

Client: EXTREME MARQUEES PTY. LTD.

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

Reference: Extreme Marquees Pty Ltd Technical Data

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

Amendment: -

JOB NO: E-11-265815



Table of Contents

1	1 Introduction	
2	2 Design Restrictions and Limitations	4
3	3 Specifications	5
	3.1 General	5
	3.2 Aluminium Properties	6
	3.3 Buckling Constants	6
	3.4 Section Properties	7
4	4 Design Loads	
	4.1 Ultimate	
	4.2 Load Combinations	
	4.2.1 Serviceability	7
	4.2.2 Ultimate	
5		
	5.1 Parameters	
	5.2 Pressure Coefficients (Cfig)	8
	5.2.1 Pressure summary	9
	5.3 Wind Load Diagrams	
	5.3.1 Wind 1(case 1)	
	5.3.2 Wind 1(case 2)	
	5.3.3 Max Bending Moment due to critical load combination in major axis	
	5.3.4 Max Bending Moment in minor axis due to critical load combination	
	5.3.5 Max Shear in due to critical load combination	
	5.3.6 Max Axial force in upright support and roof beam due to critical load co	
	5.3.7 Max reactions	
	5.3.8 Summary Table:	
6		
	6.1 Beams	
	6.2 Upright Supports	
7	7 Summary	22
	7.1 Conclusions	22
8	8 Appendix A – Base Anchorage Requirements	
9		
10	10 Appendix C – Detail Drawings	

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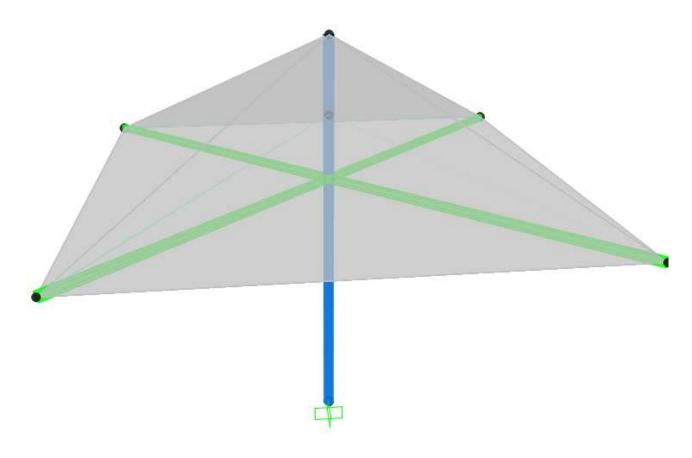
1 Introduction

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

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

The report examines the effect of 3s gust wind of 112 km/hr on 2m, 3m & 4m Café Umbrellas as the worst-case scenario. The relevant Australian Standards AS1170.0:2002 General principles, AS1170.1:2002 Permanent, imposed and other actions and AS1170.2:2011 Wind actions are used. The design check is in accordance with AS/NZS 1664.1:1997 Aluminum limit state design.



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2 Design Restrictions and Limitations

- 2.1 The erected structure is for temporary use only.
- 2.2 It should be noted that if high gust wind speeds are anticipated or forecast in the locality of the tent, the temporary umbrella should be closed.
- 2.3 For forecast winds in excess of (refer to summary) the umbrella should be completely closed. (Please note that the locality squall or gust wind speed is affected by factors such as terrain exposure and site elevations.)
- 2.4 The structure may only be erected in regions with wind classifications no greater than the limits specified on the attached wind analysis.
- 2.5 The wind classifications are based upon Terrain Category 2.5. Considerations have also been made to the regional wind terrain category, topographical location and site shielding from adjacent structures. Please note that in many instances topographical factors such as a location on the crest of a hill or on top of an escarpment may yield a higher wind speed classification than that derived for a higher wind terrain category in a level topographical region. For this reason, particular regard shall be paid to the topographical location of the structure. For localities which do not conform to the standard prescribed descriptions for wind classes as defined above, a qualified Structural Engineer may be employed to determine an appropriate wind class for that the particular site.
- 2.6 The structures in no circumstances shall ever be erected in tropical or severe tropical cyclonic condition as defined on the Map of Australia in AS 1170.2-2011, Figure 3.1.
- 2.7 The structure has not been designed to withstand snow and ice loadings such as when erected in alpine regions.
- 2.8 For the purpose of the analysis it is assumed that the umbrella is fully opened with the empty under condition. (as per AS1170.2 Cl. D3.1 "'empty under' implies that any goods or materials stored under the roof, block less than 50% of the cross-section exposed to the wind").
- 2.9 Design of fabric is by others.

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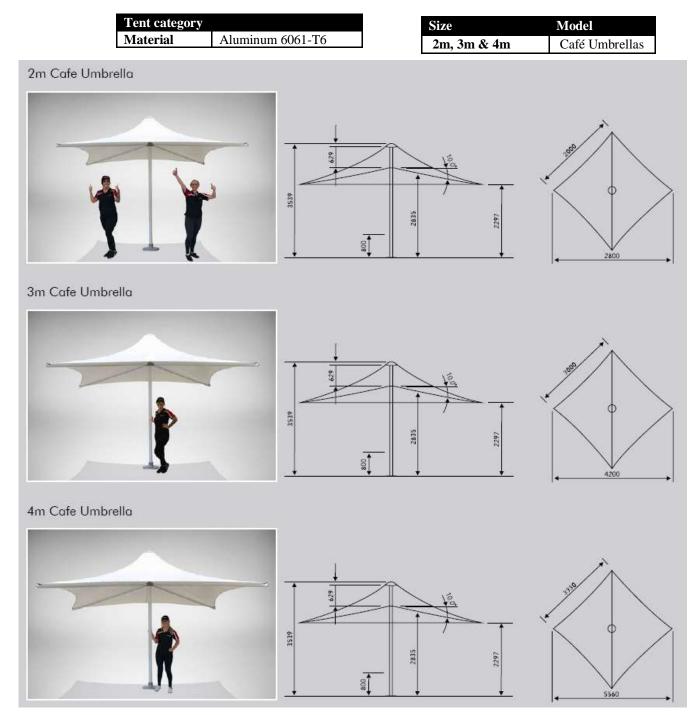
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3 Specifications

3.1 General



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5 | P a g e

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3.2 Aluminium Properties

Aluminium Properties		
Compressive yield strength	Fcy	241 MPa
Tensile yeild strength	Fty	241 MPa
Tensile ultimate strength	Ftu	262 MPa
Shear yield strength	Fsy	138 MPa
Bearing yeild strength	Fby	386 MPa
Bearing ultimate strength	Fbu	552 MPa
Yield stress (min{Fcy:Fty})	Fy	241 MPa
Elastic modulus	Е	70000 MPa
Shear modulus	G	26250 MPa
Value of coefficients	kt	1.00
	kc	1.00
Capacity factor (general yield)	фу	0.95
Capacity factor (ultimate)	φu	0.85
Capacity factor (bending)	φЬ	0.85
Capacity factor (elastic shear buckling)	φν	0.8
Capacity factor (inelastic shear buckling)	φvp	0.9

3.3 Buckling Constants

Type of member and stresses	Intercept, MPa	Slope, MPa	Intersection
Compression in columns and beam flanges	BC= 242.87	Dc= 1.43	Cc= 69.61
Compression in flat plates	Bp= 310.11	Dp= 2.06	Cp= 61.60
Compressive bending stress in solid rectangular bars	Bbr= 459.89	Dbr= 4.57	Cbr= 67.16
Compressive bending stress in round tubes	Btb= 250.32	Dtb= 14.18	Ctb= 183.52
Shear stress in flat plates	Bs= 178.29	Ds= 0.90	Cs= 81.24

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3.4 Section Properties

MEMBER(S)	Section	d	t	Уc	Ag	Z _x	Zy	S _x	Sy	l _x	ly	J	r _x	r _y
		mm	mm	mm	mm²	mm³	mm³	mm³	mm³	mm⁴	mm⁴	mm⁴	mm	mm
Beams	60.5x44.4x4	44.4	4	30.3	636.1	8112.8	7079.6	11142.1	9144.4	245291.0	157168.0	377798.0	19.6	15.7
Upright Support	D90x3.5	90	3.5	45.0	951.1	19800.4	19800.4	26202.2	26202.2	891018.5	891018.5	1782036.9	30.6	30.6

Refer Appendix 'C' for detail drawings

Design Loads

4.1 Ultimate

		Distributed load (kPa)	Design load factor (-)	Factored imposed load (kPa)
Live	Q	-	1.5	-
Self weight	G	self weight	1.35, 1.2, 0.9	1.2 self weight, 0.9 self weight
3s 112km/hr gust	W	$0.44~\mathrm{C}_{\mathrm{fig}}$	1.0	0.44 C _{fig}

4.2 **Load Combinations**

4.2.1 Serviceability

Gravity $1.0\times G\,$ =

Wind $1.0 \times G + 1.0 \times W$ =

4.2.2 Ultimate

Downward $1.35 \times G$

 $1.2\times G + W_u \\$

Upward $0.9\times G + W_u \\$

Wind Analysis

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

5.1 **Parameters**

Terrain category = 2.5

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

 $V_R = 31.11 \text{ m/s} (112 \text{ km/hr})$

(regional 3 s gust wind speed)

7 | Page

 $M_d = 1$ $M_s = 1$

 $M_t = 1$

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 $M_{z,cat}\!=0.87$

(Table 4.1(B) AS1170.2)

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

Height of structure (h) = 2.9 mWidth of structure (w) = 4 mLength of structure (l) = 4 m (mid of peak and eave)

$$\begin{split} &Pressure~(P) = 0.5 \rho_{air}~(V_{sit,\beta})^2~C_{fig}~C_{dyn} \\ &= 0.44 C_{fig}~kPa \end{split}$$

5.2 Pressure Coefficients (C_{fig})

Name	Symbol	Value	Unit	Notes	Ref.
			Input		
Importance level		2			Table 3.1 - Table 3.2 (AS1170.0)
Annual probability of exceedance		-			Table 3.3
Regional gust wind speed		112	Km/hr		Table 3.1 (AS1170.2)
Regional gust wind speed	V_{R}	31.11	m/s		
Wind Direction Multipliers	M _d	1			Table 3.2 (AS1170.2)
Terrain Category Multiplier	M _{Z,Cat}	0.87			Table 4.1 (AS1170.2)
Shield Multiplier	Ms	1			4.3 (AS1170.2)
Topographic Multiplier	Mt	1			4.4 (AS1170.2)
Site Wind Speed	$V_{Site,\beta}$	27.07	m/s	$V_{Site,\beta}=V_R^*M_d^*M_{z,cat}^*M_S,M_t$	
Pitch	α	23	Deg		
Pitch	α	-	rad		
Width	В	4	m		
Length	D	4	m		
Height	z	2.9	m		
		Wi	nd Pressu	ıre	
hoair	ρ	1.2	Kg/m ³		
dynamic response factor	C_{dyn}	1			
Wind Pressure	$ ho^{*}C_{fig}$	0.440	Kg/m ²	$\rho=0.5\rho_{air}*(V_{des,\beta})^2*C_{fig}*C_{dyn}$	2.4 (AS1170.2)
	WI	ND DIRECTI	ON 1 (θ=0) Empty Under	

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		sure			
4. Free Roof				α =0°	
Area Reduction Factor	Ka	1			D7
local pressure factor	Kı	1			
porous cladding reduction factor	K_p	1			
External Pressure Coefficient MIN	$C_{P,w}$	-0.3			
External Pressure Coefficient MAX	$C_{P,w}$	0.6			
External Pressure Coefficient MIN	$C_{P,I}$	-0.6			
External Pressure Coefficient MAX	$C_{P,I}$	0			
aerodynamic shape factor MIN	$C_{\text{fig,w}}$	-0.30			
aerodynamic shape factor MAX	$C_{fig,w}$	0.60			
aerodynamic shape factor MIN	$C_{\text{fig,I}}$	-0.60			
aerodynamic shape factor MAX	$C_{fig,I}$	0.00			
Pressure Windward MIN	Р	-0.13	kPa		
Pressure Windward MAX	P	0.13	kPa		
Pressure Leeward MIN	Р	-0.26	kPa		
Pressure Leeward MAX	P	0.00	kPa		

5.2.1 Pressure summary

WIND EXTERNAL PRESSURE	Direc	ction1
	Min (Kpa)	Max (Kpa)
W	-0.13	0.26
L	-0.26	0.00

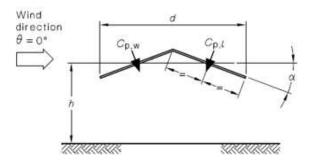


FIGURE D3 PITCHED FREE ROOFS

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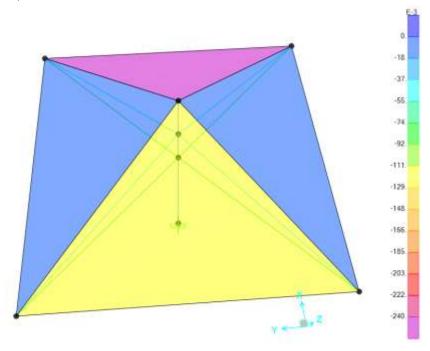
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9 | P a g e

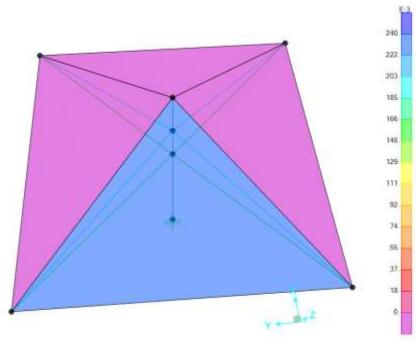


5.3 Wind Load Diagrams

5.3.1 Wind 1(case 1)



5.3.2 Wind 1(case 2)

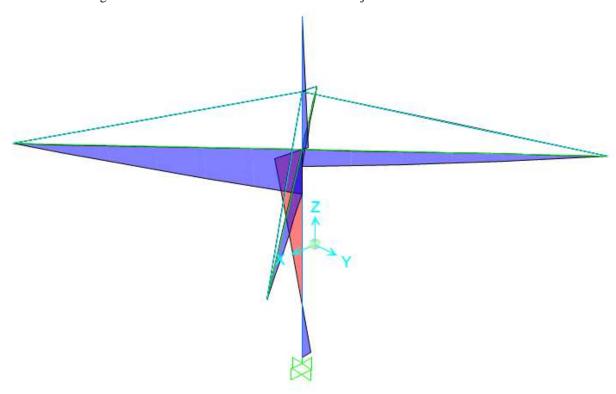


After 3D model analysis, each member is checked based on adverse load combination. In this regard the maximum bending moment, shear and axial force due to adverse load combinations for each member are presented as below:

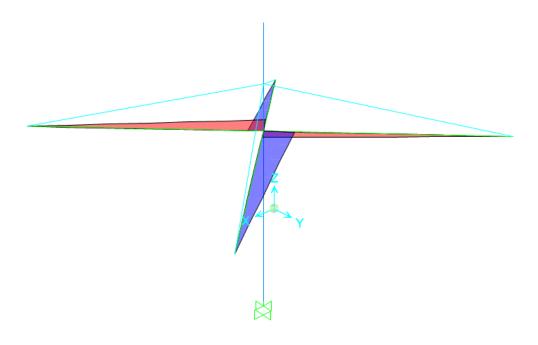
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5.3.3 Max Bending Moment due to critical load combination in major axis



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



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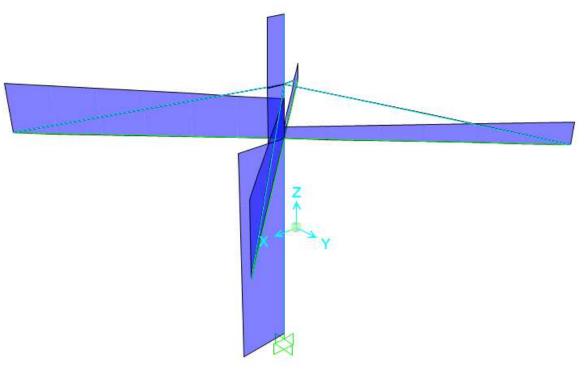
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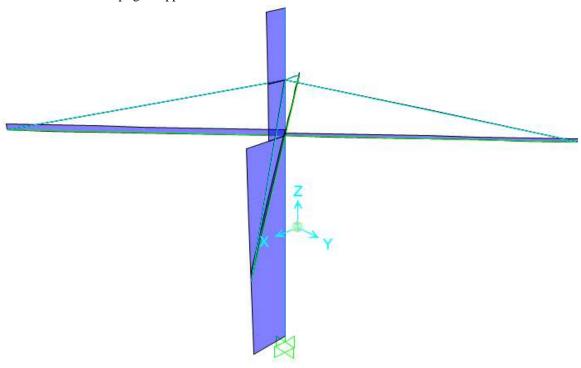
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5.3.5 Max Shear in due to critical load combination



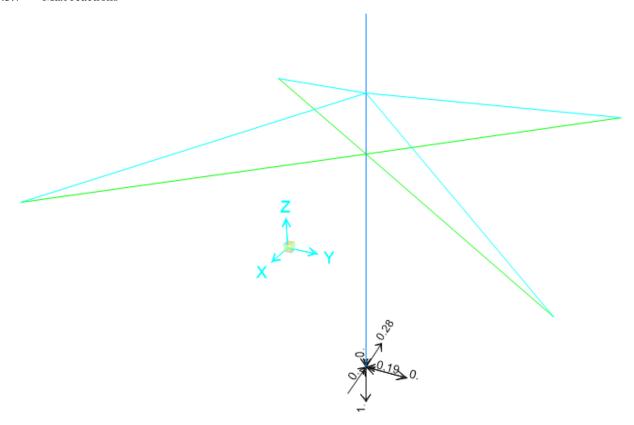
5.3.6 Max Axial force in upright support and roof beam due to critical load combination



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5.3.7 Max reactions



Max Reaction (Uplift) $N^* = 1.3 \text{ kN}$

5.3.8 Summary Table:

6 Checking Members Based on AS1664.1 ALUMINIUM LSD

6.1 Beams

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
60.5x44.4x4	Beams					
Alloy and temper	6061-T6					AS1664.1
	F_{tu}	=	262	MPa	Ultimate	T3.3(A)
Tension						13.3(A)
	F_{ty}	=	241	MPa	Yield	
Compression	F _{cy}	=	241	MPa		
Choor	F_su	=	165	MPa	Ultimate	
Shear	F_{sy}	=	138	MPa	Yield	

13 | Page

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	F_bu	=	551	MPa	Ultimate	
Bearing	F _{by}	=	386	MPa	Yield	
	-					
Modulus of elasticity	Е	=	70000	MPa	Compressive	
	k t	=	1.0			
	k _c	=	1.0			T3.4(B)
FEM ANALYSIS RESULTS						
Axial force	Р	=	0.128	kN	compression	
Axiai Torce	P	=	0.128	kN	Tension	
In plane moment	M _x	=	0.983	kNm	Tension	
Out of plane moment	My	=	0.3566	kNm		
out of plane moment	IVIy	_	0.5500	IXI VIII		
DESIGN STRESSES						
Gross cross section area	A_g	=	636.11	mm^2		
In-plane elastic section modulus	Z_{x}	=	8112.8	mm³		
Out-of-plane elastic section	-		7070 00	2		
mod.	Z_y	=	7079.63	mm ³		
Stress from axial force	fa	=	P/A _g			
		=	0.20	MPa	compression	
Stress from in-plane bending	f _{bx}	=	0.00 M _x /Z _x	MPa	Tension	
Stress from in-plane bending	¹bx	=	121.17	MPa	compression	
Stress from out-of-plane	f_{by}	=	M_y/Z_y	u	Compression	
bending	۵,	=	50.37	MPa	compression	
Tension						
3.4.3 Tension in rectangular tubes						3.4.3
	φF∟	=	267.87	MPa		
		OR	070 45	MD-		
	фГ∟	=	276.15	MPa		
COMPRESSION						
3.4.8 Compression in columns, axid	al, gross	section				
1. General						3.4.8.1
Unsupported length of member	L	=	2780	mm		
Effective length factor	k	=	2.2			
Radius of gyration about	r _y	=	15.72	mm		
buckling axis (Y)	ı y	_	10.72			

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Radius of gyration about buckling axis (X)	r _x	=	19.64	mm		
Slenderness ratio	kLb/ry	=	389.06			
Slenderness ratio	kL/rx	=	311.41			
Slenderness parameter	λ	=	7.266			
	D_c^*	=	90.3			
	S ₁ *	=	0.33			
	S_2^*	=	1.23			
	фсс	=	0.950			
Factored limit state stress	φFL	=	4.34	MPa		
2. Sections not subject to torsion	al or torsior	nal-flex	ural bucklin	g		3.4.8
Largest slenderness ratio for flexural buckling	kL/r	=	389.06			
3.4.11 Uniform compression in coflat plates Uniform compression in compone plates with both edges, walls of re	ents of colu	mns, g	-			3.4.
	\mathbf{k}_1	=	0.35			T3.3(
mid-thickness radius of round tubular column or maximum mid-thickness radius	R _m	=	20.2			
	t	=	4	mm		
Slenderness	R _m /t	=	5.05			
Limit 1	S_1	=	0.24			
Limit 2	S_2	=	672.46			
Factored limit state stress	φF _L	=	249.42	MPa		
Most adverse compressive limit state stress	Fa	=	4.34	MPa		
Most adverse tensile limit state stress	Fa	=	267.87	MPa		
Most adverse compressive & Tensile capacity factor	f _a /F _a	=	0.05		PASS	
DENDINO IN DI AND						
BENDING - IN-PLANE 3.4.13 Compression in beams, e. oval tubes	xtreme fibre	e, gross	section ro	und or		
Unbraced length for bending	L _b	=	2780	mm		

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3.4.18 Compression in components of beams - curverd plates with both edges supported k ₁ = 0.5	Consideration and of area (work					I	I
Torsion modulus $J = 3.78E+05 \text{ mm}^3$ Elastic section modulus $Z = 8112.8 \text{ mm}^3$ $R_b/t = 5.05$ Limit 1 $S_1 = 44.07$ Limit 2 $S_2 = 78.23$ Factored limit state stress $\phi F_L = 267.87 \text{ MPa}$ $3.4.18 \text{ Compression in components of beams} - curverd plates with both edges supported $		ly	=	1.57E+05	mm ⁴		
Re/t	•	J	=	3.78E+05	mm^3		
Limit 1 $S_1 = 44.07$ Limit 2 $S_2 = 78.23$ Factored limit state stress $\phi F_L = 267.87$ MPa 3.4.18 Compression in components of beams - curverd plates with both edges supported $k_1 = 0.5 \\ k_2 = 2.04$ $mid-thickness radius of round tubular column or maximum mid-thickness radius t = 4 \\ mm Slenderness R_b/t = 5.05 Limit 1 S_1 = 2.75 Limit 2 S_2 = 78.23 Factored limit state stress \phi F_L = 232.34 MPa Most adverse in-plane bending limit state stress \phi F_L = 232.34 MPa Most adverse in-plane bending capacity factor BENDING - OUT-OF-PLANE NOTE: Limit state stress \phi F_L are the same for out-of-plane bending (doubly symmetric section) Factored limit state stress \phi F_L = 232.34 MPa$	Elastic section modulus	Z	=	8112.8	${\rm mm^3}$		
Limit 2 $S_2 = 78.23$ Factored limit state stress $\phi F_L = 267.87$ MPa 3.4.18 Compression in components of beams - curverd plates with both edges supported $\begin{array}{ccccccccccccccccccccccccccccccccccc$		R _b /t	=	5.05			
Factored limit state stress \$\textbf{\textit{\textbf{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\textit{\text{\textit{\textit{\textit{\textit{\textit{\texti	Limit 1	S_1	=	44.07			
3.4.18 Compression in components of beams - curverd plates with both edges supported K_1	Limit 2	S_2	=	78.23			
edges supported $k_1 = 0.5 \\ k_2 = 2.04$ mid-thickness radius of round tubular column or maximum mid-thickness radius $t = 4 \text{mm}$ Slenderness $R_b/t = 5.05$ Limit 1 $S_1 = 2.75$ $Limit 2$ $S_2 = 78.23$ Factored limit state stress $\Phi F_L = 232.34 MPa$ Most adverse in-plane bending limit state stress Most adverse in-plane bending capacity factor $BENDING - OUT-OF-PLANE$ NOTE: Limit state stress, ΦF_L are the same for out-of-plane bending (doubly symmetric section) Factored limit state stress $\Phi F_L = 232.34 MPa$ Most adverse out-of-plane bending (mid state stress) $\Phi F_L = 232.34 MPa$ Most adverse out-of-plane bending (mid state stress) $\Phi F_L = 232.34 MPa$ Most adverse out-of-plane bending (mid state stress) $\Phi F_L = 232.34 MPa$	Factored limit state stress	фГ∟	=	267.87	MPa		3.4.13
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		nts of beam	ns - cu	ırverd plates	with both		
mid-thickness radius of round tubular column or maximum mid-thickness radius $t = 4 \text{mm}$ Slenderness $R_b/t = 5.05$ Limit 1 $S_1 = 2.75$ Limit 2 $S_2 = 78.23$ Factored limit state stress $\Phi F_L = 232.34 MPa$ Most adverse in-plane bending limit state stress $\Phi F_{bx} = 232.34 MPa$ Most adverse in-plane bending capacity factor $F_{bx} = 0.52 PASS$ $ENDING - OUT-OF-PLANE$ NOTE: Limit state stresses, ΦF_L are the same for out-of-plane bending (doubly symmetric section) $F_{actored limit state stress}$ $\Phi F_L = 232.34 MPa$ Most adverse out-of-plane bending (doubly symmetric section) $F_{actored limit state stress}$ $\Phi F_L = 232.34 MPa$ Most adverse out-of-plane bending limit state stress $\Phi F_L = 232.34 MPa$ Most adverse out-of-plane bending limit state stress $\Phi F_L = 232.34 MPa$		k 1	=	0.5			T3.3(D)
mid-thickness radius of round tubular column or maximum mid-thickness radius $t = 4 \text{mm}$ Slenderness $R_b/t = 5.05$ Limit 1 $S_1 = 2.75$ Limit 2 $S_2 = 78.23$ Factored limit state stress $\Phi F_L = 232.34 MPa$ Most adverse in-plane bending limit state stress $\Phi F_b = 232.34 MPa$ Most adverse in-plane bending capacity factor $F_{bx} = 0.52 PASS$ $ENDING - OUT-OF-PLANE$ NOTE: Limit state stresses, ΦF_L are the same for out-of-plane bending (doubly symmetric section) $F_{ab} = 232.34 MPa$ Most adverse out-of-plane bending (doubly symmetric section) $F_{by} = 232.34 MPa$ Most adverse out-of-plane bending limit state stress $\Phi F_L = 232.34 MPa$ Most adverse out-of-plane bending limit state stress $\Phi F_L = 232.34 MPa$		k_2	=	2.04			T3.3(D)
mid-thickness radius $t = 4 \text{mm}$ Slenderness $R_b/t = 5.05$ Limit 1 $S_1 = 2.75$ Limit 2 $S_2 = 78.23$ Factored limit state stress $\phi F_L = 232.34 MPa$ Most adverse in-plane bending limit state stress Most adverse in-plane bending capacity factor $\frac{BENDING - OUT - OF - PLANE}{NOTE: Limit state stress}, \phi F_L \text{ are the same for out-of-plane bending (doubly symmetric section)}$ Factored limit state stress $\phi F_L = 232.34 MPa$ Most adverse out-of-plane bending limit state stress $\phi F_L = 232.34 MPa$ Most adverse out-of-plane bending limit state stress $\phi F_L = 232.34 MPa$ Most adverse out-of-plane bending limit state stress Most adverse out-of-plane bending limit state stress Most adverse out-of-plane	mid-thickness radius of round						
Slenderness $R_b/t = 5.05$ Limit 1 $S_1 = 2.75$ Limit 2 $S_2 = 78.23$ Factored limit state stress $\phi F_L = 232.34$ MPa Most adverse in-plane bending limit state stress Most adverse in-plane bending capacity factor $f_{bx}/F_{bx} = 0.52$ PASS BENDING - OUT-OF-PLANE NOTE: Limit state stresses, ϕF_L are the same for out-of-plane bending (doubly symmetric section) Factored limit state stress $\phi F_L = 232.34$ MPa Most adverse out-of-plane bending limit state stress $\phi F_L = 232.34$ MPa		R_b	=	20.2	mm		
Limit 1 $S_1 = 2.75$ Limit 2 $S_2 = 78.23$ Factored limit state stress $\phi F_L = 232.34$ MPa Most adverse in-plane bending limit state stress Most adverse in-plane bending capacity factor $\phi F_L = 232.34$ MPa MPa 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 $\phi F_L = 232.34$ MPa Most adverse out-of-plane bending limit state stress Most adverse out-of-plane		t	=	4	mm		
Limit 2 $S_2 = 78.23$ Factored limit state stress $\phi F_L = 232.34$ MPa Most adverse in-plane bending limit state stress Most adverse in-plane bending capacity factor $\phi F_L = 232.34$ MPa Most adverse in-plane bending $\phi F_L = 0.52$ PASS BENDING - OUT-OF-PLANE NOTE: Limit state stresses, ϕF_L are the same for out-of-plane bending (doubly symmetric section) Factored limit state stress $\phi F_L = 232.34$ MPa Most adverse out-of-plane bending limit state stress	Slenderness	R _b /t	=	5.05			
Factored limit state stress $\phi F_L = 232.34$ MPa Most adverse in-plane bending limit state stress Most adverse in-plane bending capacity factor $\phi F_L = 232.34$ MPa 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 $\phi F_L = 232.34$ MPa Most adverse out-of-plane bending limit state stress $\phi F_L = 232.34$ MPa	Limit 1	S_1	=	2.75			
Most adverse in-plane bending limit state stress Most adverse in-plane bending capacity factor $ \begin{array}{lll} F_{bx} &=& 232.34 & \text{MPa} \\ F_{bx} &=& 0.52 \end{array} $ PASS PASS 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 $ \phi F_L &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stress } F_{by} &=& 232.34 & \text{MPa} \\ \hline Most adverse out-of-plane bending limit state stres$	Limit 2	S_2	=	78.23			
limit state stress Most adverse in-plane bending capacity factor $ \begin{array}{cccccccccccccccccccccccccccccccccc$	Factored limit state stress	φF∟	=	232.34	MPa		
capacity factor $BENDING - OUT - OF - PLANE$ $NOTE: Limit state stresses, \phi F_L are the same for out - of - plane bending (doubly symmetric section) Factored limit state stress \phi F_L = 232.34 MPa Most adverse out - of - plane bending limit state stress \phi F_{by} = 232.34 MPa Most adverse out - of - plane bending limit state stress \phi F_{by} = 232.34 MPa$		F _{bx}	=	232.34	MPa]	
NOTE: Limit state stresses, ϕF_L are the same for out-of-plane bending (doubly symmetric section) Factored limit state stress $\phi F_L = 232.34 MPa$ Most adverse out-of-plane bending limit state stress $F_{by} = 232.34 MPa$ Most adverse out-of-plane for out-of-plane are the same for out-of-plane bending bending bending limit state stress		f _{bx} /F _{bx}	=	0.52		PASS	
NOTE: Limit state stresses, ϕF_L are the same for out-of-plane bending (doubly symmetric section) Factored limit state stress $\phi F_L = 232.34 MPa$ Most adverse out-of-plane bending limit state stress $F_{by} = 232.34 MPa$ Most adverse out-of-plane for out-of-plane are the same for out-of-plane bending bending bending limit state stress	DENDING OUT OF DUANE						
Most adverse out-of-plane bending limit state stress Most adverse out-of-plane 5. /E. = 232.34 MPa	NOTE: Limit state stresses, φF _L a	re the sam	ne for c	out-of-plane b	pending		
bending limit state stress Most adverse out-of-plane Fig. 232.34 IMPa	Factored limit state stress	φF∟	=	232.34	MPa		
	bending limit state stress	F _{by}	=	232.34	MPa		
l I		f_{by}/F_{by}	=	0.22		PASS	
COMBINED ACTIONS	COMBINED ACTIONS						
		d bendina					4.1.1
g	and the second compression and						

16 | P a g e

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

6.2 Upright Supports

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
D90x3.5	Upright Support					
Alloy and temper	6061-T6					AS1664. 1
Tension	Ftu	=	262	MPa	Ultimate	T3.3(A)
1 61121011	F_{ty}	=	241	MPa	Yield	

17 | Page

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3.4.8 Compression in columns, a1. General	ixíal, gross s	section				3.4.8.1
COMPRESSION						
	φF _L	R =	276.15	MPa		
	φFL	= O	267.87	MPa		
3.4.3 Tension in round or oval tu	bes					3.4.3
Tension						
bending	·•	=	0.00	MPa	compression	
Stress from out-of-plane	$f_{ m by}$	=	M_y/Z_y		,	
and the second s	- 64	=	46.67	MPa	compression	
Stress from in-plane bending	f _{bx}	=	M _x /Z _x	u	7 37.0.0.7	
		=	1.51 0.00	MPa MPa	compression Tension	
Stress from axial force	fa	=	P/A _g	MDe	oomnroosia-	
Out-of-plane elastic section mod.	Zy	=	19800.41	mm ³		
In-plane elastic section modulus	Z_{x}	=	19800.41	mm ³		
Gross cross section area	A_g	=	951.1171 8	mm²		
DESIGN STRESSES			054 4454			
Out of plane moment	M_y	=	2.46E-15	kNm		
In plane moment	M _x	=	0.9241	kNm		
	Р	=	0	kN	Tension	
Axial force	Р	=	1.436	kN	compression	
FEM ANALYSIS RESULTS						
EEM ANALVOIS DESUITS						
	k _c	=	1.0			T3.4(B)
	k_{t}	=	1.0			
Modulus of elasticity	E	=	70000	MPa	Compressive	
Bearing	F_by	=	386	MPa	Yield	
	F_bu	=	551	MPa	Ultimate	
Shear	F _{sy}	=	138	MPa	Yield	
Compression	F _{cy} F _{su}	=	241 165	MPa MPa	Ultimate	

18 | P a g e

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Effective length factor k Radius of gyration about buckling axis (Y) Radius of gyration about buckling axis (X) Slenderness ratio kLb/slenderness ratio kLb/slenderness ratio kLb/slenderness parameter \$\text{A}\$ Slenderness parameter \$\text{A}\$ \$\text{D}_c\$ \$\text{S}_1\$ \$\text{S}_2\$ \$\phi_c\$ Factored limit state stress \$\phi\$F 2. Sections not subject to torsional or to Largest slenderness ratio for flexural buckling \$\text{A.11}\$ Uniform compression in components of plates with both edges, walls of round of the components of plates with both edges, walls of round of the components of plates of the components of plates with both edges, walls of round of the components of plates of the components of plates with both edges, walls of round of the components of plates with some plates with	= //ry =	30.61 30.61 165.32 251.57 4.70 90.3 0.33 1.23 0.950 10.37 sural buckling 251.57	MPa
Factored limit state stress 2. Sections not subject to torsional or to Largest slenderness ratio for flexural buckling 3.4.11 Uniform compression in components of the buckling axis (Y) Factored limit state of the stress of	= /ry = /rx	30.61 165.32 251.57 4.70 90.3 0.33 1.23 0.950 10.37 cural buckling 251.57	mm MPa
Radius of gyration about puckling axis (X) Slenderness ratio kLb/slenderness ratio kL/s Slenderness parameter \(\lambda \) Slenderness parameter \(\lambda \) Signature \(\lambda \) Signature \(\lambda \) Factored limit state stress \(\lambda \) Factored limit state stres	/ry = rx = * = * = c = orsional-flex /r =	165.32 251.57 4.70 90.3 0.33 1.23 0.950 10.37 cural buckling 251.57	MPa
Slenderness ratio KLb/ Slenderness ratio KLb/ Slenderness ratio KLb/ Slenderness parameter A Dc S1 S2 Φα Factored limit state stress ΦF C. Sections not subject to torsional or to argest slenderness ratio for lexural buckling KL/ SA-11 Uniform compression in components of Uniform compression in components of	rx = * = * = c = orsional-flex tents of colu	251.57 4.70 90.3 0.33 1.23 0.950 10.37 cural buckling 251.57 umns, gross	MPa
Slenderness parameter \$\lambda D_c \\ \hat{S}_1 \\ \hat{S}_2 \\ \phi_{\alpha} Factored limit state stress \$\phi\$ Is a stress of the stress of	= * = * = * = * = * = * = * = * = * = *	4.70 90.3 0.33 1.23 0.950 10.37 cural buckling 251.57	MPa
Do S1 S2 \$\phi_{\text{cattored limit state stress}} \phi_{\text{F}} \$ Sections not subject to torsional or to Largest slenderness ratio for lexural buckling} \text{kL} \$ \$3.4.11 Uniform compression in components of the components of t	* = * = * = c = orsional-flex /r =	90.3 0.33 1.23 0.950 10.37 cural buckling 251.57	g
S1 S2 \$2 \$2 \$2 \$3 \$4 \$6 Factored limit state stress Factored limit state stress Gamma Sections not subject to torsional or to torsional or tors	* = * = c = orsional-flex /r =	0.33 1.23 0.950 10.37 tural buckling 251.57 umns, gross	g
Factored limit state stress • C. Sections not subject to torsional or to Largest slenderness ratio for Elexural buckling • C. Sections not subject to torsional or to Largest slenderness ratio for Elexural buckling • C. Sections not subject to torsional or to Largest slenderness ratio for Elexural buckling • C. Sections not subject to torsional or to Largest slenderness ratio for Elexural buckling • C. Sections not subject to torsional or to Largest slenderness ratio for Elexural buckling • C. Sections not subject to torsional or to Largest slenderness ratio for Elexural buckling • C. Sections not subject to torsional or to Largest slenderness ratio for Elexural buckling • C. Sections not subject to torsional or to Largest slenderness ratio for Elexural buckling	* = c = orsional-flex /r =	1.23 0.950 10.37 cural buckling 251.57 umns, gross	g
φα Factored limit state stress Q. Sections not subject to torsional or to argest slenderness ratio for lexural buckling 3.4.11 Uniform compression in components of	c = critical = critical = critical = critical =	0.950 10.37 Eural buckling 251.57 Lumns, gross	g
Factored limit state stress 2. Sections not subject to torsional or to Largest slenderness ratio for lexural buckling 3.4.11 Uniform compression in compone Uniform compression in components of	rsional-flex /r =	10.37 cural buckling 251.57 umns, gross	g
2. Sections not subject to torsional or to Largest slenderness ratio for lexural buckling 3.4.11 Uniform compression in compone Uniform components of	orsional-flex /r = nents of colu	rural buckling 251.57 umns, gross	g
argest slenderness ratio for kL/exural buckling 8.4.11 Uniform compression in componing the superior of the s	r =	251.57 umns, gross	
lexural buckling 3.4.11 Uniform compression in compon Uniform compression in components of	ents of colu	umns, gross	
3.4.11 Uniform compression in compon Jniform compression in components of		-	section
mid-thickness radius of round tubular column or	or oval tube		
maximum mid-thickness R _n	m =	43.25	
t	=		mm
Slenderness R _m	/t =	12.3571 3	4
Limit 1 S ₁	1 =	0.24	
Limit 2 S ₂		0=0.40	
Factored limit state stress φF	:L =	220.80	MPa
Most adverse compressive Iimit state stress	a =	10.37	MPa
Most adverse tensile limit state stress	a =	267.87	MPa
Most adverse compressive & fa/F	- a =	0.15	

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3.4.13 Compression in beams, tubes	extreme fibre,	gross	section round	l or oval		
Unbraced length for bending	L_b	=	2300	mm		
Second moment of area (weak axis)	ly	=	8.91E+05	mm ⁴		
Torsion modulus	J	=	1.78E+06	mm³		
Elastic section modulus	Z	=	19800.41	${\sf mm}^3$		
	R _b /t	=	12.36			
Limit 1	S ₁	=	44.07			
Limit 2	S_2	=	78.23			
Factored limit state stress	φF _L	=	267.87	MPa		3.4.13
3.4.18 Compression in componedges supported	ents of beams	s - curv	rerd plates wi	th both		
	\mathbf{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	R_b	=	43.25	mm		
radius	t	=	3.5	mm		
Slenderness	R _b /t		12.35714			
		=	3			
Limit 1	S ₁	=	2.75			
Limit 2	S ₂	=	78.23			
Factored limit state stress	фГ∟	=	220.80	MPa		
Most adverse in-plane bending limit state stress	F _{bx}	=	220.80	MPa		
Most adverse in-plane bending capacity factor	f_{bx}/F_{bx}	=	0.21		PASS	
BENDING - OUT-OF-PLANE NOTE: Limit state stresses, ϕF_L (doubly symmetric section) Factored limit state stress	are the same	e for out	-of-plane ber 220.80	nding MPa		
Most adverse out-of-plane bending limit state stress	F _{by}	=	220.80	MPa		
Most adverse out-of-plane bending capacity factor	f _{by} /F _{by}	=	0.00		PASS	

20 | P a g e

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COMBINED ACTIONS						
4.1.1 Combined compression a	nd bending					4.1.
,	J					
	F_a	=	10.37	MPa		3.4.1
	F_{ao}	=	220.80	MPa		3.4.1
	F_bx	=	220.80	MPa		3.4.1
	F_by	=	220.80	MPa		3.4.1
	f _a /F _a	=	0.146			
Check:	$f_a/F_a + f_{bx}/F_{bx}$	+ f _{by} /F _{by}	≤ 1.0			4.1
i.e.	0.36	≤	1.0		PASS	
SHEAR						
3.4.24 Shear in webs (Major Axis)						3.4.2
	R	=	45	mm		
	t	=	3.5	mm		
Equivalent h/t	h/t	=	42.49			
Limit 1	S ₁	=	29.01			
Limit 2	S_2	=	59.31			
actored limit state stress	φF∟	=	117.45	MPa		
Stress From Shear force	f_{sx}	=	V/A_w			
			1.19	MPa		
3.4.25 Shear in webs (Minor Axis)						3.4.2
Clear web height	R	=	45	mm		
	t	=	3.5	mm		
Equivalent h/t	h/t	=	42.49			
actored limit state stress	φF∟	=	117.45	MPa		
Stress From Shear force	\mathbf{f}_{sy}	=	V/A_{w}			
			0.27	MPa		

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7 Summary

7.1 Conclusions

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

Yours faithfully,

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

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22 | P a g e



8 Appendix A – Base Anchorage Requirements

2m, 3m & 4m Café Umbrellas:

Tent Span	Sile Type	Required Weight				
		Per Leg				
	Α	320kg				
	В	320kg				
4 m	С	320kg				
	D	320kg				
	E	320kg				
	Α	250kg				
	В	250kg				
3 m	С	250kg				
	D	250kg				
	E	250kg				
	Α	150kg				
	В	150kg				
2 m	С	150kg				
	D	150kg				
	E	150kg				

<u>Definition of Soil Types:</u>

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

Type B: Medium to stiff clays or silty clays

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

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

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

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

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23 | P a g e



9 Appendix B – Dina Bolt Anchorage Requirements

7 DynaBolt™ Sleeve Anchors

Installation and Performance Details

	Installation details				Minimum Dimensions*			Reduced Characteristic Capacity			
Anchor size,	Drilled	Fixture	Anchor effective	Tightening	Edge	Anchor spacing, a, (mm)	Substrate thickness, b _m (mm)	Shear V _a (kN)		Tension N _a (kN)	
u _k (IIIIII)	hole Ø, d. (mm)	hole Ø, d _r (mm)	depth, h	torque, T _r (Nm)	distance, e, (mm)			Concrete compressive strength (MPa)			
		′ (mm)	(,	-c ()	-c ()	-m ()	20 MPa	20 MPa	32 MPa	40 MPa	
M6	6	8	20	10	30	60	40	3.4	3.0	3.7	4.2
IVIO	Ů	0	30	10	55	105	70	3.4	5.4	5.4	5.4
M8	8	10	30	15	50	95	65	6.0	5.4	6.9	7.7
IVIO	0	10	40	15	75	150	100	6.0	8.3	9.6	9.6
Man	40	40	(35)	(25)	50	100	70	10.9	6.8	8.6	9.7
(M10)	M10 10 12	50	(35)	85	165	110	10.9	11.7	14.8	16.5	
			40		65	125	85	15.8	8.3	10.6	11.8
M12	12	15	50	55	90	180	120	15.8	11.7	14.8	16.5
			60		105	210	140	15.8	15.3	19.4	21.7
			55		75	145	95	20.9	13.5	17.0	19.0
M16	16	19	70	85	105	210	140	20.9	19.3	24.4	27.3
			80		135	270	180	20.9	23.6	29.9	33.4
			70		90	180	120	31.1	19.3	24.4	27.3
M20	20	24	85	165	130	255	170	31.1	25.9	32.7	36.6
			100		195	390	260	31.1	33.0	41.7	46.7

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

Reduced Characteristic

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

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

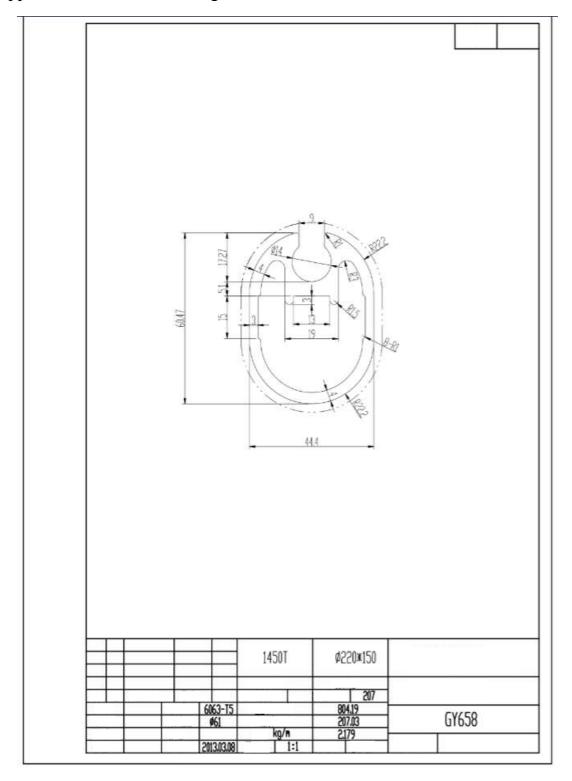
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Email: hited@bigpond.net.au



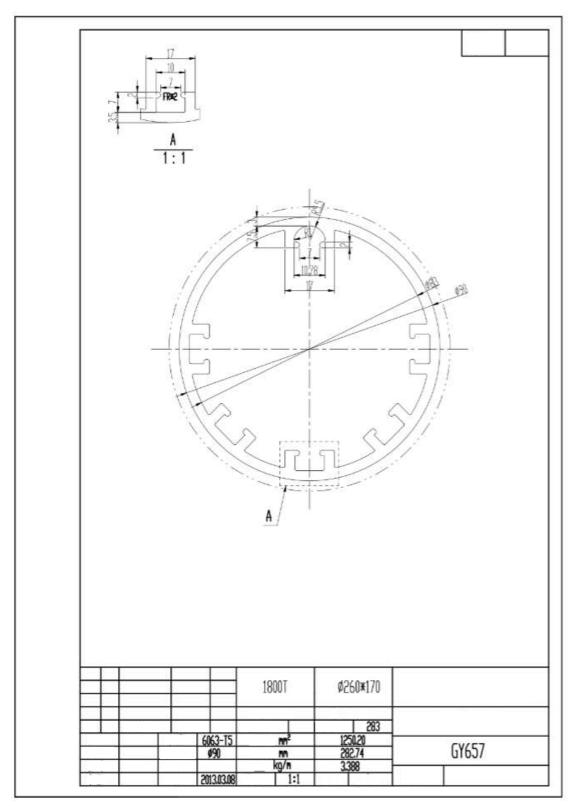
10 Appendix C – Detail Drawings



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