Prime Consulting Engineers Pty. Ltd.

Design Report:

4m x 4m, 4m x 5m & 5m x 5m

Square Umbrella Structures

For

60km/hr Wind speed

For

EXTREME MARQUEES

Ref: R-23-696

Date: 17/11/2023

Amendment: -

Prepared by: AK

Checked by: KZ

Email: info@primeengineers.com.au
Web: www.primeengineers.com.au
Address: Level M/394 Lane Cove Rd, Macquarie Park
Phone: (02) 8964 1818

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 5m x 5m Square Umbrella Structures for **60km/hr** wind speed. 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 on 5m x 5m Square 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

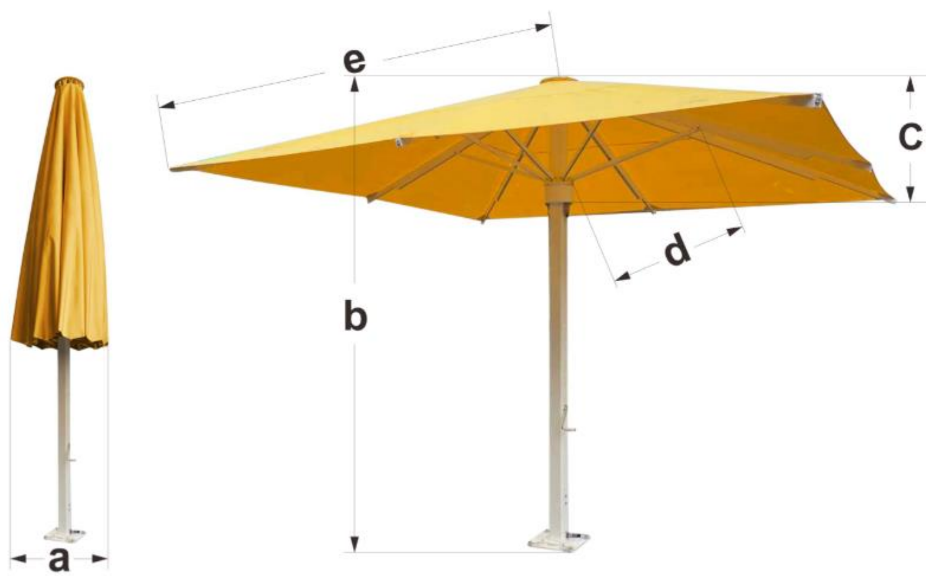
- The documents referred to in this report are as follows:
  - Report on results produced through SAP2000 V24 software & excel spreadsheets.
- The basic standards used in this report are as follows:
  - AS 1170.0:2002 – Structural Design Actions (Part 0: General principles)
  - AS 1170.1:2002 – Structural 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



	RD				SQ		
	Φ4m	Φ5m	Φ6m	Φ7m	4X4m	4x5m	5x5m
a	50	50	50	50	50	50	50
b	4350	4350	4350	4350	4350	4350	4350
c	1100	1100	1100	1100	1100	1100	1100
d	880	976	1190	1548	2815	3180	3490
e	1990	2505	2980	3500	2030	2030/2500	2620

Figure 1 Data sheet

2.2 Assumptions & Limitations

- For forecast winds in excess of **60km/hr,** the umbrella structure should be folded.
- 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 490gr/m^2.
- Aluminium alloy is to be 6061-T6.

2.3 Exclusions

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

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)

1.1.1 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

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	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*	*mm^2*	*mm^3*	*mm^3*	*mm^3*	*mm^3*	*mm^4*	*mm^4*	*mm^4*	*mm*	*mm*
Pole	105x105x3.9	105	105	3.9	52.5	1577.2	51252.3	51252.3	59823.7	59823.7	2690745.4	2690745.4	4030120.9	41.3	41.3
Long Rib1	40x20x2+ 35x30x3	20	75	2	37.5	364.0	5035.0	3578.6	7191.7	4786.3	180869.7	62626.1	38065.7	20.4	12.0
Long Rib2	40x20x2+ 35x30x3	20	75	2	37.5	364.0	5035.0	3578.6	7191.7	4786.3	180869.7	62626.1	38065.7	20.4	12.0
Short Rib 1	30X20X2	20	30	2	15.0	184.0	1437.7	1112.5	1796.0	1336.0	21565.3	11125.3	22088.3	10.8	7.8
Short Rib 2	30X20X2	20	30	2	15.0	184.0	1437.7	1112.5	1796.0	1336.0	21565.3	11125.3	22088.3	10.8	7.8

4 Wind Analysis

4.1 Wind calculations

PRIME CONSULTING ENGINEERS PTY. LTD.

Project: EXTREME MARUQEES

Job no. 23-696 ***Designer:*** AK

Date: 16/11/2023 ***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	24	Deg		
Pitch	α	-	rad		
Width	B	5	m		
Length	D	5	m		
Height	Z	3.8	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	*$p=0.5\rho_{air}*(V_{des,\beta})^2*C_{fig}*C_{dyn}$*	*2.4 (AS1170.2)*
WIND DIRECTION 1 (θ=0)					
External Pressure					
1. Free Roof				*α=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**	$C_{P,w}$	0.64			
External Pressure Coefficient **MIN**	$C_{P,l}$	-0.62			
External Pressure Coefficient **MAX**	$C_{P,l}$	0			
aerodynamic shape factor **MIN**	$C_{fig,w}$	-0.30			
aerodynamic shape factor **MAX**	$C_{fig,w}$	0.64			
aerodynamic shape factor **MIN**	$C_{fig,l}$	-0.62			
aerodynamic shape factor **MAX**	$C_{fig,l}$	0.00			
Pressure Windward **MIN**	P	**-0.04**	**kPa**		
Pressure Windward **MAX**	P	**0.09**	**kPa**		
Pressure Leeward **MIN**	P	**-0.09**	**kPa**		
Pressure Leeward **MAX**	P	**0.00**	**kPa**		
WIND DIRECTION 2 (θ=90)					
External Pressure					
4. Free Roof				*α=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	0.088	-0.041	0.055
Leeward	-0.086	0.000	-0.055	0.000

4.2 Wind Load Diagrams

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

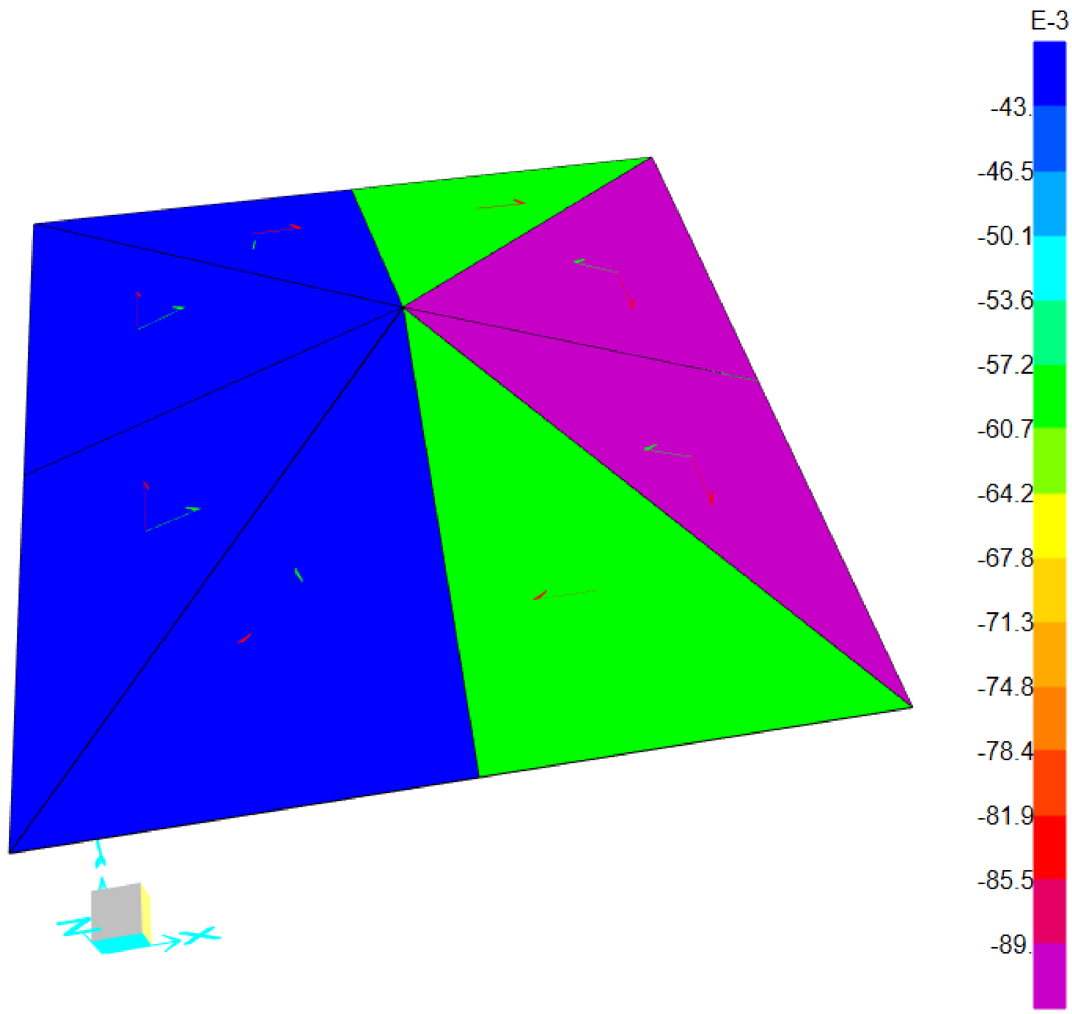


Figure 2 Wind Min

4.2.2 Wind Load Ultimate (W_{max}) _ Opened Condition

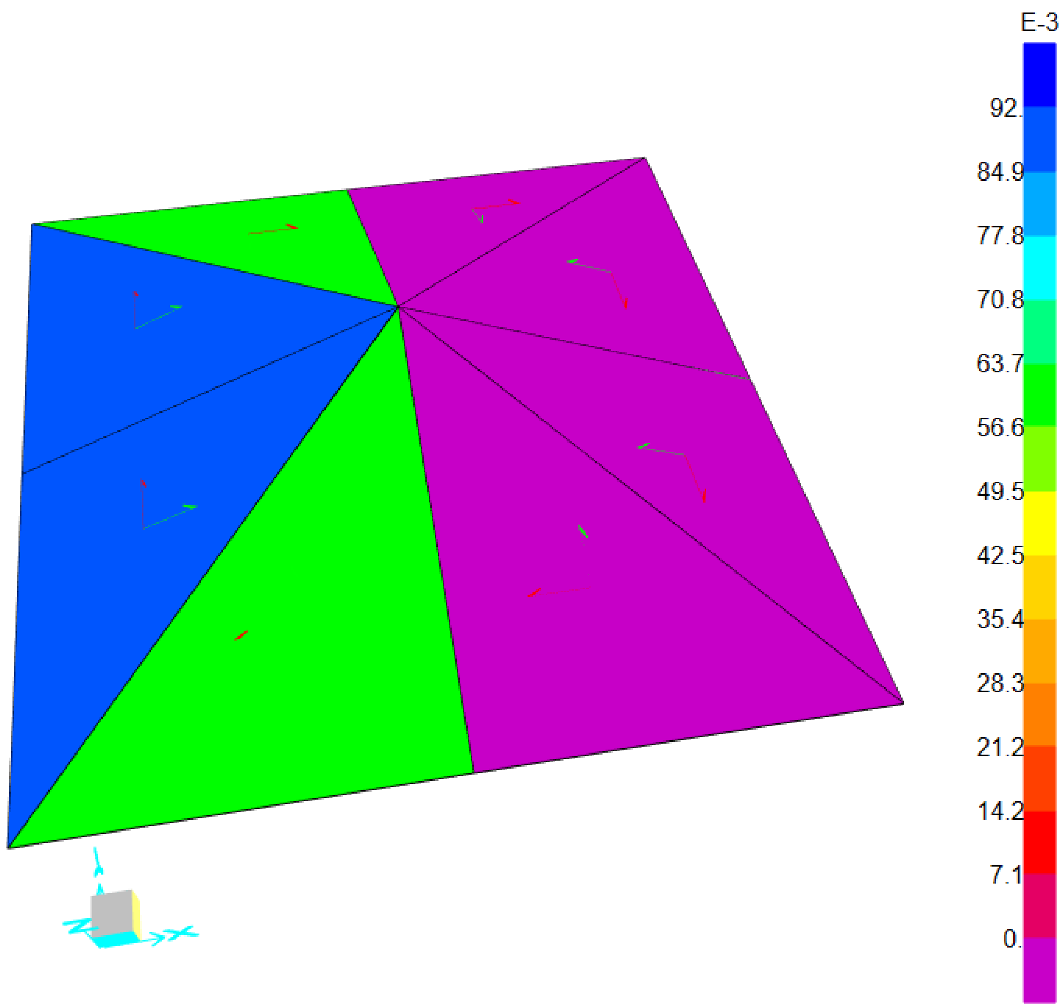


Figure 3 Wind Max

4.2.3 Wind Load – Closed Condition

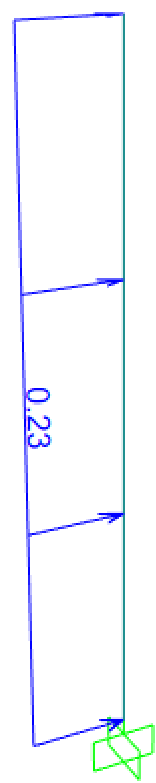


Figure 4 Wind_Closed

5 Analysis

5.1 Results

5.1.1 Maximum Bending Moment in Major Axis

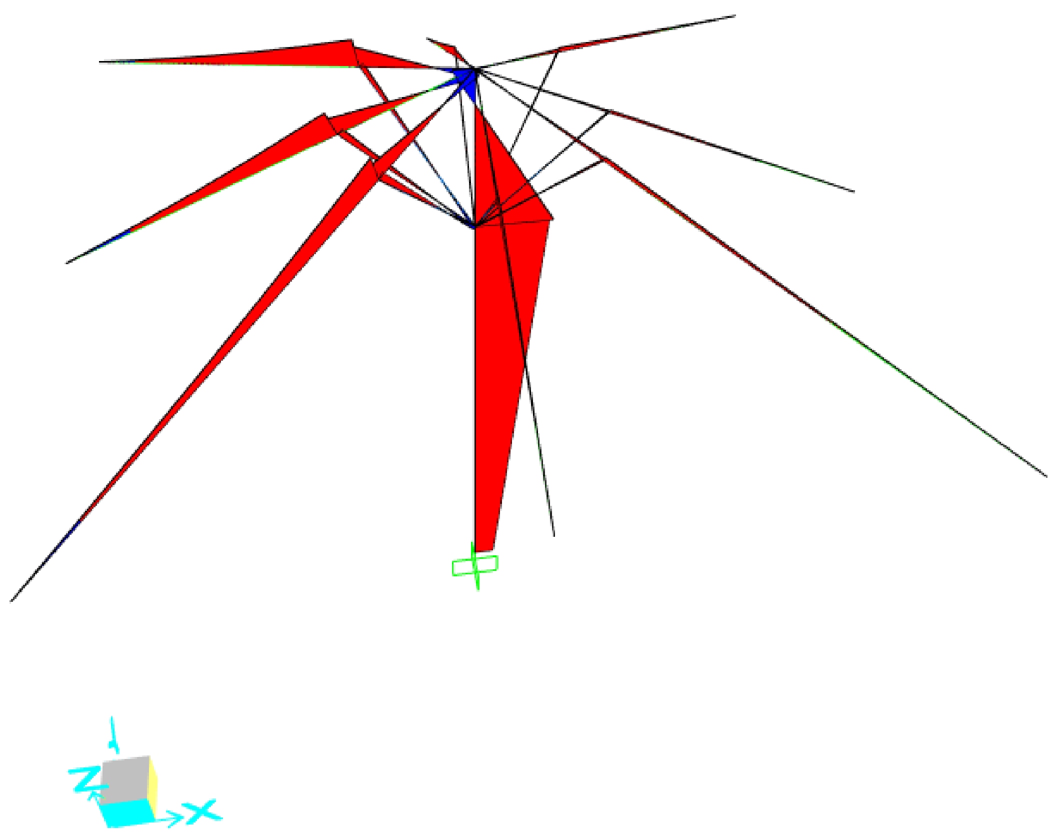


Figure 5 Maximum Bending Moment - Major

5.1.2 Maximum Bending Moment in Minor Axis

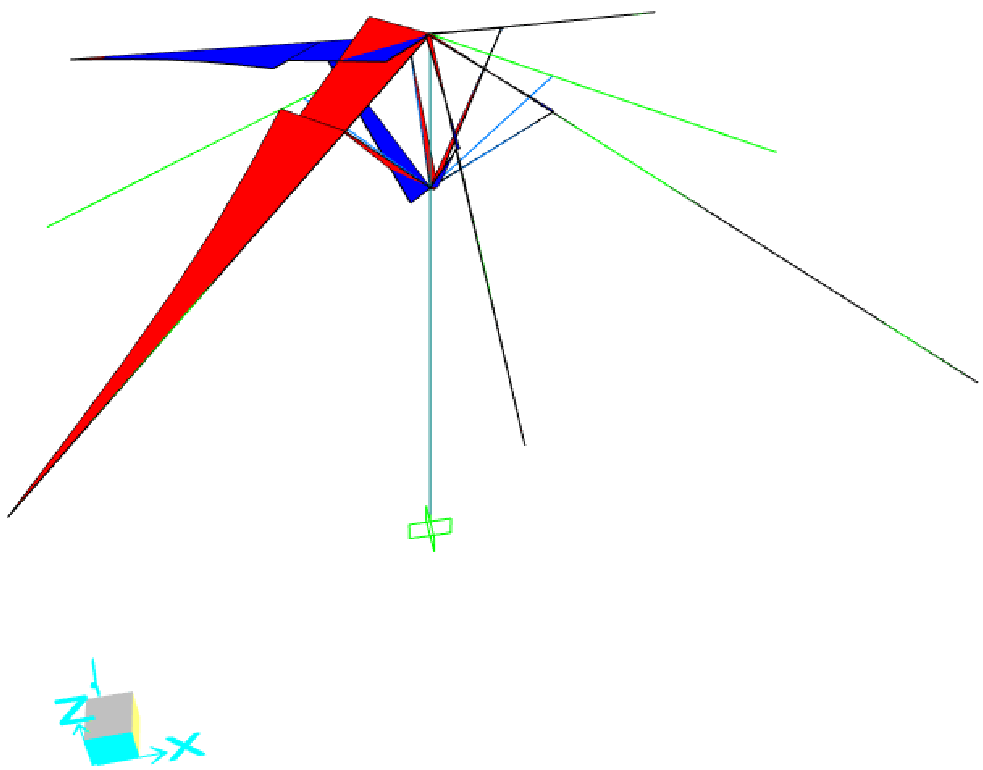


Figure 6: Maximum Bending Moment - Minor

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

5.1.3 Maximum Shear

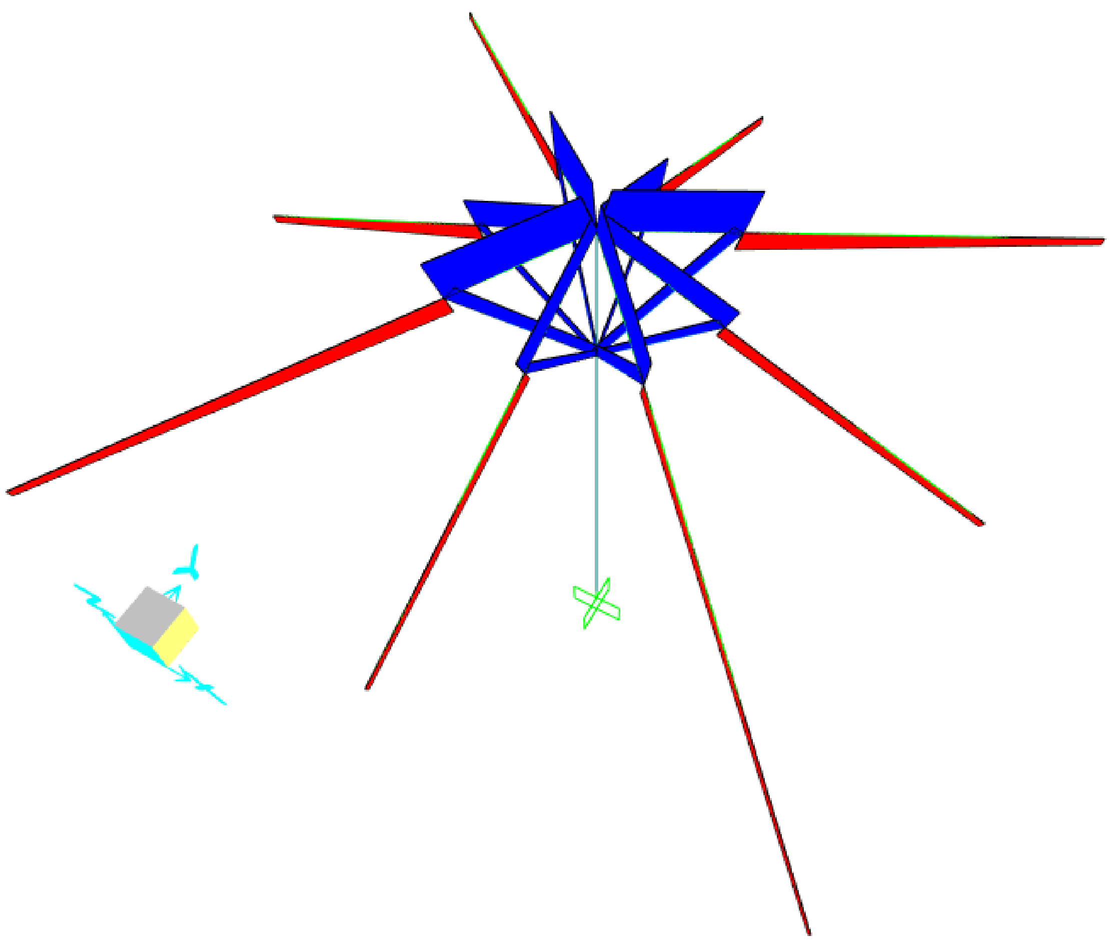


Figure 7 Maximum Shear

5.1.4 Maximum Axial Force

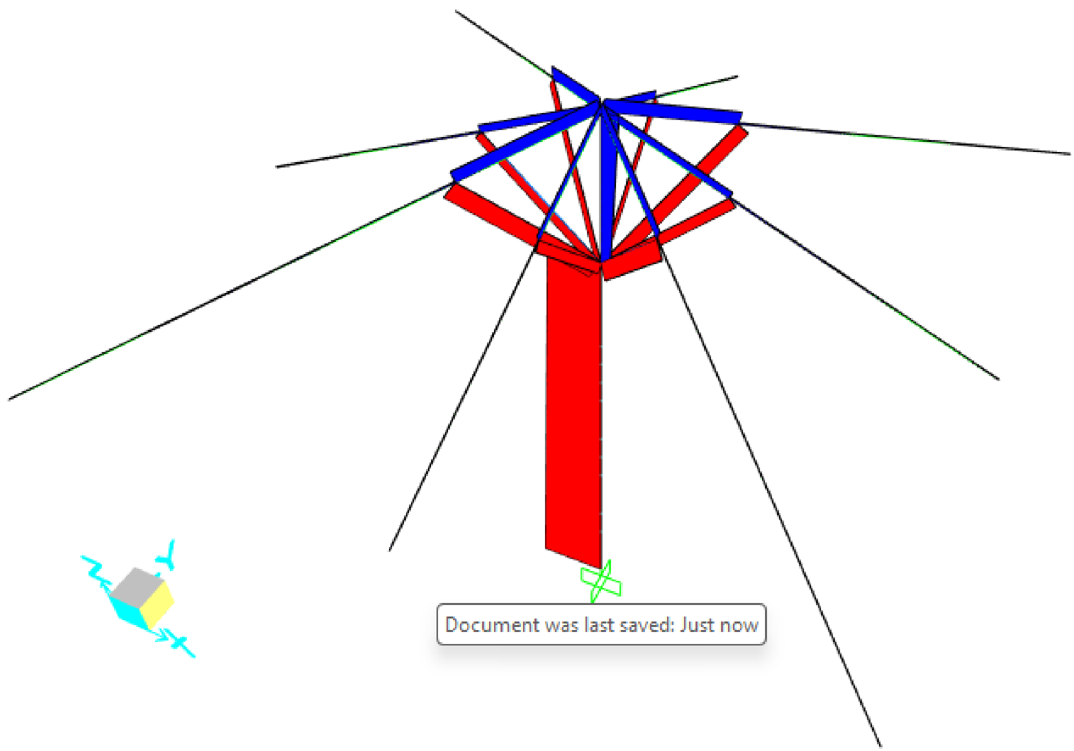


Figure 8 Maximum Axial Force

5.1.5 Maximum Reactions – Opened

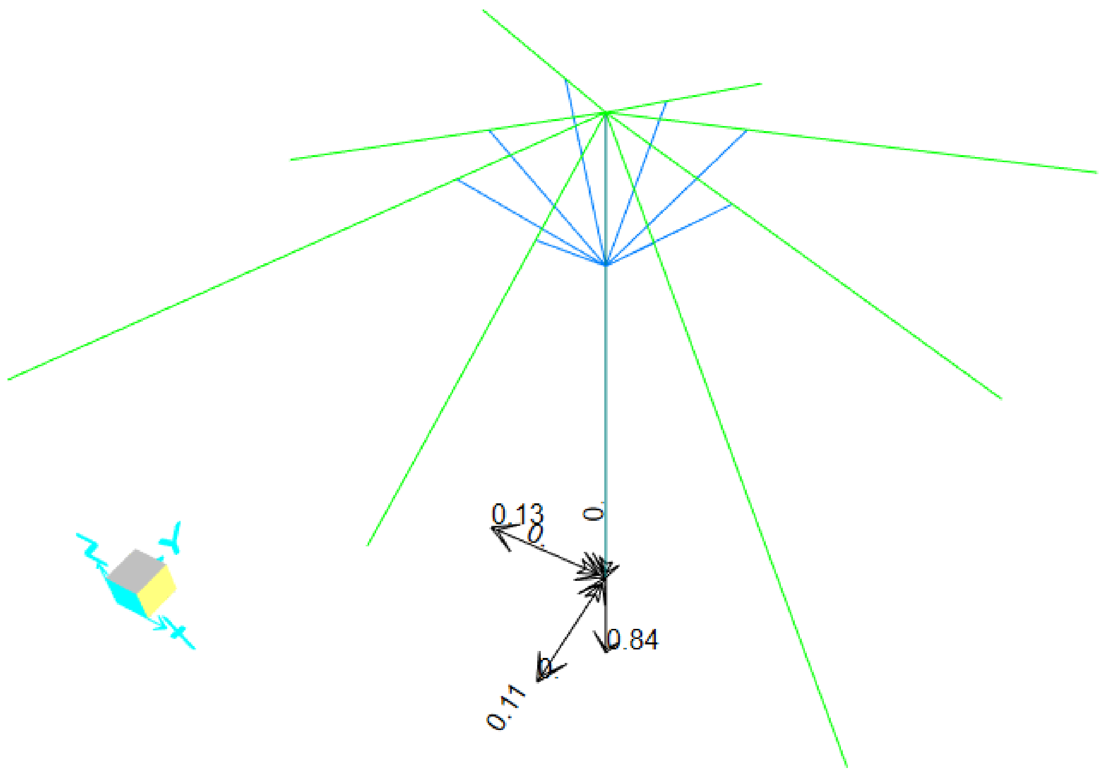


Figure 9 Maximum Reaction

F_x = 0.73 kN
F_y = 0.01 kN
$F_{z(up\ lift)}$ = 0.99 kN
$F_{z\ (Bearing)}$ = 1.56 kN
M_y = 1.81 kN-m

5.1.6 Maximum Reactions – Closed

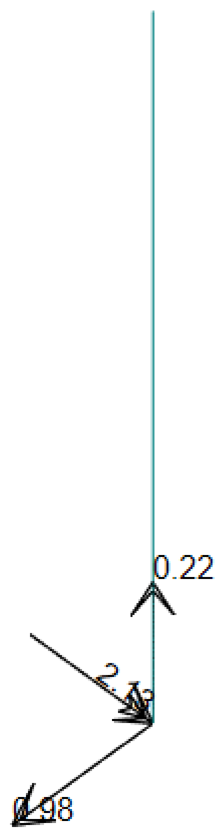


Figure 10 Maximum Reaction

F_x = 0.98 kN
F_y = 0.01 kN
F_z = 0.22 kN
M_y = 2.13 kN-m

6 Aluminium Member Design

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

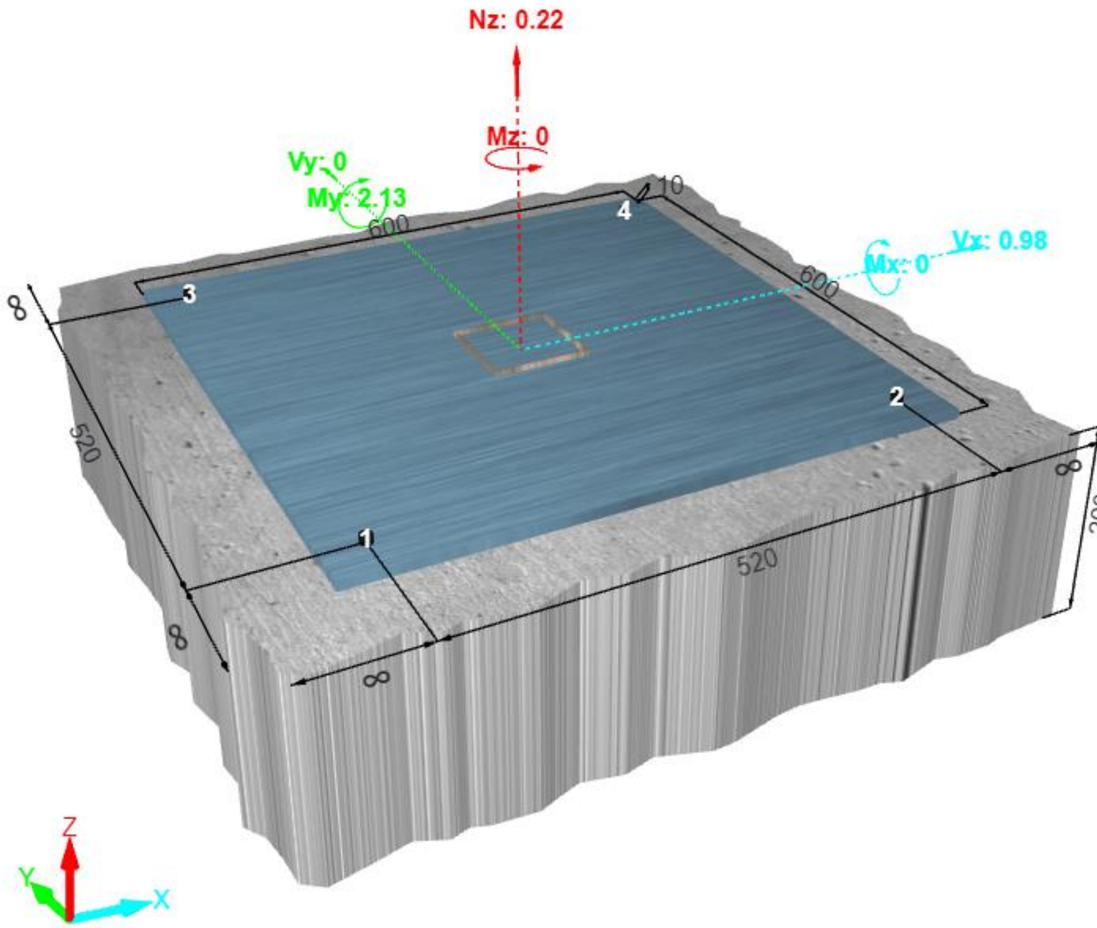
MEMBER(S)	Section	b	d	t	Vx	Vy	P (Axial)	Mx	My
		mm	mm	mm	kN	kN	kN	kN.m	kN.m
Pole	105x105x3.9	105	105	3.9	0.73	-9.8E-14	-1.56	-1.81	-9.397E-14
Long Rib1	40x20x2+ 35x30x3	20	75	2	-0.25	0.015	0.009948	-0.426	0.0242
Long Rib2	40x20x2+ 35x30x3	20	75	2	-0.32	1.9E-11	0.011	-0.3929	3.69E-11
Short Rib 1	30X20X2	20	30	2	0.136	0.00851	-0.967	-0.1121	0.0013
Short Rib 2	30X20X2	20	30	2	0.136	-9.8E-12	-0.967	-0.1048	1.645E-12
0	100x50x5	50	100	5	0	0	0	0	0
0	100x50x5	50	100	5	0	0	0	0	0

7 Anchor Design

7.1 Permanent Installation

600 x 600 x 10 Base Plate with Mechanical Anchors (bolted to min. 200mm thick concrete slab 32mPa)
Use 4 off TRUBOLT XTREM M10x90/10 or equivalent.

Refer Appendix 'B' for details.



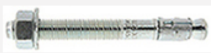
Design Actions :

Action [kN] / [kNm]	Action type	N_{Ed}	$V_{Ed,X}$	$V_{Ed,Y}$	$M_{Ed,Z}$	$M_{Ed,X}$	$M_{Ed,Y}$
Combination 1	standard	0.22	0.98	0	0	0	2.13

START 1. APPLICATIONS 2. DIMENSIONS 3. MATERIAL 4. LOADS 5. DESIGN 6. CALCULATE

Anchor selection | Detailed view | PDF | ETA | ACAD | STEP

Anchor selected: TRUBOLT XTREM M10X90/10



Tensile 30.18%

Shear 2

Utilization 16.67%

Design method applied:AS 5216:2021 Design for static, quasi-static loading

Loads

Loads on anchors

Anchor	Tensile	Shear[x]	Shear[y]
1	1.99	0.24	0
2	0.05	0.24	0
3	1.99	0.24	0
4	0.05	0.24	0

7.2 Temporary Installation

Maximum uplift force at toe: 0.99kN

Self-weight of the base plate: 90kg

Thus, required **additional weight** to counteract uplift forces due to design wind speed (60km/hr) = **175kg**

8 Summary and Recommendations

- The 5m x 5m Square Umbrella Structures as specified is capable of withstanding **60 m/s Wind Loads when open and 140.4km/hr when folded.**
- 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 however the umbrella with permanent anchorage system can remain folded on site when forecast wind not exceeding **140.4 km/hr**.
- Refer to Cl. 7 for the required anchorage system.

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

9 Appendix A – Aluminium Design Based on AS1664.1

9.1 Pole

PRIME CONSULTING ENGINEERS PTY. LTD

Job no. 23-696-1 **Date:** 17/11/2023

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
105x105x3.9	**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			T3.4(B)
	k_c	=	1			
FEM ANALYSIS RESULTS						
Axial force	P	=	1.392	kN	*compression*	
	P	=	0	kN	*Tension*	
In plane moment	M_x	=	1.1869	kNm		
Out of plane moment	M_y	=	9.397E-14	kNm		
DESIGN STRESSES						
Gross cross section area	A_g	**=**	1577.16	mm^2		
In-plane elastic section modulus	Z_x	**=**	51252.293	mm^3		
Out-of-plane elastic section mod.	Z_y	**=**	51252.293	mm^3		
Stress from axial force	$\mathbf{f_a}$	**=**	P/A_g			
		=	**0.88**	**MPa**	*compression*	
		=	**0.00**	**MPa**	*Tension*	
Stress from in-plane bending	$\mathbf{f_{bx}}$	**=**	M_x/Z_x			
		=	**23.16**	**MPa**	*compression*	

Stress from out-of-plane bending	f_{by}	=	M_y/Z_y			
		=	**0.00**	**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	=	4350	mm		
Effective length factor	k	=	1.00			
Radius of gyration about buckling axis (Y)	r_y	=	41.30	mm		
Radius of gyration about buckling axis (X)	r_x	=	41.30	mm		
Slenderness ratio	kLb/ry	=	78.68			
Slenderness ratio	kL/rx	=	105.32			
Slenderness parameter	λ	=	1.967			
	D_c*	=	90.3			
	S_1*	=	0.33			
	S_2*	=	1.23			
	ϕ_{cc}	=	0.855			
Factored limit state stress	**ϕF_L**	=	**53.28**	**MPa**		
2. Sections not subject to torsional or torsional-flexural buckling						… 3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	105.32			
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'	=	97.2			
	t	=	3.9	mm		
Slenderness	b/t	=	24.923077			
Limit 1	S_1	=	12.34			
Limit 2	S_2	=	32.87			

Factored limit state stress	**ϕF_L**	=	**193.63**	**MPa**		
Most adverse compressive limit state stress	F_a	=	53.28	MPa		
Most adverse tensile limit state stress	F_a	=	222.70	MPa		
Most adverse compressive & Tensile capacity factor	f_a/F_a	=	0.02		PASS	
BENDING - IN-PLANE						
3.4.15 *Compression in beams, extreme fibre, gross section rectangular tubes, box sections*						
Unbraced length for bending	L_b	=	3250	mm		
Second moment of area (weak axis)	I_y	=	2.69E+06	mm^4		
Torsion modulus	J	=	4.03E+06	mm^3		
Elastic section modulus	Z	=	51252.293	mm^3		
Slenderness	S	=	101.17			
Limit 1	S_1	=	0.39			
Limit 2	S_2	=	1695.86			
Factored limit state stress	**ϕF_L**	=	**207.31**	**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'	=	97.2	mm		
	t	=	3.9	mm		
Slenderness	b/t	=	24.923077			
Limit 1	S_1	=	12.34			
Limit 2	S_2	=	46.95			
Factored limit state stress	**ϕF_L**	=	**193.63**	**MPa**		
Most adverse in-plane bending limit state stress	F_{bx}	=	193.63	MPa		
Most adverse in-plane bending capacity factor	f_{bx}/F_{bx}	=	0.12		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	=	**193.63**	**MPa**		
Most adverse out-of-plane bending limit state stress	F_{by}	=	193.63	MPa		
Most adverse out-of-plane bending capacity factor	f_{by}/F_{by}	=	0.00		PASS	

COMBINED ACTIONS

4.1.1 *Combined compression and bending*						… 4.1.1(2)
	F_a	=	53.28	MPa		… 3.4.8
	F_{ao}	=	193.63	MPa		… 3.4.10
	F_{bx}	=	193.63	MPa		… 3.4.17
	F_{by}	=	193.63	MPa		… 3.4.17
	f_a/F_a	=	0.017			
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					… 4.1.1 (3)
i.e.	0.14	≤	1.0		PASS	

SHEAR

3.4.24 *Shear in webs (Major Axis)*						… 4.1.1(2)
Clear web height	h	=	97.2	mm		
	t	=	3.9	mm		
Slenderness	h/t	=	24.923077			
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			
			0.19	**MPa**		
3.4.25 *Shear in webs (Minor Axis)*						
Clear web height	b	=	97.2	mm		
	t	=	3.9	mm		
Slenderness	b/t	=	24.923077			
Factored limit state stress	ϕF_L	=	**131.10**	**MPa**		
Stress From Shear force	f_{sy}	=	V/A_w			
			0.00	**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.	0.14	≤	1.0		PASS	

9.2 Long Rib 1

PRIME CONSULTING ENGINEERS PTY. LTD

Job no. 23-696-1 **Date:** 17/11/2023

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
40x20x2+ 35x30x3	**Long Rib1**					
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	kN	*compression*	
	P	=	0.009948	kN	*Tension*	

In plane moment	M_x	=	0.426	kNm		
Out of plane moment	M_y	=	0.0242	kNm		
DESIGN STRESSES						
Gross cross section area	A_g	**=**	364	mm^2		
In-plane elastic section modulus	Z_x	**=**	5035	mm^3		
Out-of-plane elastic section mod.	Z_y	**=**	3578.6	mm^3		
Stress from axial force	$\mathbf{f_a}$	**=**	P/A_g			
		=	**0.00**	**MPa**	*compression*	
		=	**0.03**	**MPa**	*Tension*	
Stress from in-plane bending	$\mathbf{f_{bx}}$	**=**	M_x/Z_x			
		=	**84.61**	**MPa**	*compression*	
Stress from out-of-plane bending	$\mathbf{f_{by}}$	**=**	M_y/Z_y			
		=	**6.76**	**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	=	3700	mm		
Effective length factor	k	=	1.00			
Radius of gyration about buckling axis (Y)	r_y	=	12.00	mm		
Radius of gyration about buckling axis (X)	r_x	=	20.40	mm		
Slenderness ratio	kLb/ry	=	232.00			
Slenderness ratio	kL/rx	=	181.37			
Slenderness parameter	λ	=	4.33			
	D_c*	=	90.3			
	S_1*	=	0.33			
	S_2*	=	1.23			
	ϕ_{cc}	=	0.950			
Factored limit state stress	$\mathbf{\phi F_L}$	**=**	**12.19**	**MPa**		
2. Sections not subject to torsional or torsional-flexural buckling						… 3.4.8.2

Largest slenderness ratio for flexural buckling	kL/r	=	232.00			
***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'	=	16			
	t	=	2	mm		
Slenderness	b/t	=	8			
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	=	12.19	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	=	2784	mm		
Second moment of area (weak axis)	I_y	=	6.26E+04	mm^4		
Torsion modulus	J	=	3.81E+04	mm^3		
Elastic section modulus	Z	=	5035	mm^3		
Slenderness	S	=	574.19			
Limit 1	S_1	=	0.39			
Limit 2	S_2	=	1695.86			
Factored limit state stress	**ϕF_L**	=	**175.42**	**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'	=	16	mm		
	t	=	2	mm		
Slenderness	b/t	=	8			
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}	=	175.42	MPa		
Most adverse in-plane bending capacity factor	f_{bx}/F_{bx}	=	0.48		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**	=	**175.42**	**MPa**		
Most adverse out-of-plane bending limit state stress	**F_{by}**	=	175.42	MPa		
Most adverse out-of-plane bending capacity factor	**f_{by}/F_{by}**	=	0.04		PASS	
COMBINED ACTIONS						
***4.1.1** Combined compression and bending*						… 4.1.1(2)
	F_a	=	12.19	MPa		… 3.4.8
	F_{ao}	=	228.95	MPa		… 3.4.10
	F_{bx}	=	175.42	MPa		… 3.4.17
	F_{by}	=	175.42	MPa		… 3.4.17
	f_a/F_a	=	0.000			
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					… 4.1.1 (3)
i.e.	0.52	≤	1.0		PASS	
SHEAR						
***3.4.24** Shear in webs (Major Axis)*						… 4.1.1(2)
Clear web height	h	=	71	mm		
	t	=	2	mm		
Slenderness	h/t	=	35.5			

Limit 1	S_1	=	29.01			
Limit 2	S_2	=	59.31			
Factored limit state stress	**ϕF_L**	=	**124.53**	**MPa**		
Stress From Shear force	**f_{sx}**	=	V/A_w			
			0.82	**MPa**		
***3.4.25** Shear in webs (Minor Axis)*						
Clear web height	b	=	16	mm		
	t	=	2	mm		
Slenderness	b/t	=	8			
Factored limit state stress	**ϕF_L**	=	**131.10**	**MPa**		
Stress From Shear force	**f_{sy}**	=	V/A_w			
			0.05	**MPa**		
Most adverseshear capacity factor (Major Axis)	f_{sx}/F_{sx}	=	0.01	**MPa**		
Most adverseshear capacity factor (Minor Axis)	f_{sy}/F_{sy}	=	0.00	**Mpa**	PASS	
COMBINED ACTIONS						
***4.4** Combined Shear, Compression and bending*						
Check:	$f_a/F_a + f_b/F_b + (f_s/F_s)^2 \leq 1.0$					
i.e.	0.48	≤	1.0		PASS	

9.3 Long Rib 2

PRIME CONSULTING ENGINEERS PTY. LTD

Job no. 23-696-1 **Date:** 17/11/2023

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
40x20x2+ 35x30x3	**Long Rib2**					
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	kN	*compression*	
	P	=	0.011	kN	*Tension*	
In plane moment	M_x	=	0.3929	kNm		
Out of plane moment	M_y	=	3.69E-11	kNm		
DESIGN STRESSES						
Gross cross section area	A_g	=	364	mm^2		
In-plane elastic section modulus	Z_x	=	5035	mm^3		
Out-of-plane elastic section mod.	Z_y	=	3578.6	mm^3		
Stress from axial force	$\mathbf{f_a}$	=	P/A_g			
		=	**0.00**	**MPa**	*compression*	
		=	**0.03**	**MPa**	*Tension*	
Stress from in-plane bending	$\mathbf{f_{bx}}$	=	M_x/Z_x			
		=	**78.03**	**MPa**	*compression*	
Stress from out-of-plane bending	$\mathbf{f_{by}}$	=	M_y/Z_y			
		=	**0.00**	**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	=	2731	mm		
Effective length factor	k	=	1.00			

Radius of gyration about buckling axis (Y)	r_y	=	12.00	mm		
Radius of gyration about buckling axis (X)	r_x	=	20.40	mm		
Slenderness ratio	kLb/ry	=	154.42			
Slenderness ratio	kL/rx	=	133.87			
Slenderness parameter	λ	=	2.88			
	D_c*	=	90.3			
	S_1*	=	0.33			
	S_2*	=	1.23			
	ϕ_{cc}	=	0.950			
Factored limit state stress	**ϕF_L**	**=**	**27.53**	**MPa**		
2. Sections not subject to torsional or torsional-flexural buckling						… 3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	154.42			
***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'	=	16			
	t	=	2	mm		
Slenderness	b/t	=	8			
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	=	27.53	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	=	1853	mm		
Second moment of area (weak axis)	I_y	=	62626.1	mm^4		
Torsion modulus	J	=	38065.7	mm^3		
Elastic section modulus	Z	=	5035	mm^3		
Slenderness	S	=	382.17			
Limit 1	S_1	=	0.39			
Limit 2	S_2	=	1695.86			
Factored limit state stress	**ϕF_L**	=	**185.54**	**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'	=	16	mm		
	t	=	2	mm		
Slenderness	b/t	=	8			
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}	=	185.54	MPa		
Most adverse in-plane bending capacity factor	f_{bx}/F_{bx}	=	0.42		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**	=	**185.54**	**MPa**		
Most adverse out-of-plane bending limit state stress	**F_{by}**	=	185.54	MPa		
Most adverse out-of-plane bending capacity factor	**f_{by}/F_{by}**	=	0.00		PASS	
COMBINED ACTIONS						

***4.1.1** Combined compression and bending*						… 4.1.1(2)
	F_a	=	27.53	MPa		… 3.4.8
	F_{ao}	=	228.95	MPa		… 3.4.10
	F_{bx}	=	185.54	MPa		… 3.4.17
	F_{by}	=	185.54	MPa		… 3.4.17
	f_a/F_a	=	0.000			
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					… 4.1.1 (3)
i.e.	0.42	≤	1.0		PASS	
SHEAR						
***3.4.24** Shear in webs (Major Axis)*						… 4.1.1(2)
Clear web height	h	=	71	mm		
	t	=	2	mm		
Slenderness	h/t	=	35.5			
Limit 1	S_1	=	29.01			
Limit 2	S_2	=	59.31			
Factored limit state stress	**ϕF_L**	=	**124.53**	**MPa**		
Stress From Shear force	**f_{sx}**	=	V/A_w			
			1.05	**MPa**		
***3.4.25** Shear in webs (Minor Axis)*						
Clear web height	b	=	16	mm		
	t	=	2	mm		
Slenderness	b/t	=	8			
Factored limit state stress	**ϕF_L**	=	**131.10**	**MPa**		
Stress From Shear force	**f_{sy}**	=	V/A_w			
			0.00	**MPa**		
Most adverseshear capacity factor (Major Axis)	f_{sx}/F_{sx}	=	0.01	**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.	0.42	≤	1.0	PASS	

9.4 Short Rib 1

PRIME CONSULTING ENGINEERS PTY. LTD

Job no. 23-696-1 **Date:** 17/11/2023

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
30X20X2	**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	=	0.967	kN	*compression*	
	P	=	0	kN	*Tension*	
In plane moment	M_x	=	0.1121	kNm		
Out of plane moment	M_y	=	0.0013	kNm		
DESIGN STRESSES						
Gross cross section area	A_g	**=**	184	mm^2		
In-plane elastic section modulus	Z_x	**=**	1437.6889	mm^3		
Out-of-plane elastic section mod.	Z_y	**=**	1112.5333	mm^3		

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

Stress from axial force	**f_a**	=	P/A_g			
		=	**5.26**	**MPa**	*compression*	
		=	**0.00**	**MPa**	*Tension*	
Stress from in-plane bending	**f_{bx}**	=	M_x/Z_x			
		=	**77.97**	**MPa**	*compression*	
Stress from out-of-plane bending	**f_{by}**	=	M_y/Z_y			
		=	**1.17**	**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	=	1200	mm		
Effective length factor	k	=	1.00			
Radius of gyration about buckling axis (Y)	r_y	=	7.78	mm		
Radius of gyration about buckling axis (X)	r_x	=	10.83	mm		
Slenderness ratio	kLb/ry	=	154.32			
Slenderness ratio	kL/rx	=	110.84			
Slenderness parameter	λ	=	2.88			
	D_c*	=	90.3			
	S_1*	=	0.33			
	S_2*	=	1.23			
	ϕ_{cc}	=	0.950			
Factored limit state stress	**ϕF_L**	**=**	**27.56**	**MPa**		
2. Sections not subject to torsional or torsional-flexural buckling						… 3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	**=**	154.32			
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'	=	16			
	t	=	2	mm		
Slenderness	b/t	=	8			
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	=	27.56	MPa		
Most adverse tensile limit state stress	F_a	=	222.70	MPa		
Most adverse compressive & Tensile capacity factor	f_a/F_a	=	0.19		PASS	
BENDING - IN-PLANE						
***3.4.15** Compression in beams, extreme fibre, gross section rectangular tubes, box sections*						
Unbraced length for bending	L_b	=	1200	mm		
Second moment of area (weak axis)	I_y	=	11125.333	mm^4		
Torsion modulus	J	=	22088.348	mm^3		
Elastic section modulus	Z	=	1437.6889	mm^3		
Slenderness	S	=	220.11			
Limit 1	S_1	=	0.39			
Limit 2	S_2	=	1695.86			
Factored limit state stress	**ϕF_L**	=	**196.36**	**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'	=	16	mm		
	t	=	2	mm		
Slenderness	b/t	=	8			
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}	=	196.36	MPa		
Most adverse in-plane bending capacity factor	f_{bx}/F_{bx}	=	0.40		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**	=	**196.36**	**MPa**		
Most adverse out-of-plane bending limit state stress	**F_{by}**	=	196.36	MPa		
Most adverse out-of-plane bending capacity factor	**f_{by}/F_{by}**	=	0.01		PASS	
COMBINED ACTIONS						
***4.1.1** Combined compression and bending*						… 4.1.1(2)
	F_a	=	27.56	MPa		… 3.4.8
	F_{ao}	=	228.95	MPa		… 3.4.10
	F_{bx}	=	196.36	MPa		… 3.4.17
	F_{by}	=	196.36	MPa		… 3.4.17
	f_a/F_a	=	0.191			
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					… 4.1.1 (3)
i.e.	0.59	$\leq$	1.0		PASS	
SHEAR						
***3.4.24** Shear in webs (Major Axis)*						… 4.1.1(2)
Clear web height	h	=	26	mm		
	t	=	2	mm		
Slenderness	h/t	=	13			
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			
			0.89	**MPa**		

***3.4.25** Shear in webs (Minor Axis)*						
Clear web height	b	=	16	mm		
	t	=	2	mm		
Slenderness	b/t	=	8			
Factored limit state stress	**ϕF_L**	=	**131.10**	**MPa**		
Stress From Shear force	**f_{sy}**	=	V/A_w			
			0.06	**MPa**		
Most adverseshear capacity factor (Major Axis)	f_{sx}/F_{sx}	=	0.01	**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.	0.59	≤	1.0		PASS	

9.5 Short Rib 2

PRIME CONSULTING ENGINEERS PTY. LTD

Job no. 23-696-1 **Date:** 17/11/2023

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
30X20X2	**Short Rib 2**					
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	=	0.967	kN	*compression*	
	P	=	0	kN	*Tension*	
In plane moment	M_x	=	0.1048	kNm		
Out of plane moment	M_y	=	1.645E-12	kNm		
DESIGN STRESSES						
Gross cross section area	A_g	**=**	184	mm^2		
In-plane elastic section modulus	Z_x	**=**	1437.6889	mm^3		
Out-of-plane elastic section mod.	Z_y	**=**	1112.5333	mm^3		
Stress from axial force	$\mathbf{f_a}$	**=**	P/A_g			
		=	**5.26**	**MPa**	*compression*	
		=	**0.00**	**MPa**	*Tension*	
Stress from in-plane bending	$\mathbf{f_{bx}}$	**=**	M_x/Z_x			
		=	**72.89**	**MPa**	*compression*	
Stress from out-of-plane bending	$\mathbf{f_{by}}$	**=**	M_y/Z_y			
		=	**0.00**	**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	=	1100	mm		
Effective length factor	k	=	1.00			
Radius of gyration about buckling axis (Y)	r_y	=	7.78	mm		
Radius of gyration about buckling axis (X)	r_x	=	10.83	mm		
Slenderness ratio	kLb/ry	=	141.46			

Slenderness ratio	kL/rx	=	101.61			
Slenderness parameter	λ	=	2.64			
	D_c*	=	90.3			
	S_1*	=	0.33			
	S_2*	=	1.23			
	ϕ_{cc}	=	0.950			
Factored limit state stress	**ϕF_L**	**=**	**32.79**	**MPa**		
2. Sections not subject to torsional or torsional-flexural buckling						… 3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	141.46			
***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'	=	16			
	t	=	2	mm		
Slenderness	b/t	=	8			
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	=	32.79	MPa		
Most adverse tensile limit state stress	F_a	=	222.70	MPa		
Most adverse compressive & Tensile capacity factor	f_a/F_a	=	0.16		PASS	
BENDING - IN-PLANE						
***3.4.15** Compression in beams, extreme fibre, gross section rectangular tubes, box sections*						
Unbraced length for bending	L_b	=	1100	mm		
Second moment of area (weak axis)	I_y	=	11125.333	mm^4		
Torsion modulus	J	=	22088.348	mm^3		

Elastic section modulus	Z	=	1437.6889	mm^3		
Slenderness	S	=	201.77			
Limit 1	S_1	=	0.39			
Limit 2	S_2	=	1695.86			
Factored limit state stress	**ϕF_L**	=	**197.80**	**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'	=	16	mm		
	t	=	2	mm		
Slenderness	b/t	=	8			
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}	=	197.80	MPa		
Most adverse in-plane bending capacity factor	f_{bx}/F_{bx}	=	0.37		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**	=	**197.80**	**MPa**		
Most adverse out-of-plane bending limit state stress	**F_{by}**	=	197.80	MPa		
Most adverse out-of-plane bending capacity factor	**f_{by}/F_{by}**	=	0.00		PASS	
COMBINED ACTIONS						
***4.1.1** Combined compression and bending*						… 4.1.1(2)
	F_a	=	32.79	MPa		… 3.4.8
	F_{ao}	=	228.95	MPa		… 3.4.10

	F_{bx}	=	197.80	MPa		… 3.4.17
	F_{by}	=	197.80	MPa		… 3.4.17
	f_a/F_a	=	0.160			
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					… 4.1.1 (3)
i.e.	0.53	≤	1.0		PASS	
SHEAR						
***3.4.24** Shear in webs (Major Axis)*						… 4.1.1(2)
Clear web height	h	=	26	mm		
	t	=	2	mm		
Slenderness	h/t	=	13			
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			
			0.89	**MPa**		
***3.4.25** Shear in webs (Minor Axis)*						
Clear web height	b	=	16	mm		
	t	=	2	mm		
Slenderness	b/t	=	8			
Factored limit state stress	ϕF_L	=	**131.10**	**MPa**		
Stress From Shear force	f_{sy}	=	V/A_w			
			0.00	**MPa**		
Most adverseshear capacity factor (Major Axis)	f_{sx}/F_{sx}	=	0.01	**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.	0.53	≤	1.0		PASS	

10 Appendix B – Anchorage Design

CALCULATION SHEET FOR RAMSET ANCHORS

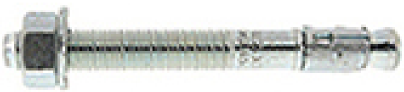
Company :	PCE	Phone number :	02 8964 1818
Carried out by :		Mail address :	info@primeengineers.com.au

Company :	Prime Consulting Engineers	Project name :	200 Series
Contact name :	KZ	Location :	
Phone number :	02 8964 1818	Fastening point :	
Mail address :	info@primeengineers.com.au		

Comment :

Recommended anchors

TRUBOLT XTREM M10x90/10



Product Code: 057769
Effective embedment : 60 mm
ETA-15/0893

Base material

Concrete resistance :	32 - fck,cyl = 32 Mpa
Cracking of concrete :	Cracked concrete
Thickness of concrete :	200 mm
Reinforcement type :	Wide concrete reinforcement
Edge reinforcement :	Straight edge reinforcement

Conditions

Installation conditions :	Dry concrete
Short term temperature :	40 °C
Long term temperature :	24 °C

Anchor plate

Thickness of part to be fixed :	10 mm
Recommended plate thickness :	The base plate thickness has not been checked
Clearance diameter :	12 mm
Profile :	100x100x2.8 SHS
Profile position :	Ex = 0 mm ; Ey = 0 mm
Stand-off :	None

Design method : AS 5216:2021 Design for static, quasi-static loading

Design Actions :

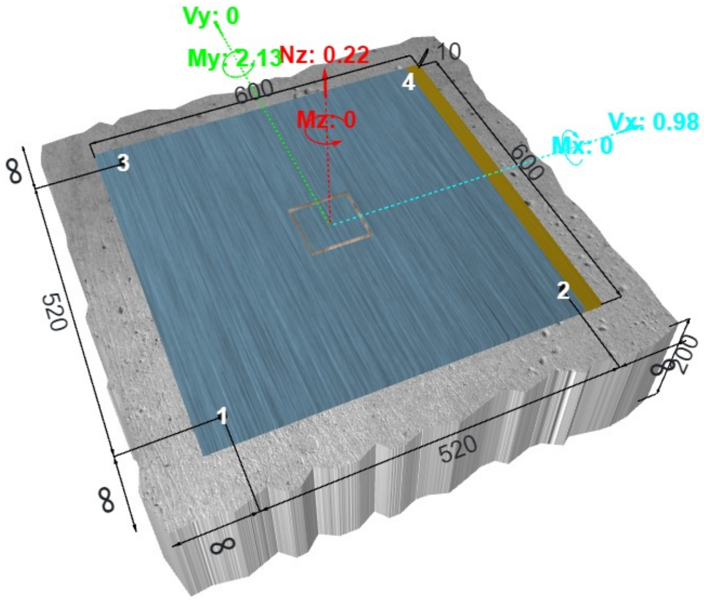
Action [kN] / [kNm]	Action type	N_{Ed}	$V_{Ed,X}$	$V_{Ed,Y}$	$M_{Ed,Z}$	$M_{Ed,X}$	$M_{Ed,Y}$
Combination 1	standard	0.22	0.98	0	0	0	2.13

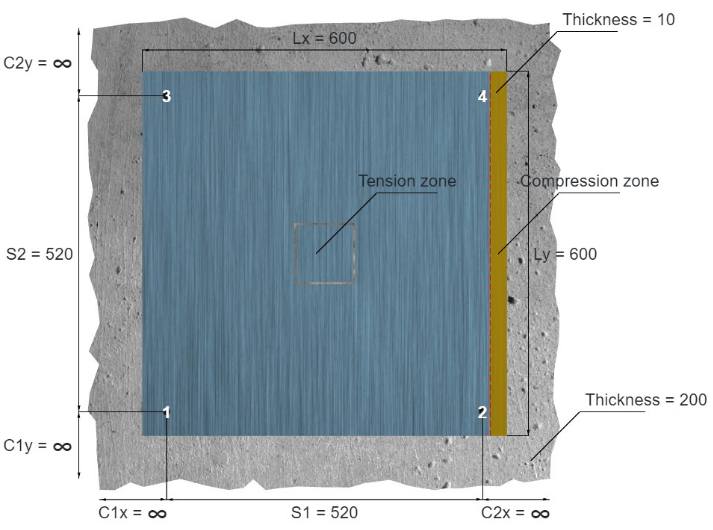
Specifications :

Static

Sustained Load : False

Geometry :





Calculation Hypothesis :

- The anchoring plate is assumed to be sufficient to resist deformation imposed by the load actions.

- Connection between profile and base plate has not been checked

- RAMSET can only be held responsible if the calculation examples exactly reflect the application and if the installation is carried out according to the instruction given in the RAMSET specifications. The calculation is correct for RAMSET anchors only. The contractor or specifier should make sure that the base material is able to support the loads especially in the case of a group of anchors. RAMSET cannot be held responsible if this software package is modified without its written approval.

Resulting anchors forces

Loads on anchors

Anchor	Tensile	Shear[x]	Shear[y]
1	1.99 kN	0.24 kN	0 kN
2	0.05 kN	0.24 kN	0 kN
3	1.99 kN	0.24 kN	0 kN
4	0.05 kN	0.24 kN	0 kN

N_g^* [kN]	N_h^* [kN]	e_{Nx} [mm]	e_{Ny} [mm]
4.07	1.99	248.3	0

V_g^* [kN]	V_h^* [kN]
0.98	0.24

Utilization

Tension load	Tension force [kN]	Strength [kN]	β_N [%]
Pull out failure	1.99	6.59	30.2
Concrete cone failure	4.07	14.36	28.3
Splitting failure	/	/	/
Steel failure	1.99	19.8	10.0

Shear load	Shear force [kN]	Strength [kN]	β_V [%]
Concrete Edge failure	/	/	/
Pryout failure	0.98	107.97	0.91
Steel failure	0.24	12.13	2.02

Combined tension and shear loads

$\beta_{Nc}^{1.5} + \beta_{Vc}^{1.5} = [0.30]^{1.5} + [0.01]^{1.5} = 0.17 \leq 1$

$\beta_{Ns}^{2} + \beta_{Vs}^{2} = [0.10]^{2} + [0.02]^{2} = 0.01 \leq 1$

THE APPLICATION IS SAFE

CALCULATION DETAILS

Tension load - Pull out failure

$\Phi_{Mp} N_{Rk,p} \geq N_h^*$ [AS 5216:2021 – Table 3.4.2.1]

$\Phi_{Mp} N_{Rk,p}$	= 6.59 kN	$N^0_{Rk,p}$	= 9 kN
$N_{Rk,p}$	= 9.89 kN	Ψ_c	= 1.10
Φ_{Mp}	= 0.67		

Tension load - Concrete cone failure

$\Phi_{Mc} N_{Rk,c} \geq N_g^*$ [AS 5216:2021 – Table 3.4.2.1]

$N_{Rk,c} = N^0_{Rk,c} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \Psi_{s,N} \cdot \Psi_{Re,N} \cdot \Psi_{ec,N} \cdot \Psi_{M,N}$ [AS 5216:2021 – Eq.(6.2.3.1)]

$N^0_{Rk,c} = k_1 \cdot \sqrt{f'_c} \cdot h_{ef}^{1.5}$ [AS 5216:2021 – Eq.(6.2.3.2)]

$\Psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} \leq 1$ [AS 5216:2021 – Eq.(6.2.3.4)]]

$\Psi_{Re,N} = 0.5 + \frac{h_{ef}}{200} \leq 1$ [AS 5216:2021 – Eq.(6.7)]]

$\Psi_{ec,N} = \frac{1}{1 + 2 \cdot (e_N / S_{Cr,N})} \leq 1$ [AS 5216:2021 – Eq.(6.2.3.6)]

$\Psi_{M,N}$ [AS 5216:2021 – Eq.(6.2.3.7)]

$\Phi_{Mc} N_{Rk,c}$	= 14.36 kN	$N^0_{Rk,c}$	= 20.24 kN
$N_{Rk,c}$	= 21.54 kN	$A_{c,N}/A^0_{c,N}$	= 4
Φ_{Mc}	= 0.67	$\Psi_{ec,Nx}$	= 0.27
		$\Psi_{ec,Ny}$	= 1.00
		$\Psi_{s,N}$	= 1.00
		$\Psi_{re,N}$	= 1.00
		$\Psi_{M,N}$	= 1.00

Tension load - Splitting failure

Failure mode not decisive.

Tension load - Steel failure

$\Phi_{Ms}N_{Rk,s} \geq N_h^*$ [AS 5216:2021 – Table 3.4.2.1]
$N_{Rk,s}$ [Approval]

$\Phi_{Ms}N_{Rk,s}$	=	19.8 kN
$N_{Rk,s}$	=	29.3 kN
Φ_{Ms}	=	0.68

Shear load - Concrete edge failure

Failure mode not decisive.

Shear load - Pryout failure

$\Phi_{Mc}V_{Rk,cp} \geq V_g^*$

$V_{Rk,cp} = k_8 \cdot N_{Rk,c}$ without supplementary reinforcement [AS 5216:2021 – Eq.(7.2.4.1(1))]

$V_{Rk,cp} = 0.75 \cdot k_8 \cdot N_{Rk,c}$ with supplementary reinforcement [AS 5216:2021 – Eq.(7.2.4.1(2)]

$\Phi_{Mc}V_{Rk,cp}$	=	107.97 kN	$N^0_{Rk,c}$	=	20.24 kN
$V_{Rk,cp}$	=	161.95 kN	$A_{c,N}/A^0_{c,N}$	=	4
Φ_{Mc}	=	0.67	$\Psi_{ec,Nx}$	=	0.27
			$\Psi_{ec,Ny}$	=	1.00
			$\Psi_{s,N}$	=	1.00
			$\Psi_{re,N}$	=	1.00
			$\Psi_{M,N}$	=	1.00

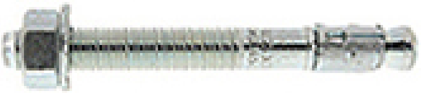
Shear load - Steel failure

$\Phi_{Ms}V_{Rk,s} \geq V_h^*$ [AS 5216:2021 – Tableau 3.4.3.1]
$V_{Rk,s}$ [Approval]

$\Phi_{Ms}V_{Rk,s}$	=	12.13 kN
$V_{Rk,s}$	=	15.4 kN
Φ_{Ms}	=	0.79

INSTALLATION DATA

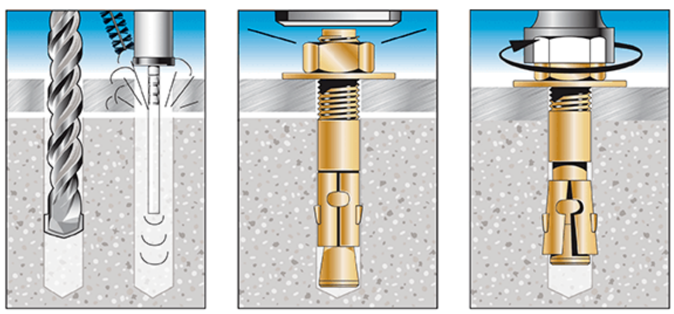
TRUBOLT XTREM M10x90/10



Product Code:	057769
Effective embedment :	60 mm
ETA-15/0893	

Effective embedment :	60 mm
Minimum thickness of base material :	120 mm
Hole diameter in the base material :	10 mm
Hole depth in the base material :	75 mm
Installation torque :	45.00 Nm
Base plate thickness :	10 mm
Profile family (section type) :	100x100x2.8 SHS
Clearance diameter :	12 mm

INSTALLATION Method



Installation

1. Drill or core a hole to the recommended diameter (same as the TruBolt™) and depth using the fixture as a template. Clean the hole thoroughly with a hole cleaning brush. Remove the debris with a hand pump, compressed air, or vacuum.
2. Insert the anchor through the fixture and drive with a hammer until the washer contacts the fixture.
3. Tighten the nut with a torque wrench to the specified assembly torque.

11 Appendix C – Technical Data Sheet

FLARE SHADE | EXTREME MARQUEES

200 Spanish Series

Apart of the Commercial Umbrella Range


PRODUCT SHOWN
5m diameter - Spanish 200 Series
Spanish Recasens - Pacific



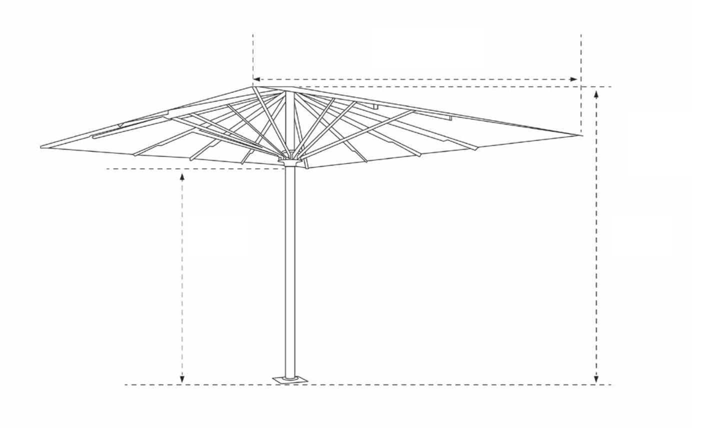


PRODUCT SHOWN
5m diameter - Spanish 200 Series
Spanish Recasens - Pacific

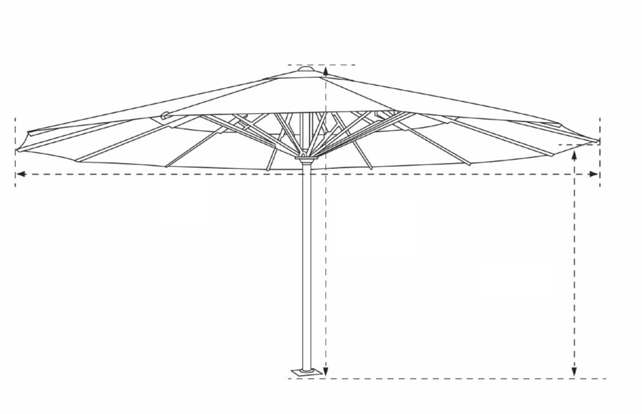
200 SPANISH SERIES

The Spanish 200 is a technically professionally engineered outdoor umbrella shade solution. The high-quality imported fabric canopy is incorporated into one of the strongest aluminium umbrella frames on the market. The pole is designed to provide a reliably stable platform on which the canopy will sit securely for many years. Built to last and maintain a level of attractive appearance expected from a shade structure of this class, the structure is complemented by the addition of imported Spanish Recasens fabric available in 20 colours. Custom branding is offered for logos and company names.

Specifications



Square
3x3m, 4x4m, 4x5m, 5x5m & 6x6m



Round
4m, 5m & 6m diameter

Specifications

Main Frame profile

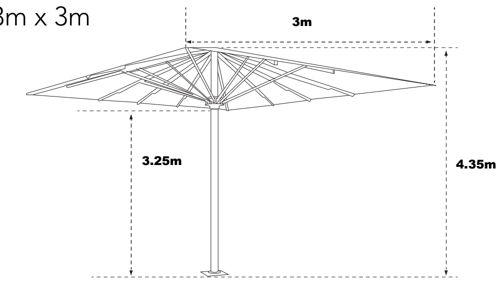
105mm x 105mm x 9mm thickness

Size	3m x 3m	4m x 4m	4m x 5m	5m x 5m	6m x 6m	4m dia.	5m dia.	6m dia.
Height	4.35m							
Clearance	3.25m	3.25m	3.25m	3.25m	3.25m	3.25m	3.25m	3.25m
Arm Span	1.5m	2m	2m/2.5m	2.5m	4.26m	2m	2.5m	4.26m
Frame Weight	83kg	88kg	88kg	110kg	155kg	83kg	88kg	110kg
Roof Weight	10kg	10kg	11kg	12kg	15kg	10kg	12kg	15kg
Frame Box Dimensions	480mm x 520mm x 600mm | 240kg							
Main Pole	105mm x 105mm x 9mm							
Small Rib	30mm x 20mm x 2mm							
Large Rib	20mm x 40mm x 2mm							
Wind Rating	Open 60kph Closed 140kph							
Umbrella Base	350mm Hinged Base Plate and 600mm Hinged Base Plate							
Framework	Aluminium							
Fabric	Spanish Recasens							
Manufacturer's Warranty	Frame: 4 Years Recasens Fabric: 5 Years							

Technical Information

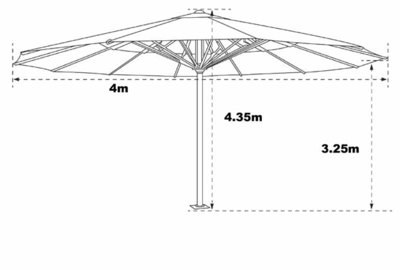
Square

3m x 3m



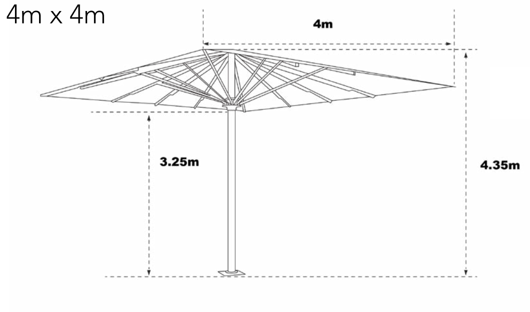
Round

4m diameter



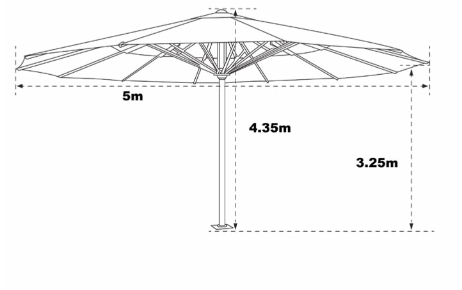
Square

4m x 4m



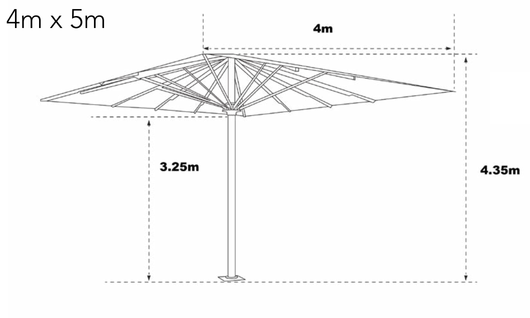
Round

5m diameter



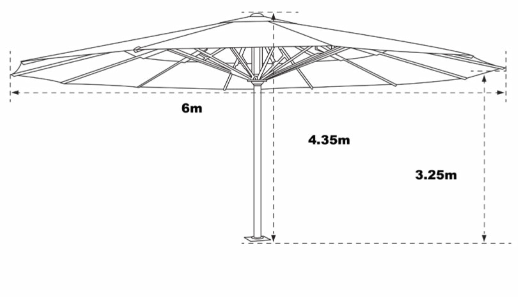
Square

4m x 5m



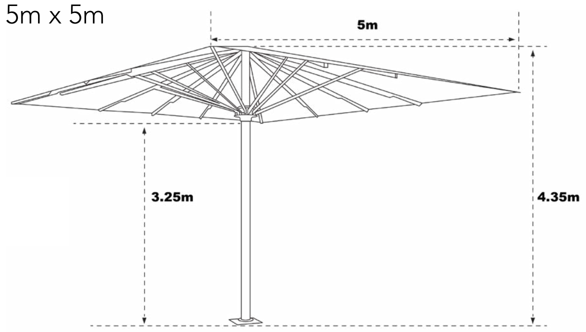
Round

6m diameter



Square

5m x 5m

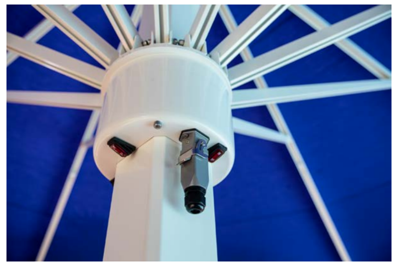


Fabric Colours

Spanish Recasens 100 & 200 Series

Extreme Marquees imports the highest quality fabric from the Recasens brand located in Spain. 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.

Frame Colour



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.

350mm Base Plate Ground Fixing

3x3m, 4x4m & 4m diameter

Hinged Steel Base Plate
Bottom Plate: 350mm x 350mm x 10mm
Hinge Plate: 190mm x 190mm x 355mm
Weight: 10kg aprox.
Screw sets: 4 (attach umbrella to base)
Concrete Bolts: 8 (permanent installation)

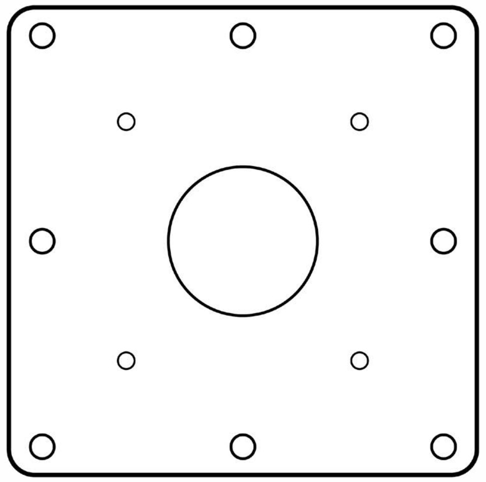
Installation

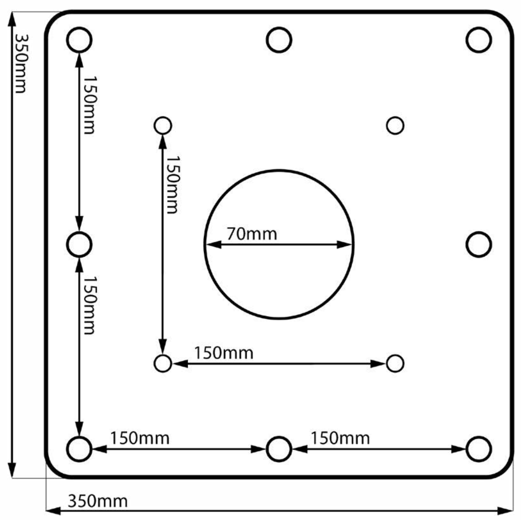
The base plate comes separated from the umbrella pole. Base is attached to the umbrella with 4 screws and washers. There are 8 concrete bolts to attach the base plate permanently a concrete slab.

Concrete Bolt
10mm x 80mm
Bolt Hole: 15mm

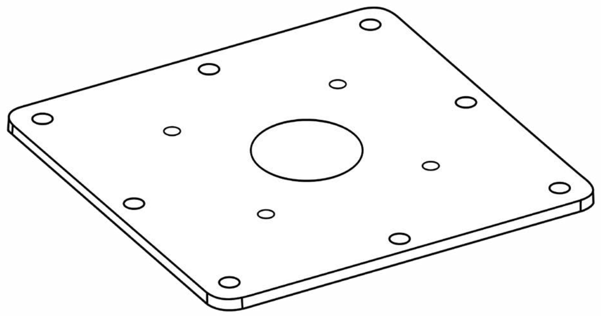
Screw
8mm x 20mm
Screw Hole: 10mm

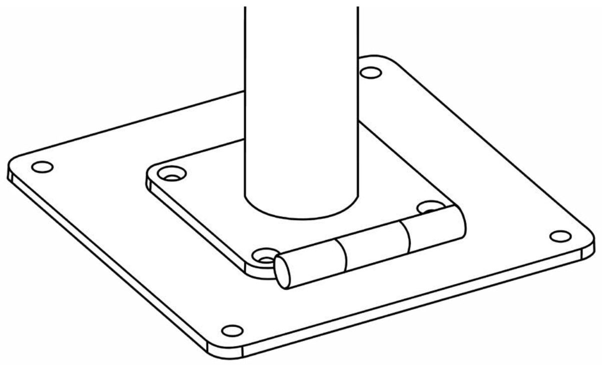
Bolt & Screw Measurement Map





Base & Umbrella Installation Example





600mm Base Plate Ground Fixing

4x5m, 5x5m, 5m diameter & 6m diameter

Hinged Steel Base Plate
Bottom Plate: 600mm x 600mm x 10mm
Hinge Plate: 300mm x 300mm x 355mm
Weight: 20kg aprox.
Screw sets: 4 (attach umbrella to base)
Concrete Bolts: 8 (permanent installation)

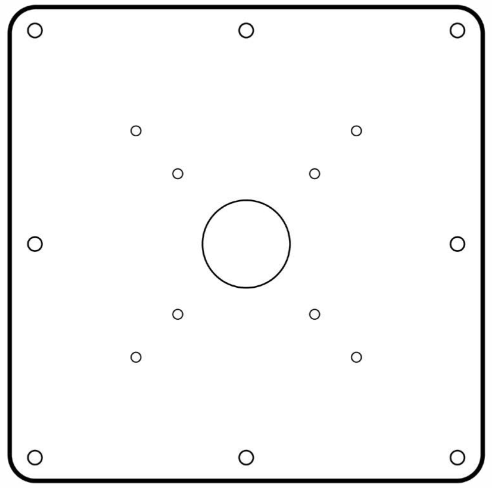
Installation

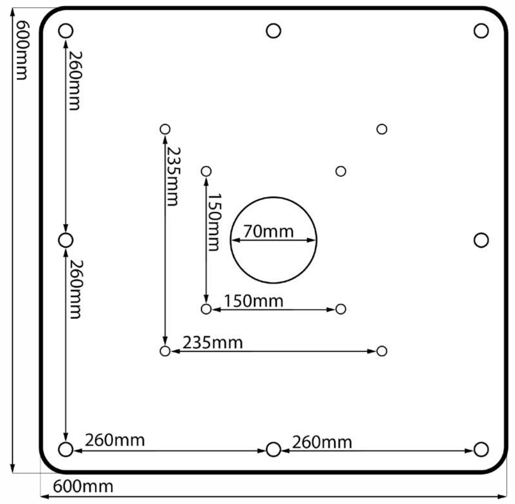
The base plate comes separated from the umbrella pole. Base is attached to the umbrella with 4 screws and washers. There are 8 concrete bolts to attach the base plate permanently a concrete slab.

Concrete Bolt
10mm x 80mm
Bolt Hole: 15mm

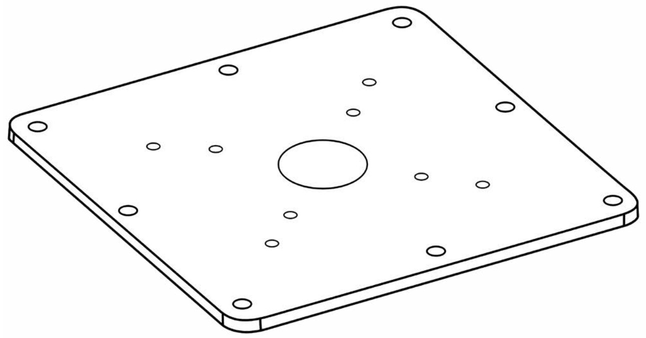
Screw
8mm x 20mm
Screw Hole: 10mm

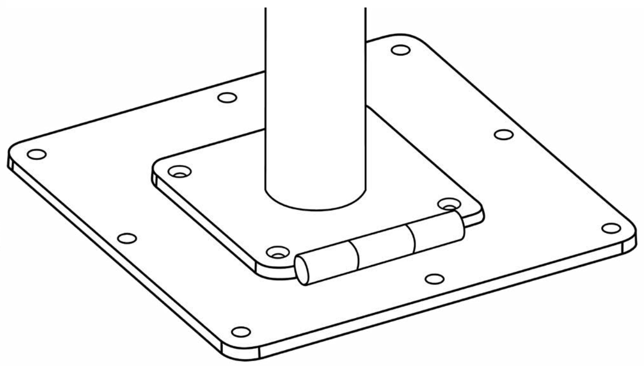
Bolt & Screw Measurement Map





Base & Umbrella Installation Example





Engineer Certification

PDF
Enginner Cert.
https://www.extreme-marquees.com.au/pdf/Umbrellas/Certificates/200-Spanish-Umbrella-Engineer-Cert-Round.pdf

PDF
Foundation Cert.
https://www.extreme-marquees.com.au/pdf/Umbrellas/Certificates/200-Spanish-FS-6m-Foundation.pdf

PDF
Fabric Colours
https://www.extreme-marquees.com.au/pdf/Umbrellas/Specification/Fabric-Spanish-Recasen-100&200-Series.pdf

P 1300 667 255
admin@flare-shade.com.au
3 Bailey Court, Brendale, QLD, Australia 4500
SHOP ONLINE www.flare-shade.com.au

P 1300 850 832 **F** 07 3355 7720
admin@extreme-marquees.com.au
3 Bailey Court, Brendale, QLD, Australia 4500
SHOP ONLINE www.extreme-marquees.com.au