PREMIUM CAFE

SAVILLE

Premium Shade Solutions

PRODUCT SHOWN
3m x 3m square - Saville
Spanish Recasens - Sunflower
Frame Colour - Black


FLARESHADE



PRODUCT SHOWN
3m x 3m square - Saville
Spanish Recasens - Pacific Blue
Frame Colour - Black

PREMIUM SAVILLE RANGE

The Premium range features a heavy duty, 30 sided, 50mm x 2mm main umbrella pole, laser engraved, solid aluminium forged centre hubs, an easy glide pulley lift system and most importantly, fabric imported from Recasens who are located in Spain and have been manufacturing high quality fabric since 1886.

Specifications

Square
2m x 2m | 2.5m x 2.5m | 3m x 3m

Octagonal
2.5m | 3m | 3.5m | 4m diameter

Specifications - Square

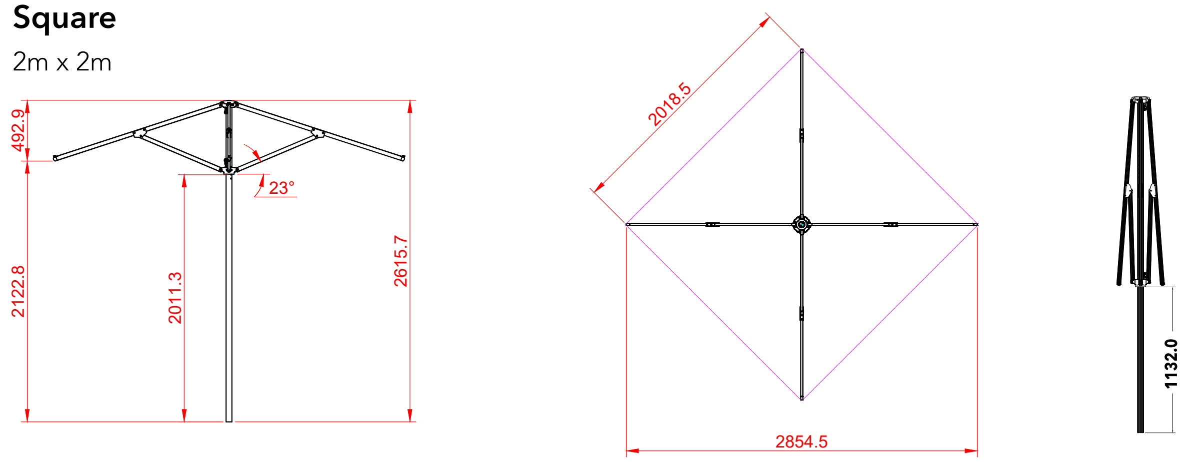
Size	2m x 2m	2.5m x 2.5m	3m x 3m
Canopy Span	2m x 2m	2.5m x 2.5m	3m x 3m
Height	2.7m		
Clearance	2.1m		
Fabric Weight	2.5kg	2.8kg	3.2kg
Frame Weight	10kg	11kg	12kg
Frame Box Dimensions	30 x 30 x 262cm		
Main Profile Dia.	50mm diameter x 2.8mm thick		
Framework	Aluminium (Black or Silver)		
Pole Connectors	Extruded Aluminium		
Lifting	4x Pulley System		
Fabric	Spanish Recasens		
Printing	UV Digital Print Screen Printing (4 colours)		
Manufacturer's Warranty	Frame 3 Years Recasens Fabric: 5 Years Printed Fabric: 2 Years		
Weight Plates	Optional accessory		

PREMIUM SAVILLE RANGE   FLARE SHADE   EXTREME MARQUEES

Technical information

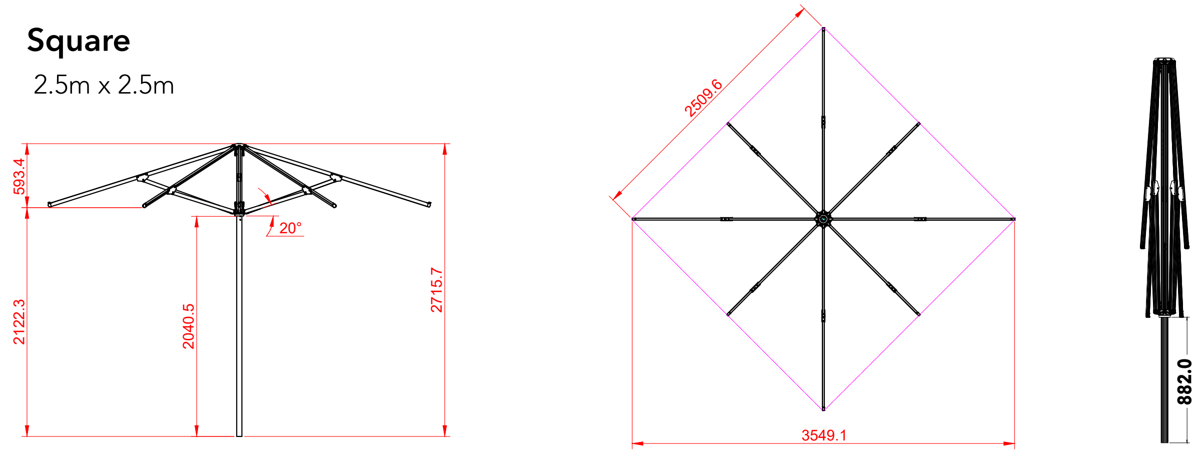
Square

2m x 2m



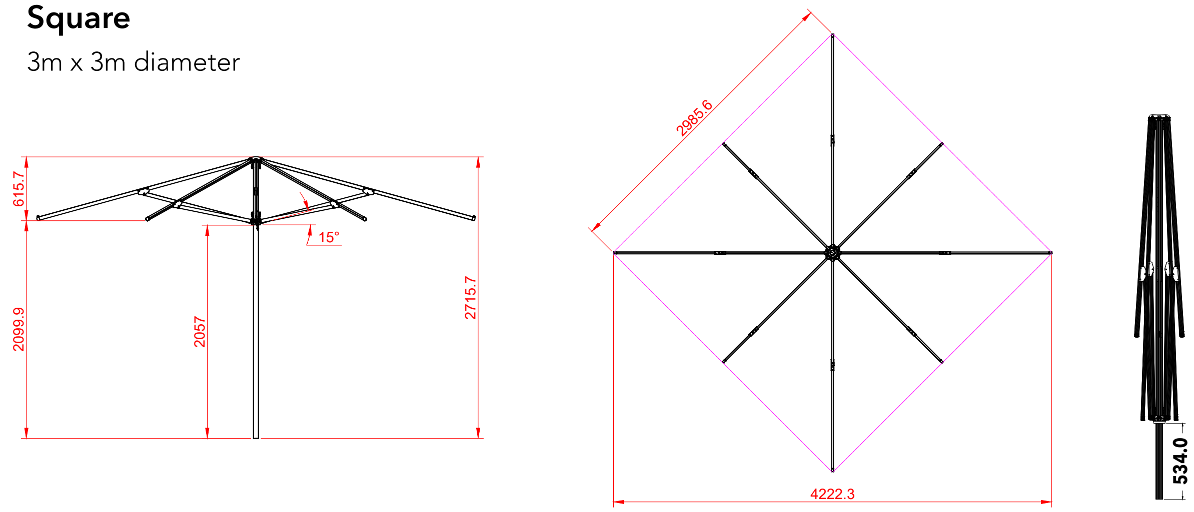
Square

2.5m x 2.5m



Square

3m x 3m diameter



Specifications - Octagonal

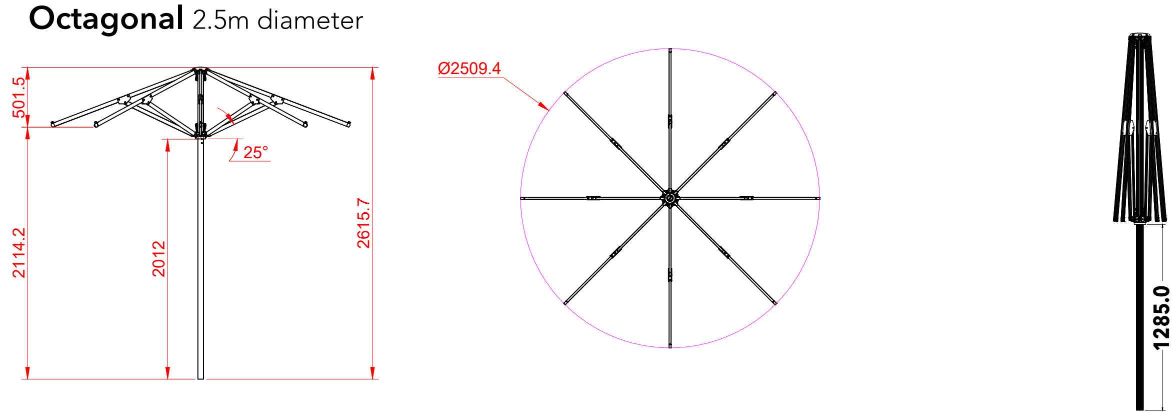
Size	2.5m dia	3m dia.	3.5m dia.	4m dia.
Canopy Diameter	2.5m	3m	3.5m	4m
Height	2.6m		2.7m	
Clearance	2.1m			
Fabric Weight	3kg	3kg	3kg	3.5kg
Frame Weight	11kg	11kg	12kg	13kg
Frame Box Dimensions	30 x 30 x 262cm			
Main Profile Dia.	50mm diameter x 2.8mm thick			
Framework	Aluminium (Black or Silver)			
Pole Connectors	Extruded Aluminium			
Lifting	4x Pulley System			
Fabric	Spanish Recasens			
Printing	UV Digital Print Screen Printing (4 colours)			
Manufacturer's Warranty	Frame 3 Years Recasens Fabric: 5 Years Printed Fabric: 2 Years			
Weight Plates	Optional accessory			

PREMIUM SAVILLE RANGE

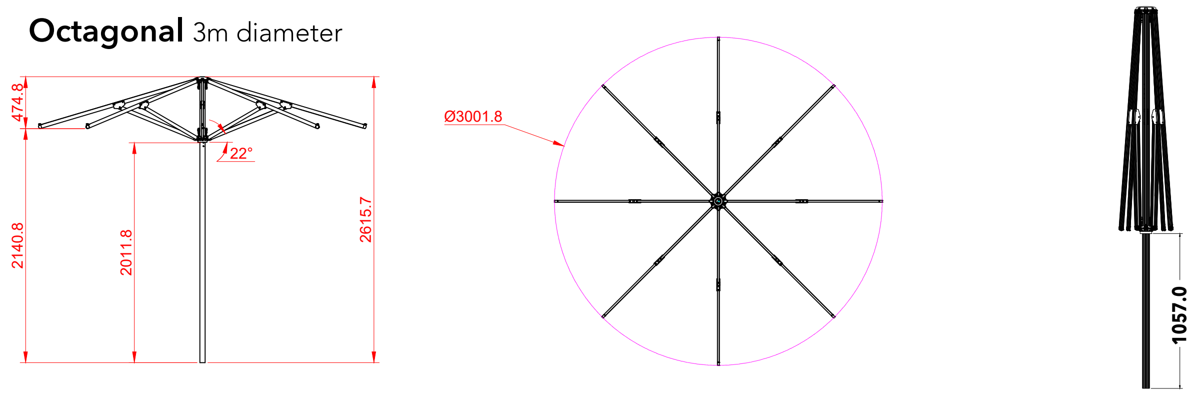
FLARE SHADE | EXTREME MARQUEES

Technical information

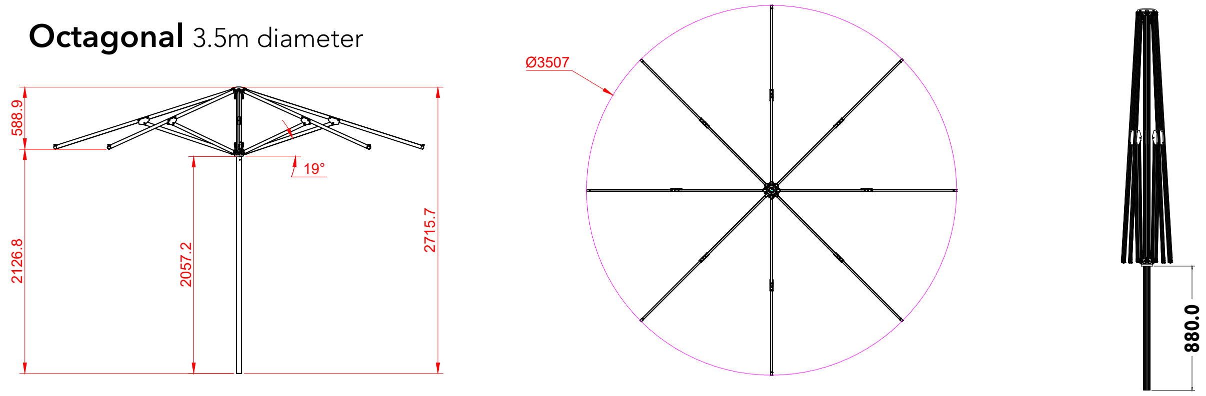
Octagonal 2.5m diameter



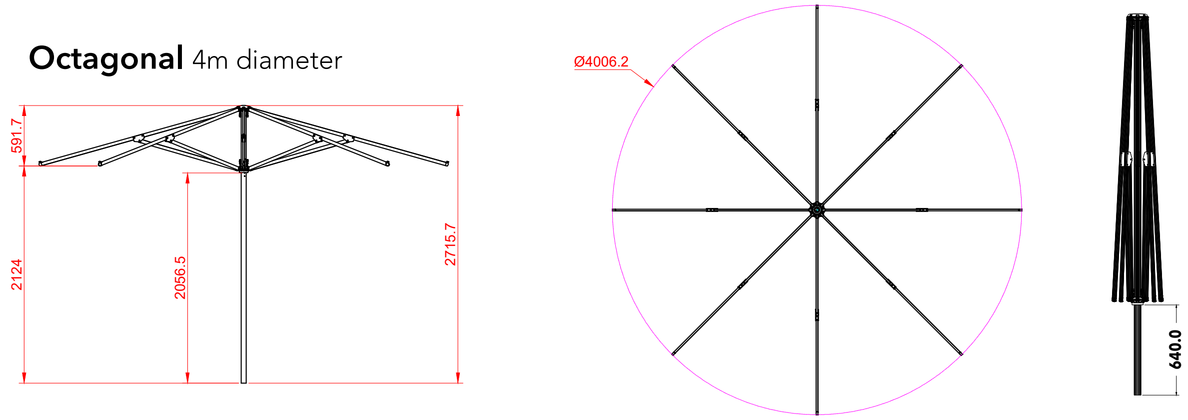
Octagonal 3m diameter



Octagonal 3.5m diameter



Octagonal 4m diameter



Fabric Colours

Spanish Recasens
The fabric is a high-performance solution-dyed and fade resistant canvas that has been optimized for high tensile and tear strength. The Recasens brand has been manufacturing high quality fabrics in Spain since 1886

Navy R175	**Burgundy** R177	**Yellow** R554	**Red Stripe** R012
Pacific R172	**Red** R176	**Toast** R100	**Orange Stripe** R005
Capiri R171	**Coral** R105	**Linen** R126	**Yellow Stripe** R055
Turquoise R171	**Terracotta** R104	**Grey** R138	**Blue Stripe** R106
Pistachio R160	**Brown** R156	**Charcoal** R164	**Turquoise Stripe** R011
Forest R102	**Orange** R567	**Black** R103	**Black Stripe** R017

Frame Colour

Silver or black

Printing

UV Printing
UV printing is a form of digital printing that uses ultra-violet lights to dry or cure ink as it is printed. As the printer distributes ink on the surface of the marquee fabric, specially designed UV lights follow close behind, "curing" or "drying" the ink instantly.

The benefits of UV printing are that it is very resistant to fading. With UV printing there is also no restrictions to the number of colours or logos on the design. UV printing is done on our heavy duty 900D PU Coated Polyester Fabric.

Screen Printing
Screen Printing is the process whereby ink is forced onto the fabric through a mesh screen. Screen printing is ideal for simple designs that are produced in higher quantities.

Ground Fixings

Square Base Plate
Size – 500mm (W) x 500mm (L) x 10mm (H)
Weight - 12.5kg
Sold seperatley, available for all sizes

Square Base Plate
Size – 500mm (W) x 500mm (L) x 15mm (H)
Weight - 25kg
Sold seperatley, available for all sizes

Square Weight Plate
Size – 500mm (W) x 500mm (L) x 30mm (H)
Weight - 12.5kg
Sold seperatley, available for all sizes

Instructions

PDF
Saville

https://www.extreme-marquees.com.au/pdf/Umbrellas/Manuals/Premium-Cafe-Saville-Instructions.pdf

Video
https://vimeo.com/722752025

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