

Prime Consulting Engineers Pty. Ltd.

Design Report:

6m, 8m, 9m, 10m & 12m X 3m Bay

Function Deluxe Tent Structures

For

80km/hr Wind speed

For



Ref: R-23-573-3

Date: 06/07/2023

Amendment: B - 18/03/2024

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9.7 Brace

56



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 12m X 12m Function Deluxe Tent Structure for 80km/hr. 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 **22.22m/s (80 km/hr)** positioned for the worst effect on 12m x 12m tent structure 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)
 - o AS 1170.2:2021 Structural Design Actions (Part 2: Wind Actions)
 - AS1664.1:1997 Aluminium Structures.
 - As 4100:1998 Streel 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

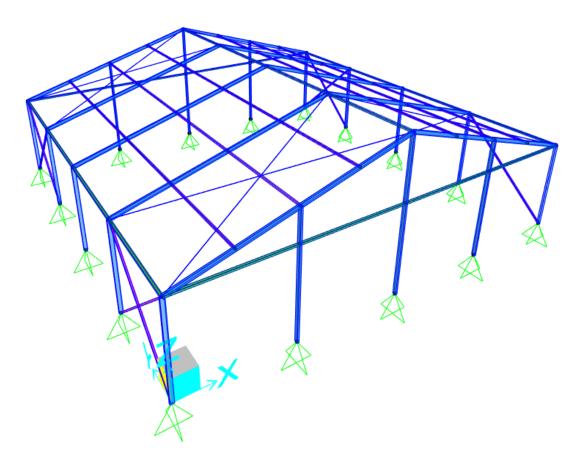


Figure 1 Isometric view of structures



2.2 Assumptions & Limitations

- The structure is for temporary use only and shall not remain erected for more than 6 months period.
- For forecast winds in excess of **80km/hr** all fabrics should be removed and the erected structure to be dismantled.
- The structure is design for wind parameters as below:
 - Wind Region A
 - o TC2
 - M_s, M_t & M_d = 1
- It is assumed that the structure is fully enclosed with all walls equally permeable for calculating the wind internal forces.
- 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.
- Wall X-bracing and roof cable bracing must be used at end bays and every third bay in between. This bracing configuration is shown in Figure 1 Isometric view of structures.
- Maximum Intermediate purlin spacing shall not exceed 1500mm for 40x40x2 purlin profiles.
- It is assumed that the fabric weighs 350gr/m².
- Aluminium alloy is to be 6061-T6.

2.3 Exclusions

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



2.4 Design Parameters and Inputs

2.4.1 Load Cases

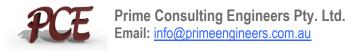
1.	G	Permanent actions (Dead load)
2.	Wu	Ultimate wind action (ULS)
3.	Ws	Serviceability wind action (SLS)

1.1.1 Load Combinations

Strength (ULS):

1.	1.35G	Permanent action only
2.	0.9G+W _u	Permanent and wind actions
3.	$1.2G+W_u$	Permanent and wind actions
Service	eability (SLS):	

1. G+W_s Wind service actions



3 Specifications

3.1 Material Properties

Material Properties												
6064 T 6	F _{tu}	F _{ty}	F_{cy}	F_{su}	F_{sy}	F_{bu}	F_{by}	Е	kt	k _c		
6061-T6	262	241	241	165	138	551	386	70000	1	1.12		

3.2 Buckling Constants

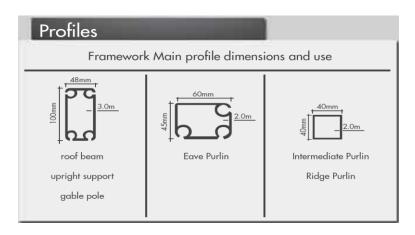
TABLE 3.3(D) BUCKLING CONSTANTS FOR ALLOY 6061-T6											
Type of member and stress	Interc	ept, MPa	Slop	oe, MPa	Inter	section					
Compression in columns and beam flanges	Bc	271.04	Dc	1.69	Cc	65.89					
Compression in flat plates	Bp	310.11	Dp	2.06	Cp	61.60					
Compression in round tubes under axial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

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



3.3 Member Sizes & Section Properties

MEMBER(S)	Section	b	d	t	Уc	Ag	Zx	Zy	Sx	Sy	lx	ly	J	r _x	ry
		mm	mm	mm	mm	mm²	mm ³	mm ³	mm ³	mm ³	mm⁴	mm⁴	mm⁴	mm	mm
Rafter	100x48x3	48	100	3	50.0	852.0	21859.1	14218.5	27222.0	16146.0	1092956.0	341244.0	805065.8	35.8	20.0
Upright Support	100x48x3	48	100	3	50.0	852.0	21859.1	14218.5	27222.0	16146.0	1092956.0	341244.0	805065.8	35.8	20.0
Gable Pole	84x48x3	48	84	3	42.0	756.0	16902.0	12190.5	20790.0	13986.0	709884.0	292572.0	632667.9	30.6	19.7
Ridge & Eave Purlin	45x60x2	60	45	2	22.5	404.0	5955.3	6999.3	6841.0	8356.0	133993.7	209978.7	246338.1	18.2	22.8
Gable Beam	45x60x2	60	45	2	22.5	404.0	5955.3	6999.3	6841.0	8356.0	133993.7	209978.7	246338.1	18.2	22.8
Intermediate Purlin	40x40x2	40	40	2	20.0	304.0	3668.3	3668.3	4336.0	4336.0	73365.3	73365.3	109744.0	15.5	15.5
Brace	40x40x2	40	40	2	20.0	304.0	3668.3	3668.3	4336.0	4336.0	73365.3	73365.3	109744.0	15.5	15.5





4 Wind Analysis

4.1 Wind calculations

	Project:	Extreme Ma	arquees		
ALE	Job no.	23-573-3		Designer:	AK
PRIME CONSULTING ENGINEERS PTY, LTD	Date:	6/07/2023		Amendment:	
Name	Symbol	Value	Unit	Notes	Ref.
		Ge	neral		
Importance level		2			Table 3.1 - Table 3.2 (AS1170.0)
Annual probability of exceedance		Temporary			Table 3.3
Regional gust wind speed		80.00	Km/hr		
Regional gust wind speed	V _R	22.22	m/s		
Wind Direction Multipliers	Md	1			Table 3.2 (AS1170.2)
Terrain Category	тс	2			(101110.2)
Terrain Category Multiplier	M _{Z,Cat}	0.91			
Shield Multiplier	Ms	1			4.3 (AS1170.2)
Topographic Multiplier	Mt	1			4.4 (AS1170.2)
Site Wind Speed	$V_{Site,\beta}$	20.22	m/s	VSite, β=VR*Md*Mz,cat*MS,Mt	
Pitch	α	20	Deg		
Pitch	α	0.349	rad		
Width	В	12	m		
Width Span	Sw	3	m		
Length	D	12	m		
Height	Z	3.5	m		
Bay Span		3	m		
Purlin Spacing		1.5	m		
Number of Intermediate Purlin		6			
	h/d	0.29			



	h/b	0.29			
		Wind	l Pressure		
hoair	ρ	1.2	Kg/m ³		
dynamic response factor	C_{dyn}	1			
Wind Pressure	ho*Cfig	0.245	Kg/m ²	ρ =0.5 $\rho_{air}^*(V_{des,\beta})^2 * C_{fig}^* C_{dyn}$	2.4 (AS1170.2
l	VIND DIR	ECTION 1 (Perpendio	cular to Length)	
		Intern	al Pressur	e	
Opening Assumption					
		ominant Op pi = n x Cp			
Internal Pressure Coefficient (Without Dominant) MIN					
Internal Pressure Coefficient (Without Dominant) MAX					
Internal Pressure Coefficient (With Dominant) MIN					
Internal Pressure Coefficient (With Dominant) MAX					
Ν		0.7		Cpi= N*Cpe	
Combination Factor	K _{C,i}	1			
Internal Pressure Coefficient MIN	$C_{p,i}$	0.70			
Internal Pressure Coefficient MAX	C _{p,i}	0.70			
		Extern	al Pressur	re	
1. Windward Wall					
External Pressure Coefficient	C _{P,e}	0.7			
Area Reduction Factor	Ka	1			Table 5.4
combination factor applied to internal pressures	K _{C,e}	0.8			
local pressure factor	Kı	1			
porous cladding reduction factor	Kp	1			
aerodynamic shape factor	C _{fig,e}	0.56			
Wind Wall Pressure	Р	0.14	kPa		
Edge Column Force	F	0.21	kN/m		
Intermediate Column Force	F	0.41	kN/m		



External Pressure Coefficient	C _{P,e}	-0.4	
Area Reduction Factor	Ka	1	
combination factor applied to	K _{C,e}	0.8	
internal pressures			
local pressure factor	K	1	
porous cladding reduction factor	Kp	1	
aerodynamic shape factor	C _{fig,e}	-0.32	
Lee Wall Pressure	Р	-0.08	kPa
Edge Column Fores	E	-0.12	kN/m
Edge Column Force Intermediate Column Force	F	-0.12 -0.24	kN/m kN/m
	Г	-0.24	KIN/111
3. Side Wall			
Area Reduction Factor	Ka	1	
combination factor applied to	K	0.0	
internal pressures	K _{C,e}	0.8	
local pressure factor	Kı	1	
porous cladding reduction factor	Kp	1	
External Pressure Coefficient	C _{P,e}	-0.65	
External Pressure Coefficient	C _{P,e}	-0.5	
External Pressure Coefficient	C _{P,e}	-0.3	
External Pressure Coefficient	$C_{P,e}$	-0.2	
aerodynamic shape factor	C _{fig,e}	-0.52	
aerodynamic shape factor	C _{fig,e}	-0.4	
aerodynamic shape factor	C _{fig,e}	-0.24	
aerodynamic shape factor	C _{fig,e}	-0.16	
Side Wall Pressure	Р	-0.13	kPa
Side Wall Pressure	P	-0.13 -0.10	кРа kPa
Side Wall Pressure	P	-0.06	kPa
Side Wall Pressure	P	-0.04	kPa
4. Roof Up Wind Slope			
Area Reduction Factor	Ka	1	
combination factor applied to	Ka	0.8	
internal pressures	K _{C,e}	0.8	
local pressure factor	Kı	1	
porous cladding reduction factor	Kp	1	
External Pressure Coefficient MIN	C _{P,e}	-0.32	
External Pressure Coefficient			
MAX	$C_{P,e}$	0.15	
aerodynamic shape factor MIN	C _{fig,e}	-0.26	
aerodynamic shape factor MAX	Cfig,e	0.12	



	_		
Pressure MIN Pressure MAX	P P	-0.06 0.03	kPa kPa
I TESSULE WIAA	Г	0.03	кга
Edge Rafter Force MIN	F	-0.09	kN/m
Edge Rafter Force Max	F	0.04	kN/m
Intermediate Rafter Force MIN	F	-0.19	kN/m
Intermediate Rafter Force MAX	F	0.09	kN/m
5. Roof Down Wind Slope			
Area Reduction Factor	Ka	1	
combination factor applied to	K _{C,e}	0.8	
internal pressures	K	1	
local pressure factor porous cladding reduction factor	κι Kp	1	
External Pressure Coefficient	rtp CP,e	-0.6	
aerodynamic shape factor	CP,e Cfig,e	-0.48	
	Jild's	0.10	
Pressure MIN	Р	-0.12	kPa
Pressure MAX	Р	-0.12	kPa
Edge Rafter Force MIN	F	-0.18	kN/m
Edge Rafter Force MAX	F	-0.18	kN/m
Intermediate Rafter Force MIN	F	-0.35	kN/m
Intermediate Rafter Force MAX	F	-0.35	kN/m
	WIND	DIRECTION	2 (Paral
		Interno	al Pressu
Opening Assumption			
	With D	ominant Op	enina
		pi = n x Cpe	
Internal Pressure Coefficient (Without Dominant) MIN			
Internal Pressure Coefficient			
(Without Dominant) MAX			
Internal Pressure Coefficient (With Dominant) MIN			
Internal Pressure Coefficient (With Dominant) MAX			
Ν		0.7	
Combination Factor	Kc,i	1	
Internal Pressure Coefficient MIN	C _{p,i}	0.70	
Internal Pressure Coefficient	C _{p,i}	0.70	
MAX	Ор,і	0.70	



		Extern	al Pressu	re	
1. Windward Wall					
External Pressure Coefficient	C _{P,e}	0.7			
Area Reduction Factor	Ka	1			Table 5.4
combination factor applied to internal pressures	K _{C,e}	0.8			
local pressure factor	K	1			
porous cladding reduction factor	Kp	1			
aerodynamic shape factor	C _{fig,e}	0.56			
Wind Wall Pressure	Р	0.14	kPa		
Edge Column Force	F	0.21	kN/m		
Intermediate Column Force	F	0.41	kN/m		
0.1					
2. Leeward Wall	0	0.5			
External Pressure Coefficient	C _{P,e}	-0.5			- <i>i i i i</i>
Area Reduction Factor	Ka	1			Table 5.4
combination factor applied to internal pressures	$K_{C,e}$	0.8			
local pressure factor	Kı	1			
porous cladding reduction factor	Kp	1			
aerodynamic shape factor	C _{fig,e}	-0.4			
Lee Wall Pressure	Р	-0.10	kPa		
Edge Column Force	F	-0.15	kN/m		
Intermediate Column Force	F	-0.29	kN/m		
3. Side Wall					
Area Reduction Factor	Ka	1			Table 5.4
combination factor applied to internal pressures	K _{C,e}	0.8			
local pressure factor	Kı	1			
porous cladding reduction factor	Kp	1			
External Pressure Coefficient	C _{P,e}	-0.65		0 to 1h	
External Pressure Coefficient	C _{P,e}	-0.5		1h to 2h	
External Pressure Coefficient	C _{P,e}	-0.3		2h to 3h	
External Pressure Coefficient	C _{P,e}	-0.2		>3h	
aerodynamic shape factor	C _{fig,e}	-0.52		0 to 1h	
aerodynamic shape factor	C _{fig,e}	-0.4		1h to 2h	



Side Wall Pressure	Р	-0.13	kPa	0 to 1h
Side Wall Pressure	Р	-0.10	kPa	1h to 2h
Side Wall Pressure	P	-0.06	kPa	2h to 3h
Side Wall Pressure	Р	-0.04	kPa	>3h
4. Roof				α <10°
Area Reduction Factor	Ka	1		
combination factor applied to internal pressures	K _{C,e}	0.8		
local pressure factor	Kı	1		
porous cladding reduction factor	Kp	1		
External Pressure Coefficient MIN	C _{P,e}	-0.9		0 to 0.5h
External Pressure Coefficient MIN	C _{P,e}	-0.9		0.5 to 1h
External Pressure Coefficient MIN	C _{P,e}	-0.5		1h to 2h
External Pressure Coefficient MIN	C _{P,e}	-0.3		2h to 3h
External Pressure Coefficient MIN	$C_{P,e}$	-0.2		>3h
External Pressure Coefficient				
MAX	$C_{P,e}$	-0.4		0 to 0.5h
External Pressure Coefficient MAX	$C_{P,e}$	-0.4		0.5 to 1h
External Pressure Coefficient MAX	C _{P,e}	0		1h to 2h
External Pressure Coefficient MAX	$C_{P,e}$	0.1		2h to 3h
External Pressure Coefficient MAX	$C_{P,e}$	0.2		>3h
aerodynamic shape factor MIN	C _{fig,e}	-0.72		0 to 0.5h
aerodynamic shape factor MIN	C _{fig,e}	-0.72		0.5 to 1h
aerodynamic shape factor MIN	C _{fig,e}	-0.4		1h to 2h
aerodynamic shape factor MIN	C _{fig,e}	-0.24		2h to 3h
aerodynamic shape factor MIN	C _{fig,e}	-0.16		>3h
	0,-			
aerodynamic shape factor MAX	$C_{\text{fig,e}}$	-0.32		0 to 0.5h
aerodynamic shape factor MAX	$C_{\text{fig,e}}$	-0.32		0.5 to 1h
aerodynamic shape factor MAX	$C_{\text{fig,e}}$	0		1h to 2h
aerodynamic shape factor MAX	$C_{\text{fig,e}}$	0.08		2h to 3h



aerodynamic shape factor MAX	C _{fig,e}	0.16		>3h	
Pressure MIN	Р	-0.18	kPa	0 to 0.5h	
Pressure MIN	Р	-0.18	kPa	0.5 to 1h	
Pressure MIN	Р	-0.10	kPa	1h to 2h	
Pressure MIN	Р	-0.06	kPa	2h to 3h	
Pressure MIN	Р	-0.04	kPa	>3h	
Pressure MAX	Р	-0.08	kPa	0 to 0.5h	
Pressure MAX	Р	-0.08	kPa	0.5 to 1h	
Pressure MAX	Р	0.00	kPa	1h to 2h	
Pressure MAX	Р	0.02	kPa	2h to 3h	
Pressure MAX	Р	0.04	kPa	>3h	
Edge Purlin Force MIN	F	-0.13	kN/m	0 to 0.5h	
Edge Purlin Force MIN	F	-0.13	kN/m	0.5 to 1h	
Edge Purlin Force MIN	F	-0.07	kN/m	1h to 2h	
Edge Purlin Force MIN	F	-0.04	kN/m	2h to 3h	
Edge Purlin Force MIN	F	-0.03	kN/m	>3h	
Edge Purlin Force MAX	F	-0.06	kN/m	0 to 0.5h	
Edge Purlin Force MAX	F	-0.06	kN/m	0.5 to 1h	
Edge Purlin Force MAX	F	0.00	kN/m	1h to 2h	
Edge Purlin Force MAX	F	0.01	kN/m	2h to 3h	
Edge Purlin Force MAX	F	0.03	kN/m	>3h	
Intermediate Purlin Force MIN	F	-0.26	kN/m	0 to 0.5h	
Intermediate Purlin Force MIN	F	-0.26	kN/m	0.5 to 1h	
Intermediate Purlin Force MIN	F	-0.15	kN/m	1h to 2h	
Intermediate Purlin Force MIN	F	-0.09	kN/m	2h to 3h	
Intermediate Purlin Force MIN	F	-0.06	kN/m	>3h	
Intermediate Purlin Force MAX	F	-0.12	kN/m	0 to 0.5h	
Intermediate Purlin Force MAX	F	-0.12	kN/m	0.5 to 1h	
Intermediate Purlin Force MAX	F	0.00	kN/m	1h to 2h	
Intermediate Purlin Force MAX	F	0.03	kN/m	2h to 3h	
Intermediate Purlin Force MAX	F	0.06	kN/m	>3h	



4.1.1 Summary

WIND EXTERNAL PRESSURE									
		Wind Di (Perpendicul	rection1 ar to Length)	Wind Direction2 (Parallel to Length)					
Windward		0.1	14	0.14					
	Leeward	-0.	08	-0.10					
	0m - 3.5m -0.13		-0.13						
Cidowall	3.5m - 7m	-0.10		-0.10	-0.10				
Sidewall	7m - 10.5m	-0.	06	-0.06	0.06				
	> 10.5m	-0.04		-0.04	.04				
				0m - 1.75m	-0.18	-0.08			
	Upwind Slope	-0.06	0.03	1.75m - 3.5m	-0.18	-0.08			
Roof				3.5m - 7m	-0.10	0.00			
	Downwind Slope	-0.12	-0.12	7m - 10.5m	-0.06	0.02			
	Downwind Slope	0.12	0.12	>10.5m	-0.04	0.04			
		Wind Intern	nal Pressure (kPa)						
		0.7 х Сре	0.7 x Cpe	0.7 х Сре	0.7 x	Сре			



4.2 Wind Load Diagrams

4.2.1 Wind Load Ultimate (W_{min} Direction1)

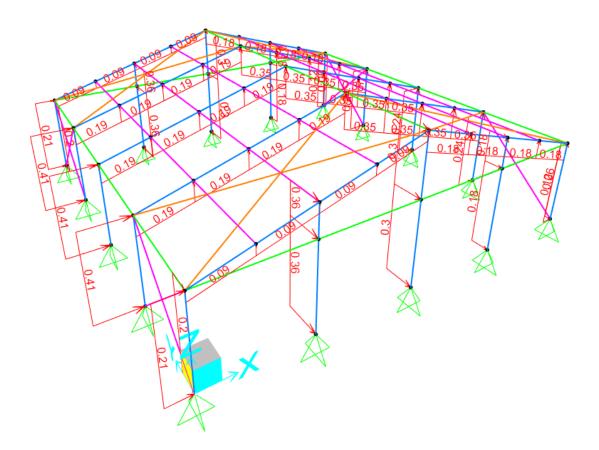


Figure 2 Wind Direction 1 Min



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4.2.2 Wind Load Ultimate (W_{max} Direction 1)

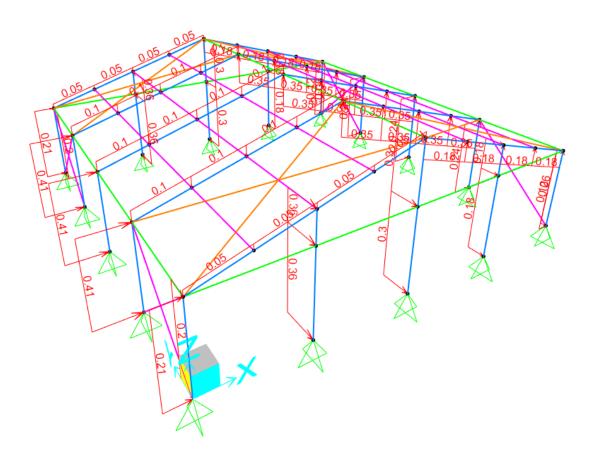


Figure 3 Wind Direction 1 Max



4.2.3 Wind Load Ultimate (W_{min} Direction 2)

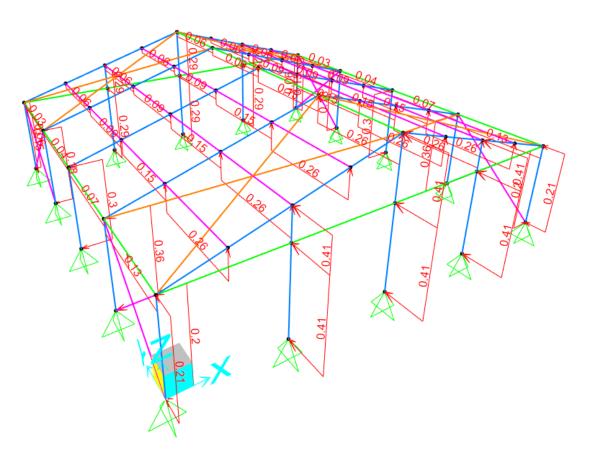


Figure 4Wind Direction 2 Min



4.2.4 Wind Load Ultimate (W_{max} Direction 2)

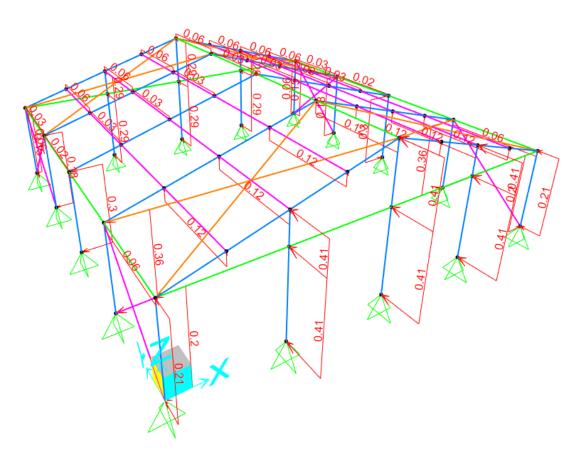


Figure 5 Wind Direction 2 Max



- 5 Analysis
- 5.1 Results

5.1.1 Maximum Bending Moment in Major Axis

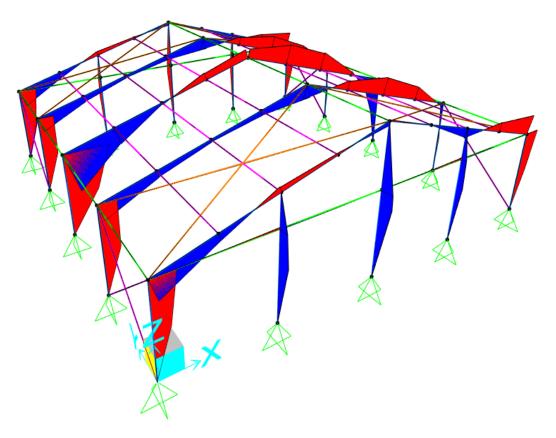
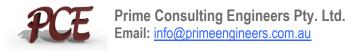


Figure 6 Maximum Bending Moment - Major



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5.1.2 Maximum Bending Moment in Minor Axis

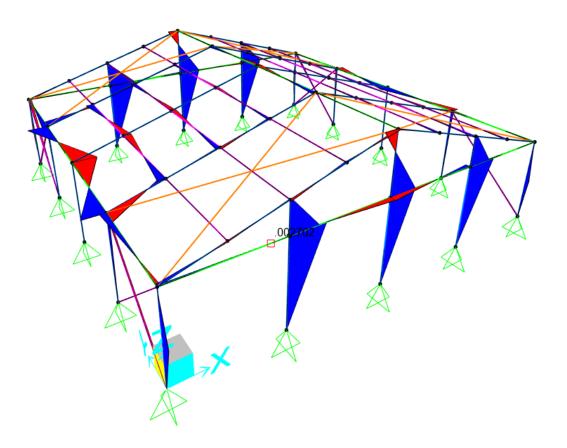


Figure 7: Maximum Bending Moment - Minor



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5.1.3 Maximum Shear

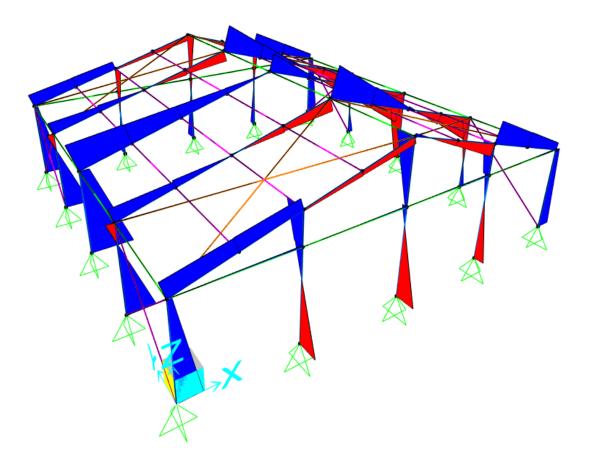


Figure 8 Maximum Shear



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5.1.4 Maximum Axial Force

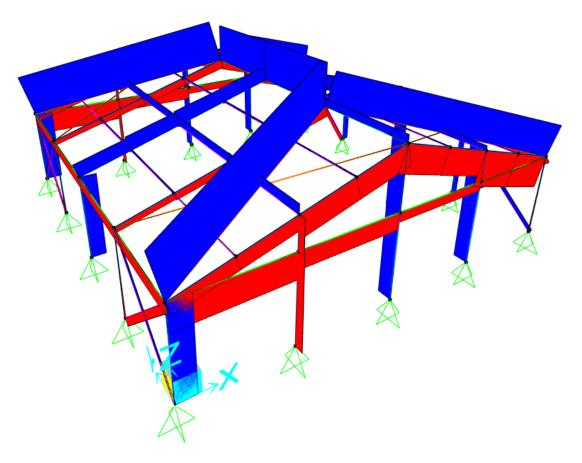
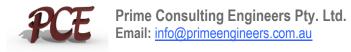


Figure 9 Maximum Axial Force



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5.1.5 Maximum Reactions

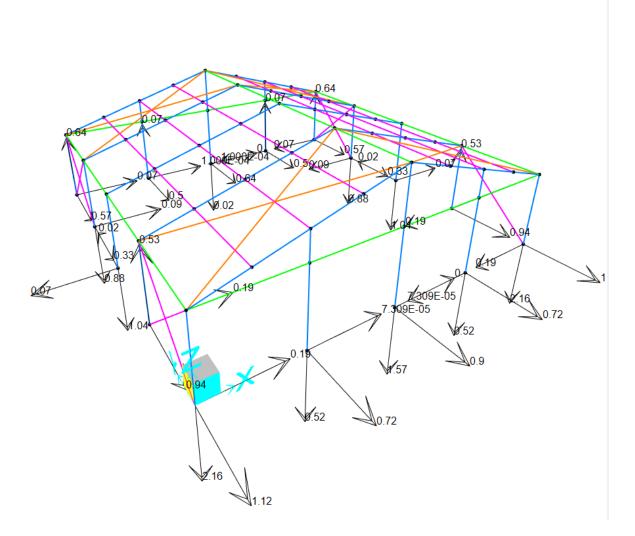


Figure 10 Maximum Reaction

 $\label{eq:Fx} \begin{array}{l} {\sf Fx} = 2.45 \ {\sf kN} \\ {\sf Fy} = 1.97 \ {\sf kN} \\ {\sf F}_{z({\sf up} \ {\sf lift})} = 2.6 \ {\sf kN} \\ {\sf F}_{z \ ({\sf Bearing})} = 4.05 \ {\sf kN} \end{array}$



6 Aluminium Member Design

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

MEMBER(S)	Section	b	d	t	Vx	Vy	P (Axial)	Мх	Му
		mm	mm	mm	kN	kN	kN	kN.m	kN.m
Rafter	100x48x3	48	100	3	1.793	-0.00266	2.025	4.0262	-0.0031
Upright Support	100x48x3	48	100	3	0.641	-0.00057	2.27	-4.0233	0.0015
Gable Pole	84x48x3	48	84	3	0.509	-0.423	-2.019	0.7455	1.0996
Ridge & Eave Purlin	45x60x2	60	45	2	0.015	0.374	-1.39	-6.939E-18	-0.5987
Gable Beam	45x60x2	60	45	2	0.047	0.012	-3.333	-0.0989	-0.0007684
Intermediate Purlin	40x40x2	40	40	2	-0	0.014	-0.333	-0.4891	0.0189
Brace	40x40x2	40	40	2	0.011	0.01	-1.903	6.939E-18	-0.0288

7 Ballast Requirements

Tent Span	Wind Region	Wind Speed (km/hr)	Holding-down Weight per Gable Pole (kg)	Holding-down Weight per Upright Support (kg)
12m	A	80	350	450
10m	A	80	350	450
9m	A	80	300	380
8m	A	80	275	350
6m	А	80	250	300



8 Summary and Recommendations

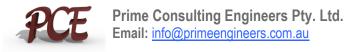
- The structure is for temporary use only and shall not remain erected for more than 6 months period.
- The temporary 12m X 12m Tent Structure as specified is capable of withstanding 22.22
 m/s Wind Loads.
- For ballast requirements, refer to <u>Cl. 7</u>.
- For forecast winds in excess of **80km/hr** all fabrics should be removed and the erected structure to be dismantled.
- Wall Bracing and roof bracing are required at each end bay and every third bay in between to resist against lateral movement due to wind direction2.
- Maximum Intermediate purlin spacing shall not exceed 1500mm for 40x40x2 purlin profiles.
- Roof cable bracings are required to have minimum **10kN SWL**.
- The bearing pressure of soil should be clarified and checked by an engineer prior to erection foundation and base plate considerations.

Yours faithfully, Prime Consulting Engineers Pty. Ltd. Kevin Zia, BEng, Meng, MIEAust, CPENG NER



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9 Appendix A – Aluminium Design Based on AS1664.1



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9.1 Upright Support



Job no.

23-573-3

Date: 6/07/2023

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
100x48x3	Upright Support					
Alloy and temper	6061-T6					AS1664.1
Tension	F _{tu}	=	262	MPa	Ultimate	T3.3(A)
rension	F _{ty}	=	241	MPa	Yield	
Compression	F _{cy}	=	241	MPa		
Shear	Fsu	=	165	MPa	Ultimate	
Shear	F _{sy}	=	138	MPa	Yield	
Bearing	F _{bu}	=	551	MPa	Ultimate	
Dearing	F _{by}	=	386	MPa	Yield	
Modulus of elasticity	E	=	70000	MPa	Compressive	
,					,	
	kt	=	1			T3.4(B)
	kc	=	1			10.4(D)
FEM ANALYSIS RESULTS						
Axial force	Р	=	0	kN	compression	
	P	=	2.27	kN	Tension	
In plane moment	Mx	=	4.0233	kNm		
Out of plane moment	My	=	0.0015	kNm		
	,		010010			
DESIGN STRESSES						
Gross cross section area	Ag	=	852	mm²		
In-plane elastic section modulus	Zx	=	21859.12	mm ³		
Out-of-plane elastic section mod.	Zy	=	14218.5	mm ³		
Stress from axial force	f _a	=	P/Ag			
		=	0.00	MPa	compression	
		=	2.66	MPa	Tension	
Stress from in-plane bending	f _{bx}	=	M _x /Z _x			



	,	=	184.06	MPa	compression	
Stress from out-of-plane bending	f _{by}	=	My/Zy	MDe	aamaraaaian	
Tension		=	0.11	МРа	compression	
3.4.3 Tension in rectangular tubes						
	φF∟	=	228.95	MPa		
	Ŧ. =	OR				
	φF∟	=	222.70	MPa		
COMPRESSION						
3.4.8 Compression in columns, axi 1. General	ial, gross sect	ion				3.4.8.1
Unsupported length of member	L	=	4000	mm		
Effective length factor	k	=	1.00			
Radius of gyration about buckling axis (Y)	r _y	=	20.01	mm		
Radius of gyration about buckling axis (X)	٢x	=	35.82	mm		
Slenderness ratio Slenderness ratio	kLb/ry kL/rx	= =	199.87 111.68			
Slenderness parameter	λ	=	3.73			
	Dc*	=	90.3			
	S1*	=	0.33			
	S ₂ *	=	1.23			
	фсс	=	0.950			
Factored limit state stress	φF∟	=	16.43	MPa		
2. Sections not subject to torsional	or torsional-f	lexural bi	uckling			3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	199.87			
3.4.10 Uniform compression in cor plates	mponents of c	olumns,	gross sectio	on - flat		
1. Uniform compression in compor with both edges supported	nents of colum	nns, gros	s section - i	flat plates		 3.4.10.1
	k1	=	0.35			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	b'	=	42			
	t	=	3	mm		
Slenderness	b/t	=	14			
Limit 1	S ₁	=	12.34			



Limit 2	S ₂	=	32.87			
Factored limit state stress	φF∟	=	224.30	MPa		
Most adverse compressive limit state stress	Fa	=	16.43	MPa		
Most adverse tensile limit state stress	Fa	=	222.70	MPa		
Most adverse compressive & Tensile capacity factor	f _a /F _a	=	0.01		PASS	
BENDING - IN-PLANE						
3.4.15 Compression in beams, extr box sections	reme fibre, gro	oss sect	ion rectangu	lar tubes,		
Unbraced length for bending	Lb	=	4000	mm		
Second moment of area (weak axis)	ly	=	3.41E+05	mm ⁴		
Torsion modulus	J	=	8.05E+05	mm ³		
Elastic section modulus	Z	=	21859.12	mm ³		
Slenderness	S	=	333.64			
Limit 1	S ₁	=	0.39			
Limit 2	S ₂	=	1695.86			
Factored limit state stress	φF∟	=	188.49	MPa		 3.4.15(2)
3.4.17 Compression in components compression), gross section - flat p				orm		
1 1 1 1	k ₁	=	0.5			T3.3(D)
	k ₂	=	2.04			T3.3(D)
Max. distance between toes of	_		-			
fillets of supporting elements for plate	b'	=	42	mm		
	t	=	3	mm		
Slenderness	b/t	=	14			
Limit 1	S ₁	=	12.34			
Limit 2	S ₂	=	46.95			
Factored limit state stress	φF∟	=	224.30	MPa		
Most adverse in-plane bending limit state stress	F _{bx}	=	188.49	MPa		
Most adverse in-plane bending capacity factor	f _{bx} /F _{bx}	=	0.98		PASS	



BENDING - OUT-OF-PLANE NOTE: Limit state stresses, ϕF_L a	re the same fo	or out-of-	plane bendin	g (doubly		
symmetric section)						
Factored limit state stress	φFι	=	188.49	МРа		
Most adverse out-of-plane bending limit state stress	F _{by}	=	188.49	MPa		
Most adverse out-of-plane bending capacity factor	f _{by} /F _{by}	=	0.00		PASS	
COMBINED ACTIONS						
4.1.1 Combined compression and	l bending					4.1.1(2)
	Fa	_	16.43	MPa		3.4.8
	Fa Fao	=		MPa MPa		3.4.8
	F _{bx}	=		MPa		3.4.10
	F _{by}	=	188.49	MPa		3.4.17
	. by		100110	ini a		
	f _a /F _a	=	0.012			
Check:	$f_a/F_a + f_{bx}/F_{bx}$	+ f _{by} /F _{by} :	≤ 1.0			4.1.1 (3)
i.e.	0.99	≤	1.0		PASS	(0)
SHEAR 3.4.24 Shear in webs (Major Axis)						4.1.1(2)
Clear web height	h	=	94	mm		
	t	=	3	mm		
Slenderness	h/t	=	31.333333			
Limit 1	S1	=	29.01			
Limit 2	S ₂	=	59.31			
Factored limit state stress	φFL	=	128.74	MPa		
Stress From Shear force	f _{sx}	=	V/A _w			
			0.90	MPa		
3.4.25 Shear in webs (Minor Axis)						
			42	mm		
Clear web height	b t	=				
Clear web height Slenderness	b t b/t	= = =	3 14	mm		



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Stress From Shear force	f _{sy}	=	V/A _w 0.00	МРа	
Most adverseshear capacity factor (Major Axis)	f _{sx} /F _{sx}	=	0.01	МРа	
Most adverseshear capacity factor (Minor Axis)	f_{sy}/F_{sy}	=	0.00	Мра	PASS
COMBINED ACTIONS					
4.4 Combined Shear, Compresio	n and bending				
Check:	$f_a/F_a + f_b/F_b + ($	$(f_s/F_{s)^2} \leq$	1.0		
i.e.	0.99	≤	1.0		PASS

9.2 Rafter

PCE	Job no.	23-573-3	Date:	6/07/2023	
PRIME CONSULTING ENGINEERS PTY, LTD					

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
100x48x3 Alloy and temper	Rafter 6061-T6					AS1664.1
Tension	Ftu	=	262	MPa	Ultimate	T3.3(A)
Compression	F _{ty} F _{cy}	=	241 241	MPa MPa	Yield	
Shear	F _{su} F _{sy}	= =	165 138	MPa MPa	Ultimate Yield	
Bearing	F _{bu}	=	551	MPa	Ultimate	
	F _{by}	=	386	MPa	Yield	
Modulus of elasticity	E	=	70000	MPa	Compressive	
	k _t kc	=	1 1			T3.4(B)
FEM ANALYSIS RESULTS						
	_					
Axial force	Р	=	0	kN	compression	



	Р	=	2.025	kN	Tension	
In plane moment	Mx	=	4.0262	kNm		
Out of plane moment	My	=	0.0031	kNm		
	,		0.0001			
DESIGN STRESSES						
Gross cross section area	Ag	=	852	mm ²		
In-plane elastic section	Zx	=	21859.12	mm ³		
modulus Out-of-plane elastic section mod.	Zy	=	14218.5	mm ³		
Stress from axial force	f _a	=	P/A _g			
		=	0.00	MPa	compression	
		=	2.38	MPa	Tension	
Stress from in-plane bending	f _{bx}	=	M _x /Z _x			
		=	184.19	MPa	compression	
Stress from out-of-plane	f _{by}	=	M _y /Z _y			
bending		=	0.22	MPa	compression	
Tension						
3.4.3 Tension in rectangular tube			220.05	MDe		
	φF∟	=	228.95	MPa		
		OR	000 70	MD		
	φF∟	=	222.70	MPa		
COMPRESSION						
3.4.8 Compression in columns, a	axial aross	sectio	n			
1. General	ixial, grooo	0001101				3.4.8.1
Unsupported length of member	L	=	6260	mm		
Effective length factor	– k	=	1.00			
Radius of gyration about						
buckling axis (Y)	r _y	=	20.01	mm		
Radius of gyration about	r _x	=	35.82	mm		
buckling axis (X)	1/1 h/m/		74 05			
Slenderness ratio	kLb/ry kL /rx	=	74.95 174 78			
	kLb/ry kL/rx	= =	74.95 174.78			
Slenderness ratio	•					
Slenderness ratio Slenderness ratio	kL/rx	=	174.78			
Slenderness ratio Slenderness ratio	kL/rx λ	=	174.78 3.264			
Slenderness ratio Slenderness ratio	kL/rx λ Dc*	= = =	174.78 3.264 90.3			
Slenderness ratio Slenderness ratio	kL/rx λ Dc* S1*	= = =	174.78 3.264 90.3 0.33			



The second state of the se			xural buckling	9		3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	174.78			
3.4.10 Uniform compression in configuration flat plates	omponents	s of co	lumns, gross	section -		
1. Uniform compression in comported plates with both edges supported		column	s, gross sect	ion - flat		 3.4.10.1
, 3,,,	k ₁	=	0.35			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	b'	=	42			
	t	=	3	mm		
Slenderness	b/t	=	14			
Limit 1	S ₁	=	12.34			
Limit 2	S ₂	=	32.87			
Factored limit state stress	φF∟	=	224.30	MPa		
Most adverse compressive limit state stress	Fa	=	21.49	MPa		
Most adverse tensile limit state stress	Fa	=	222.70	MPa		
Most adverse compressive &	£ /⊑		0.04		DAGG	
Tensile capacity factor	f _a /Fa	=	0.01		PASS	
	Ta/⊢a	=	0.01		PASS	
Tensile capacity factor BENDING - IN-PLANE 3.4.15 Compression in beams, e. tubes, box sections				tangular	PASS	
BENDING - IN-PLANE 3.4.15 Compression in beams, e.		re, gros		ctangular mm	PASS	
BENDING - IN-PLANE 3.4.15 Compression in beams, e. tubes, box sections Unbraced length for bending Second moment of area (weak	xtreme fibr	re, gros	ss section rec		PASS	
BENDING - IN-PLANE 3.4.15 Compression in beams, e. tubes, box sections Unbraced length for bending	xtreme fibr Lь	re, gros =	ss section rec 1500	mm mm ⁴	PASS	
BENDING - IN-PLANE 3.4.15 Compression in beams, e. tubes, box sections Unbraced length for bending Second moment of area (weak axis)	xtreme fibr Lь Iy	re, gros = =	ss section rec 1500 3.41E+05	mm mm ⁴	PASS	
BENDING - IN-PLANE 3.4.15 Compression in beams, e. tubes, box sections Unbraced length for bending Second moment of area (weak axis) Torsion modulus	x <i>treme fibr</i> Lь Iy J	re, gros = = =	55 section red 1500 3.41E+05 8.05E+05	mm mm ⁴ mm ³	PASS	
BENDING - IN-PLANE 3.4.15 Compression in beams, e. tubes, box sections Unbraced length for bending Second moment of area (weak axis) Torsion modulus Elastic section modulus	xtreme fibr L₀ Iy J Z	re, gros = = = =	ss section rec 1500 3.41E+05 8.05E+05 21859.12	mm mm ⁴ mm ³	PASS	
BENDING - IN-PLANE 3.4.15 Compression in beams, e. tubes, box sections Unbraced length for bending Second moment of area (weak axis) Torsion modulus Elastic section modulus Slenderness	xtreme fibr L₅ Iy J Z S	re, gros = = = = =	1500 3.41E+05 8.05E+05 21859.12 125.11	mm mm ⁴ mm ³	PASS	
BENDING - IN-PLANE 3.4.15 Compression in beams, e. tubes, box sections Unbraced length for bending Second moment of area (weak axis) Torsion modulus Elastic section modulus Slenderness Limit 1	xtreme fibr L₀ Iy J Z S S1	re, gros = = = = = =	1500 3.41E+05 8.05E+05 21859.12 125.11 0.39	mm mm ⁴ mm ³	PASS	3.4.15(2)
BENDING - IN-PLANE 3.4.15 Compression in beams, e. 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 3.4.17 Compression in component	xtreme fibr L₅ Iy J Z S S1 S2 φF L nts of bear	re, gros = = = = = = = = = ms (co	ss section red 1500 3.41E+05 8.05E+05 21859.12 125.11 0.39 1695.86 204.73 mponent und	mm mm ⁴ mm ³ mm ³ MPa	PASS	3.4.15(2)
BENDING - IN-PLANE 3.4.15 Compression in beams, e. 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	xtreme fibr L₅ Iy J Z S S1 S2 φF L nts of bear	re, gros = = = = = = = = = ms (co	ss section red 1500 3.41E+05 8.05E+05 21859.12 125.11 0.39 1695.86 204.73 mponent und	mm mm ⁴ mm ³ mm ³ MPa	PASS	3.4.15(2) T3.3(D)



Max. distance between toes of						1
fillets of supporting elements for plate	b'	=	42	mm		
	t	=	3	mm		
Slenderness	b/t	=	14			
Limit 1	S 1	=	12.34			
Limit 2	S ₂	=	46.95			
Factored limit state stress	φF∟	=	224.30	MPa		
Most adverse in-plane bending limit state stress	F _{bx}	=	204.73	MPa		
Most adverse in-plane bending capacity factor	f _{bx} /F _{bx}	=	0.90		PASS	
BENDING - OUT-OF-PLANE						
NOTE: Limit state stresses, $\phi F_{\perp} a$ (doubly symmetric section)	are the sar	ne for (out-of-plane l	pending		
Factored limit state stress	φF∟	=	204.73	MPa		
Most adverse out-of-plane bending limit state stress	F _{by}	=	204.73	MPa		
Most adverse out-of-plane bending capacity factor	f _{by} /F _{by}	=	0.00		PASS	
COMBINED ACTIONS						
4.1.1 Combined compression and	d bending					4.1.1(2)
	Fa	=	21.49	MPa		3.4.8
	F_{ao}	=	224.30	MPa		3.4.10
	F _{bx}	=	204.73	MPa		3.4.17
	F_{by}	=	204.73	MPa		3.4.17
	f _a /Fa	=	0.011			
Check:	fa/Fa + fbx	/F _{bx} + f	_{by} /F _{by} ≤ 1.0			4.1.1
i.e.	0.91	≤	1.0		PASS	(3)
SHEAR 3.4.24 Shear in webs (Major Axis)						4.1.1(2)
Clear web height	h ≁	=	94	mm		
Slenderness	t h/t	=	3 31.333333	mm		



Limit 1	S ₁	=	29.01		
Limit 2	S ₂	=	59.31		
Factored limit state stress	φF∟	=	128.74	MPa	
Stress From Shear force	f _{sx}	=	V/A _w		
3.4.25 Shear in webs (Minor Axis)			2.53	MPa	
Clear web height	b	=	42	mm	
Slandarnaaa	t b/t	=	3	mm	
Slenderness	D/I	=	14		
Factored limit state stress	φF∟	=	131.10	MPa	
Stress From Shear force	f _{sy}	=	V/A _w		
			0.00	MPa	
Most adverseshear capacity factor (Major Axis)	f _{sx} /F _{sx}	=	0.02	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	dina			
Check:	f _a /F _a + f _b /I	F _b + (f _s /	$F_{s)^2} \le 1.0$		
i.e.	0.91	≤	1.0		PASS

9.3 Gable Pole



Job no. 23-573-3 Date: 06/07/2023

Prime	CONSULTING	ENGINEERS	PTY.	LTD

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
84x48x3	Gable Pole					
Alloy and temper	6061-T6					AS1664.1
Tanaian	Ftu	=	262	MPa	Ultimate	T3.3(A)
Tension	Fty	=	241	MPa	Yield	
Compression	F _{cy}	=	241	MPa		



Shear	F_{su}	=	165	MPa	Ultimate	
Shear	F _{sy}	=	138	MPa	Yield	
Rearing	F_{bu}	=	551	MPa	Ultimate	
Bearing	F_{by}	=	386	MPa	Yield	
Modulus of elasticity	Е	=	70000	MPa	Compressive	
	kt	=	1			
	kc	=	1			T3.4(B)
FEM ANALYSIS RESULTS						
	-		2.010	1-51		
Axial force	P P	=	2.019 0	kN kN	compression Tension	
In plane moment	г Mx	=	0.7455	kNm	Tension	
Out of plane moment	My	=	1.0996	kNm		
Out of plane moment	IVIy	-	1.0550	KINITI		
DESIGN STRESSES						
Gross cross section area	Ag	=	756	mm ²		
In-plane elastic section modulus	Z _x	=	16902	mm ³		
Out-of-plane elastic section mod.	Zy	=	12190.5	mm ³		
Stress from axial force	fa	=	P/Ag			
		=	2.67	MPa	compression	
		=	0.00	MPa	Tension	
Stress from in-plane bending	f _{bx}	=	M _x /Z _x 44.11	MPa	compression	
Stragg from out of plang	f _{by}	=	44.11 My/Zy	IVIFa	compression	
Stress from out-of-plane bending	• by	_	90.20	MPa	compression	
Tension		_	00120	ini u	compression	
3.4.3 Tension in rectangular tubes	;					
6	φF∟	=	228.95	MPa		
	-	OR				
	φF∟	=	222.70	MPa		
COMPRESSION						
3.4.8 Compression in columns, ax 1. General	rial, gross	section				3.4.8.1
Unsupported length of member	L	=	4400	mm		
Effective length factor	k	=	1.00			



Radius of gyration about buckling axis (Y)	r _y	=	19.67	mm		
Radius of gyration about buckling axis (X)	r _x	=	30.64	mm		
Slenderness ratio	kLb/ry	=	152.50			
Slenderness ratio	kL/rx	=	143.59			
Slenderness parameter	λ	=	2.85			
	Dc*	=	90.3			
	S 1*	=	0.33			
	S ₂ *	=	1.23			
	фсс	=	0.950			
Factored limit state stress	φF∟	=	28.22	MPa		
2. Sections not subject to torsiona	l or torsioi	nal-flex	ural buckling	g		3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	152.50			
3.4.10 Uniform compression in co flat plates	mponents	of colu	ımns, gross	section -		
1. Uniform compression in compo plates with both edges supported	nents of c	olumns	, gross sect	ion - flat		 3.4.10.
	k ₁	=	0.35			T3.3(D
Max. distance between toes of fillets of supporting elements for plate	b'	=	42			
	t	=	3	mm		
Slenderness	b/t	=	14			
Limit 1	S ₁	=	12.34			
Limit 2	S ₂	=	32.87			
Factored limit state stress	φF∟	=	224.30	MPa		
Most adverse compressive limit state stress	Fa	=	28.22	MPa		
Most adverse tensile limit state stress	Fa	=	222.70	MPa		
Most adverse compressive & Tensile capacity factor	f _a /F _a	=	0.09		PASS	
BENDING - IN-PLANE						
3.4.15 Compression in beams, ex tubes, box sections	treme fibre	e, gross	s section red	ctangular		



					1	1
Unbraced length for bending	Lb	=	3000	mm		
Second moment of area (weak axis)	ly	=	292572	mm ⁴		
Torsion modulus	J	=	632667.86	mm ³		
Elastic section modulus	Z	=	16902	mm ³		
Slenderness	S	=	235.71			
Limit 1	S1	=	0.39			
Limit 2	S ₂	=	1695.86			
Factored limit state stress	φF∟	=	195.17	MPa		 3.4.15(2)
3.4.17 Compression in componer compression), gross section - flat						
	k 1	=	0.5			T3.3(D)
	k ₂	=	2.04			T3.3(D)
Max. distance between toes of	K2	-	2.04			10.0(D)
fillets of supporting elements for plate	b'	=	42	mm		
	t	=	3	mm		
Slenderness	b/t	=	14			
Limit 1	S ₁	=	12.34			
Limit 2	S ₂	=	46.95			
Factored limit state stress	φF∟	=	224.30	MPa		
Most adverse in-plane bending limit state stress	F _{bx}	=	195.17	MPa		
Most adverse in-plane bending capacity factor	f _{bx} /F _{bx}	=	0.23		PASS	
BENDING - OUT-OF-PLANE						
NOTE: Limit state stresses, ϕF_L a (doubly symmetric section)	re the sam	ne for d	out-of-plane b	ending		
Factored limit state stress	φF∟	=	195.17	MPa		
Most adverse out-of-plane bending limit state stress	F_{by}	=	195.17	MPa		
Most adverse out-of-plane bending capacity factor	f _{by} /F _{by}	=	0.46		PASS	
COMBINED ACTIONS						



		_					1
		Fa	=	28.22	MPa		3.4.8
		Fao	=	224.30	MPa		3.4.10
		F _{bx}	=	195.17	MPa		3.4.17
		F _{by}	=	195.17	MPa		3.4.17
		·					
		f _a /Fa	=	0.095			
Che	eck:	f _a /Fa + f _{bx} /	Fbx + fby	y/F _{by} ≤ 1.0			4.1.1 (3)
	i.e.	0.78	≤	1.0		PASS	(0)
SHEAR							
3.4.24 Shear in webs (Major Axis)	r						4.1.1(2)
Clear web height		h	=	78	mm		
		t	=	3	mm		
Slenderness		h/t	=	26			
Limit 1		S1	=	29.01			
Limit 2		S ₂	=	59.31			
Factored limit state stress		φF∟	=	131.10	MPa		
Stress From Shear force		f _{sx}	=	V/A _w			
3.4.25 Shear in webs (Minol Axis)	r			0.81	MPa		
Clear web height		b	=	42	mm		
5		t	=	3	mm		
Slenderness		b/t	=	14			
Factored limit state stress		φF∟	=	131.10	MPa		
Stress From Shear force		f _{sy}	=	V/A _w 0.67	MPa		
Most adverseshear capacity factor (Major Axis)	/	f _{sx} /F _{sx}	=	0.01	МРа		
Most adverseshear capacity factor (Minor Axis)	/	f_{sy}/F_{sy}	=	0.01	Мра	PASS	
COMBINED ACTIONS							
4.4 Combined Shear, Comp	16210	n anu bent	ung				
Ch	eck:	f _a /F _a + f _b /F	= + (f./	$F_{s}^{2} \leq 10$			



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

i.e	e. 0.56	≤	1.0	PASS		
9.4 Eave & Ridge Purlin	I					
PCE		Job no.	23-573-3	Date:	6/07/2023	

PRIME CONSULTING ENGINEERS PTY. LTD

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
45x60x2	Ridge & Eave Purlin					
Alloy and temper	6061-T6					AS1664.1
	Ftu	=	262	MPa	Ultimate	T3.3(A)
Tension	F _{ty}	=	241	MPa	Yield	
Compression	F _{cy}	=	241	MPa		
	F _{su}	=	165	MPa	Ultimate	
Shear	F _{sy}	=	138	MPa	Yield	
Desides	F _{bu}	=	551	MPa	Ultimate	
Bearing	F _{by}	=	386	MPa	Yield	
Modulus of elasticity	E	=	70000	MPa	Compressive	
	kt	=	1			
	kc	=	1			T3.4(B)
FEM ANALYSIS RESULTS						
Axial force	Р	=	1.39	kN	compression	
	Р	=	0	kN	Tension	
In plane moment	Mx	=	6.939E-18	kNm		
Out of plane moment	My	=	0.5987	kNm		
DESIGN STRESSES						
Gross cross section area	Ag	=	404	mm ²		
In-plane elastic section modulus	Zx	=	5955.2741	mm ³		
Out-of-plane elastic section mod.	Zy	=	6999.2889	mm ³		
Stress from axial force	fa	=	P/Ag			
		=	3.44	MPa	compression	



Ctropp from in plane banding	4	=	0.00	MPa	Tension	
Stress from in-plane bending	f _{bx}	=	M _x /Z _x 0.00	MPa	compression	
Stress from out-of-plane	f _{by}	=	M _y /Z _y			
bending		=	85.54	MPa	compression	
Tension						
3.4.3 Tension in rectangular tubes						
	φF∟	= OR	228.95	МРа		
	φF∟	=	222.70	MPa		
COMPRESSION						
3.4.8 Compression in columns, axia 1. General	l, gross sectior	ז				3.4.8.1
I have a stand low oth of momentary	L		2000			
Unsupported length of member Effective length factor	L k	=	3000 1.00	mm		
Radius of gyration about						
buckling axis (Y)	ry	=	22.80	mm		
Radius of gyration about	r _x	=	18.21	mm		
buckling axis (X) Slenderness ratio	kLb/ry	=	131.59			
Slenderness ratio	kL/rx	=	164.73			
Slenderness parameter	λ	=	3.08			
	D _c *	=	90.3			
	_ ₀ S₁*	=	0.33			
	S ₂ *	=	1.23			
	фсс	=	0.950			
Factored limit state stress	φF∟	=	24.19	MPa		
2. Sections not subject to torsional c	or torsional-flex	ural buckl	ina			3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	164.73			0.4.0.2
3.4.10 Uniform compression in com	ponents of colu	umns, gros	ss section -	flat plates		
1. Uniform compression in compone both edges supported	ents of columns	s, gross se	ection - flat	plates with		 3.4.10.1
	k 1	=	0.35			T3.3(D)
Max. distance between toes of fillets of supporting elements	b'	=	56			
for plate						



	t	=	2	mm		I
Slenderness	b/t	=	28			
Limit 1	S ₁	=	12.34			
Limit 2	S ₂	=	32.87			
Factored limit state stress	φF∟	=	185.00	MPa		
Most adverse compressive limit state stress	Fa	=	24.19	MPa		
Most adverse tensile limit state stress	Fa	=	222.70	MPa		
Most adverse compressive & Tensile capacity factor	f _a /F _a	=	0.14		PASS	
BENDING - IN-PLANE						
3.4.15 Compression in beams, extre box sections	eme fibre, gros	s section	rectangular t	ubes,		
Unbraced length for bending	L _b	=	3000	mm		
Second moment of area (weak axis)	ly	=	209978.67	mm ⁴		
Torsion modulus	J	=	246338.06	mm ³		
Elastic section modulus	Z	=	5955.2741	mm ³		
Slenderness	S	=	157.11			
Limit 1	S ₁	=	0.39			
Limit 2	S ₂	=	1695.86			
Factored limit state stress	φF∟	=	201.63	MPa		 3.4.15(2)
3.4.17 Compression in components compression), gross section - flat pl						
	k1	=	0.5			T3.3(D)
	k ₂	=	2.04			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	b'	=	56	mm		
ioi piate	t	_	2	mm		
Slenderness	b/t	=	2 28	mm		
Limit 1	D/t S₁	=	12.34			
Limit 2	S ₂	=	46.95			
Factored limit state stress	φF∟	=	185.00	MPa		



Most adverse in-plane bending limit state stress	F _{bx}	=	185.00	MPa		
Most adverse in-plane bending capacity factor	f_{bx}/F_{bx}	=	0.00		PASS	
BENDING - OUT-OF-PLANE						
NOTE: Limit state stresses, φF∟ are symmetric section)	e the same for c	out-of-plar	ne bending (doubly		
Factored limit state stress	φF∟	=	185.00	MPa		
Most adverse out-of-plane bending limit state stress	F _{by}	=	185.00	MPa		
Most adverse out-of-plane bending capacity factor	f _{by} /F _{by}	=	0.46		PASS	
COMBINED ACTIONS						
4.1.1 Combined compression and l	bending					 4.1.1(2
	Fa	=	24.19	MPa		3.4.
	Fao	=	185.00	MPa		3.4.1
	F _{ao} F _{bx}	=	185.00 185.00	MPa MPa		
						3.4.1
	F _{bx}	=	185.00	MPa		3.4.1 3.4.1
Check: f	F _{bx} F _{by}	= = =	185.00 185.00 0.142	MPa		3.4.1 3.4.1 4.1.
Check: fa i.e.	F _{bx} F _{by} f _a /Fa	= = =	185.00 185.00 0.142	MPa	PASS	3.4.1 3.4.1 3.4.1 4.1. (3
i.e.	Fbx Fby fa/Fa a/Fa + fbx/Fbx + fb	= = ,y/F _{by} ≤ 1	185.00 185.00 0.142 .0	MPa	PASS	3.4.1 3.4.1 4.1.
i.e. SHEAR 3.4.24 Shear in webs (Major	Fbx Fby fa/Fa a/Fa + fbx/Fbx + fb	= = ,y/F _{by} ≤ 1	185.00 185.00 0.142 .0	MPa	PASS	3.4.1 3.4.1 4.1.
i.e. SHEAR 3.4.24 Shear in webs (Major Axis)	F_{bx} F_{by} f_a/F_a $f_a/F_a + f_{bx}/F_{bx} + f_b$ 0.60	= = yy/Fby ≤ 1 ≤ =	185.00 185.00 0.142 .0 1.0	MPa MPa	PASS	3.4.1 3.4.1 4.1. (3
i.e. SHEAR 3.4.24 Shear in webs (Major Axis) Clear web height	F_{bx} F_{by} f_a/F_a $f_a/F_a + f_{bx}/F_{bx} + f_b$ 0.60 h t	= = ny/Fby ≤ 1 ≤ = =	185.00 185.00 0.142 .0 1.0 41 2	MPa MPa	PASS	3.4.1 3.4.1 4.1. (3
i.e. SHEAR 3.4.24 Shear in webs (Major Axis) Clear web height Slenderness	F_{bx} F_{by} f_a/F_a $f_a/F_a + f_{bx}/F_{bx} + f_b$ 0.60 h t h/t	= = yy/Fby ≤ 1 ≤ =	185.00 185.00 0.142 .0 1.0 41 2 20.5	MPa MPa	PASS	3.4.1 3.4.1 4.1. (3
i.e. SHEAR 3.4.24 Shear in webs (Major Axis) Clear web height Slenderness Limit 1	F_{bx} F_{by} f_a/F_a $f_a/F_a + f_{bx}/F_{bx} + f_b$ 0.60 h t	= = yy/Fby ≤ 1 ≤ = =	185.00 185.00 0.142 .0 1.0 41 2	MPa MPa	PASS	3.4.1 3.4.1 4.1. (;
	F_{bx} F_{by} f_a/F_a $f_a/F_a + f_{bx}/F_{bx} + f_b$ 0.60 h t h/t S_1	= = yy/Fby ≤ 1 ≤ = = =	185.00 185.00 0.142 .0 1.0 41 2 20.5 29.01	MPa MPa	PASS	3.4.1 3.4.1 4.1. (5



3.4.25 Shear in webs (Minor Axis)					
Clear web height	b	=	56	mm	
Olaradamaaa	t	=	2	mm	
Slenderness	b/t	=	28		
Factored limit state stress	φF∟	=	131.10	MPa	
Stress From Shear force	f _{sy}	=	V/A _w		
			1.11	MPa	
Most adverseshear capacity factor (Major Axis)	f _{sx} /F _{sx}	=	0.00	MPa	
Most adverseshear capacity factor (Minor Axis)	f _{sy} /F _{sy}	=	0.01	Мра	PASS
COMBINED ACTIONS					
4.4 Combined Shear, Compresid	n and bending				
Check:	$f_a/F_a + f_b/F_b + (f_s/F_b)$	$(s_{s})^{2} \leq 1.0$			
i.e.	0.60	≤	1.0		PASS

9.5 Gable Beam

PCE	Job no.	23-573-3	Date: 6/07/2023	
PRIME CONSULTING ENGINEERS PTY. LTD				

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
45x60x2	Gable Beam					
Alloy and temper	6061-T6					AS1664.1
Tanaian	Ftu	=	262	MPa	Ultimate	T3.3(A)
Tension	F _{ty}	=	241	MPa	Yield	
Compression	F _{cy}	=	241	MPa		
Shear	F _{su}	=	165	MPa	Ultimate	
Shear	F _{sy}	=	138	MPa	Yield	
Dearing	F_bu	=	551	MPa	Ultimate	
Bearing	F _{by}	=	386	MPa	Yield	



Modulus of elasticity	Е	=	70000	MPa	Compressiv e	
	Ŀ		4			
	k _t	=	1			T3.4(B)
	kc	=	1			
FEM ANALYSIS RESULTS						
Axial force	Р	=	3.333	kN	compression	
	Р	=	0	kN	Tension	
In plane moment	Mx	=	0.0989	kNm		
Out of plane moment	My	=	0.000768 4	kNm		
DESIGN STRESSES						
Gross cross section area	Ag	=	404	mm ²		
In-plane elastic section modulus	Zx	=	5955.274 1	mm ³		
Out-of-plane elastic section	7		ı 6999.288	mm 3		
mod.	Zy	=	9	mm ³		
Stress from axial force	f _a	=	P/Ag	MDe		
		=	8.25 0.00	MPa MPa	compression Tension	
Stress from in-plane bending	f _{bx}	=	M _x /Z _x			
		=	16.61	MPa	compression	
Stress from out-of-plane	f _{by}	=	M_y/Z_y			
bending		=	0.11	MPa	compression	
Tension						
3.4.3 Tension in rectangular tubes			229.05	MDe		
	φF∟	= 0	228.95	МРа		
		R				
	φF∟	=	222.70	МРа		
COMPRESSION						
3.4.8 Compression in columns, ax 1. General	ial, gross s	section				3.4.8.1
			2000	~~~~		
Unsupported length of member Effective length factor	L k	=	3000 1.00	mm		
Radius of gyration about						
buckling axis (Y)	ry	=	22.80	mm		
Radius of gyration about buckling axis (X)	r _x	=	18.21	mm		
Slenderness ratio	kLb/ry	=	131.59			
					I	I I



Slenderness ratio	kL/rx	=	164.73			
Slenderness parameter	λ	=	3.08			
	Dc*	=	90.3			
	S 1*	=	0.33			
	S ₂ *	=	1.23			
	фсс	=	0.950			
Factored limit state stress	φF∟	=	24.19	MPa		
2. Sections not subject to torsiona	l or torsion	nal-flexu	ural buckling			3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	164.73			
3.4.10 Uniform compression in co flat plates	mponents	of colu	mns, gross s	ection -		
1. Uniform compression in compo plates with both edges supported	nents of co	olumns,	gross sectio	on - flat		 3.4.10.1
	k ₁	=	0.35			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	b'	=	56			
ioi piato	t	=	2	mm		
Slenderness	b/t	=	28			
Limit 1	S ₁	=	12.34			
Limit 2	S ₂	=	32.87			
Factored limit state stress	φF∟	=	185.00	MPa		
Most adverse compressive limit state stress	Fa	=	24.19	MPa		
Most adverse tensile limit state stress	Fa	=	222.70	MPa		
Most adverse compressive & Tensile capacity factor	f_a/F_a	=	0.34		PASS	
BENDING - IN-PLANE						
3.4.15 Compression in beams, ex tubes, box sections	treme fibre	e, gross	section rect	angular		
Unbraced length for bending	L _b	=	3000	mm		
Second moment of area (weak axis)	ly	=	209978.6 7	mm⁴		
Torsion modulus	J	=	246338.0 6	mm ³		



3.4.17 Compression in components of beams (component under uniform compression), gross section - flat plates with both edges supportedT3.3(Ik1=0.5T3.3(Ik2=2.04T3.3(IMax. distance between toes of fillets of supporting elements for plateb'=56mmt=2mmSlendernessb/t=28T3.3(ILimit 1S1=12.34T3.3(ILimit 2S2=46.95T3.3(IMost adverse in-plane bending imit state stress F_{bx} =185.00MPaMost adverse in-plane bending (doubly symmetric section) F_{bx} =185.00MPaMost adverse in-plane bending (doubly symmetric section) F_{bx} =185.00MPaMost adverse out-of-plane bending limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending limit state stress f_{by}/F_{by} =0.00PASSCOMBINED ACTIONS </th <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>							
Limit 1 S: = 0.39 Limit 2 S ₂ = 1695.86 Factored limit state stress ϕF_L = 201.63 MPa 3.4.16(3.4.17 Compression in components of beams (component under uniform compression), gross section - flat plates with both edges supported k ₁ = 0.5 k ₂ = 2.04 Max. distance between toes of fillets of supporting elements for plate t = 2 mm Slenderness b/t = 28 Limit 1 S ₁ = 12.34 Limit 2 S ₂ = 46.95 Factored limit state stress ϕF_L = 185.00 MPa Most adverse in-plane bending fbw/Fbx = 0.09 BENDING - OUT-OF-PLANE NOTE: Limit state stress, ϕF_L = 185.00 MPa Most adverse out-of-plane bending fbw/Fbx = 0.09 Factored limit state stress, ϕF_L = 185.00 MPa Most adverse out-of-plane bending fbw/Fbx = 0.09 Factored limit state stress ϕF_L = 185.00 MPa Most adverse out-of-plane bending fbw/Fbx = 0.09 Factored limit state stress ϕF_L = 185.00 MPa Most adverse out-of-plane bending fbw/Fbx = 0.09 Factored limit state stress ϕF_L = 185.00 MPa Most adverse out-of-plane bending fbw/Fbw = 0.00 Factored limit state stress ϕF_L = 185.00 MPa Most adverse out-of-plane bending fbw/Fbw = 0.00 Factored limit state stress ϕF_L = 185.00 MPa Most adverse out-of-plane bending fbw/Fbw = 0.00 Factored limit state stress ϕF_L = 185.00 MPa Most adverse out-of-plane bending fbw/Fbw = 0.00 Factored limit state stress ϕF_L = 185.00 MPa Most adverse out-of-plane bending fbw/Fbw = 0.00 Factored limit state stress ϕF_L = 185.00 MPa	Elastic section modulus	Z	=		mm ³		
Limit 2 $S_2 = 1695.86$ Factored limit state stress $\phi F_L = 201.63$ MPa 3.4.15(2) 3.4.17 Compression in components of beams (component under uniform compression), gross section - flat plates with both edges supported $k_1 = 0.5$ $k_2 = 2.04$ Max. distance between toes of fillets of supporting elements for plate t = 2 mm Slenderness $b/t = 28$ Limit 1 $S_1 = 12.34$ Limit 2 $S_2 = 46.95$ Factored limit state stress $\phi F_L = 185.00$ MPa Most adverse in-plane bending $f_{bv}/F_{bx} = 0.09$ PASS BENDING - OUT-OF-PLANE NOTE: Limit state stress $\phi F_L = 185.00$ MPa Most adverse out-of-plane bending (doubly symmetric section) Factored limit state stress $\phi F_L = 185.00$ MPa Most adverse out-of-plane bending $f_{bv}/F_{bx} = 0.09$ PASS COMBINED ACTIONS A111 Combined compression and bending $f_{bv}/F_{by} = 0.00$ PASS	Slenderness	S	=	157.11			
Factored limit state stress ϕF_L =201.63MPa3.4.17 Compression in components of beams (component under uniform compression), gross section - flat plates with both edges supportedT3.3(1) k_1 =0.5 k_2 = k_2 =2.04T3.3(1)Max. distance between toes of fillets of supporting elementsb'= b' =56mmSlenderness b/t =28Limit 1 S_1 =12.34Limit 2 S_2 =46.95Factored limit state stress ϕF_L =185.00Most adverse in-plane bending capacity factor F_{bx} =0.09BENDING - OUT-OF-PLANENOTE: Limit state stress ϕF_L =185.00NOTE: Limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending limit state stress ϕF_L =185.00MOTE: Limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending limit state stress ϕF_L =185.00Most adverse out-of-plane bending limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending capacity factor F_{by}/F_{by} =0.00PASSCOMBINED ACTIONSCombined compression and bending capacity factorImage: State stression and bending four factorImage: State stression a	Limit 1	S ₁	=	0.39			
3.4.17 Compression in components of beams (component under uniform compression), gross section - flat plates with both edges supported $k_{1} = 0.5$ $k_{2} = 2.04$ Max. distance between toes of fillets of supporting elements b' = 56 mm for plate t = 2 mm Slenderness b/t = 28 Limit 1 S ₁ = 12.34 Limit 2 S ₂ = 46.95 Factored limit state stress $\phi F_{L} = 185.00$ MPa Most adverse in-plane bending f _{bx} /F _{bx} = 0.09 PASS BENDING - OUT-OF-PLANE NOTE: Limit state stress $\phi F_{L} = 185.00$ MPa Most adverse out-of-plane bending f _{by} /F _{by} = 0.09 PASS ECOMBINED ACTIONS 4.11 Combined compression and bending	Limit 2	S ₂	=	1695.86			
compression), gross section - flat plates with both edges supported $k_{1} = 0.5$ $k_{2} = 2.04$ Max. distance between toes of fillets of supporting elements for plate $t = 2$ mm Slenderness $b/t = 28$ Limit 1 $S_{1} = 12.34$ Limit 2 $S_{2} = 46.95$ Factored limit state stress $\phi F_{L} = 185.00$ MPa Most adverse in-plane bending fbx/Fbx = 0.09 PASS BENDING - OUT-OF-PLANE NOTE: Limit state stresss $\phi F_{L} = 185.00$ MPa Most adverse in-plane bending fbx/Fbx = 0.09 PASS BENDING - OUT-OF-PLANE NOTE: Limit state stresss $\phi F_{L} = 185.00$ MPa Most adverse out-of-plane bending limit state stress $\phi F_{L} = 185.00$ MPa Most adverse out-of-plane bending limit state stress $\phi F_{L} = 185.00$ MPa Most adverse out-of-plane bending limit state stress $\phi F_{L} = 185.00$ MPa Most adverse out-of-plane bending limit state stress $\phi F_{L} = 185.00$ MPa Most adverse out-of-plane bending limit state stress $\phi F_{L} = 185.00$ MPa Most adverse out-of-plane bending limit state stress $\phi F_{L} = 185.00$ MPa Most adverse out-of-plane bending limit state stress $\phi F_{L} = 0.00$ PASS	Factored limit state stress	φF∟	=	201.63	MPa		 3.4.15(2)
k_2 =2.04T3.3(D)Max. distance between toes of fillets of supporting elements for plateb'=56mm b' =26mmSecondSecondSecondSlendernessb/t=28MmSecondSecondSecondLimit 1S1=12.34SecondMPaMost adverse in-plane bending limit state stress F_{bx} =185.00MPaMost adverse in-plane bending capacity factor F_{bx} =0.09PASSBENDING - OUT-OF-PLANE NOTE: Limit state stresses, ϕF_L are the same for out-of-plane bending (doubly symmetric section)MPaPASSFactored limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending limit state stress f_{by}/F_{by} =0.00PASSCOMBINED ACTIONSCOMBINED ACTIONSAL11 Combined compression and bendingAL11 Combined compression and bending							
k_2 =2.04T3.3(1)Max. distance between toes of fillets of supporting elements for plateb'=56mmt=2mm k_1 =28Limit 1S1=12.34Limit 2 k_2 =46.95Factored limit state stress ΦF_L =185.00MPaMost adverse in-plane bending limit state stress F_{bx} =0.09PASSBENDING - OUT-OF-PLANE NOTE: Limit state stresses, ϕF_L are the same for out-of-plane bending (doubly symmetric section) ΦF_L =185.00MPaFactored limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending limit state stress f_{by}/F_{by} =0.00PASSCOMBINED ACTIONSImage: comparameter stress on the prolong f_{by}/F_{by} =0.00PASS		k ₁	=	0.5			T3.3(D)
Max. distance between toes of fillets of supporting elementsb'=56mmfor platet=2mmSlendernessb/t=28Limit 1S1=12.34Limit 2S2=46.95Factored limit state stress \ensuremathbf{PL} =185.00MPaMost adverse in-plane bending limit state stress \ensuremathbf{Fbx} =185.00MPaMost adverse in-plane bending capacity factor \ensuremathbf{Fbx} =0.09PASSBENDING - OUT-OF-PLANE NOTE: Limit state stresses, \ensuremathbf{PL} =185.00MPaMost adverse out-of-plane bending limit state stress \ensuremathbf{PL} =185.00MPaMost adverse out-of-plane bending limit state stress \ensuremathbf{Pby} =1.00PASSCOMBINED ACTIONSImage: state stress \ensuremathbf{Fby} =0.00PASS		k ₂	=	2.04			T3.3(D)
t=2mmSlendernessb/t=28Limit 1S1=12.34Limit 2S2=46.95Factored limit state stress ϕF_L =185.00MPaMost adverse in-plane bending limit state stress F_{bx} =185.00MPaMost adverse in-plane bending capacity factor f_{bx}/F_{bx} =0.09PASSBENDING - OUT-OF-PLANE NOTE: Limit state stresses, ϕF_L are the same for out-of-plane bending (doubly symmetric section)MPaPASSFactored limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending limit state stress ϕ_F_L =185.00MPaMost adverse out-of-plane bending capacity factor f_{by}/F_{by} =0.00PASSCOMBINED ACTIONSCOMBINED ACTIONSImage: compression and bendingImage: compression and bending	fillets of supporting elements		=	56	mm		
Slendernessb/t=28Limit 1S1=12.34Limit 2S2=46.95Factored limit state stress ϕF_L =185.00MPaMost adverse in-plane bending limit state stress F_{bx} =185.00MPaMost adverse in-plane bending capacity factor F_{bx} =0.09PASSBENDING - OUT-OF-PLANE NOTE: Limit state stresses, ϕF_L are the same for out-of-plane bending (doubly symmetric section)Factored limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending limit state stress ϕF_L =185.00MPaPASSMost adverse out-of-plane bending limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending capacity factor F_{by} =0.00PASSCOMBINED ACTIONSCOMBINED ACTIONSHat 1 Combined compression and bendingHat 1 Combined compression and bending	for plate			2			
Limit 1 $S_1 = 12.34$ Limit 2 $S_2 = 46.95$ Factored limit state stress $\phi F_L = 185.00$ MPa Most adverse in-plane bending f_{bx} = 185.00 MPa Most adverse in-plane bending $f_{bx}/F_{bx} = 0.09$ 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 $\phi F_L = 185.00$ MPa Most adverse out-of-plane $F_{by} = 185.00$ MPa Most adverse out-of-plane $f_{by}/F_{by} = 0.00$ PASS COMBINED ACTIONS 4.111 Combined compression and bending	Slenderness	-			mm		
Limit 2 $S_2 = 46.95$ Factored limit state stress $\phi F_L = 185.00$ MPa Most adverse in-plane bending $F_{bx} = 185.00$ MPa Most adverse in-plane bending $f_{bx}/F_{bx} = 0.09$ 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 $\phi F_L = 185.00$ MPa Most adverse out-of-plane $F_{by} = 185.00$ MPa Most adverse out-of-plane $f_{by}/F_{by} = 0.00$ PASS COMBINED ACTIONS 411 Combined compression and bending							
Most adverse in-plane bending limit state stress F_{bx} =185.00MPaMost adverse in-plane bending capacity factor f_{bx}/F_{bx} =0.09PASSBENDING - OUT-OF-PLANE NOTE: Limit state stresses, ϕF_L are the same for out-of-plane bending (doubly symmetric section)Factored limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending capacity factor F_{by} =0.00PASSCOMBINED ACTIONSUUUUA 11 Combined compression and bending compared to the stressMost adverseUU			=				
Imit state stress F_{bx} =183.00MIPaMost adverse in-plane bending capacity factor f_{bx}/F_{bx} =0.09PASSBENDING - OUT-OF-PLANENOTE: Limit state stresses, ϕF_L are the same for out-of-plane bending (doubly symmetric section)Factored limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending capacity factor F_{by} =0.00PASSCOMBINED ACTIONSImage: compression and bending compression and bendingImage: compression and bendingImage: compression and bending	Factored limit state stress	φF∟	=	185.00	MPa		
capacity factorIbx/Fbx= 0.09 PASSBENDING - OUT-OF-PLANE $NOTE: Limit state stresses, \phi F_L are the same for out-of-plane bending(doubly symmetric section)\phi F_L = 185.00 MPaFactored limit state stress\phi F_L = 185.00 MPaMost adverse out-of-planebending limit state stressF_{by} = 185.00 MPaMost adverse out-of-planebending capacity factorf_{by}/F_{by} = 0.00PASSCOMBINED ACTIONSA111 Combined compression and bendingA111 Combined compression and bending$		F _{bx}	=	185.00	MPa	1	
NOTE: Limit state stresses, ϕF_L are the same for out-of-plane bending (doubly symmetric section)Factored limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending limit state stress F_{by} =185.00MPaMost adverse out-of-plane bending capacity factor f_{by}/F_{by} =0.00PASSCOMBINED ACTIONSA11 Combined compression and bendingImage: compression and bendingImage: compression and bending		f_{bx}/F_{bx}	=	0.09		PASS	
(doubly symmetric section)Factored limit state stress ϕF_L =185.00MPaMost adverse out-of-plane bending limit state stress F_{by} =185.00MPaMost adverse out-of-plane bending capacity factor f_{by}/F_{by} =0.00PASSCOMBINED ACTIONSA 1 1 Combined compression and bending	BENDING - OUT-OF-PLANE						
Most adverse out-of-plane bending limit state stress \mathbf{F}_{by} =185.00MPaMost adverse out-of-plane bending capacity factor $\mathbf{f}_{by}/\mathbf{F}_{by}$ =0.00PASSCOMBINED ACTIONS		are the sam	e for o	ut-of-plane b	ending		
bending limit state stress F _{by} = 185.00 MPa Most adverse out-of-plane bending capacity factor f _{by} /F _{by} = 0.00 PASS COMBINED ACTIONS A 1 1 Combined compression and bending	Factored limit state stress	φF∟	=	185.00	MPa		
bending capacity factor Iby/Fby = 0.00 PASS COMBINED ACTIONS		F _{by}	=	185.00	MPa		
111 Combined compression and bending		f _{by} /F _{by}	=	0.00		PASS	
4.1.1 Combined compression and bending	COMBINED ACTIONS						
4.1.1(2	4.1.1 Combined compression and	d bending					 4.1.1(2)
F _a = 24.19 MPa 3.4.		Fa	=	24.19	MPa		3.4.8



	F _{ao} F _{bx}	= =	185.00 185.00	MPa MPa		3.4.10
	F _{by}	=	185.00	MPa		3.4.17
	fa/Fa	=	0.341			
Check:	f _a /F _a + f _{bx} /F	F _{bx} + f _{by} /	$F_{by} \leq 1.0$			4.1.1 (3)
i.e.	0.43	≤	1.0		PASS	(-)
SHEAR						
3.4.24 Shear in webs (Major Axis)						4.1.1(2)
Clear web height	h	=	41	mm		
	t	=	2	mm		
Slenderness	h/t	=	20.5			
Limit 1	S1	=	29.01			
Limit 2	S ₂	=	59.31			
Factored limit state stress	φF∟	=	131.10	MPa		
Stress From Shear force	f _{sx}	=	V/A _w			
			0.14	MPa		
3.4.25 Shear in webs (Minor Axis)						
Clear web height	b	=	56	mm		
	t	=	2	mm		
Slenderness	b/t	=	28			
Factored limit state stress	φF∟	=	131.10	MPa		
Stress From Shear force	f _{sy}	=	V/A _w			
			0.04	MPa		
Most adverseshear capacity factor (Major Axis)	f _{sx} /F _{sx}	=	0.00	МРа		
Most adverseshear capacity factor (Minor Axis)	f _{sy} /F _{sy}	=	0.00	Мра	PASS	
COMBINED ACTIONS						
4.4 Combined Shear, Compresident	on and benc	ding				
Chaoly						
Check:	$f_a/F_a + f_b/F$				DACC	
i.e.	0.43	≤	1.0		PASS	



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

9.6 Intermediate Purlin



Job no. 23-573-3 Date: 6/07/2023

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
40x40x2	Intermediate Purlin					
Alloy and temper	6061-T6					AS1664.1
Tension	F _{tu}	=	262	MPa	Ultimate	T3.3(A)
Tension	F _{ty}	=	241	MPa	Yield	
Compression	F _{cy}	=	241	MPa		
Shear	Fsu	=	165	MPa	Ultimate	
Shear	F _{sy}	=	138	MPa	Yield	
Decring	F_bu	=	551	MPa	Ultimate	
Bearing	F _{by}	=	386	MPa	Yield	
Modulus of elasticity	E	=	70000	MPa	Compressive	
	k _t	=	1			
	kc	=	1			T3.4(B)
FEM ANALYSIS RESULTS						
Axial force	Р	=	0.333	kN	compression	
	Р	=	0	kN	Tension	
In plane moment	Mx	=	0.4891	kNm		
Out of plane moment	My	=	0.0189	kNm		
DESIGN STRESSES						
Gross cross section area	Ag	=	304	mm²		
In-plane elastic section modulus	Zx	=	3668.2667	mm ³		
Out-of-plane elastic section mod.	Zy	=	3668.2667	mm ³		
Stress from axial force	f _a	=	P/Ag			
		=	1.10 0.00	MPa MPa	compression Tension	
Stress from in-plane bending	f _{bx}	=	M _x /Z _x			
		=	133.33	MPa	compression	



Stress from out-of-plane bending	f _{by}	=	M _y /Z _y 5.15	MPa	compression	
Tension						
3.4.3 Tension in rectangular tubes						
	φF∟	= OR	228.95	МРа		
	φF∟	=	222.70	MPa		
COMPRESSION						
3.4.8 Compression in columns, axian 1. General	al, gross sectio	n				3.4.8.1
Unsupported length of member	L	=	3000	mm		
Effective length factor	k	=	1.00			
Radius of gyration about buckling axis (Y)	۲ _y	=	15.53	mm		
Radius of gyration about buckling axis (X)	٢x	=	15.53	mm		
Slenderness ratio	kLb/ry	=	193.11			
Slenderness ratio	kL/rx	=	193.11			
Slenderness parameter	λ	=	3.61			
	D _c *	=	90.3			
	S ₁ *	=	0.33			
	S ₂ *	=	1.23			
	фсс	=	0.950			
Factored limit state stress	φF∟	=	17.60	MPa		
2. Sections not subject to torsional	or torsional-fle	xural bucl	dina			3.4.8.2
Largest slenderness ratio for						
flexural buckling	kL/r	=	193.11			
3.4.10 Uniform compression in con plates	nponents of col	umns, gro	oss section	- flat		
1. Uniform compression in compon with both edges supported	ents of column	s, gross s	ection - flat	plates		 3.4.10.1
	k 1	=	0.35			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	b'	=	36			
-	t	=	2	mm		
Slenderness	b/t	=	18			
Limit 1	S1	=	12.34			



Limit 2	S ₂	=	32.87			
Factored limit state stress	φF∟	=	213.07	MPa		
Most adverse compressive limit state stress	Fa	=	17.60	MPa		
Most adverse tensile limit state stress	Fa	=	222.70	MPa		
Most adverse compressive & Tensile capacity factor	f _a /Fa	=	0.06		PASS	
BENDING - IN-PLANE						
3.4.15 Compression in beams, extrebox sections	eme fibre, gros	ss sectior	n rectangular	tubes,		
Unbraced length for bending	Lb	=	3000	mm		
Second moment of area (weak axis)	ly	=	73365.333	mm ⁴		
Torsion modulus	J	=	109744	mm ³		
Elastic section modulus	Z	=	3668.2667	mm ³		
Slenderness	S	=	245.29			
Limit 1	S ₁	=	0.39			
Limit 2	S ₂	=	1695.86			
Factored limit state stress	φF∟	=	194.46	MPa		 3.4.15(2)
3.4.17 Compression in components compression), gross section - flat pl				n		
	k 1		0.5			T3.3(D)
	k1 k2	-	2.04			T3.3(D)
May distance between tase of	NZ	-	2.04			10.0(D)
Max. distance between toes of fillets of supporting elements for plate	b'	=	36	mm		
	t	=	2	mm		
Slenderness	b/t	=	18			
Limit 1	S1	=	12.34			
Limit 2	S ₂	=	46.95			
Factored limit state stress	φF∟	=	213.07	MPa		
Most adverse in-plane bending limit state stress	F _{bx}	=	194.46	MPa		



Most adverse in-plane bending capacity factor	f _{bx} /F _{bx}	=	0.69		PASS	
BENDING - OUT-OF-PLANE						
NOTE: Limit state stresses, ϕF_L are symmetric section)	e the same for o	out-of-pla	ne bending	(doubly		
Factored limit state stress	φF∟	=	194.46	MPa		
Most adverse out-of-plane bending limit state stress	F _{by}	=	194.46	MPa		
Most adverse out-of-plane bending capacity factor	f _{by} /F _{by}	=	0.03		PASS	
COMBINED ACTIONS						
4.1.1 Combined compression and I	bending					 4.1.1(2)
	Fa	=	17.60	MPa		3.4.8
	Fao	=	213.07	MPa		3.4.10
	F _{bx}	=	194.46	MPa		3.4.17
	F _{by}	=	194.46	MPa		3.4.17
	fa/Fa	=	0.062			
Check: f	a/Fa + f _{bx} /F _{bx} + f	$_{\rm by}/{\rm F}_{\rm by} \leq 1$	1.0			4.1.1 (3)
i.e.	0.77	≤	1.0		PASS	
SHEAR						
3.4.24 Shear in webs (Major Axis)						4.1.1(2)
Clear web height	h	=	36	mm		
	t	=	2	mm		
Slenderness	h/t	=	18			
Limit 1	S1	=	29.01			
Limit 2	S ₂	=	59.31			
Factored limit state stress	φF∟	=	131.10	MPa		
Stress From Shear force	f _{sx}	=	V/A _w			
3.4.25 Shear in webs (Minor Axis)			0.00	MPa		
Clear web height	b	=	36	mm		



Slenderness	t b/t	= =	2 18	mm	
Factored limit state stress Stress From Shear force	φF∟ f _{sy}	= =	131.10 V/Aw 0.06	MPa MPa	
Most adverseshear capacity factor (Major Axis)	f _{sx} /F _{sx}	=	0.00	MPa	
Most adverseshear capacity factor (Minor Axis)	f_{sy}/F_{sy}	=	0.00	Мра	PASS
COMBINED ACTIONS	n and handing				
4.4 Combined Shear, Compresio	n and bending				
Check:	$f_a/F_a + f_b/F_b + (f_s/I_b)$	$F_{s)^2} \leq 1.0$)		
i.e.	0.75	≤	1.0		PASS

9.7 Brace



Job no.	23-573-3	Date:	6/07/2023

NAME	SYMBOL		VALUE	UNIT	NOTES	REF
40x40x2	Brace					
Alloy and temper	6061-T6					AS1664.1
	_					
Tension	Ftu	=	262	MPa	Ultimate	T3.3(A)
	F _{ty}	=	241	MPa	Yield	
Compression	F _{cy}	=	241	MPa		
Shear	F_{su}	=	165	MPa	Ultimate	
Shear	F _{sy}	=	138	MPa	Yield	
Bearing	F_{bu}	=	551	MPa	Ultimate	
Deaning	F_{by}	=	386	MPa	Yield	
Modulus of elasticity	E	=	70000	MPa	Compressiv e	



	kt	=	1			T3.4(B)
	kc	=	1			
FEM ANALYSIS RESULTS						
Axial force	Р	=	1.903	kN	compression	
	Р	=	0	kN	Tension	
In plane moment	Mx	=	6.939E-18	kNm		
Out of plane moment	Mу	=	0.0288	kNm		
DESIGN STRESSES						
Gross cross section area	Ag	=	304	mm²		
In-plane elastic section modulus	Z _x	=	3668.266 7	mm ³		
Out-of-plane elastic section mod.	Zy	=	3668.266 7	mm ³		
Stress from axial force	fa	=	P/A _g			
		=	6.26	MPa	compression	
		=	0.00	MPa	Tension	
Stress from in-plane bending	f _{bx}	=	M _x /Z _x			
		=	0.00	MPa	compression	
Stress from out-of-plane	f _{by}	=	My/Zy			
bending		=	7.85	MPa	compression	
Tension						
3.4.3 Tension in rectangular tubes	s					
	φF∟	= 0	228.95	МРа		
		R				
	φF∟	=	222.70	MPa		
COMPRESSION						
3.4.8 Compression in columns, as 1. General	xial, gross s	sectior	ו			3.4.8.1
r. General						0.4.0.1
Unsupported length of member	L	=	4000	mm		
Effective length factor	k	=	1.00			
Radius of gyration about buckling axis (Y)	r _y	=	15.53	mm		
Radius of gyration about buckling axis (X)	r _x	=	15.53	mm		
Slenderness ratio	kLb/ry	=	257.48			
Slenderness ratio	kL0/Ty kL/rx	=	257.48			
		_	201.40			
Slenderness parameter	λ	=	4.81			



	S ₁ *	=	0.33			
	S ₂ *	=	1.23			
	фсс	=	0.950			
Factored limit state stress	φF∟	=	9.90	MPa		
2. Sections not subject to torsiona	l or torsior	nal-flexu	ural buckling			3.4.8.2
Largest slenderness ratio for flexural buckling	kL/r	=	257.48			
3.4.10 Uniform compression in conflat plates	mponents	of colu	mns, gross s	ection -		
1. Uniform compression in compo- plates with both edges supported	nents of co	olumns,	, gross sectio	on - flat		 3.4.10.1
	k 1	=	0.35			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	b'	=	36			
	t	=	2	mm		
Slenderness	b/t	=	18			
Limit 1	S ₁	=	12.34			
Limit 2	S ₂	=	32.87			
Factored limit state stress	φF∟	=	213.07	MPa		
Most adverse compressive limit state stress	Fa	=	9.90	MPa		
Most adverse tensile limit state stress	Fa	=	222.70	MPa		
Most adverse compressive & Tensile capacity factor	f _a /F _a	=	0.63		PASS	
BENDING - IN-PLANE						
3.4.15 Compression in beams, ex tubes, box sections	treme fibre	e, gross	s section rect	angular		
Unbraced length for bending	L _b	=	4000	mm		
Second moment of area (weak axis)	ly	=	73365.33 3	mm ⁴		
Torsion modulus	J	=	109744	mm ³		
Elastic section modulus	Z	=	3668.266 7	mm ³		
			-		1	
Slenderness	S	=	327.05			



Limit 2	S ₂	=	1695.86			
Factored limit state stress	φF∟	=	188.90	MPa		 3.4.15(2)
3.4.17 Compression in component compression), gross section - flat						
	k 1	=	0.5			T3.3(D)
	k ₂	=	2.04			T3.3(D)
Max. distance between toes of fillets of supporting elements for plate	b'	=	36	mm		
	t	=	2	mm		
Slenderness	b/t	=	18			
Limit 1	S ₁	=	12.34			
Limit 2	S ₂	=	46.95			
Factored limit state stress	φF∟	=	213.07	MPa		
Most adverse in-plane bending limit state stress	F _{bx}	=	188.90	MPa		
Most adverse in-plane bending capacity factor	f _{bx} /F _{bx}	=	0.00		PASS	
BENDING - OUT-OF-PLANE						
NOTE: Limit state stresses, ϕF_{\perp} a (doubly symmetric section)	are the same	e for oı	ıt-of-plane b	ending		
Factored limit state stress	φF∟	=	188.90	MPa		
Most adverse out-of-plane	F _{by}	=	188.90	MPa		
bending limit state stress						
Most adverse out-of-plane bending capacity factor	f _{by} /F _{by}	=	0.04		PASS	
Most adverse out-of-plane	f _{by} /F _{by}	-	0.04		PASS	4.1.1(2)
Most adverse out-of-plane bending capacity factor COMBINED ACTIONS	f _{by} /F _{by}		_	MDa	PASS	
Most adverse out-of-plane bending capacity factor COMBINED ACTIONS	f _{by} /F _{by} d bending Fa	=	9.90	MPa	PASS	3.4.8
Most adverse out-of-plane bending capacity factor COMBINED ACTIONS	f _{by} /F _{by} d bending Fa Fao	=	9.90 213.07	MPa	PASS	3.4.8
Most adverse out-of-plane bending capacity factor COMBINED ACTIONS	f _{by} /F _{by} d bending Fa	=	9.90		PASS	3.4.8



	fa/Fa	=	0.632			
Check:	f _a /F _a + f _{bx} /	F _{bx} + f _{by} /	$F_{by} \leq 1.0$			4.1.1 (3)
i.e.	0.67	≤	1.0		PASS	(-)
SHEAR 3.4.24 Shear in webs (Major						4.4.4(0)
Axis)						4.1.1(2)
Clear web height	h	=	36	mm		
	t	=	2	mm		
Slenderness	h/t	=	18			
Limit 1	S1	=	29.01			
Limit 2	S ₂	=	59.31			
Factored limit state stress	φF∟	=	131.10	MPa		
Stress From Shear force	f _{sx}	=	V/A _w			
			0.04	MPa		
3.4.25 Shear in webs (Minor Axis)						
Clear web height	b	=	36	mm		
	t	=	2	mm		
Slenderness	b/t	=	18			
Factored limit state stress	φF∟	=	131.10	MPa		
Stress From Shear force	f _{sy}	=	V/A _w			
			0.04	MPa		
Most adverseshear capacity factor (Major Axis)	f _{sx} /F _{sx}	=	0.00	МРа	1	
Most adverseshear capacity factor (Minor Axis)	f _{sy} /F _{sy}	=	0.00	Мра	PASS	
COMBINED ACTIONS						
4.4 Combined Shear, Compresid	on and here	lina				
		iii iy				
Check:	fa/Fa + fb/F	b + (fs/F	$_{\rm s)^2} \le 1.0$			
i.e.	0.67	≤	1.0		PASS	