

Prime Consulting Engineers Pty. Ltd.

**Design Report:** 

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

**Square Umbrella Structures** 

For

60km/hr Wind speed

For



Ref: R-23-696

Date: 17/11/2023

Amendment: -

Prepared by: AK

Checked by: KZ



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44 49 50



# **1** Introduction and Scope:

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

Prime Consulting Engineers have been engaged by Extreme Marquees Pty. Ltd. to carry out a structural analysis of 5m x 5m Square Umbrella Structures for **60km/hr** wind speed. It should be noted that the outcome of our analysis is limited to the selected items as outlined in this report.

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

## **1.1 Project Description**

The report examines the effect of the peak gust wind that an equivalent moving average time of approximately 0.2S **16.67m/s (60 km/hr)** positioned for the worst effect on 5m x 5m Square Umbrella Structures as the worst-case scenario. The relevant Australian Standards AS1170.0:2002 General principles, AS1170.1:2002 Permanent, imposed, and other actions and AS1170.2:2021 Wind actions are used. The design check is in accordance with AS1664.1 Aluminium Structures.

### 1.2 References

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



		R	D		SQ					
	Φ4m	Φ5m	Φ6m	Φ7m	4X4m	4x5m	5x5m			
а	50	50	50	50	50	50	50			
b	4350	4350	4350	4350	4350	4350	4350			
с	1100	1100	1100	1100	1100	1100	1100			
d	880	976	1190	1548	2815	3180	3490			
е	1990	2505	2980	3500	2030	2030/2500	2620			

Figure 1 Data sheet



#### 2.2 Assumptions & Limitations

- For forecast winds in excess of **60km/hr**, the umbrella structure should be folded.
- The structure is design for wind parameters as below:
  - Wind Region A
  - o TC2
  - O M<sub>s</sub>, M<sub>t</sub> & M<sub>d</sub> = 1
- Shall the site conditions/wind parameters exceed prescribed design wind actions (refer to <u>Cl.4</u>), Prime Consulting Engineers Pty. Ltd. should be informed to determine appropriate wind classifications and amend computations accordingly.
- It is assumed that the fabric weighs 490gr/m<sup>2</sup>.
- Aluminium alloy is to be 6061-T6.

#### 2.3 Exclusions

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

#### 2.4 Design Parameters and Inputs

#### 2.4.1 Load Cases

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

#### **1.1.1 Load Combinations**

#### Strength (ULS):

- 1.1.35GPermanent action only
- 2. 0.9G+W<sub>u</sub> Permanent and wind actions
- 3. 1.2G+W<sub>u</sub> Permanent and wind actions

#### Serviceability (SLS):



1. G+W<sub>s</sub> Wind service actions

# 3 Specifications

## 3.1 Material Properties

Material Properties												
6064 TC	F <sub>tu</sub>	F <sub>ty</sub>	$F_{cy}$	$F_{su}$	F <sub>sy</sub>	$F_bu$	$F_{by}$	Е	kt	k <sub>c</sub>		
6061-T6	262	241	241	165	138	551	386	70000	1	1.12		



## **3.2 Buckling Constants**

TABLE 3.3(D) BUCKLING CONSTANTS FOR ALLOY 6061-T6												
Type of member and stress	Interce	ept, MPa	Slop	oe, MPa	Intersection							
Compression in columns and beam flanges	Bc	271.04	Dc	1.69	Cc	65.89						
Compression in flat plates	Bp	310.11	Dp	2.06	Cp	61.60						
Compression in round tubes under axial end load	Bt	297.39	Dt	10.70	Ct	*						
Compressive bending stress in rectangular bars	B <sub>br</sub>	459.89	D <sub>br</sub>	4.57	Cbr	67.16						
Compressive bending stress in round tubes	B <sub>tb</sub>	653.34	D <sub>tb</sub>	50.95	C <sub>tb</sub>	78.23						
Shear stress in flat plates	Bs	178.29	Ds	0.90	Cs	81.24						
Ultimate strength of flat plates in compression	<b>k</b> 1	0.35	k2	2.27								
Ultimate strength of flat plates in bending	<b>k</b> 1	0.5	k <sub>2</sub>	2.04								

 $^*$  C<sub>t</sub> shall be determined using a plot of curves of limit state stress based on elastic and inelastic buckling or by trial and error solution



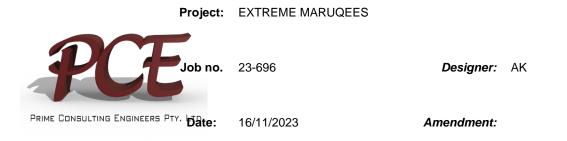
# **3.3** Member Sizes & Section Properties

MEMBER(S	Section	b	d	t	Ус	Ag	Zx	Zy	Sx	Sy	I <sub>x</sub>	ly	J	r <sub>x</sub>	ry
		mm	mm	mm	mm	mm²	mm³	mm³	mm³	mm <sup>3</sup>	mm⁴	mm <sup>4</sup>	mm⁴	mm	mm
Pole	105x105x3.9	105	105	3.9	52.5	1577.2	51252.3	51252.3	59823.7	59823.7	2690745.4	2690745.4	4030120.9	41.3	41.3
Long Rib1	40x20x2+ 35x30x3	20	75	2	37.5	364.0	5035.0	3578.6	7191.7	4786.3	180869.7	62626.1	38065.7	20.4	12.0
Long Rib2	40x20x2+ 35x30x3	20	75	2	37.5	364.0	5035.0	3578.6	7191.7	4786.3	180869.7	62626.1	38065.7	20.4	12.0
Short Rib 1	30X20X2	20	30	2	15.0	184.0	1437.7	1112.5	1796.0	1336.0	21565.3	11125.3	22088.3	10.8	7.8
Short Rib 2	30X20X2	20	30	2	15.0	184.0	1437.7	1112.5	1796.0	1336.0	21565.3	11125.3	22088.3	10.8	7.8



4 Wind Analysis

## 4.1 Wind calculations



Name	Symbol	Value	Unit	Notes	Ref.
		In	put	_	
Importance level		2			Table 3.1 - Table 3.2 (AS1170.0)
Annual probability of exceedance		1/500			Table 3.3
Regional gust wind speed		60.012	Km/hr		
Regional gust wind speed	VR	16.67	m/s		
Wind Direction Multipliers	Md	1			Table 3.2 (AS1170.2)
Terrain Category	тс	2			
Terrain Category Multiplier	M <sub>Z,Cat</sub>	0.91			
Shield Multiplier	Ms	1			4.3 (AS1170.2)
Topographic Multiplier	Mt	1			4.4 (AS1170.2)
Site Wind Speed	V <sub>Site,β</sub>	15.17	m/s	V <sub>Site,β</sub> =V <sub>R</sub> *M <sub>d</sub> *M <sub>z,cat</sub> *M <sub>S</sub> ,M <sub>t</sub>	
Pitch	α	24	Deg		
Pitch	α	-	rad		
Width	В	5	m		
Length	D	5	m		
Height	Z	3.8	m		
Porosity Ratio	δ	1		ratio of solid area to total area	
		Wind F	Pressure		



hoair dynamic response factor	ρ Cdyn	1.2 1	Kg/m <sup>3</sup>		
Wind Pressure	ho*Cfig	0.138	Kg/m <sup>2</sup>	$ ho=0.5 ho_{air}^*(V_{des,\beta})^2*C_{fig}*C_{dyn}$	2.4 (AS1170.2)
		WIND DIREC	CTION 1	(0=0)	
		External	Pressur	e	
1. Free Roof				α <b>=0°</b>	
Area Reduction Factor	Ka	1			D7
local pressure factor	Kı	1			
porous cladding reduction factor	Kp	1.00			
External Pressure Coefficient <b>MIN</b>	$C_{P,w}$	-0.3			
External Pressure Coefficient	$C_{P,w}$	0.64			
External Pressure Coefficient <b>MIN</b>	C <sub>P,I</sub>	-0.62			
External Pressure Coefficient <b>MAX</b>	C <sub>P,I</sub>	0			
aerodynamic shape factor <b>MIN</b>	$C_{\text{fig},w}$	-0.30			
aerodynamic shape factor MAX	$C_{\text{fig},w}$	0.64			
aerodynamic shape factor MIN	Cfig,I	-0.62			
aerodynamic shape factor <b>MAX</b>	C <sub>fig,I</sub>	0.00			
Pressure Windward MIN	Р	-0.04	kPa		
Pressure Windward MAX	Р	0.09	kPa		
Pressure Leeward MIN	Р	-0.09	kPa		
Pressure Leeward MAX	Р	0.00	kPa		
		WIND DIREC		6-00)	
		External			
				1000	
4. Free Roof				α <b>=180°</b>	D7
Area Reduction Factor	Ka K	1 1			
local pressure factor porous cladding reduction	K	_			
factor External Pressure Coefficient	Kp	1.00			
MIN	C <sub>P,w</sub>	-0.3			
External Pressure Coefficient <b>MAX</b>	$C_{P,w}$	0.4			



External Pressure Coefficient	C <sub>P,I</sub>	-0.4	
External Pressure Coefficient	C <sub>P,I</sub>	0	
aerodynamic shape factor	C <sub>fig,w</sub>	-0.30	
aerodynamic shape factor <b>MAX</b>	$C_{\text{fig},w}$	0.40	
aerodynamic shape factor <b>MIN</b>	C <sub>fig,I</sub>	-0.40	
aerodynamic shape factor MAX	$C_{\text{fig,I}}$	0.00	
Pressure MIN (Windward Side)	Ρ	-0.04	kPa
Pressure MAX (Windward Side)	Ρ	0.06	kPa
Pressure MIN (Leeward Side)	Ρ	-0.06	kPa
Pressure MAX (Leeward Side)	Р	0.00	kPa

# 4.1.1 Summary

WIND EXTERNAL	Dire	ction1	Direction2			
PRESSURE	Min (Kpa)	Max (Kpa)	Min (Kpa)	Max (Kpa)		
Windward	-0.041	0.088	-0.041	0.055		
Leeward	-0.086	0.000	-0.055	0.000		



### 4.2 Wind Load Diagrams

### 4.2.1 Wind Load Ultimate (W<sub>min</sub>) \_ Opened Condition

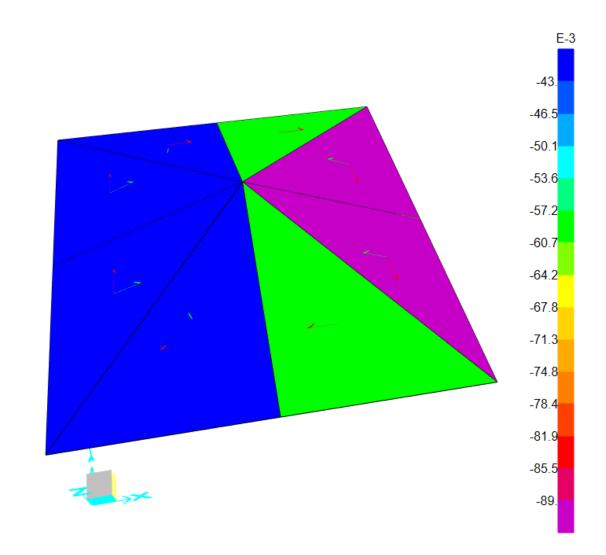


Figure 2 Wind Min



### 4.2.2 Wind Load Ultimate (W<sub>max</sub>) \_ Opened Condition

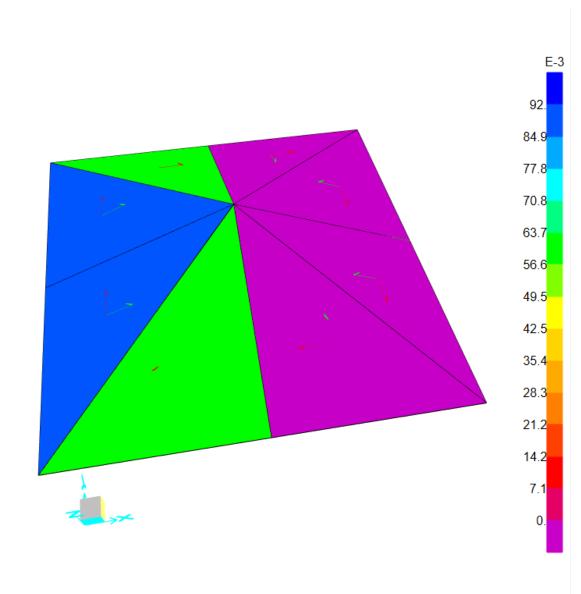


Figure 3 Wind Max



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## 4.2.3 Wind Load – Closed Condition

0.23

Figure 4 Wind\_Closed



- 5 Analysis
- 5.1 Results

### 5.1.1 Maximum Bending Moment in Major Axis

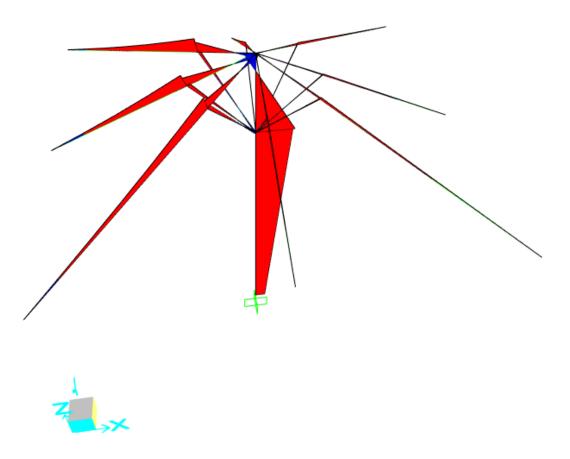


Figure 5 Maximum Bending Moment - Major



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#### 5.1.2 Maximum Bending Moment in Minor Axis

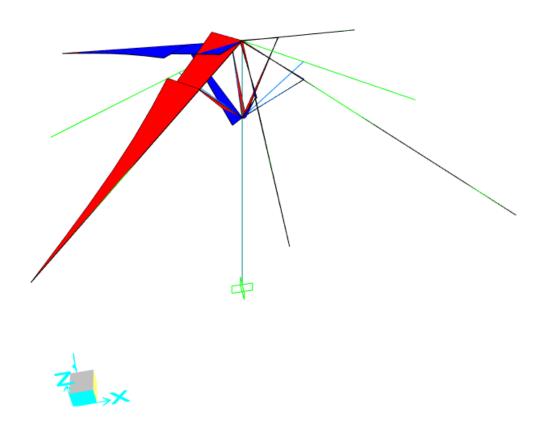


Figure 6: Maximum Bending Moment - Minor



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## 5.1.3 Maximum Shear

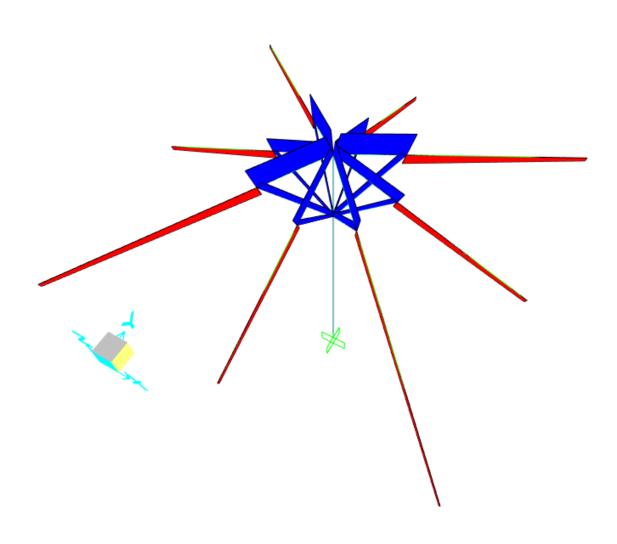


Figure 7 Maximum Shear



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#### 5.1.4 Maximum Axial Force

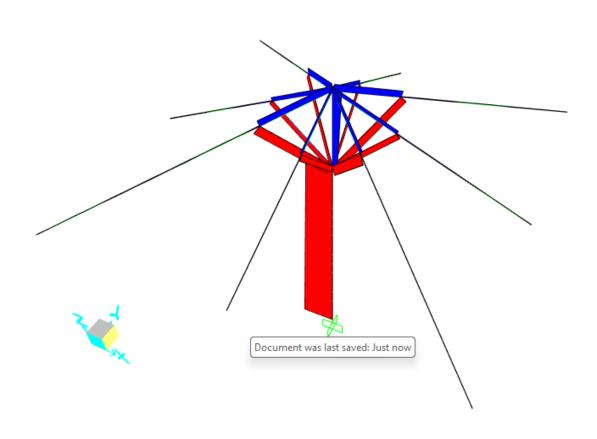
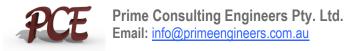
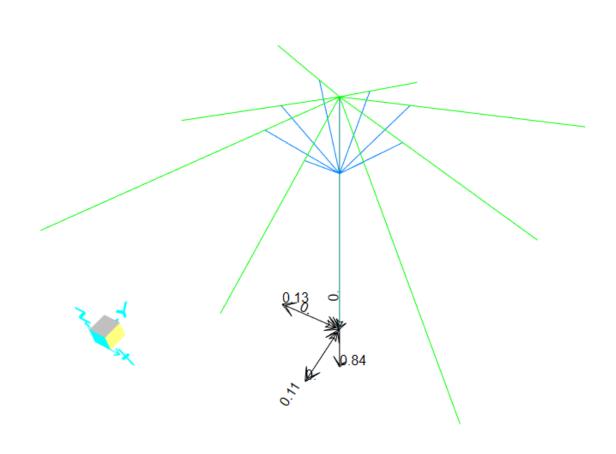


Figure 8 Maximum Axial Force



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#### 5.1.5 Maximum Reactions – Opened



#### Figure 9 Maximum Reaction

$$Fx = 0.73 \text{ kN} Fy = 0.01 \text{ kN} F_{z(up lift)} = 0.99 \text{ kN} F_{z (Bearing)} = 1.56 \text{ kN} My = 1.81 \text{ kN-m}$$



#### 5.1.6 Maximum Reactions – Closed

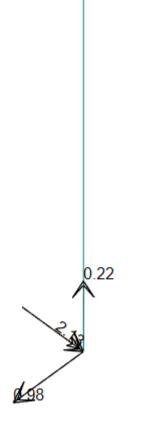


Figure 10 Maximum Reaction

 $\label{eq:Fx} \begin{array}{l} {\sf Fx} = 0.98 \ {\sf kN} \\ {\sf Fy} = 0.01 \ {\sf kN} \\ {\sf F_z} \ = 0.22 \ {\sf kN} \\ {\sf M_y} = 2.13 \ {\sf kN-m} \end{array}$ 



# 6 Aluminium Member Design

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

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

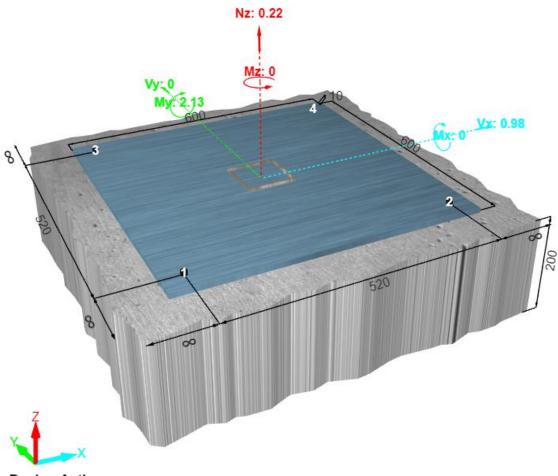


# 7 Anchor Design

## 7.1 Permanent Installation

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

Refer Appendix 'B' for details.



Design Actions :

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



START 1. APPLICATIONS	2. DIMENSION	S 3. MATERIAL	4. LOADS	5. DESIGN	6. CALCULATE			
Anchor s	election			Detailed view	w	PDF	ETA ACAD	STEP
Anchor selected: TRUBOL	T XTREM M10X	90/10						
	Tensile	30.18%			<b>~</b>			
	Shear	2			⊻			
	Utilization	16.67%			⊻			
Design method applied:A	S 5216:2021 Des	ion for static, quas	i-static loadi	ina				
Boolgii motilou appilou		igni ion otatio, quao	, otatio lotati					
Loads on anchors								
Anchor		Tensile		Shea	ar[x]		Shear[y]	
1		1.99		0.:	24		0	
1		1.99 0.05		0.:				
					24		0	

# 7.2 Temporary Installation

Maximum uplift force at toe: 0.99kN

Self-weight of the base plate: 90kg

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



# 8 Summary and Recommendations

• The 5m x 5m Square Umbrella Structures as specified is capable of withstanding **60 m/s** 

Wind Loads when open and 140.4km/hr when folded.

- For forecast winds in excess of **60km/hr** the umbrella structure should be completely folded. The umbrella with temporary anchorage system must be stored in an enclosed building however the umbrella with permanent anchorage system can remain folded on site when forecast wind not exceeding **140.4 km/hr**.
- Refer to <u>Cl. 7</u> for the required anchorage system.

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



# 9 Appendix A – Aluminium Design Based on AS1664.1



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## 9.1 Pole



Job no.

23-696-1

Date: 17/11/2023

105x105x3.9 Alloy and temperPole $6061-T6$ Ultimate YieldTension $F_{ty}$ =262MPa MPa YieldUltimate YieldCompression $F_{cy}$ =241MPa MPaYieldShear $F_{su}$ =165MPa MPaUltimate YieldBearing $F_{bu}$ =551MPa MPaUltimate VieldModulus of elasticityE=70000MPaCompressivekt=1k1kfesionFEM ANALYSIS RESULTSP=1.392kN N Pcompression TensionAxial forceP=1.392kN N Out of plane momentMx=1.1869kNm N DESIGN STRESSES Gross cross section areaAg=1577.16mm²	AS1664.1 T3.3(A)
Tension $F_{tu}$ = $262$ MPa MPaUltimate YieldCompression $F_{cy}$ = $241$ MPaUltimate YieldShear $F_{su}$ = $165$ MPa 	
Tension $F_{ty}$ =241MPaYieldCompression $F_{cy}$ =241MPaUltimateShear $F_{su}$ =165MPaUltimate $F_{sy}$ =138MPaYieldBearing $F_{bu}$ =551MPaUltimateModulus of elasticityE=70000MPaCompressive $k_t$ =1 $k_t$ =1 $k_c$ =1 $K_t$ =1FEM ANALYSIS RESULTSP=1.392kNcompressionAxial forceP=1.392kNCompression $P$ =0kNTensionTensionIn plane moment $M_x$ =1.1869kNmCompression $DESIGN STRESSES$ $K_{V}$ $K_{V}$ $K_{V}$ $K_{V}$ $K_{V}$	T3.3(A)
Tension $F_{ty}$ =241MPaYieldCompression $F_{cy}$ =241MPaVieldShear $F_{su}$ =165MPaUltimate $F_{sy}$ =138MPaYieldVieldBearing $F_{bu}$ =551MPaUltimateModulus of elasticityE=70000MPaCompressive $k_t$ =1 $k_c$ =1FEM ANALYSIS RESULTSAxial forceP=1.392kN $P$ =0kNTensionIn plane momentMx=1.1869kNm $DESIGN STRESSES$ $W_{res}$ $W_{res}$ $W_{res}$ $W_{res}$	13.3(A)
Compression $F_{cy}$ =241MPaUltimateShear $F_{su}$ =165MPaUltimate $F_{sy}$ =138MPaVieldBearing $F_{bu}$ =551MPaUltimate $F_{by}$ =386MPaCompressiveModulus of elasticityE=70000MPaCompressive $k_t$ =1 $k_t$ =1 $k_c$ =1 $k_t$ =1FEM ANALYSIS RESULTSV=0kNAxial forceP=1.392kN $P$ =0kNCompression $P$ =0kNCompression $P$ =0kNVield $Out of plane momentM_x=1.1869kNmDESIGN STRESSESKKKK$	
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Shear $F_{sy}$ =138MPaYieldBearing $F_{bu}$ =551MPaUltimate $F_{by}$ =386MPaYieldModulus of elasticityE=70000MPaCompressive $k_t$ =1 $K_t$ =1 $k_c$ =1 $K_t$ =1FEM ANALYSIS RESULTS $F$ =1.392 $KN$ $KN$ Axial forceP=1.392 $KN$ $Compression$ $P$ =0 $KN$ $Tension$ In plane moment $M_x$ =1.1869 $KNm$ $Out of plane moment$ $M_y$ =9.397E-14 $KNm$ $DESIGN STRESSES$ $K$ $K$ $K$ $K$	
Bearing $F_{bu}$ $F_{by}$ =551 386MPa MPaUltimate YieldModulus of elasticityE=70000MPaCompressive $k_t$ $k_c$ =1Image: state of the	
Bearing $F_{by}$ =386MPaYieldModulus of elasticityE=70000MPaCompressive $k_t$ =1 $k_t$ =1 $k_t$ $k_c$ =1 $k_t$ =1 $k_t$ FEM ANALYSIS RESULTSAxial forceP=1.392kNP=0kN $k_t$ In plane momentMx=1.1869kNmOut of plane momentMy=9.397E-14kNmDESIGN STRESSES $K_t$ $K_t$ $K_t$ $K_t$	
$F_{by}$ =386MPaYieldModulus of elasticityE=70000MPaCompressive $k_t$ =1 $k_t$ =1 $k_c$ =1 $k_t$ =1FEM ANALYSIS RESULTSAxial forceP=1.392kNP=0kNCompressionP=0kNTensionIn plane momentMx=1.1869kNmOut of plane momentMy=9.397E-14kNmDESIGN STRESSESVVV	
$k_t = 1$ $k_c = 1$ $k_r = 1$ <i>FEM ANALYSIS RESULTS</i> $k_r = 1.392$ Axial force $P = 1.392$ $k_r = 1.1869$ $P = 0$ $k_r = 1.1869$ $k_r = 1.1869$ In plane moment $M_x = 1.1869$ $k_r = 1.1869$ Out of plane moment $M_y = 9.397E-14$ $k_r = 1.1869$ DESIGN STRESSES $K_r = 1.1869$ $K_r = 1.1869$	1
$\begin{array}{cccc} k_t & = & 1 \\ k_c & = & 1 \end{array} \end{array} \begin{array}{cccc} FEM \ ANALYSIS \ RESULTS & & & & \\ \hline FEM \ ANALYSIS \ RESULTS & & & & \\ \hline Axial \ force & P & = & 1.392 & kN \\ P & = & 0 & kN \\ P & = & 0 & kN \\ In \ plane \ moment & M_x & = & 1.1869 & kNm \\ Out \ of \ plane \ moment & M_y & = & 9.397E-14 & kNm \\ \hline DESIGN \ STRESSES & & & & \\ \hline \end{array}$	
$k_c$ =1Image: second	
FEM ANALYSIS RESULTSAxial forceP= $1.392$ kNCompressionP=0kNTensionIn plane momentMx= $1.1869$ kNmOut of plane momentMy= $9.397E-14$ kNmDESIGN STRESSES	T2 4(D)
Axial forceP=1.392kNcompressionP=0kNIn plane moment $M_x$ =1.1869kNmOut of plane moment $M_y$ =9.397E-14kNmDESIGN STRESSES </td <td>T3.4(B)</td>	T3.4(B)
$\begin{array}{ccccccc} P & = & 0 & kN & Tension \\ \mbox{In plane moment} & M_x & = & 1.1869 & kNm \\ \mbox{Out of plane moment} & M_y & = & 9.397E-14 & kNm \\ \hline \mbox{DESIGN STRESSES} & & & & & & & & & & & & \\ \end{array}$	
$\begin{array}{ccccc} P & = & 0 & kN & Tension \\ \mbox{In plane moment} & M_x & = & 1.1869 & kNm \\ \mbox{Out of plane moment} & M_y & = & 9.397E-14 & kNm \\ \hline \mbox{DESIGN STRESSES} & & & & & & & & & & & & & & & & & & &$	
Out of plane momentMy=9.397E-14kNmDESIGN STRESSES	
DESIGN STRESSES	
In-plane elastic section $Z_x = 51252.293 \text{ mm}^3$	
Out-of-plane elastic section $Z_y = 51252.293 \text{ mm}^3$	
Stress from axial force $f_a = P/A_g$	
= 0.88 MPa compression	
= 0.00 MPa Tension	
Stress from in-plane bending $f_{bx} = M_x/Z_x$	
= 23.16 MPa compression	



Stress from out-of-plane	f <sub>by</sub>	=	M <sub>y</sub> /Z <sub>y</sub>			
bending		=	0.00	MPa	compression	
Tension						
<b>3.4.3</b> Tension in rectangular tube			222.05	MDe		
	φF∟	=	228.95	МРа		
		OR	000 70	MDa		
	φF∟	=	222.70	МРа		
COMPRESSION						
<b>3.4.8</b> Compression in columns, a	xial. aross	sectio	n			
1. General	, g					3.4.8.1
Unsupported length of member	L	=	4350	mm		
Effective length factor	k	=	1.00			
Radius of gyration about	r <sub>y</sub>	=	41.30	mm		
buckling axis (Y)	,					
Radius of gyration about buckling axis (X)	r <sub>x</sub>	=	41.30	mm		
Slenderness ratio	kLb/ry	=	78.68			
Slenderness ratio	kL/rx	=	105.32			
Slenderness parameter	λ	=	1.967			
	Dc*	=	90.3			
	S <sub>1</sub> *	=	0.33			
	S <sub>2</sub> *	=	1.23			
	фсс	=	0.855			
Factored limit state stress	φF∟	=	53.28	MPa		
2. Sections not subject to torsion	al or torsio	nal-fle	xural buckling	9		3.4.8.2
Largest slenderness ratio for	kL/r	=	105.32			
flexural buckling						
<b>3.4.10</b> Uniform compression in co flat plates	omponents	of col	umns, gross	section -		
1. Uniform compression in compo plates with both edges supported		olumn	s, gross sect	ion - flat		 3.4.10.1
	<b>k</b> ₁	=	0.35			T3.3(D)
Max. distance between toes of						
fillets of supporting elements for plate	b'	=	97.2			
	t	=	3.9	mm		
Slenderness	b/t	=	24.923077			
Limit 1	S <sub>1</sub>	=	12.34			
Limit 2	S <sub>2</sub>	=	32.87			



Factored limit state stress	φF∟	=	193.63	MPa		
Most adverse compressive limit state stress	Fa	=	53.28	MPa		
Most adverse tensile limit state stress	Fa	=	222.70	MPa		
Most adverse compressive & Tensile capacity factor	fa/Fa	=	0.02		PASS	
BENDING - IN-PLANE						
<b>3.4.15</b> Compression in beams, ex tubes, box sections	treme fibro	e, gro	ss section rec	tangular		
Unbraced length for bending	L <sub>b</sub>	=	3250	mm		
Second moment of area (weak axis)	ly	=	2.69E+06	mm <sup>4</sup>		
Torsion modulus	J	=	4.03E+06	mm <sup>3</sup>		
Elastic section modulus	Z	=	51252.293	mm <sup>3</sup>		
Slenderness	S	=	101.17			
Limit 1	S <sub>1</sub>	=	0.39			
Limit 2	S <sub>2</sub>	=	1695.86			
Factored limit state stress	φF∟	=	207.31	MPa		3.4.15(2
<b>3.4.17</b> Compression in componer compression), gross section - flat						
····	<b>k</b> 1	=	0.5			T3.3(E
	<b>k</b> 2	=	2.04			T3.3(E
Max. distance between toes of	K2	_	2.04			10.0(2
fillets of supporting elements for plate	b'	=	97.2	mm		
	t	=	3.9	mm		
Slenderness	b/t	_	24.923077			
Limit 1	S <sub>1</sub>	=	12.34			
Limit 2	S <sub>2</sub>	=	46.95			
Factored limit state stress	φF∟	=	193.63	MPa		
Most adverse in-plane bending limit state stress	F <sub>bx</sub>	=	193.63	MPa		
Most adverse in-plane bending	f <sub>bx</sub> /F <sub>bx</sub>	=	0.12		PASS	



	. –					
Factored limit state stress	φF∟	=	193.63	МРа		
Most adverse out-of-plane bending limit state stress	F <sub>by</sub>	=	193.63	MPa		
Most adverse out-of-plane bending capacity factor	f <sub>by</sub> /F <sub>by</sub>	=	0.00		PASS	
COMBINED ACTIONS						
4.1.1 Combined compression and	d bending					4.1.1(2)
	Fa	=	53.28	MPa		3.4.8
	$F_{ao}$	=	193.63	MPa		3.4.10
	$F_{bx}$	=	193.63	MPa		3.4.17
	$F_{by}$	=	193.63	MPa		3.4.17
	f₀/Fa	=	0.017			
Check:	f <sub>a</sub> /Fa + f <sub>bx</sub>	/F <sub>bx</sub> + 1	$f_{by}/F_{by} \leq 1.0$			4.1.1 (3)
i.e.	0.14	≤	1.0		PASS	
SHEAR						
<b>3.4.24</b> Shear in webs (Major Axis)						4.1.1(2)
Clear web height	h	=	97.2	mm		
	t	=	3.9	mm		
Slenderness	h/t	=	24.923077			
Limit 1	S1	=	29.01			
Limit 2	S <sub>2</sub>	=	59.31			
Factored limit state stress	φF∟	=	131.10	MPa		
Stress From Shear force	f <sub>sx</sub>	=	V/A <sub>w</sub>			
3.4.25 Shear in webs (Minor			0.19	MPa		
Axis)				<b>m</b> m		
<i>Axis)</i> Clear web height	b	=	97.2	mm		
	b t b/t	= = =	97.2 3.9 24.923077	mm		
Clear web height Slenderness	t b/t	= =	3.9 24.923077	mm		
Clear web height	t	=	3.9			



Most adverseshear capacity factor (Major Axis)	f <sub>sx</sub> /F <sub>sx</sub>	=	0.00	МРа	
Most adverseshear capacity factor (Minor Axis)	$f_{sy}/F_{sy}$	=	0.00	Мра	PASS
COMBINED ACTIONS					
4.4 Combined Shear, Compresio	n and bend	ding			
Check:	$f_a/F_a + f_b/F_a$	F₀ + (f₅/F₅	$(5)^2 \leq 1.0$		
i.e.	0.14	≤	1.0		PASS

# 9.2 Long Rib 1

PCE	Job no.	23-696-1	<b>Date:</b> 17/11/2023	3
PRIME CONSULTING ENGINEERS PTY. LTD				

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
40x20x2+ 35x30x3	Long Rib1					
Alloy and temper	6061-T6					AS1664.1
	F <sub>tu</sub>	=	262	MPa	Ultimate	T3.3(A)
Tension	F <sub>ty</sub>	=	241	MPa	Yield	
Compression	F <sub>cy</sub>	=	241	MPa		
	F <sub>su</sub>	=	165	MPa	Ultimate	
Shear	F <sub>sy</sub>	=	138	MPa	Yield	
Desting	$F_{bu}$	=	551	MPa	Ultimate	
Bearing	$F_{by}$	=	386	MPa	Yield	
Modulus of elasticity	E	=	70000	MPa	Compressiv e	
	<b>k</b> t	=	1			
	kc	=	1			T3.4(B)
FEM ANALYSIS RESULTS						
Axial force	Р	=	0	kN	compression	
	Р	=	0.009948	kN	Tension	



In plane moment	Mx	=	0.426	kNm		
Out of plane moment	Mу	=	0.0242	kNm		
DESIGN STRESSES						
Gross cross section area	Ag	=	364	mm <sup>2</sup>		
In-plane elastic section modulus	Z <sub>x</sub>	=	5035	mm <sup>3</sup>		
Out-of-plane elastic section mod.	Zy	=	3578.6	mm <sup>3</sup>		
Stress from axial force	f <sub>a</sub>	=	P/A <sub>g</sub>			
		=	0.00 0.03	MPa MPa	compression Tension	
Stress from in-plane bending	f <sub>bx</sub>	=	0.03 M <sub>x</sub> /Z <sub>x</sub>	IVIPa	Tension	
Stress norm in-plane bending	ъх	_	84.61	MPa	compression	
Stress from out-of-plane	<b>f</b> <sub>by</sub>	_	M <sub>y</sub> /Z <sub>y</sub>	ini a	Compression	
bending	. 69	=	<b>6.76</b>	MPa	compression	
Tension						
3.4.3 Tension in rectangular tubes	s					
	φF∟	= O R	228.95	MPa		
	φF∟	=	222.70	MPa		
COMPRESSION						
<b>3.4.8</b> Compression in columns, as	xial, gross s	ection				
1. General						3.4.8.1
Unsupported length of member	L	=	3700	mm		
Effective length factor	k	=	1.00			
Radius of gyration about buckling axis (Y)	r <sub>y</sub>	=	12.00	mm		
Radius of gyration about buckling axis (X)	r <sub>x</sub>	=	20.40	mm		
Slenderness ratio Slenderness ratio	kLb/ry kL/rx	= =	232.00 181.37			
Slenderness parameter	λ	=	4.33			
	Dc*	=	90.3			
	S <sub>1</sub> *	=	0.33			
	<b>S</b> <sub>2</sub> *	=	1.23			
	фсс	=	0.950			
		_	12.19	MPa		
Factored limit state stress	φF∟	=	12.19	IVIF a		



flexural buckling	kL/r	=	232.00			
<b>3.4.10</b> Uniform compression in co	mponents	of colu	mns, gross s	ection -		
flat plates 1. Uniform compression in compo plates with both addaes supported	nents of co	olumns,	gross sectio	on - flat		 3.4.10.1
plates with both edges supported	k <sub>1</sub>	=	0.35			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	b'	=	16			(2)
	t	=	2	mm		
Slenderness	b/t	=	8			
Limit 1	S <sub>1</sub>	=	12.34			
Limit 2	S <sub>2</sub>	=	32.87			
Factored limit state stress	φF∟	=	228.95	MPa		
Most adverse compressive	Fa	=	12.19	MPa		
limit state stress						
Most adverse tensile limit state stress	Fa	=	222.70	MPa		
Most adverse compressive & Tensile capacity factor	f <sub>a</sub> /Fa	=	0.00		PASS	
, ,						
BENDING - IN-PLANE	tuo no o filo no					
	treme fibre	, gross	section rect	angular		
BENDING - IN-PLANE <b>3.4.15</b> Compression in beams, ex	treme fibre L₅	, gross =	section rect	angular mm		
BENDING - IN-PLANE <b>3.4.15</b> Compression in beams, ex tubes, box sections		-		mm		
BENDING - IN-PLANE 3.4.15 Compression in beams, ex tubes, box sections Unbraced length for bending Second moment of area (weak	Lb	=	2784	mm		
BENDING - IN-PLANE 3.4.15 Compression in beams, ex tubes, box sections Unbraced length for bending Second moment of area (weak axis)	L <sub>b</sub> Iy	=	2784 6.26E+04	mm mm <sup>4</sup>		
BENDING - IN-PLANE 3.4.15 Compression in beams, ex tubes, box sections Unbraced length for bending Second moment of area (weak axis) Torsion modulus	L <sub>b</sub> Iy J	= = =	2784 6.26E+04 3.81E+04	mm mm <sup>4</sup> mm <sup>3</sup>		
BENDING - IN-PLANE 3.4.15 Compression in beams, ex tubes, box sections Unbraced length for bending Second moment of area (weak axis) Torsion modulus Elastic section modulus Slenderness	L <sub>b</sub> Iy J Z	= = =	2784 6.26E+04 3.81E+04 5035	mm mm <sup>4</sup> mm <sup>3</sup>		
BENDING - IN-PLANE 3.4.15 Compression in beams, ex tubes, box sections Unbraced length for bending Second moment of area (weak axis) Torsion modulus Elastic section modulus	L₀ Iy J Z S	= = = =	2784 6.26E+04 3.81E+04 5035 574.19	mm mm <sup>4</sup> mm <sup>3</sup>		
BENDING - IN-PLANE <b>3.4.15</b> Compression in beams, ex tubes, box sections Unbraced length for bending Second moment of area (weak axis) Torsion modulus Elastic section modulus Slenderness Limit 1	L₀ Iy J Z S S1	= = = = =	2784 6.26E+04 3.81E+04 5035 574.19 0.39	mm mm <sup>4</sup> mm <sup>3</sup>		 3.4.15(2)
BENDING - IN-PLANE <b>3.4.15</b> Compression in beams, ex tubes, box sections Unbraced length for bending Second moment of area (weak axis) Torsion modulus Elastic section modulus Slenderness Limit 1 Limit 2 Factored limit state stress <b>3.4.17</b> Compression in component	L₅ Iy J Z S 1 S₂ <b>φF</b> ∟ ts of beam	= = = = = = s (com	2784 6.26E+04 3.81E+04 5035 574.19 0.39 1695.86 <b>175.42</b> ponent unde	mm mm <sup>4</sup> mm <sup>3</sup> mm <sup>3</sup> MPa		 3.4.15(2)
BENDING - IN-PLANE <b>3.4.15</b> Compression in beams, ex tubes, box sections Unbraced length for bending Second moment of area (weak axis) Torsion modulus Elastic section modulus Slenderness Limit 1 Limit 2 Factored limit state stress <b>3.4.17</b> Compression in component	L₀ Iy Z S S1 S2 <b>φF</b> ∟ ts of beam plates with	= = = = = = s (com	2784 6.26E+04 3.81E+04 5035 574.19 0.39 1695.86 <b>175.42</b> ponent unde	mm mm <sup>4</sup> mm <sup>3</sup> mm <sup>3</sup> MPa		
BENDING - IN-PLANE <b>3.4.15</b> Compression in beams, ex tubes, box sections Unbraced length for bending Second moment of area (weak axis) Torsion modulus Elastic section modulus Slenderness Limit 1 Limit 2 Factored limit state stress	L₅ Iy J Z S 1 S₂ <b>φF</b> ∟ ts of beam	= = = = = = s (com	2784 6.26E+04 3.81E+04 5035 574.19 0.39 1695.86 <b>175.42</b> ponent unde	mm mm <sup>4</sup> mm <sup>3</sup> mm <sup>3</sup> MPa		 3.4.15(2) T3.3(D) T3.3(D)



Max. distance between toes of fillets of supporting elements for plate	b'	=	16	mm		
	t	=	2	mm		
Slenderness	b/t	=	8			
Limit 1	S <sub>1</sub>	=	12.34			
Limit 2	S <sub>2</sub>	=	46.95			
Factored limit state stress	φF∟	=	228.95	MPa		
Most adverse in-plane bending limit state stress	F <sub>bx</sub>	=	175.42	MPa		
Most adverse in-plane bending capacity factor	f <sub>bx</sub> /F <sub>bx</sub>	=	0.48		PASS	
BENDING - OUT-OF-PLANE						
NOTE: Limit state stresses, $\phi F_L a$ (doubly symmetric section)	nre the sam	e for ou	t-of-plane b	pending		
Factored limit state stress	φF∟	=	175.42	MPa		
Most adverse out-of-plane bending limit state stress	$F_{by}$	=	175.42	MPa		
Most adverse out-of-plane bending capacity factor	f <sub>by</sub> /F <sub>by</sub>	=	0.04		PASS	
COMPINED ACTIONS						
COMBINED ACTIONS 4.1.1 Combined compression and	d bending					4.1.1(2)
	Fa	=	12.19	MPa		3.4.8
	Fao		228.95	MPa		3.4.10
	Fao Fbx	=	228.95 175.42	MPa		3.4.10
		=				
	F <sub>by</sub>	=	175.42	MPa		3.4.17
	f <sub>a</sub> /Fa	=	0.000			
Check:	f <sub>a</sub> /F <sub>a</sub> + f <sub>bx</sub> /F	- by + fby/	$F_{hv} \leq 1.0$			4.1.1
					DACC	(3)
i.e.	0.52	≤	1.0		PASS	
SHEAR <b>3.4.24</b> Shear in webs (Major Axis)						4.1.1(2)
Clear web height	h ≁	=	71	mm		
Slenderness	t h/t	=	2 35.5	mm		



Limit 1	S <sub>1</sub>	=	29.01		
Limit 2	<b>S</b> <sub>2</sub>	=	59.31		
Factored limit state stress	φF∟	=	124.53	MPa	
Stress From Shear force	f <sub>sx</sub>	=	V/A <sub>w</sub>		
			0.82	MPa	
<b>3.4.25</b> Shear in webs (Minor Axis)					
Clear web height	b	=	16	mm	
	t	=	2	mm	
Slenderness	b/t	=	8		
Factored limit state stress	φF∟	=	131.10	MPa	
Stress From Shear force	<b>f</b> <sub>sy</sub>	=	V/A <sub>w</sub>		
			0.05	MPa	
Most adverseshear capacity factor (Major Axis)	f <sub>sx</sub> /F <sub>sx</sub>	=	0.01	MPa	
Most adverseshear capacity factor (Minor Axis)	f <sub>sy</sub> /F <sub>sy</sub>	=	0.00	Мра	PASS
COMBINED ACTIONS					
<b>4.4</b> Combined Shear, Compresion	n and hendi	'na			
		''Y			
Check:	f <sub>a</sub> /F <sub>a</sub> + f <sub>b</sub> /F <sub>b</sub>	+ (f <sub>s</sub> /F <sub>s</sub>	$_{0}^{2} \leq 1.0$		
i.e.	0.48	≤	1.0		PASS

## 9.3 Long Rib 2



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

PRIME CONSULTING ENGINEERS PTY. LTD

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
40x20x2+ 35x30x3	Long Rib2					
Alloy and temper	6061-T6					AS1664.1
Tension	Ftu	=	262	MPa	Ultimate	T3.3(A)
	F <sub>ty</sub>	=	241	MPa	Yield	
Compression	F <sub>cy</sub>	=	241	MPa		



ShearFor For For For BearingTo be the form For<		Fsu	=	165	MPa	Ultimate	
BearingFby=386MPaYieldModulus of elasticityE=70000MPaCompressivekt=1	Shear	Fsy	=	138	MPa	Yield	
$F_{by}$ =386MPaYieldModulus of elasticityE=70000MPaCompressive $k_t$ =1T3.4(B)FEM ANALYSIS RESULTSImage: compression pression pressi		Fbu	=	551	MPa	Ultimate	
kt=1 kT3.4(8)FEM ANALYSIS RESULTSIIIAxial forceP=0KN 0.011compression TensionIn plane momentMx=0.3929KNmOut of plane momentMy=3.69E-11KNmDESIGN STRESSESImage: state stat	Bearing	F <sub>by</sub>	=	386	MPa	Yield	
kc=1T3.4(8)FEM ANALYSIS RESULTS $I$	Modulus of elasticity	E	=	70000	MPa	Compressive	
kc=1T3.4(8)FEM ANALYSIS RESULTS $I$							
FEM ANAL YSIS RESULTSP=0kN compression Tensioncompression TensionAxial forceP=0.011kN mcompression Tensioncompression TensionIn plane momentMx=0.3929kNm mcompression Tensioncompression TensionDESIGN STRESSESF5035mm3 modulusZx=5035mm3 m Stress from axial forceZy=3578.6mm3 modulusStress from in-plane bendingfbx=P/Ag mcompression Tensioncompression Tensioncompression TensionStress from in-plane bendingfby=Mx/Zx mcompression Tensioncompression TensionTensionfby=228.95MPa compressioncompression compressioncompressionStress from in-plane bendingfby=228.95MPa compressioncompression compressioncompressionTensionfby=228.95MPa compressioncompressioncompressionStress from out-of-planefby=228.95MPa compressioncompressionTensionii=228.95MPa compressioncompressionStress from out-of-planefby=228.95MPa compressioncompressionTensionii=228.95MPa compressioniStress form nectangular tubesiiiiStress form necta							T3.4(B)
Axial forceP P= 00kN kN kN ecompression TensionIn plane momentMx=0.3929kNmNmOut of plane momentMy=3.69E-11kNmNmDESIGN STRESSEST5035mm³TTGross cross section areaAg=364mm²TTIn-plane elastic section modulusZx=5035mm³TTOut-of-plane elastic section mod.Zy=3578.6mm³TTStress from axial forcefa=P/AgcompressionTTE0.03MPacompressionTTTTStress from out-of-plane bendingfbx=Mx/ZxcompressionTTStress from out-of-plane bendingfby=My/ZycompressionTTT3.4.3 Tension in rectangular tubes $\phi F_L$ =228.95MPaCTTT3.4.8 Compression in columns, axial, gross section 1. GeneralI=2731mmII3.4.8.1		Kc	=	1			
$\begin{array}{c c c c c c c c } P & = & 0.011 & kN & Tension \\ \hline P & = & 0.3929 & kNm \\ Out of plane moment & M_x & = & 3.69E-11 & kNm & Tension \\ \hline DESIGN STRESSES & & & & & & & & & & & & & & & & & $	FEM ANALYSIS RESULTS						
$\begin{array}{c c c c c c c c } P & = & 0.011 & kN & Tension \\ \hline P & = & 0.3929 & kNm \\ Out of plane moment & M_x & = & 3.69E-11 & kNm & Tension \\ \hline DESIGN STRESSES & & & & & & & & & & & & & & & & & $	Axial force	P	_	0	kN	compression	
$ \begin{array}{c c c c c c c } \mbox{In plane moment} & M_x & = & 0.3929 & kNm \\ \mbox{Out of plane moment} & M_y & = & 3.69E-11 & kNm \\ \label{eq:construction} & M_y & = & 364 & mm^2 \\ \mbox{Gross cross section area} & A_g & = & 364 & mm^2 \\ \mbox{In-plane elastic section} & Z_x & = & 5035 & mm^3 \\ \mbox{Out-of-plane elastic section} & Z_y & = & 3578.6 & mm^3 \\ \mbox{Out-of-plane elastic section} & Z_y & = & 3578.6 & mm^3 \\ \mbox{Stress from axial force} & f_a & = & P/A_g \\ & = & 0.00 & MPa \\ & & = & 0.03 & MPa \\ & & & M_y/Z_y \\ & = & 78.03 & MPa \\ \mbox{Stress from out-of-plane bending} & f_{bx} & = & M_y/Z_y \\ \mbox{Stress from out-of-plane bending} & f_{by} & = & M_y/Z_y \\ \mbox{bending} & & & & & & & & & & & & & & & & & & &$						-	
Out of plane moment $M_y$ = $3.69E-11$ $kNm$ Image: constant of the section area in the section area in the section and the section and the section area in the s	In plane moment					1 choich	
DESIGN STRESSESGross cross section area $A_g$ = $364$ mm²In-plane elastic section $Z_x$ = $5035$ mm³Out-of-plane elastic section $Z_y$ = $3578.6$ mm³Out-of-plane elastic section $Z_y$ = $3578.6$ mm³Stress from axial force $\mathbf{f}_a$ = $P/A_g$ compression $=$ $0.00$ MPacompressionStress from out-of-plane $\mathbf{f}_{bx}$ = $M_v/Z_x$ compression $=$ $0.00$ MPacompressionStress from out-of-plane $\mathbf{f}_{by}$ = $M_v/Z_y$ compression $=$ $0.00$ MPacompression $Tension$ $\mathbf{f}_{by}$ = $228.95$ MPa $\mathbf{M}$ $\mathbf{M}$ $\mathbf{C}$ $\mathbf{M}$ $\mathbf{M}$ $\mathbf{M}$ $\mathbf{C}$ $\mathbf{M}$ $\mathbf{M}$ $\mathbf{F}_L$ = $228.95$ $\mathbf{M}$ <							
Gross cross section area In-plane elastic section modulus $A_g$ = $364$ $mm^2$ $mm^2$ $Dut-of-plane elastic sectionmod.Z_x=5035mm^3mm^3Stress from axial force\mathbf{f}_a=P/A_g=0.00MPaTensioncompressionTensionStress from in-plane bendingbending\mathbf{f}_{bx}=M_x/Z_x=TensioncompressionStress from out-of-planebending\mathbf{f}_{by}=M_x/Z_y=compressioncompressionStress from out-of-planebending\mathbf{f}_{by}=M_y/Z_y=compressioncompressionStress from out-of-planebending\mathbf{f}_{by}=M_y/Z_ycompressioncompressionStress from out-of-planebending\mathbf{f}_{by}=228.95MPacompressionStress from out-of-planebending\mathbf{f}_{by}=222.70MPacompressionStress form out-of-planebending\mathbf{f}_{by}=228.95MPacompressionStress form out-of-planebending\mathbf{f}_{by}=222.70MPamm^2Stress form out-of-planebending\mathbf{f}_{by}=222.70MPamm^2Stress form out-of-planebending\mathbf{f}_{by}=\mathbf{f}_{by}\mathbf{f}_{by}\mathbf{f}_{by}Stress from out-of-planebending\mathbf{f}_{by}=\mathbf{f}_{by}\mathbf{f}_{by}\mathbf{f}_{by}Stress from out-of-plane$		iviy		5.052 11			
In-plane elastic section modulus $Z_x$ = $5035$ mm³Out-of-plane elastic section mod. $Z_y$ = $3578.6$ mm³Stress from axial force $f_a$ = $P/A_g$ $e^{-1}$ $=$ $0.00$ MPa $compression$ $=$ $0.03$ MPa $compression$ Stress from in-plane bending $f_{bx}$ = $M_x/Z_x$ $=$ $78.03$ MPa $compression$ Stress from out-of-plane $f_{by}$ = $M_y/Z_y$ bending $=$ $0.00$ MPa $compression$ Tension $=$ $0.00$ MPa $compression$ Stress from out-of-plane $f_{by}$ = $M_y/Z_y$ bending $=$ $228.95$ MPa $compression$ Tension $F_L$ = $228.95$ MPaStress form in rectangular tubes $\rho F_L$ = $222.70$ MPaCOMPRESSION $GR$ $GR$ $GR$ $GR$ $1.$ General $L$ $=$ $2731$ mm	DESIGN STRESSES						
modulus $Z_x$ = $3033$ mm <sup>1</sup> Out-of-plane elastic section mod. $Z_y$ = $3578.6$ mm <sup>3</sup> Stress from axial force $f_a$ = $P/A_g$ $P/A_g$ =0.00MPacompression TensionStress from in-plane bending $f_{bx}$ = $M_x/Z_x$ =78.03MPacompressionStress from out-of-plane bending $f_{by}$ = $M_y/Z_y$ =0.00MPacompressionStress from out-of-plane bending $f_{by}$ = $M_y/Z_y$ a0.00MPacompressionStress from out-of-plane bending $f_{by}$ = $M_y/Z_y$ bending $\phi_{F_L}$ = $228.95$ MPaStress from out-of-plane bending $\phi_{F_L}$ = $228.95$ MPaCompression in rectangular tubes $P_{F_L}$ = $222.70$ MPaCOMPRESSION 3.4.8.1 3.4.8.1 3.4.8.1Unsupported length of memberL= $2731$ mm	Gross cross section area	Ag	=	364	mm <sup>2</sup>		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		Zx	=	5035	mm <sup>3</sup>		
$\begin{array}{cccc} & = & 0.0 & MPa \\ = & 0.03 & MPa \\ = & M_{\rm W}/Z_{\rm X} & & compression \\ Tension & Tension \\ \end{array}$ Stress from out-of-plane bending $f_{by}$ = $M_{\rm W}/Z_{\rm Y}$ compression $MPa$ compression $MPa$ $M_{\rm W}/Z_{\rm W}$ $M_{\rm $	Out-of-plane elastic section	Zy	=	3578.6	mm <sup>3</sup>		
Stress from in-plane bending $f_{bx}$ $=$ $0.03$ MPaTensionStress from out-of-plane bending $f_{by}$ $=$ $78.03$ MPacompressionStress from out-of-plane bending $f_{by}$ $=$ $M_y/Z_y$ $ompression$ $ompression$ Tension $=$ $0.00$ MPacompressionTension $F_{by}$ $=$ $228.95$ MPa $ompression$ 3.4.3 Tension in rectangular tubes $\phi F_L$ $=$ $228.95$ MPa $ompression$ $\phi F_L$ $=$ $222.70$ MPa $ompression$ $ompression$ COMPRESSION $F_L$ $=$ $222.70$ MPa $ompression$ 3.4.8 Compression in columns, axial, gross section 1. General $\dots$ 3.4.8.1 $\dots$ 3.4.8.1Unsupported length of member $L$ $=$ $2731$ mm	Stress from axial force	fa	=	P/A <sub>g</sub>			
Stress from in-plane bending $f_{bx}$ = $M_x/Z_x$ = $Compression$ Stress from out-of-plane bending $f_{by}$ = $M_y/Z_y$ = $compression$ Tension=0.00MPa $compression$ 3.4.3 Tension in rectangular tubes $\phi F_L$ = $228.95$ MPa $\rho F_L$ = $222.70$ MPa $\Gamma = 100000000000000000000000000000000000$			=				
Stress from out-of-plane bending=78.03 $M_y/Z_y$ MPacompressionTension=0.00MPacompressionTension in rectangular tubes $\phi F_L$ =228.95MPa $\phi F_L$ =228.95MPaImage: Compression in columns, axial, gross section in c			=		MPa	Tension	
Stress from out-of-plane bending $f_{by}$ = $M_y/Z_y$ = $compression$ Tension=0.00MPacompression3.4.3 Tension in rectangular tubes $\phi F_L$ =228.95MPa $\phi F_L$ =222.70MPaImage: Stress for the stress for	Stress from in-plane bending	f <sub>bx</sub>					
bending = 0.00 MPa compression Tension 3.4.3 Tension in rectangular tubes $\phi F_L = 228.95$ MPa $\sigma R$ $\sigma R$ $\phi F_L = 222.70$ MPa $\sigma R$ $\sigma R$		£			мРа	compression	
TensionImage: State and a complete and c		Гby			MDo	aampropoion	
<b>3.4.3</b> Tension in rectangular tubes $\phi F_L = 228.95$ MPa $\phi F_L = 222.70$ MPa $OR$ $\phi F_L = 222.70$ MPaSection 1. GeneralUnsupported length of memberL = 2731mm	-		=	0.00	MPa	compression	
$\begin{array}{c} \varphi F_L & = & 228.95 & MPa \\ OR \\ \varphi F_L & = & 222.70 & MPa \end{array}$							
$\begin{array}{c} OR \\ \phi F_L & = & 222.70  MPa \end{array}$			=	228.95	MPa		
		<b>4</b> . r					
COMPRESSION      3.4.8.1         3.4.8 Compression in columns, axial, gross section      3.4.8.1         1. General      3.4.8.1         Unsupported length of member       L       =       2731       mm		ΦF∟		222.70	MPa		
<b>3.4.8</b> Compression in columns, axial, gross section       3.4.8.1         1. General       3.4.8.1         Unsupported length of member       L       =       2731       mm		•					
1. General       3.4.8.1         Unsupported length of member       L       =       2731       mm	COMPRESSION						
	-		3.4.8.1				
	Unsupported length of member	L	=	2731	mm		
		k	=				



buckling axis (Y)	r <sub>y</sub>	=	12.00	mm		
Radius of gyration about buckling axis (X)	r <sub>x</sub>	=	20.40	mm		
Slenderness ratio	kLb/ry	=	154.42			
Slenderness ratio	kL/rx		133.87			
Slenderness parameter	λ	=	2.88			
	Dc*	=	90.3			
	<b>S</b> 1*	=	0.33			
	<b>S</b> <sub>2</sub> *	=	1.23			
	фсс	=	0.950			
Factored limit state stress	φF∟	=	27.53	MPa		
2. Sections not subject to torsion	al or torsior	nal-flex	ural bucklin	g		3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	154.42			
<b>3.4.10</b> Uniform compression in c flat plates	omponents	of colu	ımns, gross	section -		
1. Uniform compression in comp plates with both edges supported		olumns	, gross sec	tion - flat		 3.4.10. <sup>-</sup>
	k1	=	0.35			T3.3(D
Max. distance between toes of fillets of supporting elements for plate	b'	=	16			
	t	=	2	mm		
	b/t	=	8			
Slenderness			40.04			
Slenderness Limit 1	S₁	=	12.34			
	S1 S2	=	12.34 32.87			
Limit 1				МРа		
Limit 1 Limit 2	<b>S</b> <sub>2</sub>	=	32.87	<b>MPa</b> MPa		
Limit 1 Limit 2 Factored limit state stress Most adverse compressive limit	S₂ <b>φF</b> ⊾	=	32.87 <b>228.95</b>			
Limit 1 Limit 2 Factored limit state stress Most adverse compressive limit state stress Most adverse tensile limit state	S₂ <b>¢F∟</b> Fa	= = =	32.87 <b>228.95</b> 27.53	MPa	PASS	
Limit 1 Limit 2 Factored limit state stress Most adverse compressive limit state stress Most adverse tensile limit state stress Most adverse compressive &	S₂ <b>φF∟</b> Fa Fa	= = =	32.87 <b>228.95</b> 27.53 222.70	MPa	PASS	



Unbraced length for bending	Lb	=	1853	mm		
Second moment of area (weak	-					
axis)	ly	=	62626.1	mm <sup>4</sup>		
Torsion modulus	J	=	38065.7	mm <sup>3</sup>		
Elastic section modulus	Z	=	5035	mm <sup>3</sup>		
Slenderness	S	=	382.17			
Limit 1	S1	=	0.39			
Limit 2	S <sub>2</sub>	=	1695.86			
Factored limit state stress	φF∟	=	185.54	MPa		 3.4.15(2)
<b>3.4.17</b> Compression in componer compression), gross section - flat						
	<b>k</b> 1	=	0.5			T3.3(D)
	k <sub>2</sub>	=	2.04			T3.3(D)
Max. distance between toes of						(-)
fillets of supporting elements for plate	b'	=	16	mm		
	t	=	2	mm		
Slenderness	b/t	=	8			
Limit 1	S <sub>1</sub>	=	12.34			
Limit 2	S <sub>2</sub>	=	46.95			
Factored limit state stress	φF∟	=	228.95	МРа		
Most adverse in-plane bending limit state stress	F <sub>bx</sub>	=	185.54	MPa		
Most adverse in-plane bending capacity factor	f <sub>bx</sub> /F <sub>bx</sub>	=	0.42		PASS	
BENDING - OUT-OF-PLANE						
NOTE: Limit state stresses, $\phi F_L$ a (doubly symmetric section)	re the sam	ne for c	out-of-plane	bending		
Factored limit state stress	φF∟	=	185.54	MPa		
Most adverse out-of-plane bending limit state stress	$F_{by}$	=	185.54	MPa		
Most adverse out-of-plane bending capacity factor	f <sub>by</sub> /F <sub>by</sub>	=	0.00		PASS	
COMBINED ACTIONS						



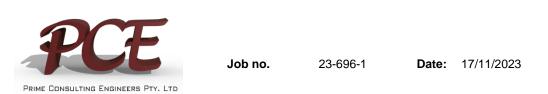
4.1.1 Combined compression and	d bending					4.1.1(2)
	Fa	=	27.53	MPa		3.4.8
	Fao	=	228.95	MPa		3.4.10
	F <sub>bx</sub>	=	185.54	MPa		3.4.17
	Fby	=	185.54	MPa		3.4.17
	·					
	fa/Fa	=	0.000			
Check:	f <sub>a</sub> /Fa + f <sub>bx/</sub>	/F <sub>bx</sub> + f <sub>by</sub>	$_{\rm y}/{\rm F}_{\rm by} \leq 1.0$			4.1.1 (3)
i.e.	0.42	≤	1.0		PASS	(3)
SHEAR						
<b>3.4.24</b> Shear in webs (Major Axis)						4.1.1(2)
Clear web height	h	=	71	mm		
	t	=	2	mm		
Slenderness	h/t	=	35.5			
Limit 1	S <sub>1</sub>	=	29.01			
Limit 2	S <sub>2</sub>	=	59.31			
Factored limit state stress	φF∟	=	124.53	MPa		
Stress From Shear force	<b>f</b> <sub>sx</sub>	=	V/A <sub>w</sub>			
			1.05	MPa		
<b>3.4.25</b> Shear in webs (Minor Axis)						
Clear web height	b	=	16	mm		
	t	=	2	mm		
Slenderness	b/t	=	8			
Factored limit state stress	φF∟	=	131.10	MPa		
Stress From Shear force	<b>f</b> sy	=	V/A <sub>w</sub>			
			0.00	MPa		
Most adverseshear capacity factor (Major Axis)	f <sub>sx</sub> /F <sub>sx</sub>	=	0.01	MPa		
Most adverseshear capacity factor (Minor Axis)	$f_{sy}/F_{sy}$	=	0.00	Мра	PASS	
COMBINED ACTIONS						
4.4 Combined Shear, Compresio	n and ben	ding				
Check:	fa/Fa + fb/l	Fb <b>+ (f</b> s/	$F_{s)^2} \le 1.0$			



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i.e.	0.42	≤	1.0	PASS	

### 9.4 Short Rib 1



NAME	SYMBOL		VALUE	UNIT	NOTES	REF
30X20X2	Short Rib 1					
Alloy and temper	6061-T6					AS1664.1
Tanalan	Ftu	=	262	MPa	Ultimate	T3.3(A)
Tension	F <sub>ty</sub>	=	241	MPa	Yield	
Compression	F <sub>cy</sub>	=	241	MPa		
Chaor	$F_{su}$	=	165	MPa	Ultimate	
Shear	F <sub>sy</sub>	=	138	MPa	Yield	
Decise	$F_bu$	=	551	MPa	Ultimate	
Bearing	F <sub>by</sub>	=	386	MPa	Yield	
Modulus of elasticity	E	=	70000	MPa	Compressiv e	
	kt	=	1			T2 4(D)
	kc	=	1			T3.4(B)
FEM ANALYSIS RESULTS						
Axial force	Р	=	0.967	kN	compression	
	P	=	0	kN	Tension	
In plane moment	Mx	=	0.1121	kNm		
Out of plane moment	My	=	0.0013	kNm		
DESIGN STRESSES						
Gross cross section area	Ag	=	184	mm <sup>2</sup>		
In-plane elastic section modulus	Zx	=	1437.6889	mm <sup>3</sup>		
Out-of-plane elastic section mod.	Zy	=	1112.5333	mm <sup>3</sup>		



Stress from axial force	fa	=	P/A <sub>g</sub>			
		=	5.26	MPa	compression	
		=	0.00	MPa	Tension	
Stress from in-plane bending	<b>f</b> <sub>bx</sub>	=	M <sub>x</sub> /Z <sub>x</sub>			
		=	77.97	MPa	compression	
Stress from out-of-plane	<b>f</b> <sub>by</sub>	=	M <sub>y</sub> /Z <sub>y</sub>			
bending	-,	=	1.17	MPa	compression	
Tension						
<b>3.4.3</b> Tension in rectangular tube	ç					
	_ φF∟	=	228.95	MPa		
	Ψι	– OR	220.33	IVIF a		
	<b>.</b>		222 70	MDe		
	φF∟	=	222.70	МРа		
COMPRESSION						
<b>3.4.8</b> Compression in columns, a:	xial aross	section				
1. General	aa, grooo	000001				3.4.8.1
Unsupported length of member	L	=	1200	mm		
Effective length factor	k	=	1.00			
Radius of gyration about		_	7.78	<b>m</b> m		
buckling axis (Y)	r <sub>y</sub>	=	1.10	mm		
Radius of gyration about	r <sub>x</sub>	=	10.83	mm		
buckling axis (X)						
Slenderness ratio	kLb/ry	=	154.32			
Slenderness ratio	kL/rx	=	110.84			
Slenderness parameter	λ	=	2.88			
	D <sub>c</sub> *	=	90.3			
	5₀ S₁*	=	0.33			
	S <sub>2</sub> *	=	1.23			
	фсс	=	0.950			
Factored limit state stress	φF∟	=	27.56	MPa		
	Ψ'L	-	21.00	u		
2. Sections not subject to torsiona	al or torsior	nal-flexu	ural bucklind	7		3.4.8.2
Largest slenderness ratio for				•		
flexural buckling	kL/r	=	154.32			
				-		
<b>3.4.10</b> Uniform compression in co flat plates	omponents	of colu	mns, gross	section -		
1. Uniform compression in compo		olumns,	gross sect	ion - flat		
plates with both edges supported						3.4.10.1
	<b>k</b> 1	=	0.35			T3.3(D)



					1	
Max. distance between toes of						
fillets of supporting elements for plate	b'	=	16			
	t	=	2	mm		
Slenderness	b/t	=	8			
Limit 1	S1	=	12.34			
Limit 2	S <sub>2</sub>	=	32.87			
Factored limit state stress	φF∟	=	228.95	МРа		
Most adverse compressive limit state stress	Fa	=	27.56	MPa		
Most adverse tensile limit state stress	Fa	=	222.70	MPa		
Most adverse compressive & Tensile capacity factor	f <sub>a</sub> /F <sub>a</sub>	=	0.19		PASS	
BENDING - IN-PLANE						
3.4.15 Compression in beams, ex	treme fibre	e. aros	s section rect	angular		
tubes, box sections		, <u> </u>				
Unbraced length for bending	L <sub>b</sub>	=	1200	mm		
Second moment of area (weak axis)	ly	=	11125.333	mm <sup>4</sup>		
Torsion modulus	J	=	22088.348	mm <sup>3</sup>		
Elastic section modulus	Z	=	1437.6889	mm <sup>3</sup>		
Slenderness	S	=	220.11			
Limit 1	S1	=	0.39			
Limit 2	S <sub>2</sub>	=	1695.86			
Factored limit state stress	φF∟	=	196.36	MPa		 3.4.15(2)
	•					3.4.15(2)
<b>3.4.17</b> Compression in componen compression), gross section - flat						
	k₁	=	0.5			T3.3(D)
	k <sub>2</sub>	=	2.04			T3.3(D)
Max. distance between toes of fillets of supporting elements	b'	=	16	mm		
for plate			0			
Slenderness	t b/t	=	2 8	mm		
	b/t	=				
Limit 1	S <sub>1</sub>	=	12.34			
Limit 2	S <sub>2</sub>	=	46.95			



Factored limit state stress	φF∟	=	228.95	MPa		
Most adverse in-plane bending limit state stress	F <sub>bx</sub>	=	196.36	MPa		
Most adverse in-plane bending capacity factor	$f_{bx}/F_{bx}$	=	0.40		PASS	
BENDING - OUT-OF-PLANE						
NOTE: Limit state stresses, $\phi F_{\perp} a$ (doubly symmetric section)	are the san	ne for ol	ut-of-plane k	pending		
Factored limit state stress	φF∟	=	196.36	MPa		
Most adverse out-of-plane bending limit state stress	$F_{by}$	=	196.36	MPa		
Most adverse out-of-plane bending capacity factor	$f_{by}/F_{by}$	=	0.01		PASS	
COMBINED ACTIONS						
<b>4.1.1</b> Combined compression and	d bending					4.1.1(2)
	Fa	=	27.56	MPa		3.4.8
	F <sub>ao</sub>		228.95	MPa		3.4.10
	F <sub>bx</sub>		196.36	MPa		3.4.17
	F <sub>by</sub>	=	196.36	MPa		3.4.17
	I by	-	190.00			0.4.17
	fa/Fa	=	0.191			
Check:	f <sub>a</sub> /Fa + f <sub>bx</sub> /	/F <sub>bx</sub> + f <sub>by</sub>	/F <sub>by</sub> ≤ 1.0			4.1.1
i.e.	0.59	, ≤	1.0		PASS	(3)
		-				
SHEAR						
<b>3.4.24</b> Shear in webs (Major Axis)						4.1.1(2)
Clear web height	h	=	26	mm		
Slenderness	t h/t	=	2 13	mm		
Limit 1	S <sub>1</sub>	_	29.01			
Limit 2	S <sub>2</sub>	=	59.31			
Factored limit state stress	φF∟	=	131.10	MPa		
Stress From Shear force	f <sub>sx</sub>	=	V/A <sub>w</sub>			
			0.89	МРа		



<b>3.4.25</b> Shear in webs (Minor Axis)					
Clear web height	b	=	16	mm	
	t	=	2	mm	
Slenderness	b/t	=	8		
Factored limit state stress	φF∟	=	131.10	MPa	
Stress From Shear force	<b>f</b> <sub>sy</sub>	=	V/A <sub>w</sub>		
			0.06	MPa	
Most adverseshear capacity factor (Major Axis)	f <sub>sx</sub> /F <sub>sx</sub>	=	0.01	MPa	1
Most adverseshear capacity factor (Minor Axis)	f <sub>sy</sub> /F <sub>sy</sub>	=	0.00	Мра	PASS
COMBINED ACTIONS 4.4 Combined Shear, Compresion	and hence	lina			
		ill ig			
Check:	f <sub>a</sub> /F <sub>a</sub> + f <sub>b</sub> /F	F <sub>b</sub> + (f <sub>s</sub> /F	$(s_{s})^{2} \leq 1.0$		
i.e.	0.59	≤	1.0		PASS

### 9.5 Short Rib 2



NAME	SYMBOL		VALUE	UNIT	NOTES	REF
30X20X2	Short Rib 2					
Alloy and temper	6061-T6					AS1664.1
Tension	F <sub>tu</sub>	=	262	MPa	Ultimate	T3.3(A)
	F <sub>ty</sub>	=	241	MPa	Yield	
Compression	F <sub>cy</sub>	=	241	MPa		
Shear	F <sub>su</sub>	=	165	MPa	Ultimate	
Sileal	F <sub>sy</sub>	=	138	MPa	Yield	
Bearing	$F_bu$	=	551	MPa	Ultimate	
	F <sub>by</sub>	=	386	MPa	Yield	



I					I	
Modulus of elasticity	E	=	70000	MPa	Compressiv e	
	kt	=	1			
	kc	=	1			T3.4(B)
	-					
FEM ANALYSIS RESULTS						
Axial force	Р	=	0.967	kN	compression	
	P	=	0	kN	Tension	
In plane moment	Mx	=	0.1048	kNm		
Out of plane moment	My	=	1.645E-12	kNm		
DESIGN STRESSES Gross cross section area	Ag	=	184	mm <sup>2</sup>		
In-plane elastic section	-		1437.688			
modulus	Zx	=	9	mm <sup>3</sup>		
Out-of-plane elastic section mod.	Zy	=	1112.533 3	mm <sup>3</sup>		
Stress from axial force	fa	=	P/A <sub>g</sub>			
		=	5.26	MPa	compression	
Stress from in-plane bending	<b>f</b> <sub>bx</sub>	=	<b>0.00</b> M <sub>x</sub> /Z <sub>x</sub>	МРа	Tension	
Chees nom in plane behang	"DX	_	72.89	MPa	compression	
Stress from out-of-plane	<b>f</b> <sub>by</sub>	=	M <sub>y</sub> /Z <sub>y</sub>		,	
bending		=	0.00	MPa	compression	
Tension						
<b>3.4.3</b> Tension in rectangular tube						
	φF∟	= 0	228.95	МРа		
		R				
	φF∟	=	222.70	МРа		
COMPRESSION						
<b>3.4.8</b> Compression in columns, at	xial, gross s	section	ו			
1. General						3.4.8.1
Unsupported length of member	L	=	1100	mm		
Effective length factor	k	=	1.00			
Radius of gyration about buckling axis (Y)	r <sub>y</sub>	=	7.78	mm		
Radius of gyration about buckling axis (X)	r <sub>x</sub>	=	10.83	mm		
Slenderness ratio	kLb/ry	=	141.46			
	2				1	



					1	I
Slenderness ratio	kL/rx	=	101.61			
Slenderness parameter	λ	=	2.64			
	Dc*	=	90.3			
	S1*	=	0.33			
	<b>S</b> <sub>2</sub> *	=	1.23			
	фсс	=	0.950			
Factored limit state stress	φF∟	=	32.79	MPa		
2. Sections not subject to torsiona	l or torsior	nal-flex	ural buckling	,		3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	141.46			
<b>3.4.10</b> Uniform compression in conflat plates	mponents	of colu	mns, gross s	section -		
1. Uniform compression in compo- plates with both edges supported	nents of co	olumns	, gross sectio	on - flat		 3.4.10.1
	<b>k</b> 1	=	0.35			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	b'	=	16			
	t	=	2	mm		
Slenderness	b/t	=	8			
Limit 1	S <sub>1</sub>	=	12.34			
Limit 2	S <sub>2</sub>	=	32.87			
Factored limit state stress	φF∟	=	228.95	MPa		
Most adverse compressive limit	Fa	=	32.79	MPa		
state stress Most adverse tensile limit state						
stress	Fa	=	222.70	MPa		
Most adverse compressive & Tensile capacity factor	f <sub>a</sub> /F <sub>a</sub>	=	0.16		PASS	
BENDING - IN-PLANE						
<b>3.4.15</b> Compression in beams, extubes, box sections	treme fibre	e, gross	s section rect	tangular		
Unbraced length for bending	L <sub>b</sub>	=	1100	mm		
Second moment of area (weak axis)	ly	=	11125.33 3	mm <sup>4</sup>		
Torsion modulus	J	=	22088.34 8	mm <sup>3</sup>		



					1	1
Elastic section modulus	Z	=	1437.688 9	mm <sup>3</sup>		
Slenderness	S	=	201.77			
Limit 1	<b>S</b> 1	=	0.39			
Limit 2	S <sub>2</sub>	=	1695.86			
Factored limit state stress	φF∟	=	197.80	MPa		 3.4.15(2)
<b>3.4.17</b> Compression in component compression), gross section - flat						
	k₁	=	0.5			T3.3(D)
	k <sub>2</sub>	=	2.04			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	b'	=	16	mm		
	t	=	2	mm		
Slenderness	b/t	=	8			
Limit 1	S <sub>1</sub>	=	12.34			
Limit 2	S <sub>2</sub>	=	46.95			
Factored limit state stress	φF∟	=	228.95	MPa		
Most adverse in-plane bending limit state stress	F <sub>bx</sub>	=	197.80	MPa		
Most adverse in-plane bending capacity factor	$f_{bx}/F_{bx}$	=	0.37		PASS	
BENDING - OUT-OF-PLANE						
NOTE: Limit state stresses, $\phi F_L = (doubly symmetric section)$	are the sam	e for o	ut-of-plane b	ending		
	are the sam <b>φF</b> ∟	e for o =	ut-of-plane b <b>197.80</b>	ending MPa		
(doubly symmetric section) Factored limit state stress Most adverse out-of-plane bending limit state stress			-	-		
(doubly symmetric section) Factored limit state stress Most adverse out-of-plane	φF∟	=	197.80	MPa	PASS	
(doubly symmetric section) Factored limit state stress Most adverse out-of-plane bending limit state stress Most adverse out-of-plane bending capacity factor COMBINED ACTIONS	φF∟ F <sub>by</sub> f <sub>by</sub> /F <sub>by</sub>	=	<b>197.80</b> 197.80	MPa	PASS	
(doubly symmetric section) Factored limit state stress Most adverse out-of-plane bending limit state stress Most adverse out-of-plane bending capacity factor	φF∟ F <sub>by</sub> f <sub>by</sub> /F <sub>by</sub>	=	<b>197.80</b> 197.80	MPa	PASS	4.1.1(2)
(doubly symmetric section) Factored limit state stress Most adverse out-of-plane bending limit state stress Most adverse out-of-plane bending capacity factor COMBINED ACTIONS	φF∟ F <sub>by</sub> f <sub>by</sub> /F <sub>by</sub>	=	<b>197.80</b> 197.80	MPa	PASS	4.1.1(2)



$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		F <sub>bx</sub> F <sub>by</sub>	= =	197.80 197.80	MPa MPa		3.4.17 3.4.17
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		-					
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		f <sub>a</sub> /F <sub>a</sub>	=	0.160			
i.e. $0.53 \le 1.0$ PASS SHEAR 3.4.24 Shear in webs (Major Axis) Clear web height h = 26 mm t = 2 mm Slenderness h/t = 13 Limit 1 S <sub>1</sub> = 29.01 Limit 2 S <sub>2</sub> = 59.31 Factored limit state stress $\phi F_L$ = 131.10 MPa Stress From Shear force $f_{sx}$ = V/A <sub>w</sub> 0.89 MPa 3.4.25 Shear in webs (Minor Axis) Clear web height b = 16 mm Slenderness b/t = 8 Factored limit state stress $\phi F_L$ = 131.10 MPa Stress From Shear force $f_{sy}$ = V/A <sub>w</sub> 0.00 MPa Most adverseshear capacity $f_{sy}/F_{sy}$ = 0.01 MPa Most adverseshear capacity $f_{sy}/F_{sy}$ = 0.00 Mpa Most adverseshear capacity $f_{sy}/F_{sy}$ = 0.00 Mpa COMBINED ACTIONS 4.4 Combined Shear, Compresion and bending Check: $f_a/F_a + f_b/F_b + (f_a/F_{sy}^2 \le 1.0$	Check:	f <sub>a</sub> /F <sub>a</sub> + f <sub>bx</sub> /	F <sub>bx</sub> + f <sub>by</sub>	$F_{by} \leq 1.0$			
<b>3.4.24</b> Shear in webs (Major Axis) 4.1.1(2)Clear web heighth=26mmt=2mmSlendernessh/t=13Limit 1S1=29.01Limit 2S2=59.31Factored limit state stress $\phi F_L$ = <b>131.10MPa</b> Stress From Shear force $f_{sx}$ = $V/A_w$ <b>0.89MPa3.4.25</b> Shear in webs (Minor Axis) $t$ =2mmClear web heightb=16mmt=2mmSlendernessb/t=8Factored limit state stress $\phi F_L$ = <b>131.10MPa</b> Stress From Shear force $f_{sy}$ =0.01 <b>MPa</b> Most adverseshear capacity factor (Major Axis) $f_{sx}/F_{sx}$ =0.01 <b>MPa</b> Most adverseshear capacity factor (Minor Axis) $f_{sy}/F_{sy}$ =0.00 <b>Mpa</b> COMBINED ACTIONS 4.4 Combined Shear, Compresion and bending Check: $f_{s}/F_{s} + f_{s}/F_{b} + (f_{s}/F_{s})^{2} \leq 1.0$	i.e.	0.53	≤	1.0		PASS	
<b>3.4.24</b> Shear in webs (Major Axis) 4.1.1(2)Clear web heighth=26mmt=2mmSlendernessh/t=13Limit 1S1=29.01Limit 2S2=59.31Factored limit state stress $\phi F_L$ = <b>131.10MPa</b> Stress From Shear force $f_{sx}$ = $V/A_w$ <b>0.89MPa3.4.25</b> Shear in webs (Minor Axis) $t$ =2mmClear web heightb=16mmt=2mmSlendernessb/t=8Factored limit state stress $\phi F_L$ = <b>131.10MPa</b> Stress From Shear force $f_{sy}$ =0.01 <b>MPa</b> Most adverseshear capacity factor (Major Axis) $f_{sx}/F_{sx}$ =0.01 <b>MPa</b> Most adverseshear capacity factor (Minor Axis) $f_{sy}/F_{sy}$ =0.00 <b>Mpa</b> COMBINED ACTIONS 4.4 Combined Shear, Compresion and bending Check: $f_{s}/F_{s} + f_{s}/F_{b} + (f_{s}/F_{s})^{2} \leq 1.0$							
Axis)4.1.1(2)Clear web heighth=26mmt=2mmSlendernessh/t=13Limit 1S1=29.01Limit 2S2=59.31Factored limit state stress $\phi F_L$ =131.10MPaStress From Shear force $f_{sx}$ = $V/A_w$ 0.89MPa3.4.25 Shear in webs (Minor Axis)0.89MPaMPaClear web heightb=16mmt=2mmSlendernessb/t=8Factored limit state stress Stress From Shear force $\phi F_L$ =131.10Most adverseshear capacity factor (Major Axis) $f_{ss}/F_{sx}$ =0.01MPaMost adverseshear capacity factor (Major Axis) $f_{ss}/F_{sy}$ =0.00MpaCOMBINED ACTIONS 4.4 Combined Shear, Compresion and bending Check: $f_{sr}/F_a + f_b/F_b + (f_s/F_a)^2 \le 1.0$							
$\begin{array}{c cccc} t & t & = & 2 & mm \\ t & = & 13 & t^2 & t^$							4.1.1(2)
Slendernessh/t=13Limit 1 $S_1$ =29.01Limit 2 $S_2$ =59.31Factored limit state stress $\phi F_L$ =131.10MPaStress From Shear force $f_{sx}$ = $V/A_w$ 0.89MPa3.4.25 Shear in webs (Minor Axis) $h$ =16mmClear web heightb=16mmt=2mmSlendernessb/t=8Factored limit state stress $\phi F_L$ =131.10MPaStress From Shear force $f_{sy}$ = $0.01$ MPaMost adverseshear capacity factor (Major Axis) $f_{sy}/F_{sx}$ = $0.01$ MPaMost adverseshear capacity factor (Minor Axis) $f_{sy}/F_{sy}$ = $0.00$ MpaMost adverseshear capacity factor (Minor Axis) $f_{sy}/F_{sy}$ = $0.00$ MpaCOMBINED ACTIONS 4.4 Combined Shear, Compresion and bending Check: $f_{s}/F_{a} + f_{b}/F_{b} + (f_{s}/F_{b})^{2} \leq 1.0$ Line	Clear web height	h	=	26	mm		
$\begin{array}{c cccc} \mbox{Limit 1} & S_1 & = & 29.01 \\ \mbox{Limit 2} & S_2 & = & 59.31 \\ \hline \mbox{Factored limit state stress} & $		t	=	2	mm		
Limit 2 $S_2$ = $59.31$ Factored limit state stress Stress From Shear force $\phi F_L$ $f_{sx}$ = $131.10$ $V/A_w$ MPa3.4.25 Shear in webs (Minor Axis) $b$ = $16$ mmmmClear web heightb= $16$ mmmmt= $2$ mmmmSlendernessb/t= $8$ Factored limit state stress Stress From Shear force $\phi F_L$ $f_{sy}$ = $131.10$ $V/A_w$ $0.00$ MPaMost adverseshear capacity factor (Major Axis) $f_{sy}/F_{sx}$ = $0.01$ $Mpa$ MPaMost adverseshear capacity factor (Minor Axis) $f_{sy}/F_{sy}$ = $0.00$ $Mpa$ PASSCOMBINED ACTIONS 	Slenderness	h/t	=	13			
Factored limit state stress Stress From Shear force	Limit 1	S1	=	29.01			
Stress From Shear force $f_{sx}$ = $V/A_w$ <b>3.4.25</b> Shear in webs (Minor Axis) <b>0.89MPa</b> Clear web heightb=16mm tt=2mmSlendernessb/t=8Factored limit state stress Stress From Shear force $\phi F_L$ =131.10Most adverseshear capacity factor (Major Axis) $f_{sx}/F_{sx}$ =0.01Most adverseshear capacity factor (Minor Axis) $f_{sy}/F_{sy}$ =0.00Most adverseshear capacity factor (Minor Axis) $f_{sy}/F_{sy}$ =0.00COMBINED ACTIONS 4.4 Combined Shear, Compresion and bending Check: $f_a/F_a + f_b/F_b + (f_a/F_s)^2 \le 1.0$	Limit 2	S <sub>2</sub>	=	59.31			
3.4.25 Shear in webs (Minor Axis)0.89MPaClear web heightb=16mmt=2mmSlendernessb/t=8Factored limit state stress $\phi F_L$ =131.10MPaStress From Shear force $f_{sy}$ = $V/A_w$ MPaMost adverseshear capacity factor (Major Axis) $f_{sx}/F_{sx}$ =0.01MPaMost adverseshear capacity factor (Minor Axis) $f_{sy}/F_{sy}$ =0.00MpaCOMBINED ACTIONS 4.4 Combined Shear, Compresion and bending Check: $f_a/F_a + f_b/F_b + (f_a/F_{sy})^2 \leq 1.0$ Loc	Factored limit state stress	φF∟	=	131.10	MPa		
3.4.25 Shear in webs (Minor Axis)Clear web heightb=16mmt=2mmSlendernessb/t=8Factored limit state stress $\phi F_L$ =131.10MPaStress From Shear force $f_{sy}$ = $V/A_w$ 0.00MPaMost adverseshear capacity factor (Major Axis) $f_{sx}/F_{sx}$ =0.01MPaMost adverseshear capacity factor (Minor Axis) $f_{sy}/F_{sy}$ =0.00MpaCOMBINED ACTIONS	Stress From Shear force	<b>f</b> <sub>sx</sub>	=	V/A <sub>w</sub>			
t=2mmSlenderness $b/t$ =8Factored limit state stress $\phi F_L$ =131.10MPaStress From Shear force $f_{sy}$ = $V/A_w$ 0.00MPaMost adverseshear capacity factor (Major Axis) $f_{sx}/F_{sx}$ =0.01MPaMost adverseshear capacity factor (Minor Axis) $f_{sy}/F_{sy}$ =0.00MpaCOMBINED ACTIONS4.4 Combined Shear, Compresion and bending Check: $f_a/F_a + f_b/F_b + (f_s/F_s)^2 \le 1.0$ 1.0				0.09	WIF a		
Slendernessb/t=8Factored limit state stress $\ensuremath{\varphi}F_L$ =131.10MPaStress From Shear force $\ensuremath{f_{sy}}$ = $\ensuremath{V/A_w}$ 0.00MPaMost adverseshear capacity factor (Major Axis) $\ensuremath{f_{sx}/F_{sx}}$ =0.01MPaMost adverseshear capacity factor (Minor Axis) $\ensuremath{f_{sy}/F_{sy}}$ =0.00MpaCOMBINED ACTIONS 4.4 Combined Shear, Compresion and bending Check: $\ensuremath{f_a} + \ensuremath{f_b/F_b} + (\ensuremath{f_s/F_s})^2 \leq 1.0$ 1.0	Clear web height	b	=	16	mm		
Factored limit state stress $\phi F_L$ =131.10MPaStress From Shear force $f_{sy}$ = $V/A_w$ $0.00$ MPaMost adverseshear capacity factor (Major Axis) $f_{sx}/F_{sx}$ = $0.01$ MPaMost adverseshear capacity factor (Minor Axis) $f_{sy}/F_{sy}$ = $0.00$ MpaCOMBINED ACTIONS 4.4 Combined Shear, Compresion and bending Check: $f_a/F_a + f_b/F_b + (f_s/F_s)^2 \le 1.0$ 1.0	_	t	=	2	mm		
Stress From Shear force $f_{sy}$ = $V/A_w$ 0.00MPaMost adverseshear capacity factor (Major Axis) $f_{sx}/F_{sx}$ =0.01MPaMost adverseshear capacity factor (Minor Axis) $f_{sy}/F_{sy}$ =0.00MpaPASSCOMBINED ACTIONS 4.4 Combined Shear, Compresion and bending Check: $f_a/F_a + f_b/F_b + (f_s/F_s)^2 \le 1.0$ 1.0	Slenderness	b/t	=	8			
Nost adverseshear capacity factor (Major Axis) $f_{sx}/F_{sx} = 0.01$ MPaMost adverseshear capacity factor (Minor Axis) $f_{sy}/F_{sy} = 0.00$ MpaPASSCOMBINED ACTIONS 4.4 Combined Shear, Compresion and bending Check: $f_a/F_a + f_b/F_b + (f_s/F_s)^2 \le 1.0$ 1.0	Factored limit state stress	φF∟	=	131.10	MPa		
$\begin{array}{c c} & \\ \hline Most adverseshear capacity \\ factor (Major Axis) & f_{sx}/F_{sx} & = & 0.01 & \textbf{MPa} \\ \hline Most adverseshear capacity \\ factor (Minor Axis) & f_{sy}/F_{sy} & = & 0.00 & \textbf{Mpa} \\ \hline COMBINED ACTIONS & & & & \\ \textbf{4.4 Combined Shear, Compresion and bending} \\ \hline Check: & f_a/F_a + f_b/F_b + (f_s/F_s)^2 \leq 1.0 \\ \hline \end{array}$	Stress From Shear force	<b>f</b> sy	=	V/A <sub>w</sub>			
factor (Major Axis) $I_{sx}/F_{sx}$ =0.01MPaMost adverseshear capacity factor (Minor Axis) $f_{sy}/F_{sy}$ =0.00MpaPASSCOMBINED ACTIONS 4.4 Combined Shear, Compresion and bending Check: $f_a/F_a + f_b/F_b + (f_s/F_s)^2 \le 1.0$ Image: Check in the second seco				0.00	MPa		
factor (Minor Axis) $I_{sy}/F_{sy}$ = $0.00$ MpaPASSCOMBINED ACTIONS4.4 Combined Shear, Compresion and bending Check: $f_a/F_a + f_b/F_b + (f_s/F_s)^2 \le 1.0$		$f_{sx}/F_{sx}$	=	0.01	MPa		
<b>4.4</b> Combined Shear, Compresion and bending Check: $f_a/F_a + f_b/F_b + (f_s/F_s)^2 \le 1.0$		$f_{sy}/F_{sy}$	=	0.00	Мра	PASS	
<b>4.4</b> Combined Shear, Compresion and bending Check: $f_a/F_a + f_b/F_b + (f_s/F_s)^2 \le 1.0$							
Check: $f_a/F_a + f_b/F_b + (f_s/F_s)^2 \le 1.0$		n and hore	lina				
		ni anu benc	iing				
	Check:	f <sub>a</sub> /F <sub>a</sub> + f <sub>b</sub> /F	F <sub>b</sub> + (f <sub>s</sub> /F	$(s_{s})^{2} \leq 1.0$			
						PASS	



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

## **10** Appendix B – Anchorage Design



**CALCULATION SHEET FOR RAMSET ANCHORS** 

Company :	PCE		Ph	one number :	02 8964 1818	
Carried out by :		Ма		il address :	info@primeeng	gineers.com.au
Company :	Prime Consulting En	gineers	Pro	oject name :	200 Series	
Contact name :	KZ	Loc		cation :		
Phone number :	02 8964 1818		Fa	stening point :		
Mail address :	info@primeengineers	s.com.au				
Comment :						
Recommended ar						
TRUBOLT XTRE	M M10x90/10			Product Code:		057769
- Annual Contractor				Effective embe	edment :	60 mm
				ETA-15/0893		
Base material						
	Concrete resistance : 32 - fck,cyl = 32			-		
Cracking of concre	Cracking of concrete : Cracked concrete		concrete			
Thickness of concr		200 mm				
Reinforcement type				nforcement		
Edge reinforcemen	t :	Straight e	edge rein	forcement		
Conditions		5				
Installation condition		Dry conc 40 °C	rete			
Short term tempera		40 °C 24 °C				
Long term tempera	luie.	24 °C				
Anchor plate Thickness of part to	be fixed :	10 mm				
Recommended pla			e nlate th	ickness has not l	been checked	
recommended pla			, plate ill			
Clearance diamete	r :	12 mm				
Profile :		100x100>	(2.8 SHS	6		
Profile position :		Ex = 0 mm ; Ey = 0 mm				
Stand-off :		None				
Design method :	A	S 5216:2021 Desig	n for sta	tic, quasi-static lo	bading	

### **Design Actions :**

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

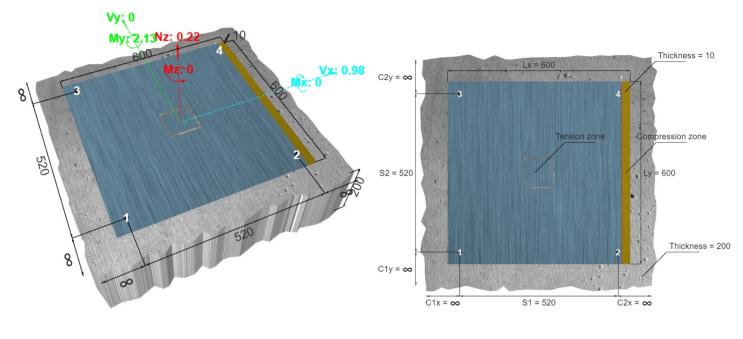
### **Specifications :**

Static

Sustained Load : False



### Geometry :



### **Calculation Hypothesis :**

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

- Connection between profile and base plate has not been checked

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



### **Resulting anchors forces**

### Loads on anchors

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

N <sup>*</sup> <sub>g</sub> [kN]	N <sub>h</sub> <sup>*</sup> [kN]	e <sub>Nx</sub> [mm]	e <sub>Ny</sub> [mm]	
4.07	1.99	248.3	0	
V <sub>g</sub> <sup>*</sup> [kN]	V <sub>h</sub> <sup>*</sup> [kN]			
0.98	0.24			

#### Utilization

Tension load	Tension force [kN]	Strength [kN]	β <sub>N</sub> [%]	
Pull out failure	1.99	6.59	30.2	
Concrete cone failure	4.07	14.36	28.3	
Splitting failure	/	1	/	
Steel failure	1.99	19.8	10.0	
Shear load	Shear force [kN]	Strength [kN]	β <sub>v</sub> [%]	
Concrete Edge failure	/	1	/	
Pryout failure	0.98	107.97	0.91	
Ote el feilure				
Steel failure	0.24	12.13	2.02	

### Combined tension and shear loads

 $\begin{array}{l} \beta_{Nc}^{1.5} \ + \ \beta_{Vc}^{1.5} \ = \ [0.30]^{1.5} \ + \ [0.01]^{1.5} \ = 0.17 \leq \ 1 \\ \\ \beta_{Ns}^{\ 2} \ + \ \beta_{Vs}^{\ 2} \ = \ [0.10]^2 \ + \ [0.02]^2 \ = 0.01 \leq \ 1 \end{array}$ 

### THE APPLICATION IS SAFE

### **CALCULATION DETAILS**

### Tension load - Pull out failure

$\Phi_{Mp} N_{Rk,p} \ge N_{h}$	* I			[AS 5216:2021 – Table 3.4.2.1]
$\Phi_{Mp}N_{Rk,p}$	= 6.59 kN	N <sup>0</sup> <sub>Rk,p</sub>	= 9 kN	
$N_{Rk,p}$	= 9.89 kN	$\Psi_{c}$	= 1.10	
$\Phi_{\text{Mp}}$	= 0.67			
Tension loa	ad - Concrete cone failure			
$\Phi_{Mc}N_{Rk,c} \ge N_g^*$				[AS 5216:2021 – Table 3.4.2.1]
$N_{Rk,c} = N_{Rk,c}^{0} \cdot \frac{4}{4}$	$\frac{\mathcal{H}_{c,N}}{\mathcal{H}_{c,N}^0} \cdot \Psi_{s,N} \cdot \Psi_{Re,N} \cdot \Psi_{ec,N} \cdot \Psi_{M,N}$			[AS 5216:2021 – Eq.(6.2.3.1)]
$N_{Rk,c}^0 = k_1 \cdot \sqrt{f_c}$	$\bar{c} \cdot h_{ef}^{1.5}$			[AS 5216:2021 – Eq.(6.2.3.2)]
$\Psi_{s,N} = 0.7 + 0.7$	0.3 · <mark>C</mark> <sub>cr,N</sub> ≤1			[AS 5216:2021 – Eq.(6.2.3.4)]]
$\Psi_{\text{Re,N}}$ = 0.5 +	<u>h<sub>ef</sub></u> ≤1			[AS 5216:2021 – Eq.(6.7)]]
$\Psi_{ec,N} = \frac{1+2\cdot(1+2)}{1+2\cdot(1+2)}$	<u>1</u> e <sub>N</sub> /S <sub>Cr.N</sub> ) ≤1			[AS 5216:2021 – Eq.(6.2.3.6)]
$\Psi_{\text{M},\text{N}}$				[AS 5216:2021 – Eq.(6.2.3.7)]
$\Phi_{\text{Mc}}N_{\text{Rk,c}}$	= 14.36 kN	N <sub>Rk,c</sub>	= 20.2	4 kN
N <sub>Rk,c</sub> Φ <sub>Mc</sub>	= 21.54 kN = 0.67	$A_{c,N}/A_{c,N}^0$	= 4	
₩C	0.01	$\Psi_{\text{ec,Nx}}$	= 0.27	
		$\Psi_{ec,Ny}$	= 1.00	
		$\Psi_{s,N}$	= 1.00	
		$\Psi_{re,N}$	= 1.00	
		$\Psi_{M,N}$	= 1.00	
Tension loa	d - Splitting failure			

Failure mode not decisive.

### **Tension load - Steel failure**

Φ <sub>Ms</sub> N <sub>Rk,s</sub> ≥N N <sub>Rk,s</sub>	lh*	[AS 5216:2021 – Table 3.4.2.1] [Approval]
$\Phi_{Ms} N_{Rk,s}$	= 19.8 kN	
N <sub>Rk,s</sub>	= 29.3 kN	
$\Phi_{Ms}$	= 0.68	
Shear load	- Concrete edge failure	

### Failure mode not decisive.

### Shear load - Pryout failure

$\Phi_{Mc}V_{Rk,cp} \geq V_g$	*			
$V_{Rk,cp} = k_8 \cdot N_{Rk,c}$ without supplementary reinforcement				[AS 5216:2021 – Eq.(7.2.4.1(1))]
$V_{Rk,cp} = 0.75 \cdot k$	$\kappa_8 \cdot N_{Rk,c}$ with supplementa	ry reinforcement		[AS 5216:2021 – Eq.(7.2.4.1(2)]
$\Phi_{\rm Mc}V_{\rm Rk,cp}$	= 107.97 kN	N <sup>0</sup> <sub>Rk,c</sub>	= 20.24 kN	
$V_{Rk,cp}$	= 161.95 kN	$A_{c,N}/A_{c,N}^0$	= 4	
$\Phi_{Mc}$	= 0.67	$\Psi_{\text{ec,Nx}}$	= 0.27	
		$\Psi_{ec,Ny}$	= 1.00	
		$\Psi_{s,N}$	= 1.00	
		$\Psi_{re,N}$	= 1.00	
		$\Psi_{M,N}$	= 1.00	

### Shear load - Steel failure

$\begin{array}{c} \Phi_{Ms} V_{Rk,s} \geq V_{h}^{*} \\ V_{Rk,s} \end{array}$		[AS 5216:2021 – Tableau 3.4.3.1] [Approval]
$\Phi_{\rm Ms}V_{\rm Rk,s}$	= 12.13 kN	
$V_{Rk,s}$	= 15.4 kN	
$\Phi_{\text{Ms}}$	= 0.79	

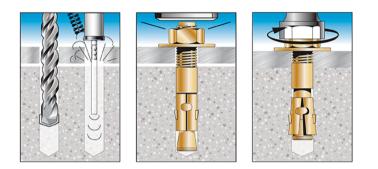


### **INSTALLATION DATA**

### **TRUBOLT XTREM M10x90/10**

		duct Code: ective embedment :	057769 60 mm
	ET/	A-15/0893	
Effective embedment :	60 mm		
Minimum thickness of base material :	120 mm		
Hole diameter in the base material :	10 mm		
Hole depth in the base material :	75 mm		
Installation torque :	45.00 Nm		
Base plate thickness :	10 mm		
Profile family (section type) :	100x100x2.8 SHS		
Clearance diameter :	12 mm		

### **INSTALLATION Method**



### Installation

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



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

## 11 Appendix C – Technical Data Sheet

FLARE EXTREME MARQUEES

MINING ALL WIND

# 200 Spanish Series

Apart of the Commercial Umbrella Range

PRODUCT SHOWN 5m diameter - Spanish 200 Se

5m diameter - Spanish 200 Series Spanish Recasens - Pacific Nalli

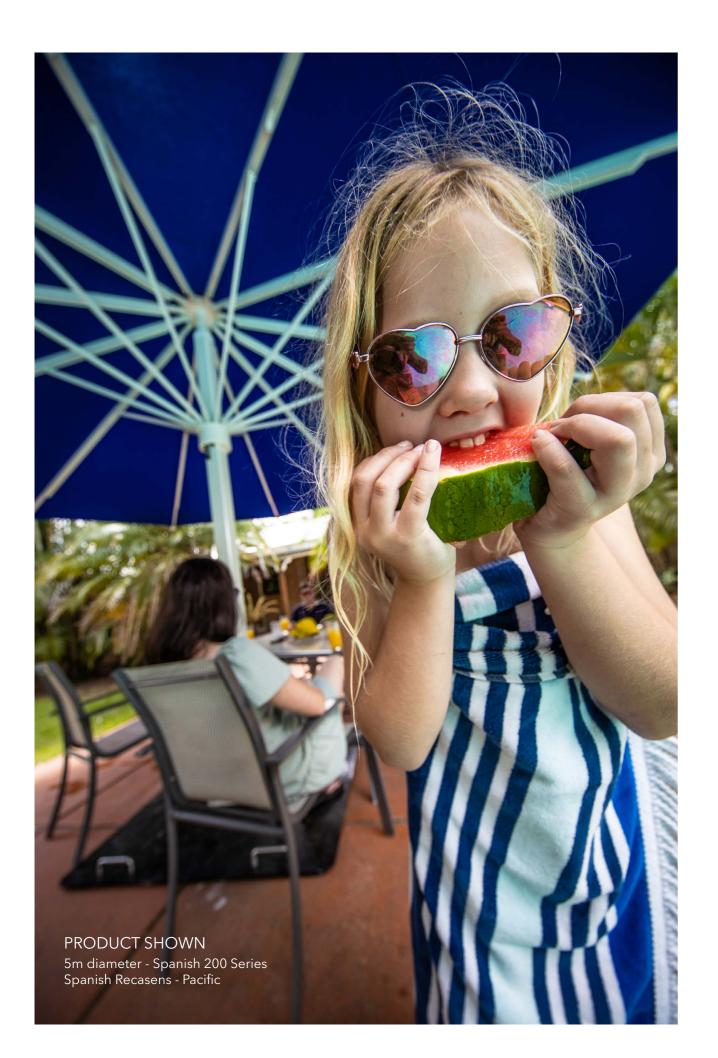
SHALLS S

. which

14.5



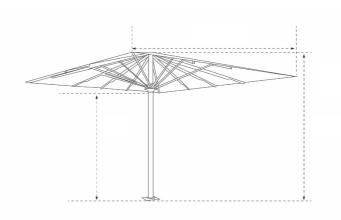




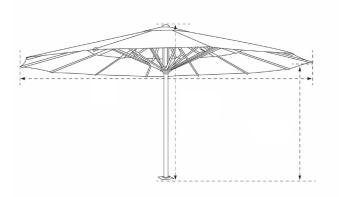
## 200 SPANISH SERIES

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

## Specifications



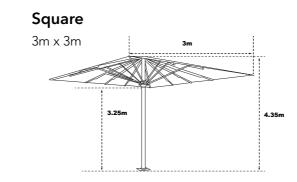
**Square** 3x3m, 4x4m, 4x5m, 5x5m & 6x6m

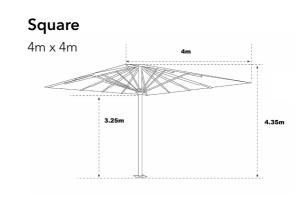


**Round** 4m, 5m & 6m diameter



## **Technical Information**





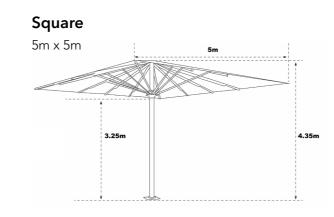
Size	3m x 3m	4m x 4m	4m x 5m	5m x 5m	6m x 6m	4m dia.	5m dia.	6m dia.
Height	4.35m							
Clearance	3.25m	3.25m	3.25m	3.25m	3.25m	3.25m	3.25m	3.25m
Arm Span	1.5m	2m	2m/2.5m	2.5m	4.26m	2m	2.5m	4.26m
Frame Weight	83kg	88kg	88kg	110kg	155kg	83kg	88kg	110kg
Roof Weight	10kg	10kg	11kg	12kg	15kg	10kg	12kg	15kg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





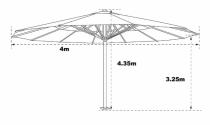


Square 4m x 5m 3.25m 4.35m



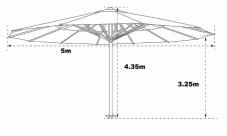
### Round

4m diameter



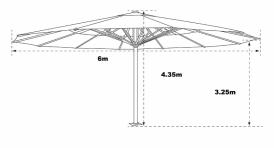
### Round

5m diameter



Round

6m diameter



## Fabric Colours

### Spanish Recasens 100 & 200 Series

Extreme Marquees imports the highest quality fabric from the Recasens brand located in Spain. The fabric is a highperformance solution-dyed and fade resistant canvas that has been optimized for high tensile and tear strength. The Recasens brand has been manufacturing high quality fabrics in Spain since 1886.



## Frame Colour



## Printing

### **UV Printing**

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

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

### **Screen Printing**

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







### 350mm Base Plate Ground Fixing

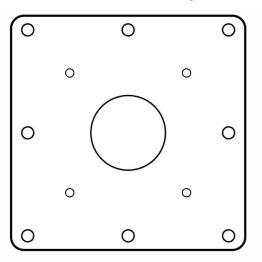
3x3m, 4x4m & 4m diameter

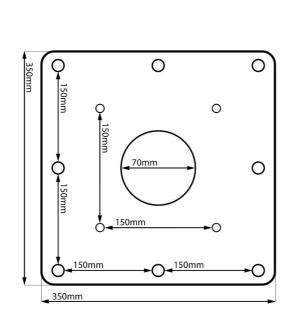
Hinged Steel Base Plate Bottom Plate: 350mm x 350mm x 10mm Hinge Plate: 190mm x 190mm x 355mm Weight: 10kg aprox. Screw sets: 4 (attach umbrella to base) Concrete Bolts: 8 (permanent installation)

### Installation

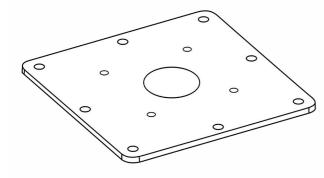
The base plate comes separated from the umbrella pole. Base is attached to the umbrella with 4 screws and washers. There are 8 concrete bolts to attach the base plate permanently a concrete slab.

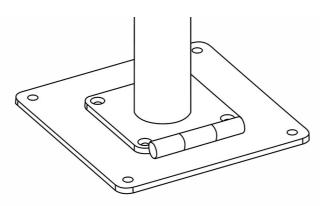
### **Bolt & Screw Measurement Map**





Base & Umbrella Installation Example









**Screw** 8mm x 20mm Screw Hole: 10mm

### 600mm Base Plate Ground Fixing

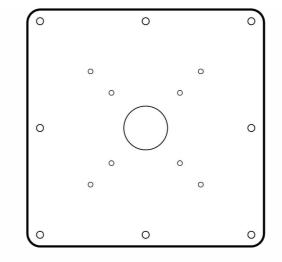
4x5m, 5x5m, 5m diameter & 6m diameter

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

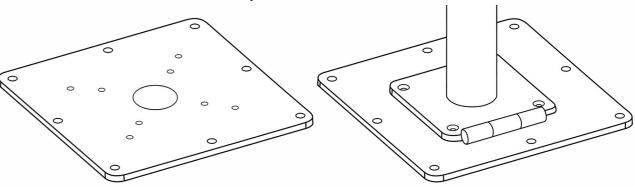
### Installation

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

### **Bolt & Screw Measurement Map**



### Base & Umbrella Installation Example

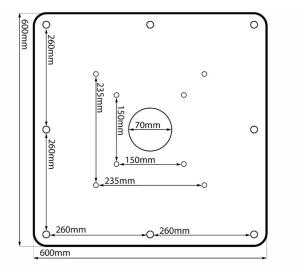








**Screw** 8mm x 20mm Screw Hole: 10mm



## **Engineer** Certification









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