Prime Consulting Engineers Pty. Ltd.

Design Report:

HOME & CAFÉ UMBRELLA (Octagonal Umbrella) for 60km/hr Wind Speed

For

UltraShade

Ref: R-25-1257-2

Date: 04/03/2025

Amendment: -

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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 Ultra Shade to carry out a structural analysis of **2.5m, 3m, 3.5m, 4m, 4.3m octagonal** Umbrella Structures for **60km/hr** wind speed in open condition and **120km/hr** in closed 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) & 33.3 m/s (120 km/hr)** positioned for the worst effect, in open and closed conditions respectively, on **4.3m octagonal** 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

Home & Cafe® Octagonal Umbrella Dimensions

Size	A	B	C	D	E	F	G	H
2.5 m	2000	2550	2500	2200	950	2550	1250	400
3.0 m	2050	2550	2950	2700	1100	2550	1000	400
3.5 m	2200	2750	3500	3200	1300	2750	970	400
4.0 m	2200	2800	3950	3550	1500	2800	750	450
4.3 m	2150	2800	4300	3900	1620	2800	600	450

NB: All measurements in millimeters.
To be used as a guide only, all measurements are approximate

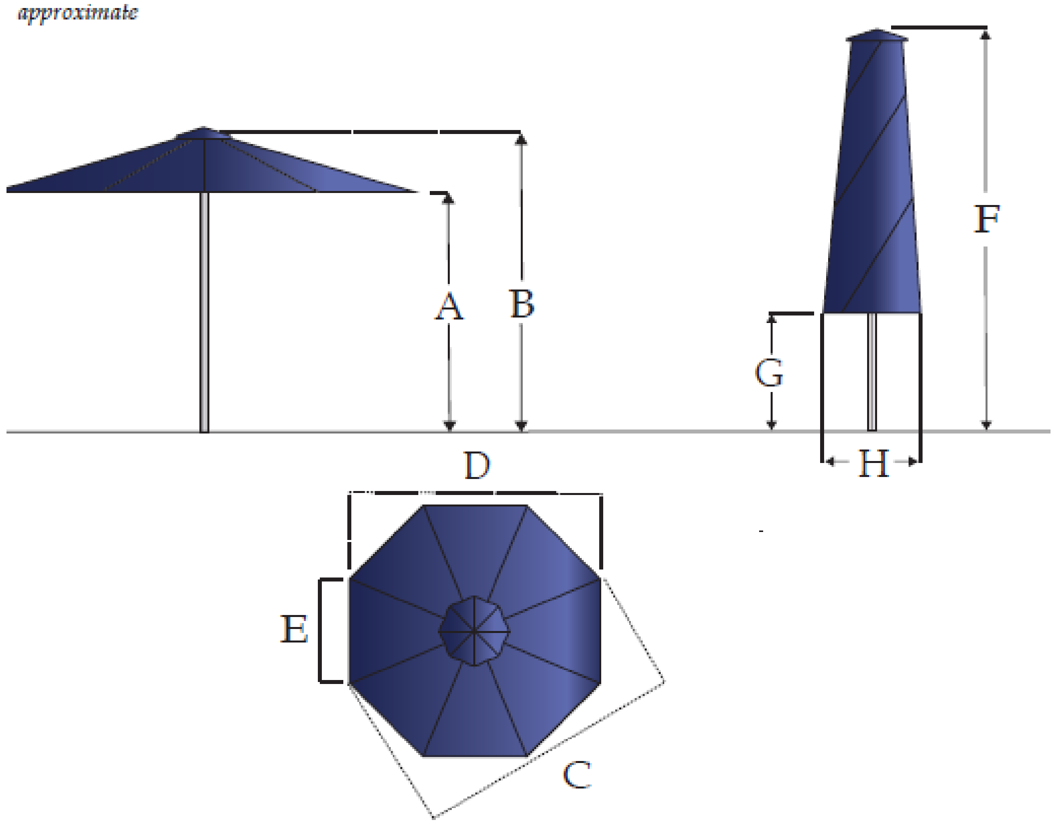

Figure 1: Geometry of the octagonal Umbrella

2.2 Assumptions & Limitations

- For forecast winds in excess of **60km/hr,** the umbrella structure should be closed.
- The umbrella with a temporary anchorage system must be stored in an enclosed building when the forecasted wind speed exceeds **60 km/h**. However, it may remain outdoors if the required ballast, as specified in Sections 7.2 and 7.3, is provided. In contrast, the umbrella with a permanent anchorage system can remain closed on-site for forecasted wind speeds of up to **120 km/h**.
- 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 **830gr/m^2**.
- Aluminium alloy is to be **Alloy 6061-T6**.
- The **posts** for the four sizes of octagonal umbrellas (ranging from 2.0 m to 4.3 m) are specified as **40 x 3 mm**, as outlined in the HOME & CAFÉ UMBRELLA INFORMATION SHEET.
- The **arm** size is specified as **19 x 19 x 1.6 mm**, as per the HOME & CAFÉ UMBRELLA INFORMATION SHEET.
- The **arm support** size is specified as **15 x 15 x 1.6 mm**, according to the HOME & CAFÉ UMBRELLA INFORMATION SHEET.
- 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.
- 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)

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

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

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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*	*mm^2*	*mm^3*	*mm^3*	*mm^3*	*mm^3*	*mm^4*	*mm^4*	*mm^4*	*mm*	*mm*
[illegible]st 40 x 3	D 40 x 3	40	3	20.0	348.7	3003.3	3003.3	4116.0	4116.0	60066.5	60066	120132.9	13.1	13.1

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
Arms	19x19x1.6	19	19	1.6	9.5	111.4	596.5	596.5	728.7	728.7	5666.7	5666.7	8428.8	7.1	7.1
Arms' supports	15x15x1.6	15	15	1.6	7.5	85.8	347.1	347.1	433.0	433.0	2603.1	2603.1	3849.8	5.5	5.5

4 Wind Analysis

4.1 Wind calculations

PRIME CONSULTING ENGINEERS PTY. LTD

Project:	Ultra shade Home & Café Octagonal umbrellas		
Job no.	25-1257-2	***Designer:***	JK
Date:	04/03/2025	***Amendment:***	-

Name	Symbol	Value	Unit	Notes	Ref.
Input					
Importance level		2			*Table 3.1 - Table 3.2 (AS1170.0)*
Annual probability of exceedance		Temporary			*Table 3.3*
Regional gust wind speed		**60.12**	Km/hr		
Regional gust wind speed	V_R	16.7	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	$V_{Site,\beta}$	**15.20**	m/s	$V_{Site,\beta}=V_R*M_d*M_{z,cat}*M_S,M_t$	
Pitch	α	16.82	Deg		
Pitch	α	-	rad		
Width	B	3.9	m		
Length	D	3.9	m		
Height	Z	2.5	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}	**0.139**	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				*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**	$C_{P,w}$	0.4485333			
External Pressure Coefficient **MIN**	$C_{P,l}$	-0.4485333			
External Pressure Coefficient **MAX**	$C_{P,l}$	0			
aerodynamic shape factor **MIN**	$C_{fig,w}$	-0.30			
aerodynamic shape factor **MAX**	$C_{fig,w}$	0.45			
aerodynamic shape factor **MIN**	$C_{fig,l}$	-0.45			
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				*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	-0.042	0.062	-0.042	0.055
Leeward	-0.062	0.000	-0.055	0.000

4.2 Wind Load Diagrams

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

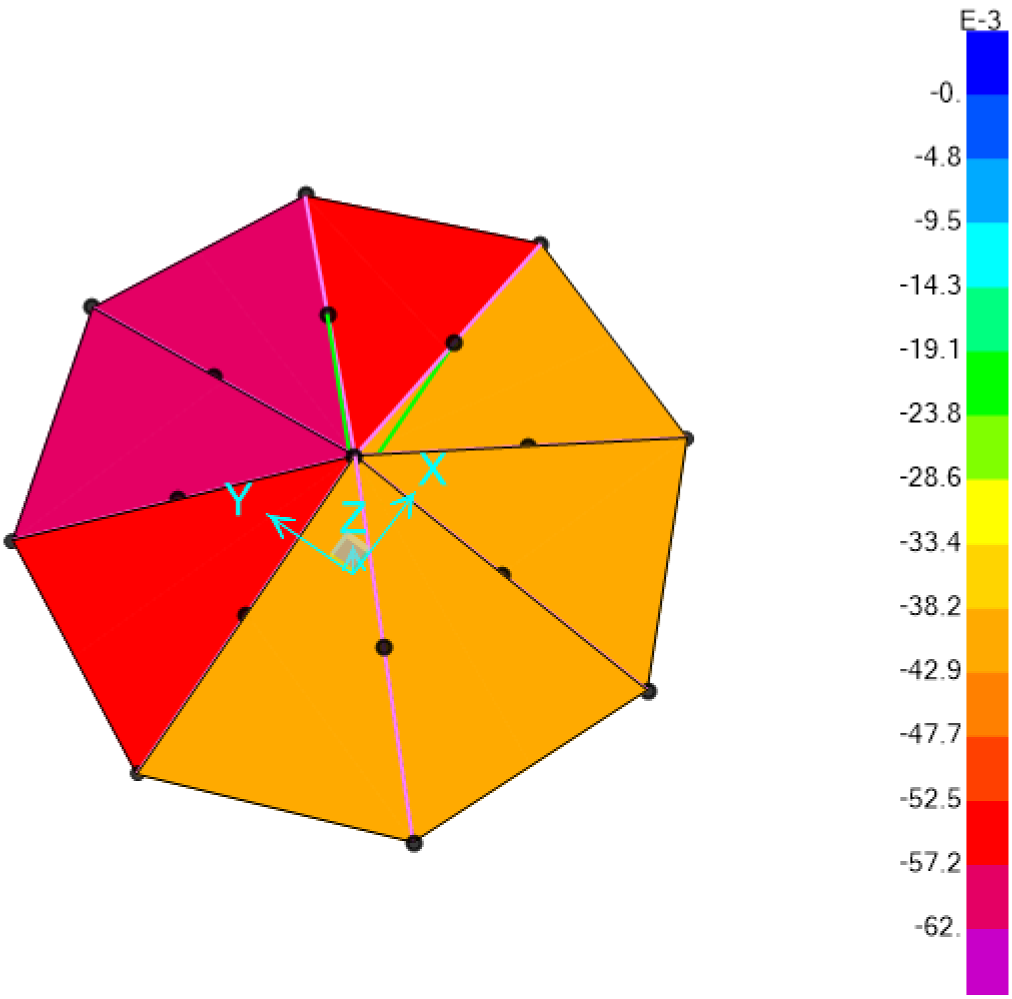

Figure 2 Wind Min (KN, m)

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

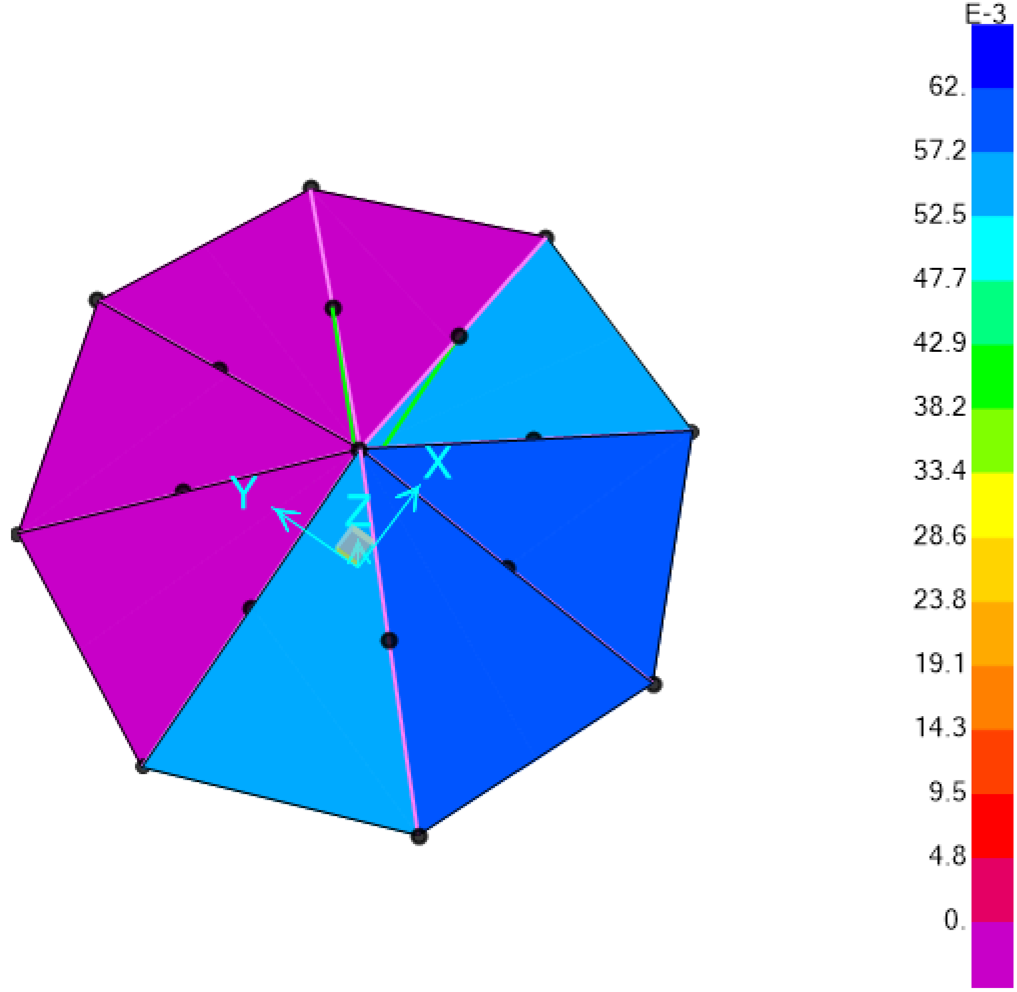

Figure 3 Wind Max

4.2.3 Wind Load – Closed Condition

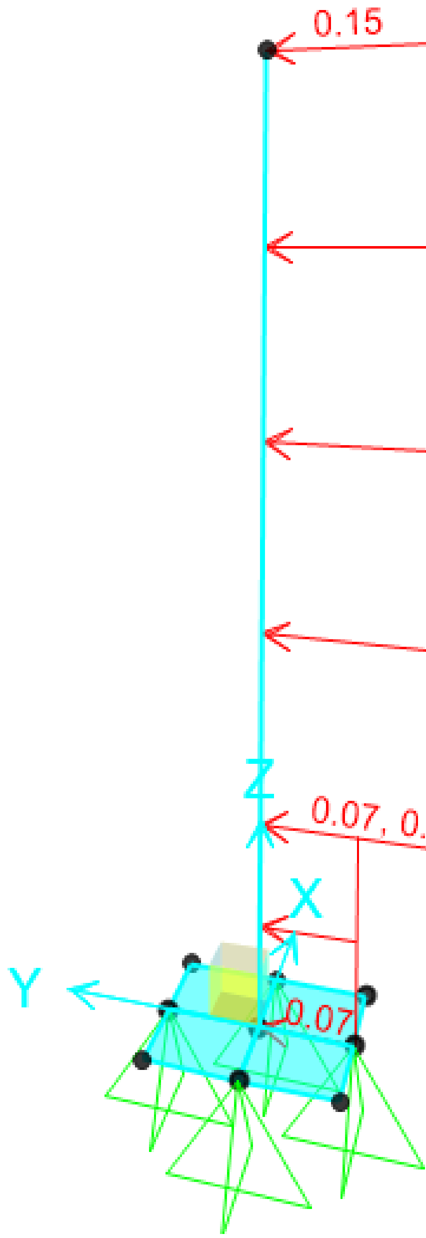

Figure 4 Wind Closed

5 Analysis

5.1 Results

5.1.1 Maximum Bending Moment in Major Axis

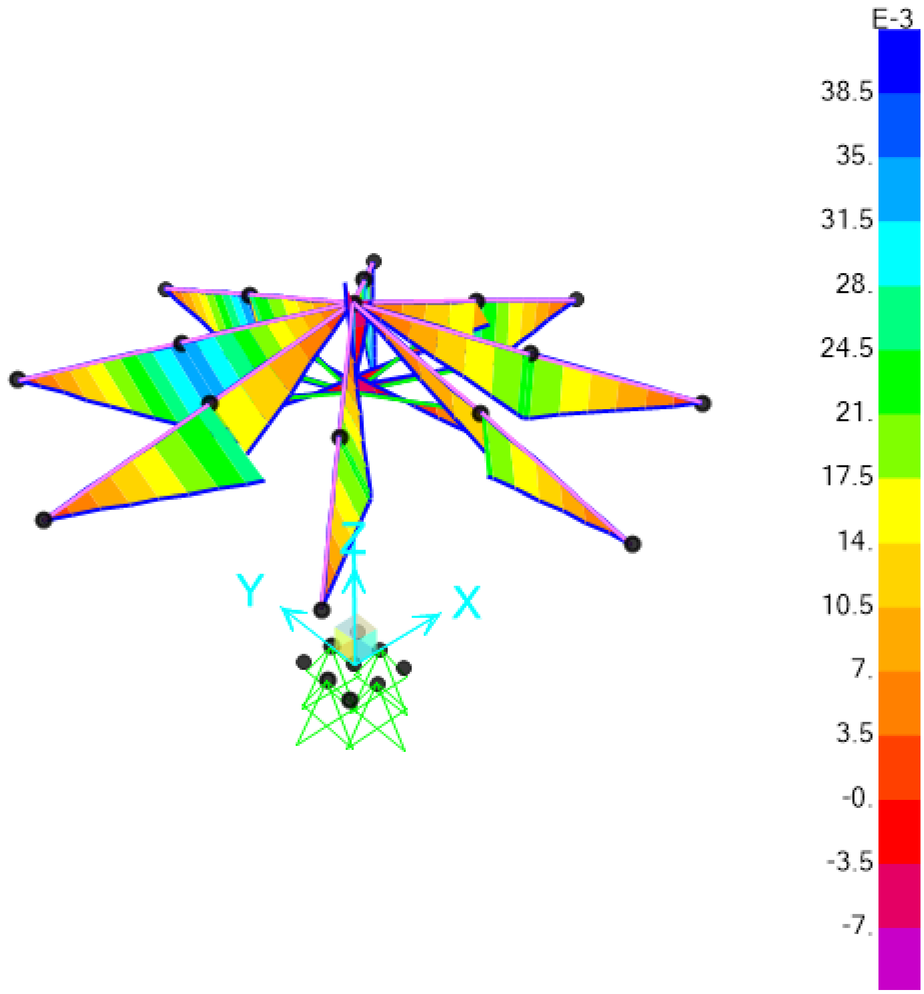

Figure 5 Maximum Bending Moment - Major

5.1.2 Maximum Bending Moment in Minor Axis

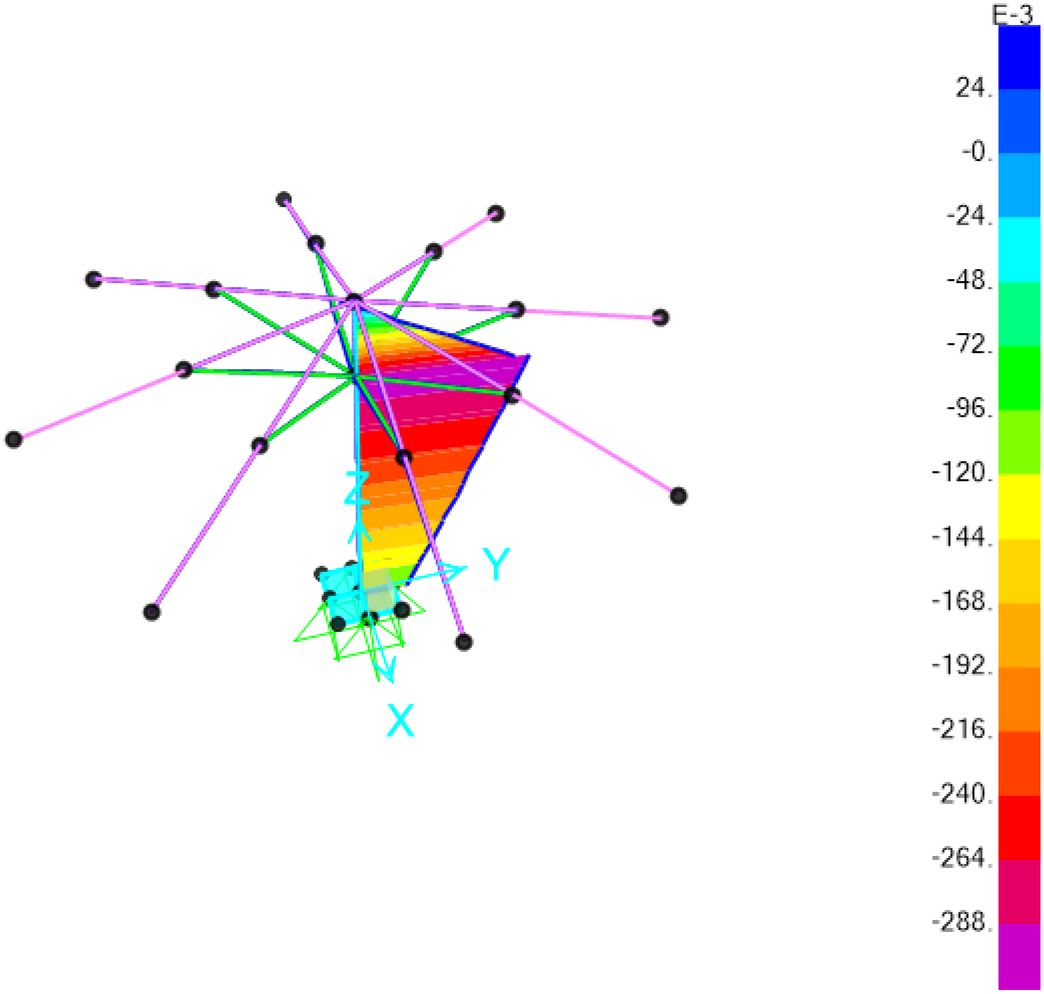

Figure 6: Maximum Bending Moment - Minor

5.1.3 Maximum Shear

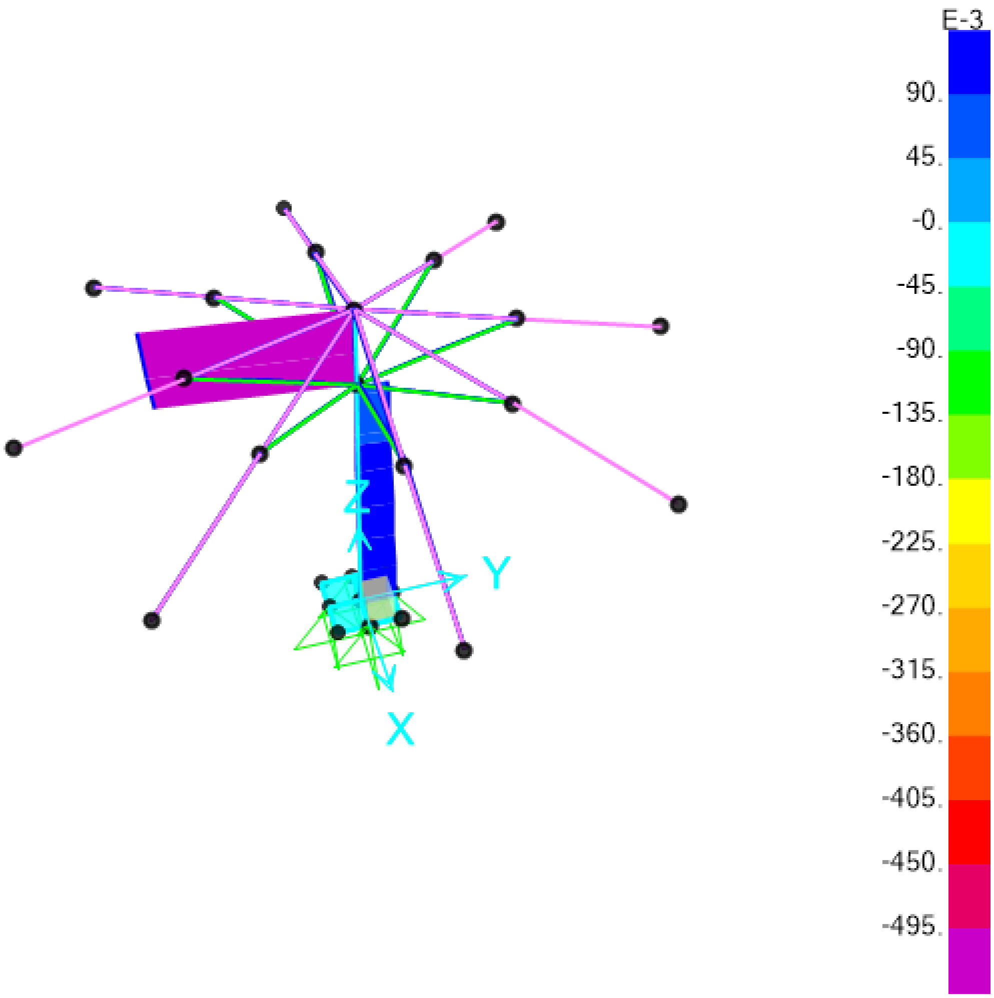

Figure 7 Maximum Shear

5.1.4 Maximum Axial Force

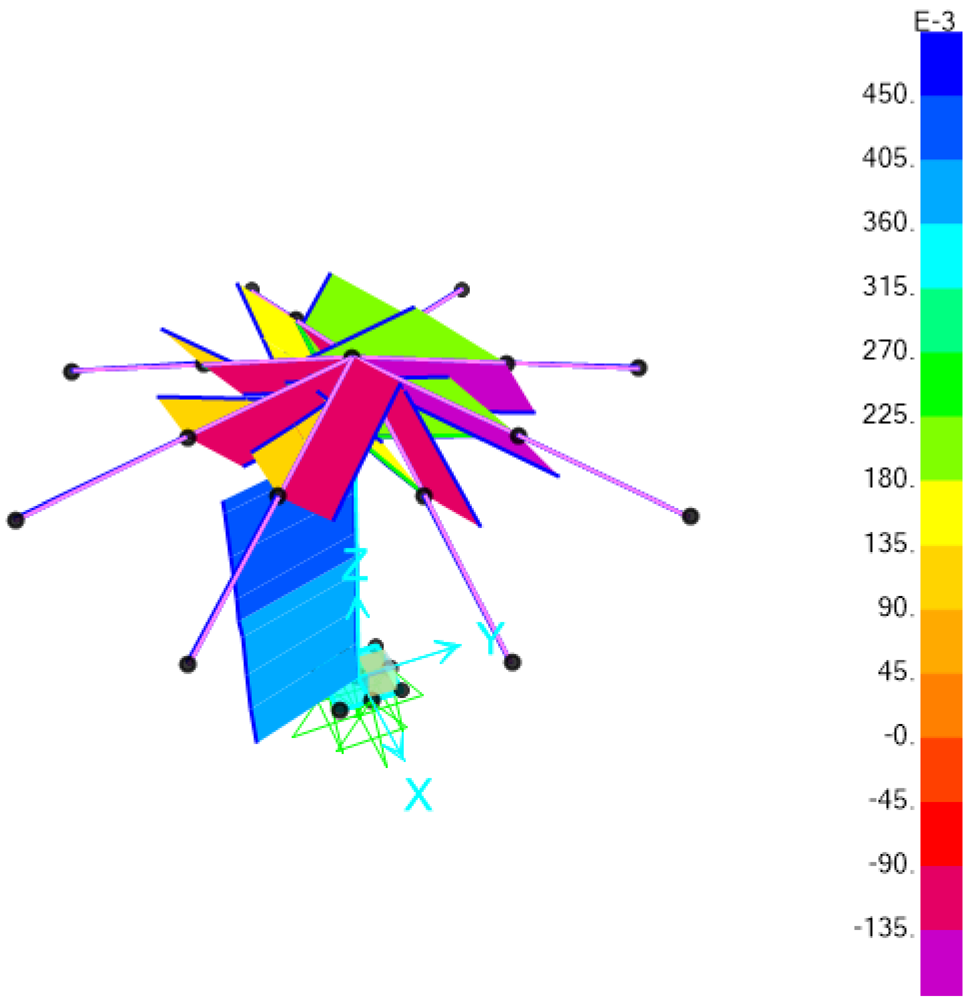

Figure 8 Maximum Axial Force

5.1.5 Maximum Reactions – Open (Temporary installation)

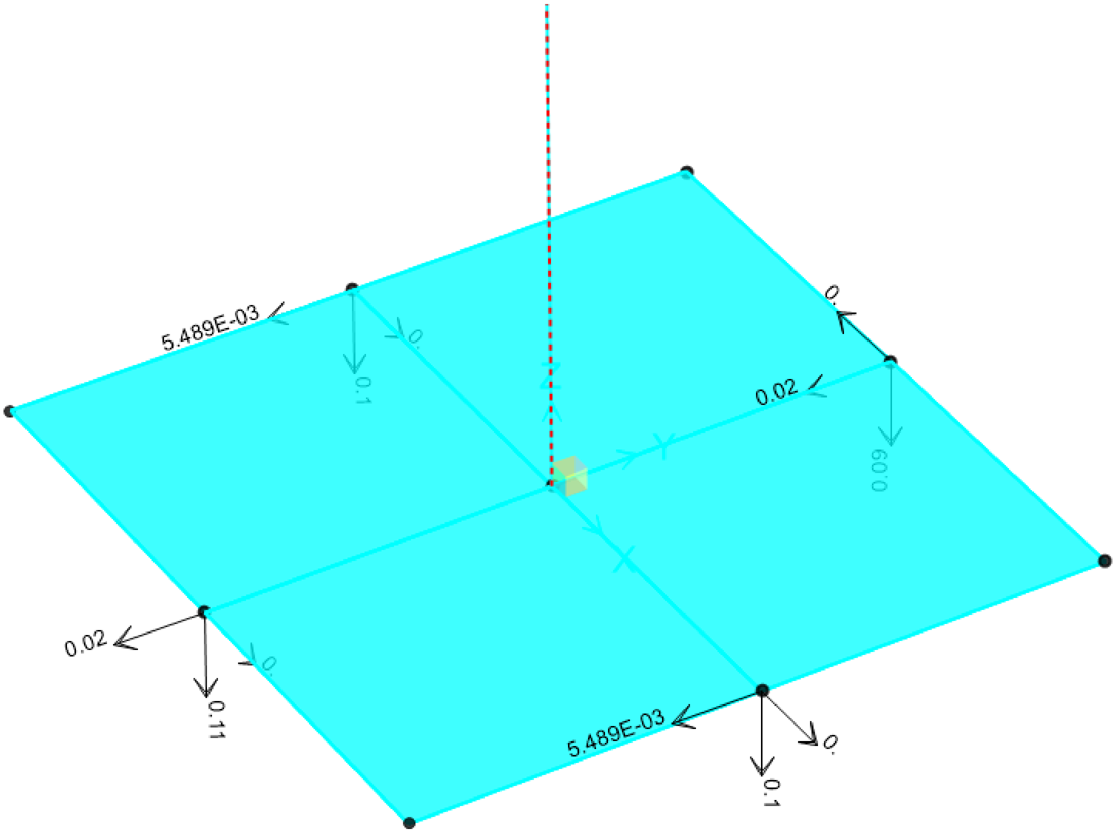

Figure 9 Maximum Reactions (opened)

Fx = 0.04 kN

Fy = 0.0 kN

$F_{z(up\ lift)}$ = 0.4 kN

$F_{z\ (Bearing)}$ = 0.71 kN

5.1.6 Maximum Reactions – Closed (Temporary installation)

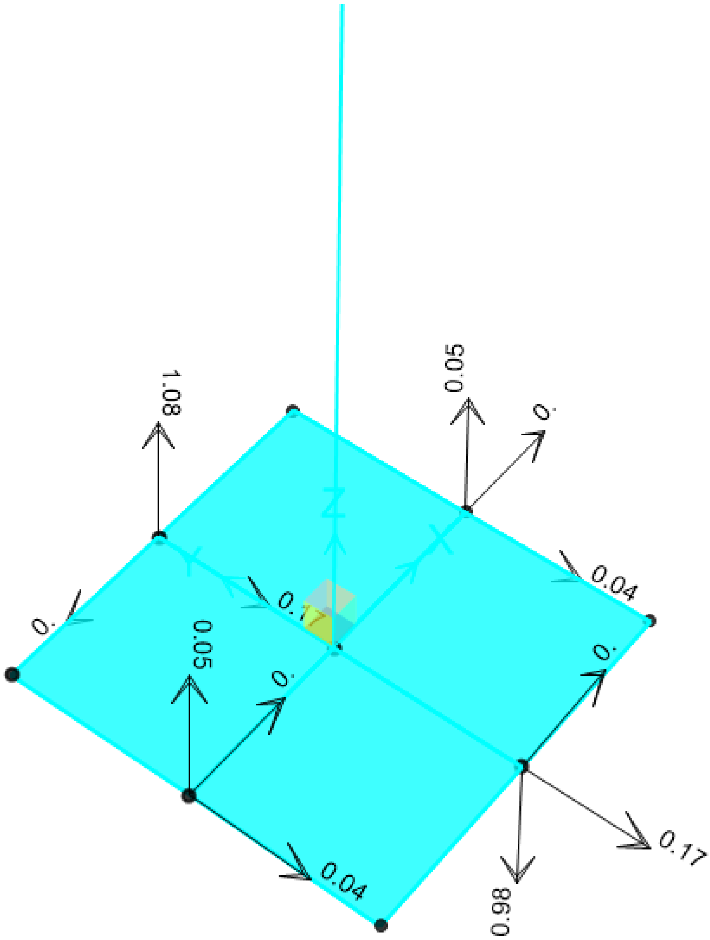

Figure 10 Maximum Reactions (Closed)

Fx = 0.00 kN

Fy = 0.08kN

$F_{z(up\ lift)}$ = 0.98 kN

$F_{z\ (Bearing)}$ = 1.08 kN

5.1.7 Maximum Reactions – Open (Permanent Installation)

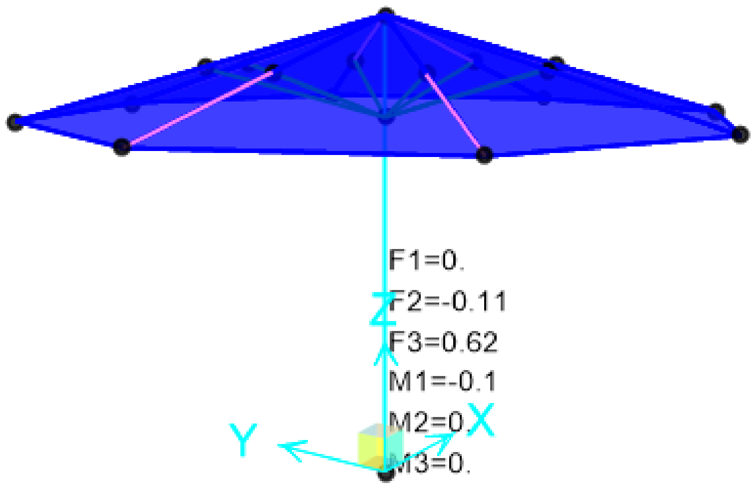

Figure 11: Maximum Reactions (Open-Permanent Installation)

5.1.8 Maximum Reactions – Closed (Permanent Installation)

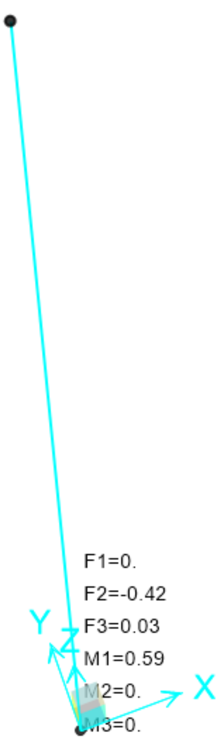

Figure 12: Maximum Reactions (Closed-Permanent Installation)

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	V_x	V_y	P (Axial) Compression (-) Tension (+)	Mx	My
		mm	*mm*	*kN*	*kN*	*kN*	*kN.m*	*kN.m*
Post 40 x 3	D 40 x 3	40	3	0.00	0.42	-0.03	0.00	0.59

MEMBER(S)	Section	b	d	t	V_x	V_y	P (Axial)	Mx	My
		mm	*mm*	*mm*	*kN*	*kN*	*kN*	*kN.m*	*kN.m*
Arms	19x19x1.6	19	19	1.6	-0.09	0.00	0.00	-0.06	0.00
Arms' supports	15x15x1.6	15	15	1.6	0.02	0.00	-0.32	-0.02	0.00

7 Anchor Design

7.1 Permanent Installation

Min. 250 x 250 x 8 Base Plate with Mechanical Anchors (bolted to min. 200mm thick concrete slab 32mPa)
Use 4 off **Allfasteners EF500R+ & Threaded Rod SS 316/A4-80M12** or equivalent. **This is applicable for all Home & café octagonal Umbrellas**.

Refer Appendix 'B' for details.

7.2 Temporary Installation with 570 x 570 x 8 G304 Stainless Steel Base Plate (3.5, 4, 4.3 m Octagonal Umbrellas)

Umbrella Structure	Umbrella condition	Max. wind Speed (km/h)	Uplift Force (KN)	Min Additional weight to counteract Uplift (kg)
4.3m Dia	Open	60	Total - 40 kg	2 x 20 kg (1 off 20 kg each side)
4.3m Dia	Close	120	Each side- 98 kg	2 x 98 kg (1 off 98kg each side)
4.0m Dia	Open	60	Total - 35 kg	2 x 18 kg (1 off 18 kg each side)
4.0m Dia	Close	120	Each side- 91 kg	2 x 91 kg (1 off 91 kg each side)
3.5m Dia	Open	60	Total - 27 kg	2 x 14 kg (1 off 14 kg each side)
3.5m Dia	Close	120	Each side- 80 kg	2 x 80 kg (1 off 91 kg each side)

7.3 Temporary Installation with 500 x 500 x 8 G304 Stainless Steel Base Plate (2.5, 3 m Octagonal Umbrellas)

Umbrella Structure	Umbrella condition	Max. wind Speed (km/h)	Uplift Force (KN)	Min Additional weight to counteract Uplift (kg)
3m Dia	Open	60	Total - 25 kg	2 x 12.5 kg (1 off 12.5 kg each side)
3m Dia	Close	120	Each side- 75 kg	2 x 75 kg (1 off 75 kg each side)
2.5m Dia	Open	60	Total - 20 kg	2 x 10 kg (1 off 10 kg each side)
2.5m Dia	Close	120	Each side- 63 kg	2 x 63 kg (1 off 63 kg each side)

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8 Summary and Recommendations

- The octagonal Umbrella Structures as specified are capable of withstanding **60 km/hr Wind Loads when open and 120 km/hr when folded.**
- The umbrella pole (40 x 3 mm) is designed to withstand the total wind loads at a wind velocity of **120 km/h.**
- 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 **120 Km/hr**.
- Refer to Cl. 7 for the ballast and anchorage requirements for temporary and permanent installations.

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 Post 40 x 3 mm

PRIME CONSULTING ENGINEERS PTY. LTD

Job no. 25-1257-2 **Date:** 04/03/2025

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
D 40 x 3	**Post 40 x 3**					
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	=	0.0311733	kN	*compression*	
	P	=	0	kN	*Tension*	
In plane moment	M_x	=	2.769E-17	kNm		
Out of plane moment	M_y	=	0.5881605	kNm		
DESIGN STRESSES						
Gross cross section area	A_g	**=**	348.71678	mm^2		
In-plane elastic section modulus	Z_x	**=**	3003.3233	mm^3		
Out-of-plane elastic section mod.	Z_y	**=**	3003.3233	mm^3		
Stress from axial force	$\mathbf{f_a}$	**=**	P/A_g			
		=	**0.09**	**MPa**	*compression*	
		=	**0.00**	**MPa**	*Tension*	
Stress from in-plane bending	$\mathbf{f_{bx}}$	**=**	M_x/Z_x			

		=	**0.00**	**MPa**	*compression*	
Stress from out-of-plane bending	f_{by}	**=**	M_y/Z_y			
		=	**195.84**	**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	=	2800	mm		
Effective length factor	k	=	1.00			
Radius of gyration about buckling axis (Y)	r_y	=	13.12	mm		
Radius of gyration about buckling axis (X)	r_x	=	13.12	mm		
Slenderness ratio	kLb/ry	=	213.34			
Slenderness ratio	kL/rx	=	213.34			
Slenderness parameter	λ	=	3.985			
	D_c*	=	90.3			
	S_1*	=	0.62			
	S_2*	=	1.23			
	ϕ_{cc}	=	0.950			
Factored limit state stress	**ϕF_L**	**=**	**14.42**	**MPa**		
2. Sections not subject to torsional or torsional-flexural buckling						3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	**=**	213.34			
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	=	18.5			
	t	**=**	3	mm		
Slenderness	R_m/t	**=**	6.1666667			
Limit 1	S_1	**=**	0.50			

Limit 2	S_2	=	672.46			
Factored limit state stress	**ϕF_L**	=	**246.29**	**MPa**		
Most adverse compressive limit state stress	F_a	=	14.42	MPa		
Most adverse tensile limit state stress	F_a	=	267.87	MPa		
Most adverse compressive & Tensile capacity factor	f_a/F_a	=	0.01		PASS	
BENDING - IN-PLANE						
***3.4.13** Compression in beams, extreme fibre, gross section round or oval tubes*						
Unbraced length for bending	L_b	=	2800	mm		
Second moment of area (weak axis)	I_y	=	6.01E+04	mm^4		
Torsion modulus	J	=	1.20E+05	mm^3		
Elastic section modulus	Z	=	3003.3233	mm^3		
	R_b/t	=	6.17			
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 - curved 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	=	18.5	mm		
	t	=	3	mm		
Slenderness	R_b/t	=	6.1666667			
Limit 1	S_1	=	2.75			
Limit 2	S_2	=	78.23			
Factored limit state stress	**ϕF_L**	=	**230.19**	**MPa**		
Most adverse in-plane bending limit state stress	F_{bx}	=	230.19	MPa		
Most adverse in-plane bending capacity factor	f_{bx}/F_{bx}	=	0.00		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	=	**230.19**	**MPa**		
Most adverse out-of-plane bending limit state stress	F_{by}	=	230.19	MPa		
Most adverse out-of-plane bending capacity factor	f_{by}/F_{by}	=	0.85		PASS	
COMBINED ACTIONS						
4.1.1 *Combined compression and bending*						4.1.1
	F_a	=	14.42	MPa		3.4.11
	F_{ao}	=	246.29	MPa		3.4.11
	F_{bx}	=	230.19	MPa		3.4.18
	F_{by}	=	230.19	MPa		3.4.18
	f_a/F_a	=	0.006			
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					4.1.1
i.e.	0.86	$\leq$	1.0		PASS	
SHEAR						
3.4.24 *Shear in webs (Major Axis)*						3.4.24
	R	=	20	mm		
	t	=	3	mm		
Equivalent h/t	h/t	=	32.65			
Limit 1	S_1	=	29.01			
Limit 2	S_2	=	59.31			
Factored limit state stress	ϕF_L	=	**127.41**	**MPa**		
Stress From Shear force	f_{sx}	=	V/A_w			
			0.00	**MPa**		
3.4.25 *Shear in webs (Minor Axis)*						3.4.24
Clear web height	R	=	20	mm		
	t	=	3	mm		
Equivalent h/t	h/t	=	32.65			
Factored limit state stress	ϕF_L	=	**127.41**	**MPa**		

Stress From Shear force	f_{sy}	=	V/A_w			
			2.41	**MPa**		
Most adverse shear capacity factor (Major Axis)	f_{sx}/F_{sx}	=	0.00	**MPa**		
Most adverse shear capacity factor (Minor Axis)	f_{sy}/F_{sy}	=	0.02	**Mpa**	PASS	
COMBINED ACTIONS						
***4.4** Combined Shear, Compression and bending*						4.4
Check: $f_a/F_a + f_b/F_b + (f_s/F_s)^2 \leq 1.0$						
i.e. 0.86 ≤ 1.0					PASS	

9.2 Arms (19 x 19 x 1.6 mm)

PRIME CONSULTING ENGINEERS PTY. LTD

Job no. 24-1257-2 **Date:** 04/03/2025

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
19x19x1.6	**Arms**					
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	=	0.0040118	kN	*Tension*	

In plane moment	M_x	=	0.0606205	kNm		
Out of plane moment	M_y	=	6.471E-10	kNm		
DESIGN STRESSES						
Gross cross section area	A_g	=	111.36	mm^2		
In-plane elastic section modulus	Z_x	=	596.49886	mm^3		
Out-of-plane elastic section mod.	Z_y	=	596.49886	mm^3		
Stress from axial force	f_a	=	P/A_g			
		=	**0.00**	**MPa**	*compression*	
		=	**0.04**	**MPa**	*Tension*	
Stress from in-plane bending	f_{bx}	=	M_x/Z_x			
		=	**101.63**	**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	=	2.2	mm		
Effective length factor	k	=	1.00			
Radius of gyration about buckling axis (Y)	r_y	=	7.13	mm		
Radius of gyration about buckling axis (X)	r_x	=	7.13	mm		
Slenderness ratio	kLb/ry	=	0.31			
Slenderness ratio	kL/rx	=	0.31			
Slenderness parameter	λ	=	0.006			
	D_c*	=	90.3			
	S_1*	=	0.33			
	S_2*	=	1.23			
	ϕ_{cc}	=	0.950			
Factored limit state stress	**ϕF_L**	**=**	**228.95**	**MPa**		
2. Sections not subject to torsional or torsional-flexural buckling						… 3.4.8.2

Largest slenderness ratio for flexural buckling	kL/r	=	0.31			
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'	=	15.8			
	t	=	1.6	mm		
Slenderness	b/t	=	9.875			
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	=	228.95	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	=	2.2	mm		
Second moment of area (weak axis)	I_y	=	5.67E+03	mm^4		
Torsion modulus	J	=	8.43E+03	mm^3		
Elastic section modulus	Z	=	596.49886	mm^3		
Slenderness	S	=	0.38			
Limit 1	S_1	=	0.39			
Limit 2	S_2	=	1695.86			
Factored limit state stress	**ϕF_L**	=	**228.95**	**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'	=	15.8	mm		
	t	=	1.6	mm		
Slenderness	b/t	=	9.875			
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}	=	228.95	MPa		
Most adverse in-plane bending capacity factor	f_{bx}/F_{bx}	=	0.44		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**	=	**228.95**	**MPa**		
Most adverse out-of-plane bending limit state stress	**F_{by}**	=	228.95	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	=	228.95	MPa		… 3.4.8
	F_{ao}	=	228.95	MPa		… 3.4.10
	F_{bx}	=	228.95	MPa		… 3.4.17
	F_{by}	=	228.95	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.	0.44	≤	1.0		PASS	
SHEAR						
3.4.24 *Shear in webs (Major Axis)*						… 4.1.1(2)
Clear web height	h	=	15.8	mm		
	t	=	1.6	mm		
Slenderness	h/t	=	9.875			

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			
			0.98	**MPa**		
***3.4.25** Shear in webs (Minor Axis)*						
Clear web height	b	=	15.8	mm		
	t	=	1.6	mm		
Slenderness	b/t	=	9.875			
Factored limit state stress	**ϕF_L**	=	**131.10**	**MPa**		
Stress From Shear force	**f_{sy}**	=	V/A_w			
			0.00	**MPa**		
Most adverse shear capacity factor (Major Axis)	f_{sx}/F_{sx}	=	0.01	**MPa**		
Most adverse shear 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.	0.44	$\leq$	1.0		PASS	

9.3 Arm's support (15 x 15 x 1.6 mm)

PRIME CONSULTING ENGINEERS PTY. LTD

Job no. 25-1257-2 **Date:** 04/03/2025

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
15x15x1.6	**Arms' supports**					
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	=	0.3159677	kN	*compression*	
	P	=	0	kN	*Tension*	
In plane moment	M_x	=	0.0188445	kNm		
Out of plane moment	M_y	=	6.868E-05	kNm		
DESIGN STRESSES						
Gross cross section area	A_g	**=**	85.76	mm^2		
In-plane elastic section modulus	Z_x	**=**	347.08025	mm^3		
Out-of-plane elastic section mod.	Z_y	**=**	347.08025	mm^3		
Stress from axial force	$\mathbf{f_a}$	**=**	P/A_g			
		=	**3.68**	**MPa**	*compression*	
		=	**0.00**	**MPa**	*Tension*	
Stress from in-plane bending	$\mathbf{f_{bx}}$	**=**	M_x/Z_x			
		=	**54.29**	**MPa**	*compression*	
Stress from out-of-plane bending	$\mathbf{f_{by}}$	**=**	M_y/Z_y			
		=	**0.20**	**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	=	1.1	mm		
Effective length factor	k	=	1.00			
Radius of gyration about buckling axis (Y)	r_y	=	5.51	mm		

Radius of gyration about buckling axis (X)	r_x	=	5.51	mm		
Slenderness ratio	kLb/ry	=	0.20			
Slenderness ratio	kL/rx	=	0.20			
Slenderness parameter	λ	=	0.004			
	D_c*	=	90.3			
	S_1*	=	0.33			
	S_2*	=	1.23			
	ϕ_{cc}	=	0.950			
Factored limit state stress	**ϕF_L**	**=**	**228.95**	**MPa**		
2. Sections not subject to torsional or torsional-flexural buckling						… 3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	0.20			
***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'	=	11.8			
	t	=	1.6	mm		
Slenderness	b/t	=	7.375			
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	=	228.95	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	=	1.1	mm		
Second moment of area (weak axis)	I_y	=	2.60E+03	mm^4		

Torsion modulus	J	=	3.85E+03	mm^3		
Elastic section modulus	Z	=	347.08025	mm^3		
Slenderness	S	=	0.24			
Limit 1	S_1	=	0.39			
Limit 2	S_2	=	1695.86			
Factored limit state stress	**ϕF_L**	=	**228.95**	**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'	=	11.8	mm		
	t	=	1.6	mm		
Slenderness	b/t	=	7.375			
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}	=	228.95	MPa		
Most adverse in-plane bending capacity factor	f_{bx}/F_{bx}	=	0.24		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**	=	**228.95**	**MPa**		
Most adverse out-of-plane bending limit state stress	**F_{by}**	=	228.95	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	=	228.95	MPa		… 3.4.8
	F_{ao}	=	228.95	MPa		… 3.4.10
	F_{bx}	=	228.95	MPa		… 3.4.17

	F_{by}	=	228.95	MPa		… 3.4.17
	f_a/F_a	=	0.016			
Check:	$f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$					… 4.1.1 (3)
i.e.	0.25	≤	1.0		PASS	
SHEAR						
***3.4.24** Shear in webs (Major Axis)*						… 4.1.1(2)
Clear web height	h	=	11.8	mm		
	t	=	1.6	mm		
Slenderness	h/t	=	7.375			
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			
			0.29	**MPa**		
***3.4.25** Shear in webs (Minor Axis)*						
Clear web height	b	=	11.8	mm		
	t	=	1.6	mm		
Slenderness	b/t	=	7.375			
Factored limit state stress	ϕF_L	=	**131.10**	**MPa**		
Stress From Shear force	f_{sy}	=	V/A_w			
			0.00	**MPa**		
Most adverse shear capacity factor (Major Axis)	f_{sx}/F_{sx}	=	0.00	**MPa**		
Most adverse shear 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.	0.25	≤	1.0		PASS	

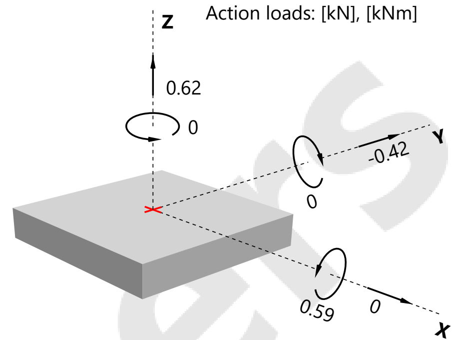
10 Appendix B – Anchorage Design

Company:		E-mail:	
Designer:		Phone:	
Address:		Fax:	
Project:		Date:	3/3/2025
Comments:		Page:	1 / 7

1. Input Data

Selected anchors:

- Allfasteners EF500R+ & Threaded Rod SS 316/A4-80 M12
  Injection anchor Epoxy
  Stainless steel A4/316, CRC III
  Design based on AS 5216
- Assessment ETA-20/0583
  Issued by ZUS, on 8/17/2021
- Effective anchorage depth h_{ef} = 75 mm
- Drilled hole Φ x h_0 = 14.0 x 75 mm



Base material:

- Cracked concrete, Thickness of base material h=200mm
  Strength class 32MPa, f'_c=32.0N/mm²
- Wide concrete reinforcement
  Rebar spacing a≥150mm for all Ø or a≥100mm for Ø≤10mm
- No edge and stirrup reinforcement
- Long-term temperature 24°C, Short-term temperature 40°C
- Hammer drilled, dry hole

Action loads:

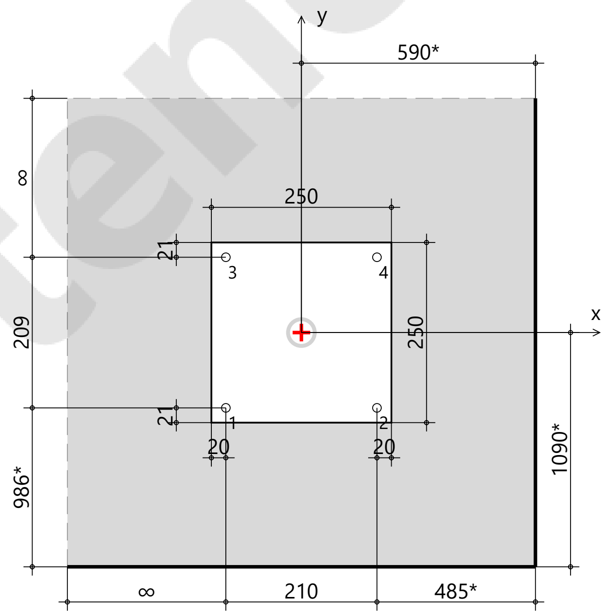
- Predominantly static and quasi-static design loads, α_{sus}=0.6

Installation:

- Base plate lies on the concrete surface directly
- Without gap filling

Base plate:

- G300, E=200000N/mm²
  f_y=300N/mm², ϕ_s=0.741, f_{yd}= $\phi_s \cdot f_y$
- Assumed: elastic plate
- Current thickness: 8.0mm
  σ/f_{yd} =192.1/222.2=86.4%
- Rectangle
  Side length: 250 x 250 mm

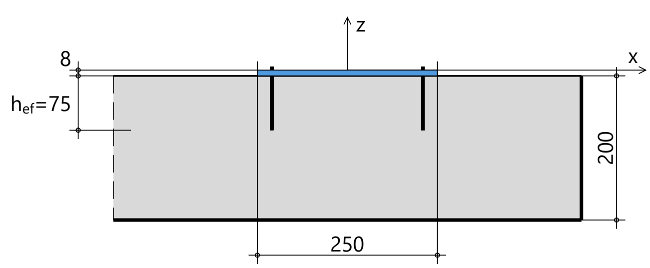


Profile:

- Circular Hollow Section: Geometry user-defined
  H x W x T x FT [mm]: 40 x 40 x 3.0 x 0.0
  Action point [mm]: [0, 0]
  Rotation counterclockwise: 0°
- No profile stiffness

Coordinates of anchors [mm]:

No.	x	y	Slotted hole L-x	L-y
1	-104.9	-104.5		
2	104.9	-104.5		
3	-104.9	104.5		
4	104.9	104.5		

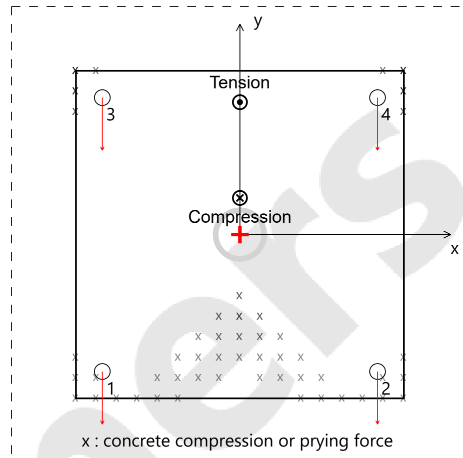


(* drawn not to scale)

2. Anchor internal forces [kN]

Tension load of anchors is calculated with elastic base plate.
Assumed: Anchor stiffness factor 1.00 ⟶ Anchor spring constant C_g = 212.3 kN/mm.
Assumed: coefficient for concrete bedding factor b = 15.0 ⟶ concrete bedding factor Cc = b · fc = 480.0 N/mm³

Anchor No.	Tension N_i	Shear V_i	Shear x	Shear y
1	0.067	0.105	0.000	-0.105
2	0.067	0.105	0.000	-0.105
3	3.981	0.105	0.000	-0.105
4	3.981	0.105	0.000	-0.105

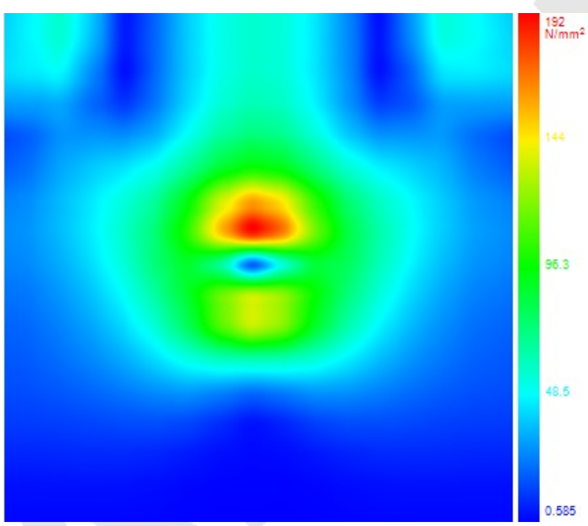


Maximum plate displacement into concrete (x/y=-125.0/125.0): 0.007 [mm]
Maximum concrete compressive stress: 3.15 [N/mm²]
Mean concrete compressive stress: 0.69 [N/mm²]
Resultant tension force in (x/y=0.0/101.0): 8.097 [kN]
Resultant compression force in (x/y=0.0/28.0): 7.477 [kN]
Remark: The edge distance is not to scale.

Displacement and rotation of profile on base plate *)
Displacement δ_z (+ve out of concrete): 0.190 [mm]
Rotation θ_x: 6.993 [mrad]
Rotation θ_y: 0.000 [mrad]

*) Calculated using the best fit plane

Bending stresses in the base plate



Concrete compression stresses under the base plate

3. Verification at ultimate limit state based on AS 5216

3.1 Tension load

	Related anchor	Action [kN]	Resistance [kN]	Utilization [%]	Status
Steel failure	3,4	3.981	41.875	9.5	√
Combined failure	3,4	7.963	28.819	**27.6**	√
Combined failure e *)	-	-	-	-	not applicable
Concrete cone failure	3,4	7.963	48.446	16.4	√
Concrete cone failure e *)	-	-	-	-	not applicable
Splitting failure	-	-	-	-	not applicable

*) additional proof for the fastening with elastic base plate

Steel failure

$N_{Rd,s} = N_{Rk,s} \cdot \phi_{s,N}$ $\beta_{N,s} = N^* / N_{Rd,s}$

$N_{Rk,s}$ [kN]	$\phi_{s,N}$	$N_{Rd,s}$ [kN]	N^* [kN]	$\beta_{N,s}$
67.0	0.625	41.875	3.981	0.095

Combined pull-out and concrete cone failure

$N_{Rk,Np}=N^0_{Rk,p} \cdot \psi_{A,Np} \cdot \psi_{s,Np} \cdot \psi_{g,Np} \cdot \psi_{ec,Np} \cdot \psi_{re,Np}$ $N^0_{Rk,p} = \psi_{sus} \cdot \pi \cdot d \cdot l_b \cdot \tau_{Rk} \cdot \psi_c$ [N] $\psi_{A,Np} = A_{p,N}/A^0_{p,N}$ $N_{Rd,Np} = N_{Rk,Np} \cdot \phi_{p,N}$

$s_{cr,Np} = 7.3 \cdot d \cdot (\psi_{sus} \cdot \tau_{Rk,ucr})^{0.5} \leq 3 \cdot l_b$ $\psi_{g,Np} = \psi^0_{g,Np} - (s_m / s_{cr,Np})^{0.5} \cdot (\psi^0_{g,Np} - 1) \geq 1.0$

$\psi^0_{g,Np} = n^{0.5} - (n^{0.5} - 1) \cdot (\tau_{Rk} / \tau_{Rk,c})^{1.5} \geq 1.0$ $\tau_{Rk,c} = k_3 \cdot (h_{ef} \cdot f'_c)^{0.5} / (\pi \cdot d)$ $\psi^0_{sus} = 0.72$ $\alpha_{sus} = 0.6$ $\psi_{sus} = 1.0$

τ_{Rk} [N/mm²]	$\tau_{Rk,ucr}$ [N/mm²]	ψ_c	d [mm]	k_3	f'_c [N/mm²]	h_{ef} [mm]	$s_{cr,Np}$ [mm]	$c_{cr,Np}$ [mm]	l_b [mm]	$\phi_{p,N}$	$\tau_{Rk,c}$ [N/mm²]
7.5	13.0	1.048	12.0	7.7	32	75.4	226.2	113.1	75.4	0.667	10.033

$N^0_{Rk,p}$ [kN]	$A_{p,N}$ [mm²]	$A^0_{p,N}$ [mm²]	$\psi_{A,Np}$	$\psi_{s,Np}$	c_{min} [mm]
22.342	98536	51166	1.926	1.000	485.1

n	$\psi^0_{g,Np}$	s_m [mm]	$\psi_{g,Np}$	$\psi_{re,Np}$	$e_{Np,x}$ [mm]	$e_{Np,y}$ [mm]	$\psi_{ec,Np,x}$	$\psi_{ec,Np,y}$	$\psi_{ec,Np}$	$N_{Rk,Np}$ [kN]	$N_{Rd,Np}$ [kN]	N^* [kN]	$\beta_{N,p}$
2	1.127	209.8	1.005	1.0	0.0	0.0	1.000	1.000	1.000	43.228	28.819	7.963	0.276

Combined failure for single anchor (additional proof for the fastening with elastic base plate)
Verification is not required.

Concrete cone failure

$N_{Rk,c}=N^0_{Rk,c} \cdot \psi_{A,N} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec,N} \cdot \psi_{M,N}$ $N^0_{Rk,c} = k_1 \cdot (f'_c)^{0.5} \cdot h_{ef}^{1.5}$ [N] $\psi_{A,N} = A_{c,N}/A^0_{c,N}$ $N_{Rd,c} = N_{Rk,c} \cdot \phi_{c,N}$

$N^0_{Rk,c}$ [kN]	$A_{c,N}$ [mm²]	$A^0_{c,N}$ [mm²]	$\psi_{A,N}$	k_1	$\phi_{c,N}$	h_{ef} [mm]	$s_{cr,N}$ [mm]	$c_{cr,N}$ [mm]
28.518	98536	51166	1.926	7.7	0.667	75.4	226.2	113.1

$\psi_{s,N}$	$\psi_{re,N}$	$e_{N,x}$ [mm]	$e_{N,y}$ [mm]	$\psi_{ec,N,x}$	$\psi_{ec,N,y}$	$\psi_{ec,N}$	$\psi_{M,N}$	$N_{Rk,c}$ [kN]	$N_{Rd,c}$ [kN]	N^* [kN]	$\beta_{N,c}$
1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.323	72.669	48.446	7.963	0.164

Concrete cone failure for single anchor (additional proof for the fastening with elastic base plate)
Verification is not required.

Splitting

Verification of splitting failure is not necessary, because:

- The smallest edge distance of anchor is $c \geq 1.2\ c_{cr,sp}$.

3.2 Shear

	Related anchor	Action [kN]	Resistance [kN]	Utilization [%]	Status
Steel failure (without l. arm)	1,2,3,4	0.105	25.564	**0.4**	√
Pry-out	1,2,3,4	0.420	111.703	0.4	√
Concrete edge failure (x+)	1,2,3,4	0.420	142.791	0.3	√

Steel failure without lever arm

$V_{Rd,s} = V_{Rk,s} \cdot k_7 \cdot \phi_{s,V}$ $\beta_{V,s} = V^* / V_{Rd,s}$

$V_{Rk,s}$ [kN]	k_7	$\phi_{s,V}$	$V_{Rd,s}$ [kN]	V^* [kN]	$\beta_{V,s}$
34.0	1.0	0.752	25.564	0.105	0.004

Pry-out failure ($N_{Rk,p}$ Decisive)

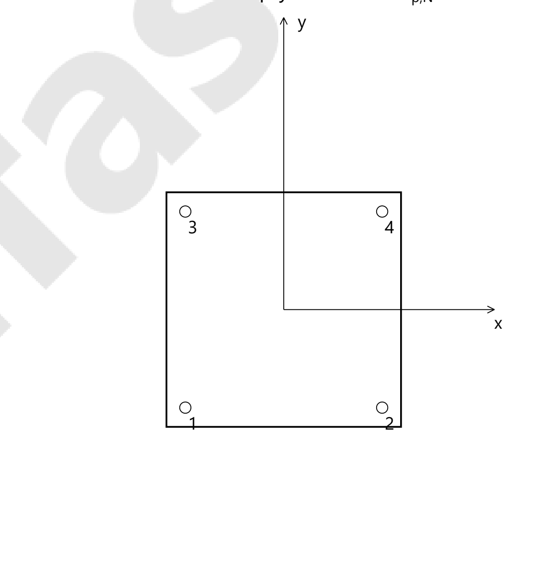
$N_{Rk,p}=N^0_{Rk,p} \cdot \psi_{A,Np} \cdot \psi_{s,Np} \cdot \psi_{g,Np} \cdot \psi_{re,Np} \cdot \psi_{ec,V,cp}$ $N^0_{Rk,p} = \pi \cdot d \cdot l_b \cdot \tau_{Rk} \cdot \psi_c$ [N] $V_{Rk,cp}=k_8 \cdot N_{Rk,p}$ $V_{Rd,cp} = V_{Rk,cp} \cdot \phi_{cp,V}$

h_{ef} [mm]	$\tau_{Rk,ucr}$ [N/mm²]	$s_{cr,Np}$ [mm]	$c_{cr,Np}$ [mm]	d [mm]	l_b [mm]	τ_{Rk} [N/mm²]	ψ_c	k_8	$\phi_{cp,V}$
75.4	13.0	226.2	113.1	12.0	75.4	7.5	1.048	2.0	0.667

$N^0_{Rk,p}$ [kN]	$A_{p,N}$ [mm²]	$A^0_{p,N}$ [mm²]	$\psi_{A,Np}$	$\psi^0_{g,Np}$	s_m [mm]	$\psi_{g,Np}$	ψ_{sus}
22.342	189660	51166	3.707	1.307	209.4	1.012	

$\psi_{s,Np}$	$\psi_{re,Np}$	$e_{V,cp,x}$ [mm]	$e_{V,cp,y}$ [mm]	$\psi_{ec,V,cp,x}$	$\psi_{ec,V,cp,y}$	$\psi_{ec,V,cp}$	$N_{Rk,p}$ [kN]	$V_{Rk,cp}$ [kN]	$V_{Rd,cp}$ [kN]	V^* [kN]	$\beta_{V,cp}$
1.0	1.0	0.0	0.0	1.0	1.0	1.0	83.777	167.555	111.703	0.420	0.004

Related area for calculation of pry-out failure $A_{p,N}$:



Remark: Edge distance (+x, -y) is not to scale.

Concrete edge failure, direction x+

$V_{Rk,c}=V^0_{Rk,c} \cdot \psi_{A,V} \cdot \psi_{s,V} \cdot \psi_{h,V} \cdot \psi_{\alpha,V} \cdot \psi_{ec,V} \cdot \psi_{re,V}$ $V^0_{Rk,c} = k_9 \cdot d^{\alpha} \cdot l_f^{\beta} \cdot (f'_c)^{0.5} \cdot c_1^{1.5}$ [N] $\psi_{A,V} = A_{c,V}/A^0_{c,V}$ $V_{Rd,c} = V_{Rk,c} \cdot \phi_{c,V}$

l_f = min(h_{ef}, 12d) $\alpha = 0.1 \cdot (l_f / c_1)^{0.5}$ $\beta = 0.1 \cdot (d / c_1)^{0.2}$

h_{ef} [mm]	k_9	f'_c [N/mm²]	$\phi_{c,V}$	c_1 [mm]	c'_1 [mm]	α	β	$V^0_{Rk,c}$ [kN]	$\psi_{s,V}$	d [mm]	l_f [mm]
75.4	1.7	32	0.667	694.9	-	0.033	0.044	231.646	0.984	12.0	75.4

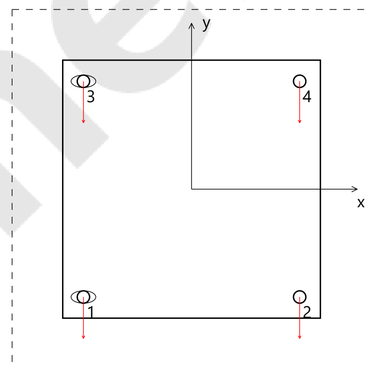
$A_{c,V}$ [mm²]	$A^0_{c,V}$ [mm²]	$\psi_{A,V}$	$\psi_{h,V}$	$\psi_{\alpha,V}$	e_V [mm]	$\psi_{ec,V}$	$\psi_{re,V}$	$V_{Rk,c}$ [kN]	$V_{Rd,c}$ [kN]	V* [kN]	$\beta_{V,c}$
447370	2172987	0.206	2.283	2.000	0.0	1.000	1.000	214.186	142.791	0.420	0.003

Concrete edge x+ : 2 nearby anchors (except the anchor(s) with slotted hole(s) in x-direction) in the first row are assumed to bear the shear load perpendicular to the edge, if there are more than 2 anchors in the row.

The worst case: The anchors 2 and 4 bear the shear load perpandicular to the edge (x+). The torsional moment is carried by all anchors.

Shear forces [kN]:

Anchor No.	Q	Qx	Qy	Qx_V	Qy_V	Qx_T	Qy_T
1	0.105	0.000	-0.105	0.000	-0.105	0.000	0.000
2	0.105	0.000	-0.105	0.000	-0.105	0.000	0.000
3	0.105	0.000	-0.105	0.000	-0.105	0.000	0.000
4	0.105	0.000	-0.105	0.000	-0.105	0.000	0.000



Explanation:
1. Qx_V, Qy_V are the x- and y-components of Anchor forces from the shear loads.
2. Qx_T, Qy_T are the x- and y-components of Anchor forces from the torsional moment.
3. The assumed slotted holes showed in the figure are not active for the calculation of shear force components Qx_T and Qy_T from the torsional moment. They serve as only for the calculation of shear load components from Qx_V and Qy_V.
4. Edge distance is not to scale.

3.3 Combined tension and shear

	Anchor	Tension(β_N)	Shear(β_V)	Condition	Utilization [%]	Status
Steel	3,4	0.095	0.004	$\beta^2_N + \beta^2_V \leq 1.0$	0.9	√
Concrete	3,4	0.276	0.004	$\beta^{1.5}_N + \beta^{1.5}_V \leq 1.0$	**14.5**	√

Anchor-related utilization

A-No.	$\beta_{N,s}$	$\beta_{N,p}$	$\beta_{N,ep}$	$\beta_{N,c}$	$\beta_{N,ec}$	$\beta_{N,sp}$	$\beta_{V,s}$	$\beta_{V,cp}$	$\beta_{V,c}$	$\beta_{N,c,max,E}$	$\beta_{V,c,max,E}$	$\boldsymbol{\beta_{combi,c,E}}$	$\boldsymbol{\beta_{combi,s,E}}$
1	0.002	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.003	0.000	0.004	0.000	0.000
2	0.002	0.000	0.000	0.000	0.000	0.000	0.004	0.004	0.003	0.000	0.004	0.000	0.000
3	0.095	0.276	0.000	0.164	0.000	0.000	0.004	0.004	0.003	0.276	0.004	0.145	0.009
4	0.095	0.276	0.000	0.164	0.000	0.000	0.004	0.004	0.003	0.276	0.004	0.145	0.009

$\beta_{N,c,max,E}$: Highest utilization of individual anchors under tension loading except steel failure
$\beta_{V,c,max,E}$: Highest utilization of individual anchors under shear loading except steel failure
$\beta_{combi,c,E}$: Utilization of individual anchors under combined tension and shear loading except steel failure
$\beta_{combi,s,E}$: Utilization of individual anchors under combined tension and shear loading at steel failure

4. Displacement

Tension loading: $\tau^{*h} = N^{*h} / (\pi \cdot d \cdot l_b)$

Short-term displacement: $\delta_N^0 = (\delta_{N0} \cdot \tau^{*h}) / 1.4$

Long-term displacement: $\delta_N^{\infty} = (\delta_{N\infty} \cdot \tau^{*h}) / 1.4$

Shear loading: $V_k^h = V^{*h} / 1.4$

Short-term displacement: $\delta_V^0 = V_k^h \cdot \delta_{V0}$

Long-term displacement: $\delta_V^{\infty} = V_k^h \cdot \delta_{V\infty}$

N^{*h} [kN]	τ^{*h} [N/mm²]	δ_{N0} [mm³/N]	$\delta_{N\infty}$ [mm³/N]	δ_N^0 [mm]	δ_N^{∞} [mm]
3.981	1.401	0.030	0.140	**0.030**	**0.140**

V^{*h} [kN]	V_k^h [kN]	δ_{V0} [mm/kN]	$\delta_{V\infty}$ [mm/kN]	δ_V^0 [mm]	δ_V^{∞} [mm]
0.105	0.075	0.310	0.460	**0.023**	**0.035**

5. Remarks

- Capacity verifications of Section 3 are in accordance with AS 5216. For more complex cases which are outside of AS 5216, the same principles of AS 5216 are still used.
- For connections with a flexurally rigid base plate, it is assumed that the base plate is sufficiently rigid. However, the current anchor design methods (ETAG, Eurocode, AS 5216, ACI 318, CSA A23.3) do not provide any usable guidance to check for rigidity. In the realistically elastic (flexible) base plate, the tension load distribution between anchors may be different to that in the assumed rigid base plate. The plate prying effects could further increase anchor tension loading. To verify the sufficient base plate bending rigidity, the stiffness condition according to the publication "Required Thickness of Flexurally Rigid Base plate for Anchor Fastenings" (fib Symposium 2017 Maastricht) is used in this software.
- For connections with an elastic base plate, the anchor tension forces are calculated with the finite element method with consideration of deformations of base plate, anchors and concrete. Background for design with elastic base plates is described in the paper "Design of Anchor Fastenings with Elastic Base Plates Subjected to Tension and Bending". This paper was published in "Stahlbau 88 (2019), Heft 8" and "5. Jahrestagung des Deutschen Ausschusses für Stahlbeton - DAfStb 2017".
  Anchor shear forces are calculated with the assumption of a rigid base plate. Attention should be paid to a narrow base plate with a width to length ratio of less than 1/3.
  More information on the required base plate stiffness for anchor design is described in the publication "Baseplate Rigidity and Anchorage Design" - https://doi.org/10.54647/cebc56110.
- Verification for the ultimate limit state and the calculated displacement under service working load are valid only if the anchors are installed properly according to ETA or anchor specification.
- For design in cracked concrete, anchor design standards/codes assume that the crack width is limited to ≤ 0.3mm by reinforcement. Splitting failure in cracked concrete is prevented by this reinforcing. The user needs to verify that this reinforcing is present in cracked concrete. Generally, concrete structures design standards/codes (e.g. AS 3600) meet this crack width requirement for most structures. Particular caution must be taken at close edge distances where the location of reinforcing is not clearly known.
- Verification of strength of concrete elements to loads applied by fasteners is to be done in accordance with AS 5216.
- All information in this report is for use of Allfasteners products only. It is the responsibility of the user to ensure that the latest version of the software is used, and in accordance with AFOS licensing agreement. This software serves only as an aid to interpret the standards and approvals without any guarantee to the absence of errors. The results of the software should be checked by a suitably qualified person for correctness and relevance of the results for the application.

The load-bearing capacity of the anchorage is: **verified !**

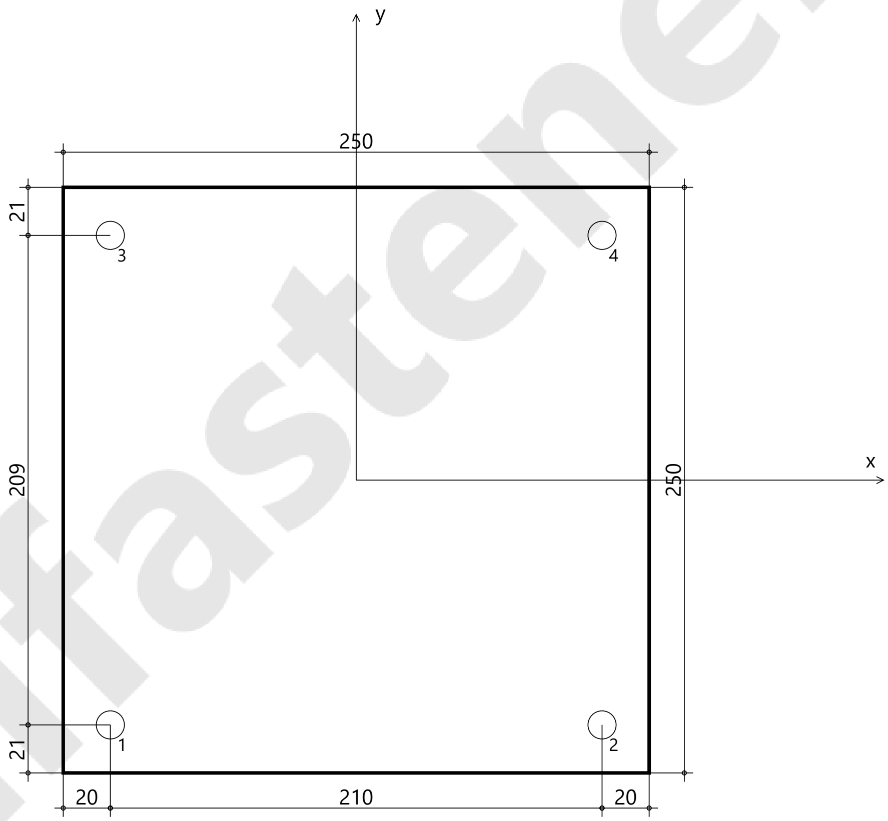
Company:		E-mail:	
Designer:		Phone:	
Address:		Fax:	
Project:		Date:	3/3/2025
Comments:		Page:	7 / 7

Anchor: **EF500R+ & Threaded Rod SS 316/A4-80 M12**

Drilled hole:	$d_0 \times h_0$ = 14 x 75 mm
Embedment depth:	h_{nom} = 75 mm
Effective anchorage depth:	h_{ef} = 75 mm
Installation torque:	T_{inst} = 40 Nm

Base plate: **G300**

Thickness:	t = 8 mm
Clearance hole:	d_f = 14 mm



11 Appendix C – Technical Data Sheet

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4014 Tel: (07) 3265 7288
Em: info@ultrashade.com.au

HOME & CAFÉ UMBRELLA

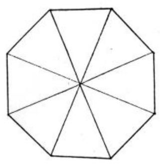
INFORMATION SHEET

Frame Specifications:

Pole Height: 2.75m - 3.0m (Size Dependant)
Post Diameter: 60mm x 2mm or 50mm x 4mm or 40mm x 3 mm
Arm Section: 19 x 19 x 1.6mm Reinforced with 15 x 15 x 1.6mm (Laminated)
Opening Mechanism: Marine Grade Rope & Pulley
Materials: Aluminium, Stainless Steel and Nylon
Finish: Dulux Powder Coating

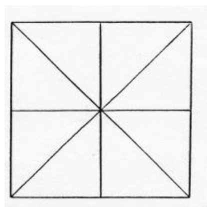
Standard Frame Colours: White, Beige, Green, White Birch, Black, Charcoal, Silver, Primrose, Claret, Navy
Custom Colours: On Request

Octagonal



2.5m Octagonal (4.8 sq/m)
3.0m Octagonal (6.5 sq/m)
3.5m Octagonal (8.73 sq/m)
4.0m Octagonal (11.5sq/m)
4.3m Octagonal (13.12 sq/m)

Square



2.0m Square (4.0 sq/m)
2.5m Square (6.25 sq/m)
2.8m Square (7.85 sq/m)
3.0m Square (9.0 sq/m)

Available Bases: **Boltdown** or **Inground** or **Mobile** *with 2 x 20KG Weight bags*

100% Acrylic Outdoor Awning Fabric
Large Colour Selection - Over 17 Options

100% UV Blockout – UV Reflective Water Resistant

Scotch Guarded

Mould & Mildew Resistant

10 Year Fade Guarantee

The Home/Cafe Umbrella Range is the ideal shade solution for any home or cafe setting.

It is specifically designed for simplicity and reliability. The umbrellas utilise a unique auto-locking rope pulley system that allows for very easy opening and closing.

The Home/Cafe range is made using the same construction techniques as our heavy duty range, proving to be a very durable and long lasting product.

Whether it be for residential or commercial use, this umbrella will provide an excellent shade solution.

Canopies are made from the most advanced awning fabrics specifically designed for outdoor use.
The 100% acrylic awning fabric provides:

- **Complete Sun Protection**
- **WaterProof fabric**
- **Mould and Mildew resistant**
- **Fade resistant**
- **U.V. Ray protection**
- **Extensive Range of Colours**

Home/Cafe Umbrella Accessories.

- **Screen Printing** – Available for any promotional Purposes.
- **Dust Cover** – Extra protection for use when umbrella isn't being used for an extended period of time.

Manufactured by: **UltraShade**
P.O. Box 856 Virginia, B.C.
Qld. Australia 4014
Phone: **(07) 3265 7288**
Fax: **(07) 3265 7304**
Email: **info@ultrashade.com.au**
Website: **www.ultrashade.com.au**
A.B.N. 77 010 472 563

Your local distributor:

ULTRASHADE Home/Cafe Umbrellas

UltraShade

Built to last

• Powder coated **aluminium frames** in a wide variety of colours offer strength and durability while maintaining a very clean finish.

• **Canopies** are made from the toughest and most advanced outdoor awning fabrics.

• **Auto Locking** rope pulley system for ease of opening

• All fittings used are Marine Grade **Stainless Steel**

Proudly 100% Australian Made

All Materials used in the construction of UltraShade Umbrellas are of the **highest quality** to ensure durability in the **harshest of Australian conditions.**

Guarantee

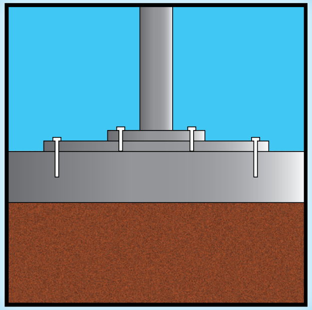
For your complete 'Peace of Mind' **UltraShade** will repair or replace, to your **satisfaction**, any malfunction of the umbrellas arising from workmanship or materials for a period of;

Frame: 2 Years. Canopy: 2 Years.

Home/Cafe Umbrellas come in a range of shapes and sizes.

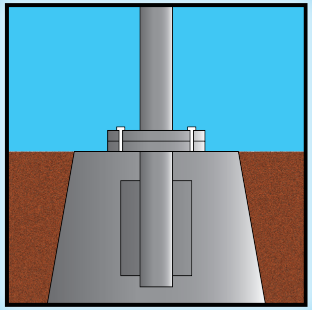
SQUARE	OCTAGONAL
1.5m	2.0m
2.0m	2.5m
2.5m	3.0m
2.8m	3.5m
3.0m	4.0m
-	4.3m

All umbrellas have a choice of either no valance, a straight valance or a scalloped valance.



Bolt Down

Ideal Base for easy fixing to existing concrete slab or decking.



In-ground

Base designed for areas without existing concrete or decking. Perfect for any areas with soft ground e.g. grass, dirt, sand or paved area.

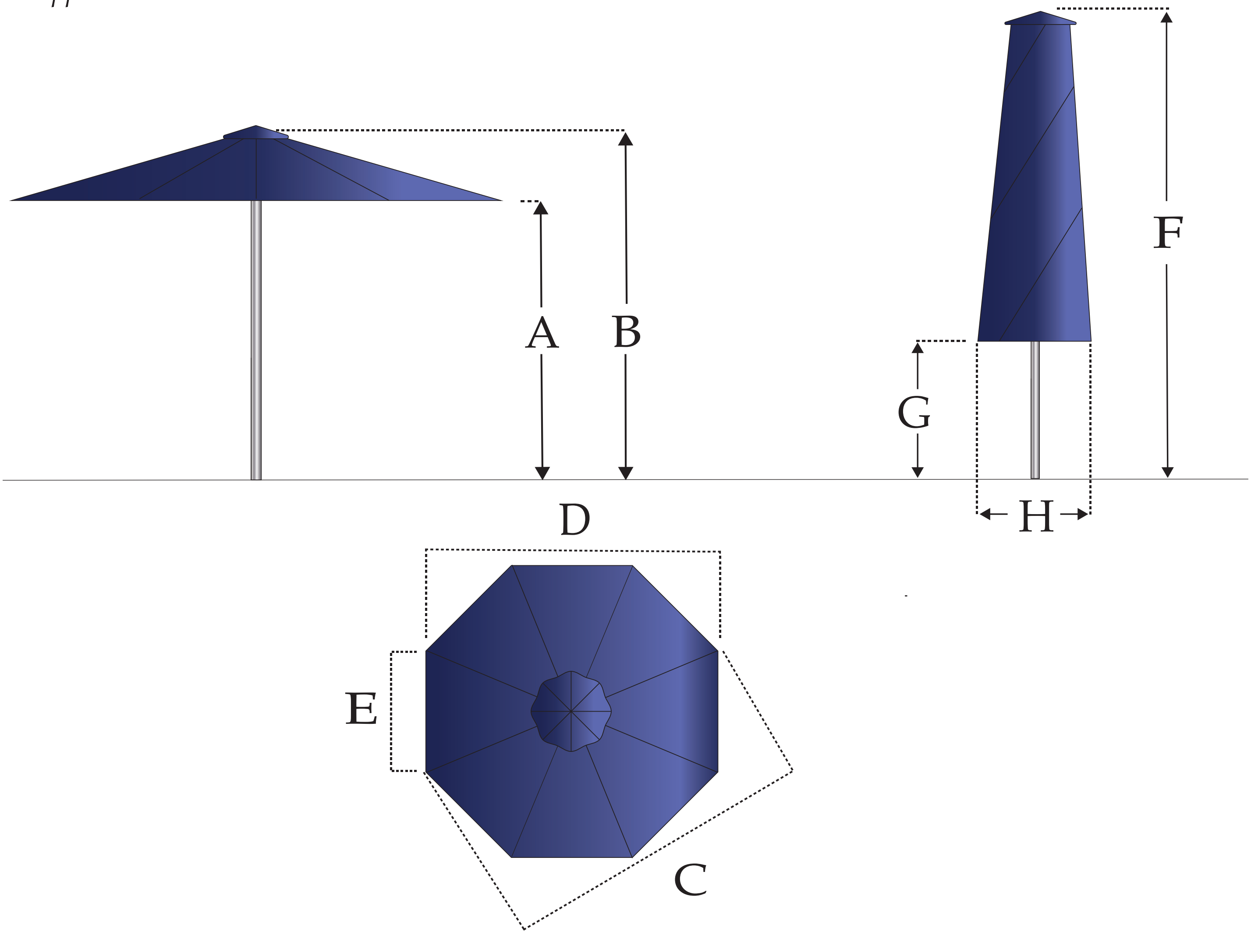
UltraShade

Mobile bases are also available for situations where you would like to move your umbrella regularly.

Home & Cafe® Octagonal Umbrella Dimensions

Size	A	B	C	D	E	F	G	H
2.5 m	2000	2550	2500	2200	950	2550	1250	400
3.0 m	2050	2550	2950	2700	1100	2550	1000	400
3.5 m	2200	2750	3500	3200	1300	2750	970	400
4.0 m	2200	2800	3950	3550	1500	2800	750	450
4.3 m	2150	2800	4300	3900	1620	2800	600	450

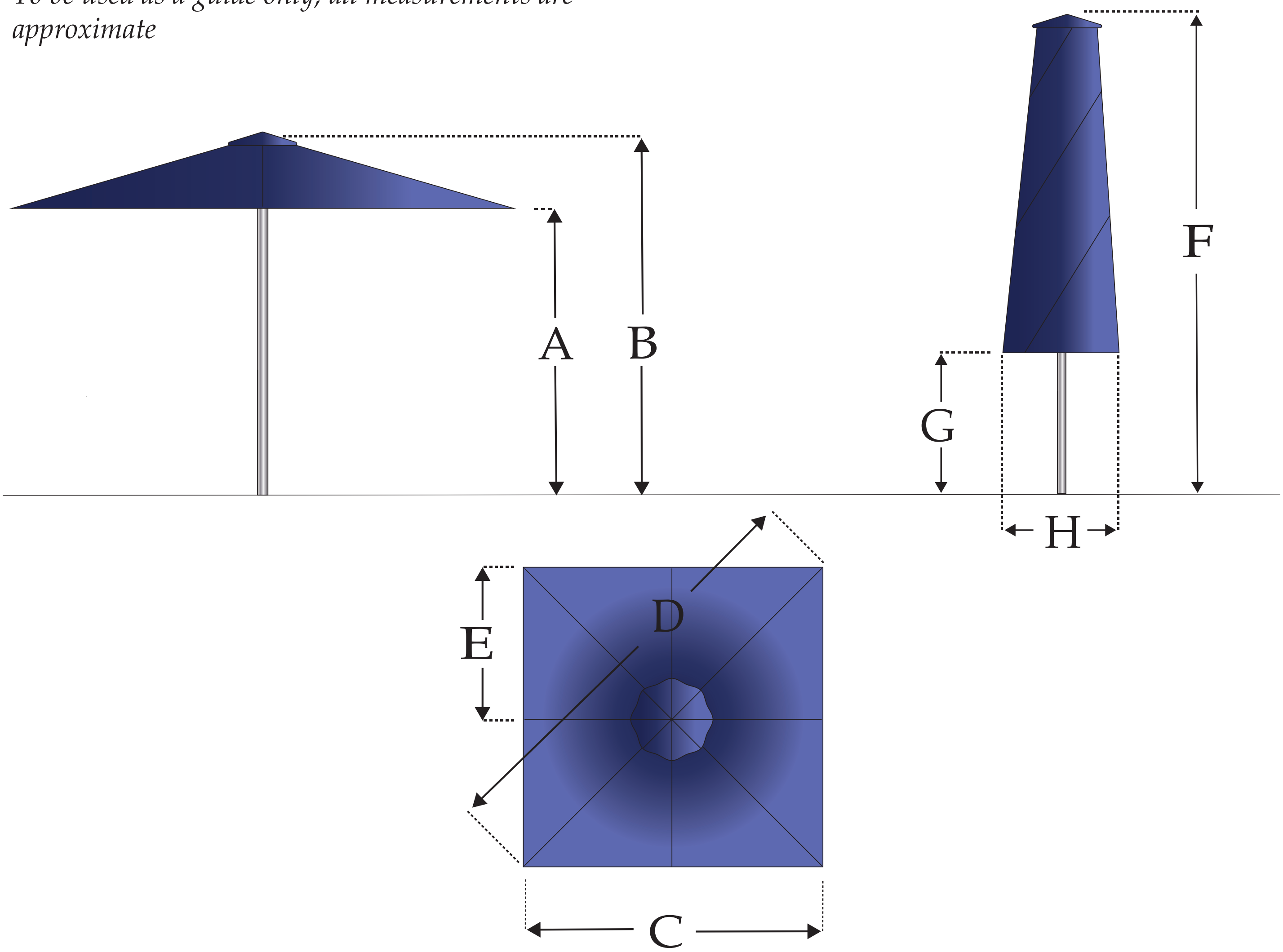
NB: All measurements in millimeters.
To be used as a guide only, all measurements are approximate



Home & Cafe® Square Umbrella Dimensions

Size	A	B	C	D	E	F	G	H
2.0 m	2100	2550	2000	2850	1000	2550	1000	400
2.5 m	2150	2700	2500	3500	1250	2700	800	400
2.8 m	2150	2800	2800	3950	1400	2800	750	450
3.0 m	2200	2800	3000	4250	1500	2800	600	450

NB: All measurements in millimeters.
To be used as a guide only, all measurements are approximate



UltraShade

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P.O. Box 856, Virginia QLD 4014
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Home and Cafe Umbrella Installation Instructions

Bolt Down Base:

Bolt down bases are supplied in two parts: **a)** Top Half – Spigot b) Bottom Half - Base Plate

1. Bolt the spigot to the base plate using the 5/16" bolts and spring washers that are supplied.
2. Bolt base plate to the concrete pad using M12 Dyna Bolts
   or Bolt base plate to timber decking using M12 bolts for timber. **Timber decks need to be reinforced between the joists with hardwood, drill through reinforcing timber and deck board with M12 Drill.**
3. Base must be level so that the spigot is plumb. Recommend using M12 Flat washers under the bolt holes to pack up to required height
4. Stand umbrella on the spigot. Open Umbrella & rotate to desired position to align.
5. Tighten grub screw with allen key supplied.
6. Fit Nylon Buffers to Umbrella arms as per for ease of opening.

In-ground Installations

Inground bases are supplied in two parts: **a**) Top Half - Spigot b) Bottom Half - Inground Base

1. Bolt spigot to in-ground base using the 5/16 bolts and spring washers supplied.
2. Dig a hole for the concrete measuring approx. 300mm dia. x 500mm deep.
3. The underside of the base flange should be **at least 12mm above** finished ground height or paving level.
4. Base must be plumbed so that the spigot is vertical.
5. Concrete must be left to set for **3 - 4 days** before standing the umbrella to ensure strength of concrete.
6. Stand umbrella on the spigot. - Open Umbrella & turn to desired position.
7. Tighten grub screw with allen key supplied
8.

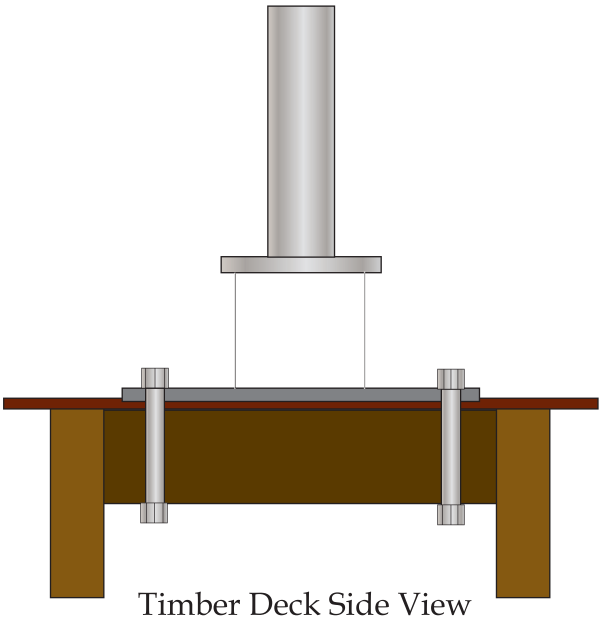
Mobile Base Installations

Mobile Bases are supplied with the following parts: **a**) Black Base Plate **b)** Spigot **c) (Optional) 20KG** Weight Bags x 2 **d**) Feet (4)

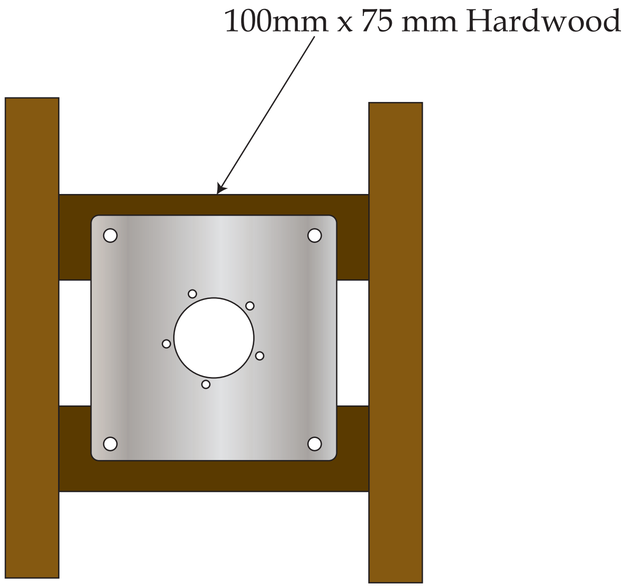
1. Attach the feet to the underside of the Stainless steel base. Place base where required.
2. Bolt the spigot to the base using the four bolts provided.
3. Place Weight bags or other ballast on the base
4. Stand umbrella on the spigot – Open Umbrella & turn to the desired position.
5. Tighten grub screw with allen key supplied.
6. Fit Nylon Buffers to Umbrella arms as for ease of opening

Please note:

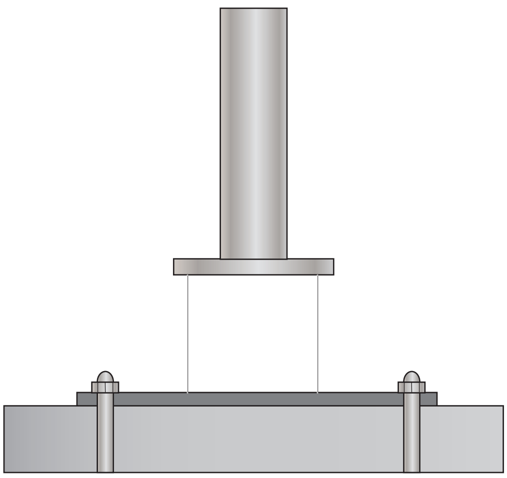
- **Over time the grub screws may loosen, especially in windy conditions.**
- **We recommend that the grub screw be checked regularly to ensure it is tight.**
- **Use the Allen Key supplied to ensure it is tight.**
- **Ensure the 6mm Bolt supplied with the allen key is installed through the post and through the spigot for extra security**
- **If installing through a table, ensure you use a base.**



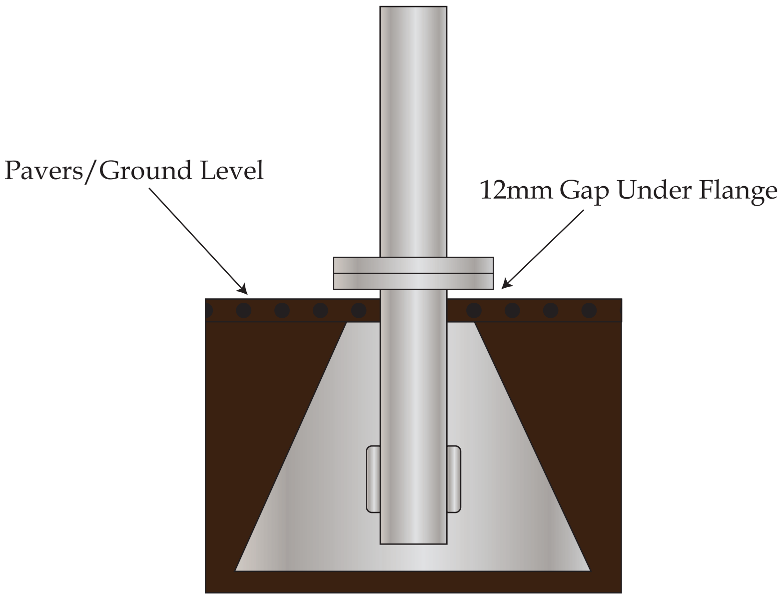
Timber Deck Side View



Timber Deck Plan View



Bolt Down Base on Concrete



Inground Base

Footing Size:
Approximately 400mm x 600 mm

A.B.N. 77 010 472 563
56 Zillmere Rd, Boondall QLD 4034
P.O. Box 856, Virginia QLD 4014
Tel: (07) 3265 7288 Fax: (07) 3265 7304 Em:
info@ultrashade.com.au

Home and Cafe Umbrella Open and Close Instructions

To Open:

1. Remove the securing strap.
2. Hold one arm out with gentle pressure, then, gently push the arms away from the central pole.
3. Pull on the rope to raise the umbrella.
4. Open the umbrella until the canopy is taut.
5. Lock the rope into the v-cleat on the main pole.
6. Ensure that there is no looseness in the canopy as it can become damaged if the canopy is not taut.

To Close:

1. Release the rope from the V Cleat by pulling on the rope away from the central post.
2. Loosen grip on the rope to let the umbrella down.
3. Ensure all the fabric is pulled out from being caught between the arms and brackets and wrap the panels around the umbrella like you would a handheld umbrella neatly. Do not bunch the panels with the strap as they will damage.
4. Ensure no panels are not caught between the arms or they will cause damage to the canopy which is not covered under the warranty.
5. Secure the umbrella with the strap provided. Failure to do so will wear out the aluminium arms by causing the arms to flop around in the breeze on the stainless steel fittings. Any such damage will not be covered under the warranty.

Phone: 07 3265 7288
www.ultrashade.com.au

UltraShade's Fabric Care Advice

FABRIC CARE

To obtain the maximum life from UltraShade Acrylic Awning Fabric products, the following points should be noted:

1. Keep the fabric clean by hosing regularly to remove dust, bird droppings and other solid particles.

2. No powered, high pressure washes to be used for cleaning fabric. * Warranty will be voided.*

3. Do not apply detergents, cleaning fluids or insecticides. Strictly use a mild soap solution and water only for cleaning.

4. Keep petrol, oil, solvents, kerosene and other similar fluids away from the fabric.

5. Do not allow bird droppings, earth, sand, or vegetable matter to remain in contact with the fabric.

6. Water based stains should be treated first by rinsing with cold water. If this is not sufficient, UltraShade canopies may be washed with a mild solution of soap in lukewarm water and rinsed thoroughly. We recommend gentle brushing with a soft brush or sponge as harsh scrubbing can damage the Teflon coating.

7. It is important that a UltraShade Umbrella is opened to dry after wet weather and should not be closed up or stored away when wet. Outdoor furniture and cushions should also be dried before storing away.

STUBBORN STAINS

Clean throughout with non-abrasive household cleaners, diluted rubbing alcohol or diluted bleach - 1:20 concentration.

Rinse immediately with clean water and dry thoroughly. General marking and mould is inevitable for outdoor fabrics, prompt attention to the affected area will minimise the chance of staining or fabric degradation.

WARRANTY

WHAT IS COVERED?

This warranty covers UltraShade acrylic fabric becoming non-functional due to loss of dimensional stability from exposure to conditions including sunlight and other normal atmospheric conditions. This warranty does not cover gradual fading, discolouration from atmospheric pollution, mould or other debris. Abnormal or excessive fading is covered.

Any defects found with regard to the fabric configuration, dimension, strength or colour that exist at the time of initial delivery, must be reported to UltraShade within a reasonable period of time before fabrication or installation of the umbrella.

HOW LONG IS THE COVERAGE PERIOD?

The warranty coverage is for 3 years from the date of purchase.

WHAT WILL ULTRASHADE DO?

UltraShade will provide a new Canopy at no cost, to replace the non-functioning fabric. This warranty does not cover the cost of labour or other consequential or incidental expenses. This warranty can only be enforced against presentation of the original installers invoice showing fabric reference and colour as well as date of delivery. The correct care procedures (as outlined above) must be followed to ensure that every step has been taken to maintain the UltraShade acrylic fabric canopy.

UltraShade

(FEBRIVILLE P/L T/A A.C.N. 010 472 563 A.B.N. 77 010 472 563)
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Tel: (07) 3265 7288 Fax: (07) 3265 7304
Em: info@ultrashade.com.au

HOME & CAFE UMBRELLA WARRANTY

Aluminum Frames are covered by a 5 Year structural warranty. Warranty specifically excludes damage to the powder coat finish caused by corrosion, scratching, pitting, fading or peeling.

Canopy Fabrics are covered by a 3 Year workmanship warranty and a fade guarantee of up to 10 years from the fabric supplier.

Conditions of Warranty:

1. This warranty does not cover any repairs consequent upon accident, alterations or repairs by any other than an authorised dealer/agent of UltraShade, misuse, fire, floods, earthquakes or excessively high wind conditions.
2. This warranty applies to the original purchaser from the purchase date and covers manufacturing faults and defects.
3. This warranty is valid only for installation made by Ultrashade/ Agent/ Dealer/ Yourself/ Tradesman: The installation must be carried out exactly as shown in the Ultrashade Installation Instructions and Technical Information.
4. Owner to ascertain position of all underground pipes and electrical wires and notify installer of any obstacles. Although all care will be taken, no responsibility can be accepted for any underground breakages.
5. This warranty is valid only if the canopy has been kept clean and free of dust/debris with regular hosing as this will prolong the life of the canopy.
6. This warranty is only valid if the umbrella is put up and collapsed as detailed in the open/close information.
7. The cost of transportation and insurance both ways for any repair to the UltraShade Umbrella is to be paid by the claimant.
8. Warranty specifically excludes general wear and tear, rusting of steel components and parts, corrosion and damage caused as a result of failure to observe reasonable care, maintenance and assembly instructions.
9. Ultrashade reserves the right to determine whether or not fault is caused by faulty workmanship or material or any other part is defective.
10. Ultrashade may offer advice but accepts no responsibility to the suitability of the ultimate position of the UltraShade Umbrellas.

The benefits conferred by this manufacturer’s warranty are in addition to all rights and remedies conveyed by the Competition and Consumer Act 2010 (Commonwealth), and any other statutory rights to which you may already be entitled, and this warranty does not exclude, restrict or modify any such rights or remedies that are implied by law.