



Ref: AJN-2024-022-CALC (Rev A)

YARDTOPIA MARYBOROUGH GAZEBO

(3m x 3m and 3m x 3.6m)

STRUCTURAL DESIGN CALCULATION

(Revision A)

AJN Consulting Engineers
Civil & Structural Engineers

16 DECEMBER 2024

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STRUCTURAL DESIGN SUMMARY

1.0 DESIGN INFORMATION AND CRITERIA

1.1 Design Codes

All structural elements are designed in accordance to Australian Standards; hence the structural design of all civil and structural engineering works shall therefore be documented in accordance with, but not limited to, the latest edition of the following:

Codes/Standards	Description
AS/NZS 1170	Structural Design Actions
AS 3600	Design of Concrete Structures
AS 4100	Design of Steel Structures
AS 1720	Design of Timber Structures

Table 1. Design Code of Practice

1.2 Design Loadings

1.2.1 Permanent actions (G)

Description	Dead Load (kN/m²)
Self-weight	as per material density
Roof	0.2

Table 2. Design Dead Loads

1.2.2 Imposed actions (Q)

Description	Dead Load (kN/m²)
Roof	0.25

Table 3. Design Live Load

1.2.3 Wind Actions (W)

The following parameters were used in calculating the design and service wind loads applied on the structure.

Description	Value
Region Site Exposure Classification (non-cyclonic)	A5
Average Recurrence Interval (Design), R	100 years
Average Recurrence Interval (Serviceability), R	25 years

Table 4. Wind Load Parameters

1.2.4 Load Combinations

All design load combinations are in accordance to Australian Standards requirements for serviceability and ultimate limit stages.

Design Load Combinations:

- a. $1.35 G$
- b. $1.2 G + 1.5 Q$
- c. $1.2 G + W$
- d. $0.9 G + W$

Serviceability Load Combinations:

- a. $0.7 Q$
- b. $G + 0.4 Q$
- c. $G + W$

1.3 Soil Bearing Capacity

The minimum soil bearing capacity defined in the calculation report is 100 kPa.

Actual soil bearing capacity is required to be verified for each site.



Consulting Engineers

YARDTOPIA MARYBOROUGH GAZEBO – 3m x 3m and 3m x 3.6m

STRUCTURAL ANALYSIS AND DESIGN

		WIND SPEED CALCULATION (AS/NZS 1170.2)		v1.0
Project No.	2024-022	Project Name	Yardtopia Maryborough Gazebo	
Designed by	AN	Date	25 November 2024	

SUMMARY OF RESULTS		
Design Wind Speed, $V_{des,\theta}$	(ULS)	40.59 m/s
Service Wind Speed, $V_{des,\theta}$	(SLS)	36.63 m/s

1. Regional Gust Wind Speed

Region Site Exposure		A5	Non-cyclonic AS/NZS 1170.2 Figure 3.1(A)
Average Recurrence Interval, R	(ULS)	100 years	for Ultimate Limit State
Average Recurrence Interval, R	(SLS)	25 years	for Serviceability Limit State
Regional Gust Wind Speed, V_R	(ULS)	41 m/s	AS/NZS 1170.2 Table 3.1
Regional Gust Wind Speed, V_R	(SLS)	37 m/s	AS/NZS 1170.2 Table 3.1

2. Site Exposure Multipliers

a. Wind Direction Multiplier

Cardinal Direction		Any Direction	
Wind Direction Multiplier, M_d		1.00	AS/NZS 1170.2 Table 3.2

b. Terrain/Height Multiplier

Terrain Category		TC 1	AS/NZS 1170.2 Sec 4.2.1
Height of building, z		3.00 m	
Terrain/Height Multiplier, $M_{z,cat}$		0.99	AS/NZS 1170.2 Table 4.1

c. Shielding Multiplier, M_s

		1.00	No shielding AS/NZS 1170.2 Sec 4.3
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d. Topographic Multiplier

Hill-shape Multiplier, M_h		1.00	AS/NZS 1170.2 Sec 4.4.2
Lee Multiplier, M_{lee}		1.00	AS/NZS 1170.2 Sec 4.4.3
Site elevation above mean sea level, E		30 m	
Topographic Multiplier, M_t		1.00	AS/NZS 1170.2 Sec 4.4
For sites where $E > 500m$: $M_t = M_h M_{lee} (1 + 0.00015 E)$			
Elsewhere, M_t = larger value of M_h and M_{lee}			

3. Wind Speed

Design Wind Speed, $V_{des,\theta}$	(ULS)	40.59 m/s	for Ultimate Limit State
Service Wind Speed, $V_{des,\theta}$	(SLS)	36.63 m/s	for Serviceability Limit State
$V_{des,\theta} = V_{sit,\beta} = V_R M_d (M_{z,cat} M_s M_t)$			



WIND PRESSURES FOR PITCHED FREE ROOF (AS/NZS 1170.2)

v1.0

Project No.	2024-022	Project Name	Yardtopia Maryborough Gazebo
Designed by	AN	Date	25 November 2024

1. Design Information

Roof Pitch	24 °
Knee Height	2.15 m
Building Width, d	3 m
Building Length, L	3.6 m
Average Height, h	2.82 m
Blockage under roof (goods or materials)	Blocked under Blockage > 75%

2. Net Pressure Coefficients, $C_{p,n}$

AS/NZS 1170.2 Table D4(A)

a. Transverse Wind ($\theta = 0^\circ$)

Roof, Set 1

Pressure coefficient (windward), $C_{p,w}$	-0.8
Pressure coefficient (leeward), $C_{p,l}$	-1.1

Roof, Set 2

Pressure coefficient (windward), $C_{p,w}$	-0.8
Pressure coefficient (leeward), $C_{p,l}$	-1.1

c. Longitudinal Wind ($\theta = 90^\circ$)

Roof, Set 1

Pressure coefficient (windward), $C_{p,w}$	-1.2
Pressure coefficient (leeward), $C_{p,l}$	-0.9

Roof, Set 2

Pressure coefficient (windward), $C_{p,w}$	-1.2
Pressure coefficient (leeward), $C_{p,l}$	-0.9

3. Aerodynamic Shape Factor

Area Reduction Factor, K_a	1.0	AS/NZS 1170.2 Appendix D1.2
Local Pressure Factor, K_l	1.0	AS/NZS 1170.2 Appendix D1.3

Aerodynamic Shape Factor, C_{fig}	$C_{p,n} \times$	1.0	for net pressure on free roofs AS/NZS 1170.2 Appendix D3.1
$C_{fig} = C_{p,n} K_a K_l$			
Aerodynamic Shape Factor, C_{fig}		0.02	for frictional drag forces AS/NZS 1170.2 Appendix D3.2
$C_{fig} = C_f$			

4. Dynamic Response Factor, C_{dyn}

1.0	AS/NZS 1170.2 Sec 6.1
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WIND PRESSURES FOR PITCHED FREE ROOF (AS/NZS 1170.2)

v1.0

Project No.	2024-022	Project Name	Yardtopia Maryborough Gazebo
Designed by	AN	Date	25 November 2024

5. Design Wind Pressure for Roof (ULS)

AS/NZS 1170.2 Sec 2.4.1

$$p_u = (0.5 \rho_{air}) [V_{des, \theta}]^2 C_{fig} C_{dyn}$$

Density of air, ρ_{air}	1.2 kg/m ³	
Design Wind Speed, $V_{des, \theta}$	40.59 m/s	for Ultimate Limit State

a. Transverse Wind ($\theta = 0^\circ$)

Roof, Set 1

Design wind pressure, p_u (windward half)	-0.81 kPa
Design wind pressure, p_u (leeward half)	-1.13 kPa

Roof, Set 2

Design wind pressure, p_u (windward half)	-0.81 kPa
Design wind pressure, p_u (leeward half)	-1.13 kPa

c. Longitudinal Wind ($\theta = 90^\circ$)

Roof, Set 1

Design wind pressure, p_u (windward half)	-1.19 kPa
Design wind pressure, p_u (leeward half)	-0.89 kPa

Roof, Set 2

Design wind pressure, p_u (windward half)	-1.19 kPa
Design wind pressure, p_u (leeward half)	-0.89 kPa

6. Service Wind Pressure for Roof (SLS)

AS/NZS 1170.2 Sec 2.4.1

$$p_s = (0.5 \rho_{air}) [V_{des, \theta}]^2 C_{fig} C_{dyn}$$

Density of air, ρ_{air}	1.2 kg/m ³	
Service Wind Speed, $V_{des, \theta}$	36.63 m/s	for Serviceability Limit State

a. Transverse Wind ($\theta = 0^\circ$)

Roof, Set 1

Service wind pressure, p_s (windward half)	-0.66 kPa
Service wind pressure, p_s (leeward half)	-0.92 kPa

Roof, Set 2

Service wind pressure, p_s (windward half)	-0.66 kPa
Service wind pressure, p_s (leeward half)	-0.92 kPa

c. Longitudinal Wind ($\theta = 90^\circ$)

Roof, Set 1

Service wind pressure, p_s (windward half)	-0.97 kPa
Service wind pressure, p_s (leeward half)	-0.72 kPa

Roof, Set 2

Service wind pressure, p_s (windward half)	-0.97 kPa
Service wind pressure, p_s (leeward half)	-0.72 kPa

Job Information

	Engineer	Checked	Approved
Name:			
Date:	23-May-23		

Structure Type	SPACE FRAME
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Number of Nodes	20	Highest Node	20
Number of Elements	28	Highest Beam	28

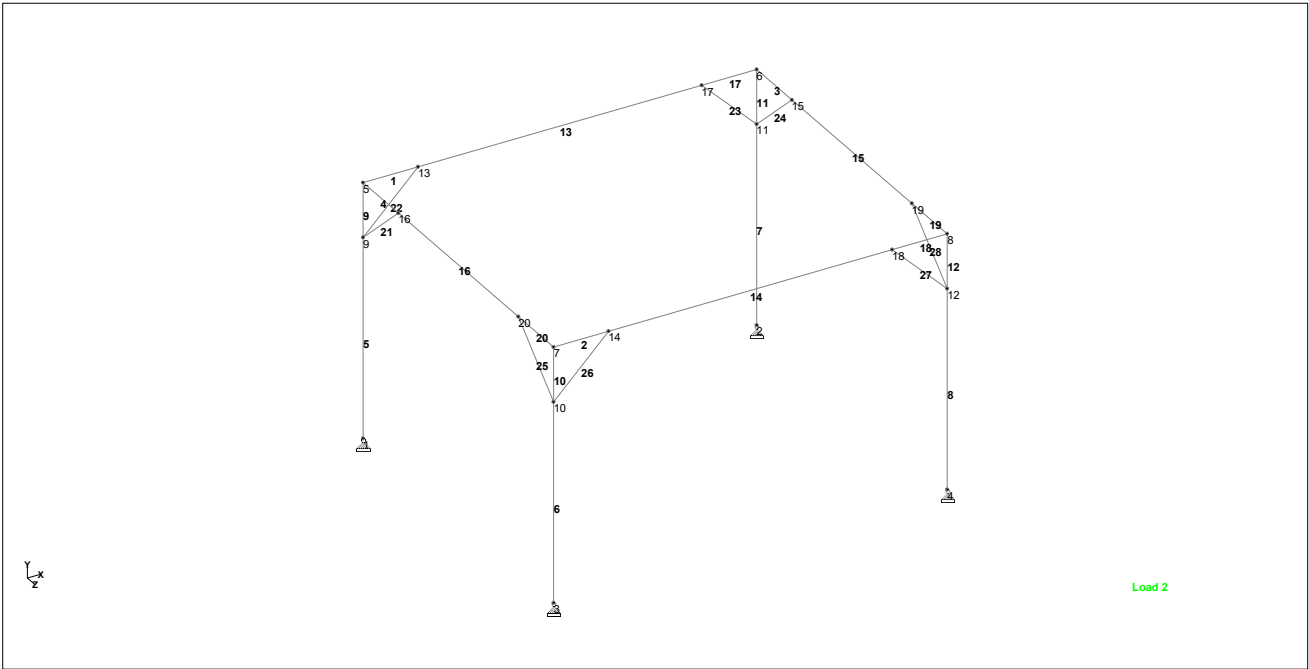
Number of Basic Load Cases	4
Number of Combination Load Cases	10

Included in this printout are data for:

All	The Whole Structure
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Included in this printout are results for load cases:

Type	L/C	Name
Primary	1	PERMANENT ACTION (G)
Primary	2	IMPOSED ACTION (Q)
Primary	3	DESIGN WIND ACTION (SET 1) - TRANS
Primary	5	DESIGN WIND ACTION (SET 1) - LONGIT
Combination	101	1.35G
Combination	102	1.2G + 1.5Q
Combination	103	1.2G + WU (SET 1) - TRANSVERSE
Combination	105	1.2G + WU (SET 1) - LONGITUDINAL
Combination	107	0.9G + WU (SET 1) - TRANSVERSE
Combination	109	0.9G + WU (SET 1) - LONGITUDINAL
Combination	201	0.7Q
Combination	202	G + 0.4Q
Combination	203	G + WS (SET 1) - TRANSVERSE
Combination	205	G + WS (SET 1) - LONGITUDINAL



Whole Structure

Nodes

Node	X (m)	Y (m)	Z (m)
1	0.000	0.000	0.000
2	3.220	0.000	0.000
3	0.000	0.000	2.700
4	3.220	0.000	2.700
5	0.000	2.100	0.000
6	3.220	2.100	0.000
7	0.000	2.100	2.700
8	3.220	2.100	2.700
9	0.000	1.650	0.000
10	0.000	1.650	2.700
11	3.220	1.650	0.000
12	3.220	1.650	2.700
13	0.450	2.100	0.000
14	0.450	2.100	2.700
15	3.220	2.100	0.500
16	0.000	2.100	0.500
17	2.770	2.100	0.000
18	2.770	2.100	2.700
19	3.220	2.100	2.200
20	0.000	2.100	2.200

Beams

Beam	Node A	Node B	Length (m)	Property	β (degrees)
1	5	13	0.450	1	0
2	7	14	0.450	1	0
3	6	15	0.500	1	0
4	5	16	0.500	1	0
5	1	9	1.650	3	0
6	3	10	1.650	3	0
7	2	11	1.650	3	0
8	4	12	1.650	3	0
9	9	5	0.450	3	0
10	10	7	0.450	3	0
11	11	6	0.450	3	0
12	12	8	0.450	3	0
13	13	17	2.320	1	0
14	14	18	2.320	1	0
15	15	19	1.700	1	0
16	16	20	1.700	1	0
17	17	6	0.450	1	0
18	18	8	0.450	1	0
19	19	8	0.500	1	0
20	20	7	0.500	1	0
21	9	16	0.673	2	0
22	9	13	0.636	2	0
23	11	17	0.636	2	0
24	11	15	0.673	2	0
25	10	20	0.673	2	0
26	10	14	0.636	2	0
27	12	18	0.636	2	0
28	12	19	0.673	2	0

Section Properties

Prop	Section	Area (cm ²)	I _{yy} (cm ⁴)	I _{zz} (cm ⁴)	J (cm ⁴)	Material
1	Rect 0.12x0.04	41.760	45.101	468.269	145.159	TIMBERF4
2	Rect 0.11x0.04	40.320	43.546	421.478	138.942	TIMBERF4
3	COLUMN140X140	115.000	2.65E+3	2.65E+3	3.8E+3	TIMBERF4

Materials

Mat	Name	E (kN/mm ²)	ν	Density (kg/m ³)	α (/°C)
1	TIMBERF4	6.100	0.400	356.901	0.000
2	STEEL	205.000	0.300	7.83E+3	12E -6
3	STAINLESSSTEEL	197.930	0.300	7.83E+3	18E -6
4	ALUMINUM	68.948	0.330	2.71E+3	23E -6
5	CONCRETE	21.718	0.170	2.4E+3	10E -6

Supports

Node	X (kN/mm)	Y (kN/mm)	Z (kN/mm)	rX (kN`m/deg)	rY (kN`m/deg)	rZ (kN`m/deg)
1	Fixed	Fixed	Fixed	-	-	-
2	Fixed	Fixed	Fixed	-	-	-
3	Fixed	Fixed	Fixed	-	-	-
4	Fixed	Fixed	Fixed	-	-	-

Primary Load Cases

Number	Name	Type
1	PERMANENT ACTION (G)	Dead
2	IMPOSED ACTION (Q)	Roof Live
3	DESIGN WIND ACTION (SET 1) - TRANS	Wind
5	DESIGN WIND ACTION (SET 1) - LONGIT	Wind

Combination Load Cases

Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
101	1.35G	1	PERMANENT ACTION (G)	1.35
102	1.2G + 1.5Q	1	PERMANENT ACTION (G)	1.20
		2	IMPOSED ACTION (Q)	1.50
103	1.2G + WU (SET 1) - TRANSVERSE	1	PERMANENT ACTION (G)	1.20
		3	DESIGN WIND ACTION (SET 1) - TRANS	1.00
105	1.2G + WU (SET 1) - LONGITUDINAL	1	PERMANENT ACTION (G)	1.20
		5	DESIGN WIND ACTION (SET 1) - LONGIT	1.00
107	0.9G + WU (SET 1) - TRANSVERSE	1	PERMANENT ACTION (G)	0.90
		3	DESIGN WIND ACTION (SET 1) - TRANS	1.00
109	0.9G + WU (SET 1) - LONGITUDINAL	1	PERMANENT ACTION (G)	0.90
		5	DESIGN WIND ACTION (SET 1) - LONGIT	1.00
201	0.7Q	2	IMPOSED ACTION (Q)	0.70
202	G + 0.4Q	1	PERMANENT ACTION (G)	1.00
		2	IMPOSED ACTION (Q)	0.40
203	G + WS (SET 1) - TRANSVERSE	1	PERMANENT ACTION (G)	1.00
		3	DESIGN WIND ACTION (SET 1) - TRANS	0.68

Combination Load Cases Cont...

Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
205	G + WS (SET 1) - LONGITUDINAL	1	PERMANENT ACTION (G)	1.00
		5	DESIGN WIND ACTION (SET 1) - LONGIT	0.68

1 PERMANENT ACTION (G) : Beam Loads

Beam	Type	Direction	Fa	Da (m)	Fb	Db	Ecc. (m)
1	UNI kN/m	GY	-0.420	-	-	-	-
2	UNI kN/m	GY	-0.420	-	-	-	-
3	UNI kN/m	GY	-0.420	-	-	-	-
4	UNI kN/m	GY	-0.420	-	-	-	-
13	UNI kN/m	GY	-0.420	-	-	-	-
14	UNI kN/m	GY	-0.420	-	-	-	-
15	UNI kN/m	GY	-0.420	-	-	-	-
16	UNI kN/m	GY	-0.420	-	-	-	-
17	UNI kN/m	GY	-0.420	-	-	-	-
18	UNI kN/m	GY	-0.420	-	-	-	-
19	UNI kN/m	GY	-0.420	-	-	-	-
20	UNI kN/m	GY	-0.420	-	-	-	-

1 PERMANENT ACTION (G) : Selfweight

Direction	Factor	Assigned Geometry
Y	-1.000	ALL

2 IMPOSED ACTION (Q) : Beam Loads

Beam	Type	Direction	Fa	Da (m)	Fb	Db	Ecc. (m)
1	UNI kN/m	GY	-0.420	-	-	-	-
2	UNI kN/m	GY	-0.420	-	-	-	-
3	UNI kN/m	GY	-0.420	-	-	-	-
4	UNI kN/m	GY	-0.420	-	-	-	-
13	UNI kN/m	GY	-0.420	-	-	-	-
14	UNI kN/m	GY	-0.420	-	-	-	-
15	UNI kN/m	GY	-0.420	-	-	-	-
16	UNI kN/m	GY	-0.420	-	-	-	-
17	UNI kN/m	GY	-0.420	-	-	-	-
18	UNI kN/m	GY	-0.420	-	-	-	-
19	UNI kN/m	GY	-0.420	-	-	-	-
20	UNI kN/m	GY	-0.420	-	-	-	-

3 DESIGN WIND ACTION (SET 1) - TRANSVERSE (WUX1) : Beam Loads

Beam	Type		Direction	Fa	Da (m)	Fb	Db	Ecc. (m)
1	UNI	kN/m	Y	1.350	-	-	-	-
2	UNI	kN/m	Y	1.880	-	-	-	-
3	UNI	kN/m	Y	1.090	-	-	-	-
4	UNI	kN/m	Y	1.090	-	-	-	-
5	UNI	kN/m	GZ	0.120	-	-	-	-
6	UNI	kN/m	GZ	0.120	-	-	-	-
7	UNI	kN/m	GZ	0.120	-	-	-	-
8	UNI	kN/m	GZ	0.120	-	-	-	-
9	UNI	kN/m	GZ	0.120	-	-	-	-
10	UNI	kN/m	GZ	0.120	-	-	-	-
11	UNI	kN/m	GZ	0.120	-	-	-	-
12	UNI	kN/m	GZ	0.120	-	-	-	-
13	UNI	kN/m	Y	1.350	-	-	-	-
14	UNI	kN/m	Y	1.880	-	-	-	-
15	UNI	kN/m	Y	1.090	0.000	-	0.850	-
	UNI	kN/m	Y	1.520	0.850	-	1.700	-
16	UNI	kN/m	Y	1.090	0.000	-	0.850	-
	UNI	kN/m	Y	1.520	0.850	-	1.700	-
17	UNI	kN/m	Y	1.350	-	-	-	-
18	UNI	kN/m	Y	1.880	-	-	-	-
19	UNI	kN/m	Y	1.520	-	-	-	-
20	UNI	kN/m	Y	1.520	-	-	-	-

5 DESIGN WIND ACTION (SET 1) - LONGITUDINAL (WUZ1) : Beam Loads

Beam	Type		Direction	Fa	Da (m)	Fb	Db	Ecc. (m)
1	UNI	kN/m	Y	1.980	-	-	-	-
2	UNI	kN/m	Y	1.980	-	-	-	-
3	UNI	kN/m	Y	1.600	-	-	-	-
4	UNI	kN/m	Y	1.600	-	-	-	-
5	UNI	kN/m	GX	0.120	-	-	-	-
6	UNI	kN/m	GX	0.120	-	-	-	-
7	UNI	kN/m	GX	0.120	-	-	-	-
8	UNI	kN/m	GX	0.120	-	-	-	-
9	UNI	kN/m	GX	0.120	-	-	-	-
10	UNI	kN/m	GX	0.120	-	-	-	-
11	UNI	kN/m	GX	0.120	-	-	-	-
12	UNI	kN/m	GX	0.120	-	-	-	-
13	UNI	kN/m	Y	1.980	-	-	-	-
14	UNI	kN/m	Y	1.980	-	-	-	-
15	UNI	kN/m	Y	1.600	-	-	-	-
16	UNI	kN/m	Y	1.600	-	-	-	-
17	UNI	kN/m	Y	1.980	-	-	-	-
18	UNI	kN/m	Y	1.980	-	-	-	-
19	UNI	kN/m	Y	1.600	-	-	-	-
20	UNI	kN/m	Y	1.600	-	-	-	-

Reactions

Node	L/C	Horizontal	Vertical	Horizontal	Moment		
		FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
1	1:PERMANENT	0.195	1.389	0.142	0.000	0.000	0.000
	2:IMPOSED AC	0.188	1.243	0.136	0.000	0.000	0.000
	3:DESIGN WIN	-0.604	-3.986	-0.675	0.000	0.000	0.000
	5:DESIGN WIN	-1.137	-5.512	-0.519	0.000	0.000	0.000
	101:1.35G	0.263	1.876	0.192	0.000	0.000	0.000
	102:1.2G + 1.5	0.516	3.532	0.375	0.000	0.000	0.000
	103:1.2G + WL	-0.369	-2.319	-0.505	0.000	0.000	0.000
	105:1.2G + WL	-0.903	-3.845	-0.349	0.000	0.000	0.000
	107:0.9G + WL	-0.428	-2.736	-0.548	0.000	0.000	0.000
	109:0.9G + WL	-0.961	-4.262	-0.391	0.000	0.000	0.000
	201:0.7Q	0.131	0.870	0.095	0.000	0.000	0.000
	202:G + 0.4Q	0.270	1.887	0.197	0.000	0.000	0.000
	203:G + WS (S)	-0.215	-1.321	-0.317	0.000	0.000	0.000
	205:G + WS (S)	-0.578	-2.359	-0.211	0.000	0.000	0.000
2	1:PERMANENT	-0.195	1.389	0.142	0.000	0.000	0.000
	2:IMPOSED AC	-0.188	1.243	0.136	0.000	0.000	0.000
	3:DESIGN WIN	0.604	-3.986	-0.675	0.000	0.000	0.000
	5:DESIGN WIN	0.633	-5.183	-0.519	0.000	0.000	0.000
	101:1.35G	-0.263	1.876	0.192	0.000	0.000	0.000
	102:1.2G + 1.5	-0.516	3.532	0.375	0.000	0.000	0.000
	103:1.2G + WL	0.369	-2.319	-0.505	0.000	0.000	0.000
	105:1.2G + WL	0.399	-3.516	-0.349	0.000	0.000	0.000
	107:0.9G + WL	0.428	-2.736	-0.548	0.000	0.000	0.000
	109:0.9G + WL	0.457	-3.933	-0.391	0.000	0.000	0.000
	201:0.7Q	-0.131	0.870	0.095	0.000	0.000	0.000
	202:G + 0.4Q	-0.270	1.887	0.197	0.000	0.000	0.000
	203:G + WS (S)	0.215	-1.321	-0.317	0.000	0.000	0.000
	205:G + WS (S)	0.235	-2.135	-0.211	0.000	0.000	0.000
3	1:PERMANENT	0.195	1.389	-0.142	0.000	0.000	0.000
	2:IMPOSED AC	0.188	1.243	-0.136	0.000	0.000	0.000
	3:DESIGN WIN	-0.840	-4.738	0.171	0.000	0.000	0.000
	5:DESIGN WIN	-1.137	-5.512	0.519	0.000	0.000	0.000
	101:1.35G	0.263	1.876	-0.192	0.000	0.000	0.000
	102:1.2G + 1.5	0.516	3.532	-0.375	0.000	0.000	0.000
	103:1.2G + WL	-0.606	-3.070	0.001	0.000	0.000	0.000
	105:1.2G + WL	-0.903	-3.845	0.349	0.000	0.000	0.000
	107:0.9G + WL	-0.665	-3.487	0.044	0.000	0.000	0.000
	109:0.9G + WL	-0.961	-4.262	0.391	0.000	0.000	0.000
	201:0.7Q	0.131	0.870	-0.095	0.000	0.000	0.000
	202:G + 0.4Q	0.270	1.887	-0.197	0.000	0.000	0.000
	203:G + WS (S)	-0.376	-1.832	-0.025	0.000	0.000	0.000
	205:G + WS (S)	-0.578	-2.359	0.211	0.000	0.000	0.000
4	1:PERMANENT	-0.195	1.389	-0.142	0.000	0.000	0.000
	2:IMPOSED AC	-0.188	1.243	-0.136	0.000	0.000	0.000
	3:DESIGN WIN	0.840	-4.738	0.171	0.000	0.000	0.000
	5:DESIGN WIN	0.633	-5.183	0.519	0.000	0.000	0.000
	101:1.35G	-0.263	1.876	-0.192	0.000	0.000	0.000
	102:1.2G + 1.5	-0.516	3.532	-0.375	0.000	0.000	0.000
	103:1.2G + WL	0.606	-3.070	0.001	0.000	0.000	0.000
	105:1.2G + WL	0.399	-3.516	0.349	0.000	0.000	0.000
	107:0.9G + WL	0.665	-3.487	0.044	0.000	0.000	0.000
	109:0.9G + WL	0.457	-3.933	0.391	0.000	0.000	0.000
	201:0.7Q	-0.131	0.870	-0.095	0.000	0.000	0.000

Reactions Cont...

Node	L/C	Horizontal	Vertical	Horizontal	Moment		
		FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
	202:G + 0.4Q	-0.270	1.887	-0.197	0.000	0.000	0.000
	203:G + WS (S)	0.376	-1.832	-0.025	0.000	0.000	0.000
	205:G + WS (S)	0.235	-2.135	0.211	0.000	0.000	0.000

Reaction Summary

	Node	L/C	Horizontal	Vertical	Horizontal	Moment		
			FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
Max FX	4	3:DESIGN WIN	0.840	-4.738	0.171	0.000	0.000	0.000
Min FX	1	5:DESIGN WIN	-1.137	-5.512	-0.519	0.000	0.000	0.000
Max FY	1	102:1.2G + 1.5	0.516	3.532	0.375	0.000	0.000	0.000
Min FY	1	5:DESIGN WIN	-1.137	-5.512	-0.519	0.000	0.000	0.000
Max FZ	4	5:DESIGN WIN	0.633	-5.183	0.519	0.000	0.000	0.000
Min FZ	1	3:DESIGN WIN	-0.604	-3.986	-0.675	0.000	0.000	0.000
Max MX	1	1:PERMANEN	0.195	1.389	0.142	0.000	0.000	0.000
Min MX	1	1:PERMANEN	0.195	1.389	0.142	0.000	0.000	0.000
Max MY	1	1:PERMANEN	0.195	1.389	0.142	0.000	0.000	0.000
Min MY	1	1:PERMANEN	0.195	1.389	0.142	0.000	0.000	0.000
Max MZ	1	1:PERMANEN	0.195	1.389	0.142	0.000	0.000	0.000
Min MZ	1	1:PERMANEN	0.195	1.389	0.142	0.000	0.000	0.000

Beam Force Detail Summary

Sign convention as diagrams:- positive above line, negative below line except Fx where positive is compression. Distance d is given from beam end A.

	Beam	L/C	d (m)	Axial Fx (kN)	Shear Fy (kN)	Fz (kN)	Torsion Mx (kNm)	Bending My (kNm)	Mz (kNm)
Max Fx	5	102:1.2G + 1.5	0.000	3.532	-0.516	0.375	0.000	0.000	-0.000
Min Fx	22	109:0.9G + WL	0.636	-5.346	-0.003	-0.000	-0.000	-0.000	-0.000
Max Fy	12	107:0.9G + WL	0.000	0.024	2.318	-0.422	-0.000	0.235	1.097
Min Fy	9	109:0.9G + WL	0.450	0.977	-3.069	1.326	-0.000	-0.049	-0.054
Max Fz	9	107:0.9G + WL	0.450	0.836	-1.488	1.638	-0.000	-0.015	-0.036
Min Fz	12	109:0.9G + WL	0.000	0.131	1.928	-1.329	0.000	0.646	0.918
Max Mx	3	103:1.2G + WL	0.000	1.493	0.469	-0.000	0.000	0.000	-0.010
Min Mx	16	103:1.2G + WL	0.000	-0.253	-0.824	0.000	-0.000	-0.000	-0.315
Max My	8	109:0.9G + WL	1.650	-3.993	-0.655	0.391	-0.000	0.646	0.918
Min My	5	107:0.9G + WL	1.650	-2.795	0.428	-0.350	-0.000	-0.740	-0.706
Max Mz	8	107:0.9G + WL	1.650	-3.547	-0.665	0.242	-0.000	0.235	1.097
Min Mz	5	109:0.9G + WL	1.650	-4.321	0.763	-0.391	-0.000	-0.646	-1.423

Beam Maximum Forces by Section Property

		Axial	Shear		Torsion	Bending	
Section		Max Fx (kN)	Max Fy (kN)	Max Fz (kN)	Max Mx (kNm)	Max My (kNm)	Max Mz (kNm)
Rect 0.12x0.04	Max +ve	3.069	1.775	0.000	0.000	0.000	0.570
	Max -ve	-1.797	-2.007	-0.000	-0.000	-0.000	-0.692
Rect 0.11x0.04	Max +ve	3.274	0.005	0.000	0.000	0.000	0.000
	Max -ve	-5.346	-0.005	0.000	0.000	0.000	0.000
COLUMN140X140	Max +ve	3.532	2.318	1.638	0.000	0.646	1.097
	Max -ve	-4.321	-3.069	-1.329	-0.000	-0.740	-1.423

Beam End Force Summary

The signs of the forces at end B of each beam have been reversed. For example: this means that the Min Fx entry gives the largest tension value for an beam.

	Beam	Node	L/C	Axial Fx (kN)	Shear Fy (kN)	Fz (kN)	Torsion Mx (kNm)	Bending My (kNm)	Mz (kNm)
Max Fx	5	1	102:1.2G + 1.5	3.532	-0.516	0.375	0.000	0.000	-0.000
Min Fx	22	13	109:0.9G + WL	-5.346	-0.003	-0.000	-0.000	-0.000	-0.000
Max Fy	12	12	107:0.9G + WL	0.024	2.318	-0.422	-0.000	0.235	1.097
Min Fy	9	5	109:0.9G + WL	0.977	-3.069	1.326	-0.000	-0.049	-0.054
Max Fz	9	5	107:0.9G + WL	0.836	-1.488	1.638	-0.000	-0.015	-0.036
Min Fz	12	12	109:0.9G + WL	0.131	1.928	-1.329	0.000	0.646	0.918
Max Mx	3	6	103:1.2G + WL	1.493	0.469	-0.000	0.000	0.000	-0.010
Min Mx	16	16	103:1.2G + WL	-0.253	-0.824	0.000	-0.000	-0.000	-0.315
Max My	8	12	109:0.9G + WL	-3.993	-0.655	0.391	-0.000	0.646	0.918
Min My	5	9	107:0.9G + WL	-2.795	0.428	-0.350	-0.000	-0.740	-0.706
Max Mz	8	12	107:0.9G + WL	-3.547	-0.665	0.242	-0.000	0.235	1.097
Min Mz	5	9	109:0.9G + WL	-4.321	0.763	-0.391	-0.000	-0.646	-1.423

	Project Yardtopia Maryborough Gazebo (3x3m & 3x3.6m)				Job no. 2024-022	
	Calcs for B1 Beam Design				Start page no./Revision 1	
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TIMBER MEMBER DESIGN TO AS1720.1-2010

Tedds calculation version 1.5.05

Analysis results

Design moment in major axis

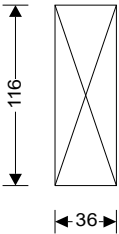
$$M^*_x = 0.690 \text{ kNm}$$

Design shear

$$V^* = 2.000 \text{ kN}$$

Design axial compression

$$N^*_c = 3.070 \text{ kN}$$



Timber section details

Breadth of timber sections

$$b = 36 \text{ mm}$$

Depth of timber sections

$$d = 116 \text{ mm}$$

Number of timber sections in member

$$N = 1$$

Overall breadth of timber member

$$b_b = N \times b = 36 \text{ mm}$$

Timber species

Mixed softwood species (excl. Pinus species)

Moisture condition

Seasoned

Timber strength grade - Table H2.1

F4

Member details

Load duration - cl.2.4.1

Standard test

Overall length of member

$$L_x = 3250 \text{ mm}$$

Effective length factor - Table 3.2

$$g_{13} = 1$$

Distance between lateral restraints in major axis

$$L_{ax} = 2350 \text{ mm}$$

Distance between lateral restraints in minor axis

$$L_{ay} = 900 \text{ mm}$$

Section properties

Cross sectional area of member

$$A = N \times b \times d = 4176 \text{ mm}^2$$

Section modulus

$$Z_x = N \times b \times d^2 / 6 = 80736 \text{ mm}^3$$

$$Z_y = d \times (N \times b)^2 / 6 = 25056 \text{ mm}^3$$

Second moment of area

$$I_x = N \times b \times d^3 / 12 = 4682688 \text{ mm}^4$$

$$I_y = d \times (N \times b)^3 / 12 = 451008 \text{ mm}^4$$

Radius of gyration

$$r_x = \sqrt{I_x / A} = 33.5 \text{ mm}$$

$$r_y = \sqrt{I_y / A} = 10.4 \text{ mm}$$

Modification factors

Duration of load factor for strength - Table 2.3

$$k_1 = 1.00$$

Moisture condition factor - cl.2.4.2.3

$$k_4 = 1.00$$

Temperature factor - cl.2.4.3

$$k_6 = 1.00$$

Length and position of bearing factor - cl.2.4.4

$$k_7 = 1.00$$

Strength sharing factor - Table 2.7

$$k_9 = 1.00$$

Temporary design action ratio

$$r = 0.25$$

Material constant - exp.E2(1)

$$\rho_b = 14.71 \times (E / f_b)^{-0.480} \times r^{-0.061} = 0.80$$

Distance between discrete lateral restraints

$$L_{ay} = 900 \text{ mm}$$

$$L_{ay} / d < 64 \times [N \times b / (\rho_b \times d)]^2$$

		Project Yardtopia Maryborough Gazebo (3x3m & 3x3.6m)		Job no. 2024-022	
		Calcs for B1 Beam Design		Start page no./Revision 2	
Calcs by AN	Calcs date 9/03/2025	Checked by	Checked date	Approved by	Approved date

Major axis slenderness coefficient - cl.3.2.3.2(b)

$$S_1 = 0.00$$

Major axis bending stability factor - exp.3.2(10)

$$k_{12bx} = 1.00$$

Minor axis slenderness coefficient - cl.3.2.3.2 (c)

$$S_2 = 0.00$$

Minor axis bending stability factor - cl.3.2.4

$$k_{12by} = 1.00$$

Material constant - exp.E2(3)

$$\rho_c = 11.39 \times (E / f'_c)^{-0.408} \times r^{-0.074} = 0.87$$

Major axis slenderness coefficient - exp.3.3(5)

$$S_3 = L_{ax} / d = 20.26$$

Major axis comp.stability factor - exp.3.3(11b)

$$k_{12cx} = 1.5 - 0.05 \times \rho_c \times S_3 = 0.62$$

Minor axis slenderness coeff. - exp.3.3(8) & (9)

$$S_4 = \min(L_{ay} / (N \times b), g_{13} \times L_x / (N \times b)) = 25.00$$

Minor axis comp.stability factor - exp.3.3(11c)

$$k_{12cy} = 200 / (\rho_c \times S_4)^2 = 0.43$$

Bending strength - cl.3.2.1

Capacity factor - Table 2.1

$$\phi_b = 0.9$$

Design capacity in major axis bending - cl.3.2(2)

$$\phi M_x = \phi_b \times k_1 \times k_4 \times k_6 \times k_9 \times k_{12bx} \times f'_b \times Z_x = 0.872 \text{ kNm}$$

PASS - Design capacity in bending exceeds design bending moment

Compressive strength - cl.3.3.1

Capacity factor - Table 2.1

$$\phi_c = 0.9$$

Cross-sectional area of member

$$A_c = N \times b \times d = 4176 \text{ mm}^2$$

Major axis design capacity in compression - exp.3.3(2)

$$\phi N_{cx} = \phi_c \times k_1 \times k_4 \times k_6 \times k_{12cx} \times f'_c \times A_c = 20.103 \text{ kN}$$

Minor axis design capacity in compression - exp.3.3(2)

$$\phi N_{cy} = \phi_c \times k_1 \times k_4 \times k_6 \times k_{12cy} \times f'_c \times A_c = 13.765 \text{ kN}$$

PASS - Design capacity in compression exceeds design compression

Combined bending and compression - cl.3.5.1

Combined bending and compression check - exp.3.5(1) and exp.3.5(2)

$$[M^*_x / \phi M_x]^2 + [N^*_c / \phi N_{cy}] = 0.849 < 1$$

$$[M^*_x / \phi M_x] + [N^*_c / \phi N_{cx}] = 0.944 < 1$$

PASS - Beam design meets combined bending and compression criteria

Flexural shear strength - cl.3.2.5

Capacity factor - Table 2.1

$$\phi_s = 0.9$$

Shear plane area

$$A_s = N \times b \times d \times 2 / 3 = 2784 \text{ mm}^2$$

Design shear capacity - exp.3.2(14)

$$\phi V = \phi_s \times k_1 \times k_4 \times k_6 \times f'_s \times A_s = 3.257 \text{ kN}$$

PASS - Design shear capacity exceeds design shear force

	Project Yardtopia Maryborough Gazebo (3x3m & 3x3.6m)				Job no. 2024-022	
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TIMBER MEMBER DESIGN TO AS1720.1-2010

Tedds calculation version 1.5.05

Analysis results

Design moment in major axis

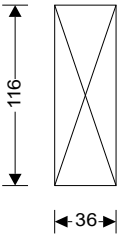
$$M^*_x = 0.330 \text{ kNm}$$

Design shear

$$V^* = 1.030 \text{ kN}$$

Design axial compression

$$N^*_c = 1.640 \text{ kN}$$



Timber section details

Breadth of timber sections

$$b = 36 \text{ mm}$$

Depth of timber sections

$$d = 116 \text{ mm}$$

Number of timber sections in member

$$N = 1$$

Overall breadth of timber member

$$b_b = N \times b = 36 \text{ mm}$$

Timber species

Mixed softwood species (excl. Pinus species)

Moisture condition

Seasoned

Timber strength grade - Table H2.1

F4

Member details

Load duration - cl.2.4.1

Standard test

Overall length of member

$$L_x = 2700 \text{ mm}$$

Effective length factor - Table 3.2

$$g_{13} = 1$$

Distance between lateral restraints in major axis

$$L_{ax} = 1700 \text{ mm}$$

Distance between lateral restraints in minor axis

$$L_{ay} = 900 \text{ mm}$$

Section properties

Cross sectional area of member

$$A = N \times b \times d = 4176 \text{ mm}^2$$

Section modulus

$$Z_x = N \times b \times d^2 / 6 = 80736 \text{ mm}^3$$

$$Z_y = d \times (N \times b)^2 / 6 = 25056 \text{ mm}^3$$

Second moment of area

$$I_x = N \times b \times d^3 / 12 = 4682688 \text{ mm}^4$$

$$I_y = d \times (N \times b)^3 / 12 = 451008 \text{ mm}^4$$

Radius of gyration

$$r_x = \sqrt{I_x / A} = 33.5 \text{ mm}$$

$$r_y = \sqrt{I_y / A} = 10.4 \text{ mm}$$

Modification factors

Duration of load factor for strength - Table 2.3

$$k_1 = 1.00$$

Moisture condition factor - cl.2.4.2.3

$$k_4 = 1.00$$

Temperature factor - cl.2.4.3

$$k_6 = 1.00$$

Length and position of bearing factor - cl.2.4.4

$$k_7 = 1.00$$

Strength sharing factor - Table 2.7

$$k_9 = 1.00$$

Temporary design action ratio

$$r = 0.25$$

Material constant - exp.E2(1)

$$\rho_b = 14.71 \times (E / f_b)^{-0.480} \times r^{-0.061} = 0.80$$

Distance between discrete lateral restraints

$$L_{ay} = 900 \text{ mm}$$

$$L_{ay} / d < 64 \times [N \times b / (\rho_b \times d)]^2$$

	Project Yardtopia Maryborough Gazebo (3x3m & 3x3.6m)				Job no. 2024-022	
	Calcs for B2 Beam Design				Start page no./Revision 2	
	Calcs by AN	Calcs date	Checked by	Checked date	Approved by	Approved date

Major axis slenderness coefficient - cl.3.2.3.2(b)

$$S_1 = 0.00$$

Major axis bending stability factor - exp.3.2(10)

$$k_{12bx} = 1.00$$

Minor axis slenderness coefficient - cl.3.2.3.2 (c)

$$S_2 = 0.00$$

Minor axis bending stability factor - cl.3.2.4

$$k_{12by} = 1.00$$

Material constant - exp.E2(3)

$$\rho_c = 11.39 \times (E / f'_c)^{-0.408} \times r^{-0.074} = 0.87$$

Major axis slenderness coefficient - exp.3.3(5)

$$S_3 = L_{ax} / d = 14.66$$

Major axis comp.stability factor - exp.3.3(11b)

$$k_{12cx} = 1.5 - 0.05 \times \rho_c \times S_3 = 0.86$$

Minor axis slenderness coeff. - exp.3.3(8) & (9)

$$S_4 = \min(L_{ay} / (N \times b), g_{13} \times L_x / (N \times b)) = 25.00$$

Minor axis comp.stability factor - exp.3.3(11c)

$$k_{12cy} = 200 / (\rho_c \times S_4)^2 = 0.43$$

Bending strength - cl.3.2.1

Capacity factor - Table 2.1

$$\phi_b = 0.9$$

Design capacity in major axis bending - cl.3.2(2)

$$\phi M_x = \phi_b \times k_1 \times k_4 \times k_6 \times k_9 \times k_{12bx} \times f'_b \times Z_x = 0.872 \text{ kNm}$$

PASS - Design capacity in bending exceeds design bending moment

Compressive strength - cl.3.3.1

Capacity factor - Table 2.1

$$\phi_c = 0.9$$

Cross-sectional area of member

$$A_c = N \times b \times d = 4176 \text{ mm}^2$$

Major axis design capacity in compression - exp.3.3(2)

$$\phi N_{cx} = \phi_c \times k_1 \times k_4 \times k_6 \times k_{12cx} \times f'_c \times A_c = 27.953 \text{ kN}$$

Minor axis design capacity in compression - exp.3.3(2)

$$\phi N_{cy} = \phi_c \times k_1 \times k_4 \times k_6 \times k_{12cy} \times f'_c \times A_c = 13.765 \text{ kN}$$

PASS - Design capacity in compression exceeds design compression

Combined bending and compression - cl.3.5.1

Combined bending and compression check - exp.3.5(1) and exp.3.5(2)

$$[M^*_x / \phi M_x]^2 + [N^*_c / \phi N_{cy}] = 0.262 < 1$$

$$[M^*_x / \phi M_x] + [N^*_c / \phi N_{cx}] = 0.437 < 1$$

PASS - Beam design meets combined bending and compression criteria

Flexural shear strength - cl.3.2.5

Capacity factor - Table 2.1

$$\phi_s = 0.9$$

Shear plane area

$$A_s = N \times b \times d \times 2 / 3 = 2784 \text{ mm}^2$$

Design shear capacity - exp.3.2(14)

$$\phi V = \phi_s \times k_1 \times k_4 \times k_6 \times f'_s \times A_s = 3.257 \text{ kN}$$

PASS - Design shear capacity exceeds design shear force

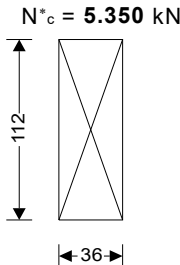
	Project Yardtopia Maryborough Gazebo (3x3m & 3x3.6m)				Job no. 2024-022	
	Calcs for BR1 Knee Brace Design				Start page no./Revision 1	
	Calcs by AN	Calcs date	Checked by	Checked date	Approved by	Approved date

TIMBER MEMBER DESIGN TO AS1720.1-2010

Tedds calculation version 1.5.05

Analysis results

Design axial compression



Timber section details

Breadth of timber sections

$b = 36 \text{ mm}$

Depth of timber sections

$d = 112 \text{ mm}$

Number of timber sections in member

$N = 1$

Overall breadth of timber member

$b_b = N \times b = 36 \text{ mm}$

Timber species

Mixed softwood species (excl.Pinus species)

Moisture condition

Seasoned

Timber strength grade - Table H2.1

F4

Member details

Load duration - cl.2.4.1

Standard test

Overall length of member

$L_x = 800 \text{ mm}$

Effective length factor - Table 3.2

$g_{13} = 1$

Distance between lateral restraints in major axis

$L_{ax} = 800 \text{ mm}$

Distance between lateral restraints in minor axis

$L_{ay} = 800 \text{ mm}$

Section properties

Cross sectional area of member

$A = N \times b \times d = 4032 \text{ mm}^2$

Section modulus

$Z_x = N \times b \times d^2 / 6 = 75264 \text{ mm}^3$

$Z_y = d \times (N \times b)^2 / 6 = 24192 \text{ mm}^3$

Second moment of area

$I_x = N \times b \times d^3 / 12 = 4214784 \text{ mm}^4$

$I_y = d \times (N \times b)^3 / 12 = 435456 \text{ mm}^4$

Radius of gyration

$r_x = \sqrt{I_x / A} = 32.3 \text{ mm}$

$r_y = \sqrt{I_y / A} = 10.4 \text{ mm}$

Modification factors

Duration of load factor for strength - Table 2.3

$k_1 = 1.00$

Moisture condition factor - cl.2.4.2.3

$k_4 = 1.00$

Temperature factor - cl.2.4.3

$k_6 = 1.00$

Length and position of bearing factor - cl.2.4.4

$k_7 = 1.00$

Strength sharing factor - Table 2.7

$k_9 = 1.00$

Temporary design action ratio

$r = 0.25$

Material constant - exp.E2(1)

$\rho_b = 14.71 \times (E / f_b)^{-0.480} \times r^{-0.061} = 0.80$

Distance between discrete lateral restraints

$L_{ay} = 800 \text{ mm}$

$L_{ay} / d < 64 \times [N \times b / (\rho_b \times d)]^2$

Major axis slenderness coefficient - cl.3.2.3.2(b)

$S_1 = 0.00$

Major axis bending stability factor - exp.3.2(10)

$k_{12bx} = 1.00$

	Project Yardtopia Maryborough Gazebo (3x3m & 3x3.6m)				Job no. 2024-022	
	Calcs for BR1 Knee Brace Design				Start page no./Revision 2	
	Calcs by AN	Calcs date	Checked by	Checked date	Approved by	Approved date

Minor axis slenderness coefficient - cl.3.2.3.2 (c)
Minor axis bending stability factor - cl.3.2.4
Material constant - exp.E2(3)
Major axis slenderness coefficient - exp.3.3(5)
Major axis comp.stability factor - exp.3.3(11a)
Minor axis slenderness coeff. - exp.3.3(8) & (9)
Minor axis comp.stability factor - exp.3.3(11b)

$S_2 = 0.00$
 $k_{12by} = 1.00$
 $\rho_c = 11.39 \times (E / f_c)^{-0.408} \times r^{-0.074} = 0.87$
 $S_3 = L_{ax} / d = 7.14$
 $k_{12cx} = 1.00$
 $S_4 = \min(L_{ay} / (N \times b), g_{13} \times L_x / (N \times b)) = 22.22$
 $k_{12cy} = 1.5 - 0.05 \times \rho_c \times S_4 = 0.54$

Compressive strength - cl.3.3.1

Capacity factor - Table 2.1
Cross-sectional area of member
Major axis design capacity in compression - exp.3.3(2)

$\phi_c = 0.9$
 $A_c = N \times b \times d = 4032 \text{ mm}^2$
 $\phi N_{cx} = \phi_c \times k_1 \times k_4 \times k_6 \times k_{12cx} \times f_c \times A_c = 31.208 \text{ kN}$

Minor axis design capacity in compression - exp.3.3(2)

$\phi N_{cy} = \phi_c \times k_1 \times k_4 \times k_6 \times k_{12cy} \times f_c \times A_c = 16.754 \text{ kN}$

PASS - Design capacity in compression exceeds design compression

Project No.	2024-022	Project Name	Yardtopia Maryborough Gazebo
Designed by	AN	Date	25 November 2024

SUMMARY OF RESULTS

Utilization Ratios:

Compression	8.5%
Bending, x-axis	55.7%
Bending, y-axis	29.0%
Combined Compression and Bending	39.5%
Combined Tension and Bending	64.2%

OK

1. Member Properties (140 x 140 x 25mm thick Square Hollow Section)

Depth, d	140 mm
Width, b	140 mm
Thickness, t	25 mm
Unsupported Length of member x-axis, L_{ax}	2050 mm
Unsupported Length of member y-axis, L_{ay}	2050 mm
Effective Length Factor, g_{13}	1.0
Cross Sectional Area, A_c	11,500 mm ²
In-plane Elastic Section Modulus, Z_x	379,226 mm ⁴
Out-of-plane Elastic Section Modulus, Z_y	379,226 mm ⁴
Area moment of inertia about x-axis, I_{xx}	26,545,833 mm ⁴
Area moment of inertia about y-axis, I_{yy}	26,545,833 mm ⁴
Radius of gyration about buckling axis (X), r_x	48.05 mm
Radius of gyration about buckling axis (Y), r_y	48.05 mm
Torsional Constant, J	38,021,875 mm ⁴

2. Material Properties

Timber Grade	F4
Characteristic value, Bending, f'_b	12 MPa
Characteristic value, Tension - parallel to grain, f'_t	5.8 MPa
Characteristic value, Shear, f'_s	1.3 MPa
Characteristic value, Comp. - parallel to grain, f'_c	8.6 MPa
Modulus of Elasticity, E	6,100 MPa
Modulus of Rigidity, G	410 MPa
Capacity Factor, ϕ	0.70
Effect of duration of load, k_1	0.80
Effect of moisture condition, k_4	1.00
Effect of temperature, k_6	1.00
Modification factor for strength-sharing, k_9	1.00

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Stability Factor, k_{12}

Material constant, ρ_b	0.90
x-axis slenderness coefficient, S_1	4.78
y-axis slenderness coefficient, S_2	0.00
x-axis stability factor, k_{12bx}	1.00
y-axis stability factor, k_{12by}	1.00
Material constant, ρ_c	1.02
x-axis slenderness coefficient, S_3	14.64
y-axis slenderness coefficient, S_4	14.64
x-axis stability factor, k_{12cx}	0.75
y-axis stability factor, k_{12cy}	0.75

3. Design Forces

Maximum axial forces

Compression, P	3.53 kN
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Maximum bending moments

Bending about x-axis, M_x	1.42 kN-m
Bending about y-axis, M_y	0.74 kN-m

Maximum shear force, V

3.07 kN

4. Design Capacity

Axial Forces

a. Compression, parallel to the grain

$N_{d,cx} = \phi k_1 k_4 k_6 k_{12cx} f'_c A_c$	$N_{d,cx} =$	41.72 kN	buckling about x-axis
$N_{d,cy} = \phi k_1 k_4 k_6 k_{12cy} f'_c A_c$	$N_{d,cy} =$	41.72 kN	buckling about y-axis

	$N_{d,c}$	>	P	PASS
Utilization Ratio	$P / N_{d,c} =$	8.5%		

Bending Moment

b. Bending about x-axis

$M_{d,x} = \phi k_1 k_4 k_6 k_9 k_{12bx} f'_b Z_x$	$M_{d,x} =$	2.55 kNm
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	$M_{d,x}$	>	M_x	PASS
Utilization Ratio	$M_x / M_{d,x} =$	55.7%		

c. Bending about y-axis

$M_{d,y} = \phi k_1 k_4 k_6 k_9 k_{12by} f'_b Z_y$	$M_{d,y} =$	2.55 kNm
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	$M_{d,y}$	>	M_y	PASS
Utilization Ratio	$M_y / M_{d,y} =$	29.0%		

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Combined Actions

f. Combined compression and bending

$$\left(\frac{M_x^*}{M_{d,x}} \right)^2 + \frac{N_c^*}{N_{d,cy}} = 0.40 \leq 1.0 \quad \text{PASS}$$

g. Combined tension and bending

$$\frac{M_x^*}{M_{d,x}} + \frac{N_c^*}{N_{d,cx}} = 0.64 \leq 1.0 \quad \text{PASS}$$



Consulting Engineers

YARDTOPIA MARYBOROUGH GAZEBO – 3m x 3m and 3m x 3.6m

FOOTING DESIGN

Project No.	2024-022	Project Name	Yardtopia Maryborough Gazebo
Designed by	AN	Date	25 November 2024

SUMMARY OF RESULTS

Required Pile Size **450mm dia. x 1300mm deep**
Required Ultimate Bearing Capacity of Soil **100 kPa**

Utilization Ratios:

Uplift 95.4%
Soil Bearing Pressure 44.4%

OK

1. Pile Properties

Diameter, D 450 mm
Depth, L 1300 mm
Cross Sectional Area, A 0.16 m²

Unit Weight of Concrete, γ_{conc} 24 kN/m³
Unit Weight of Soil, γ_{soil} 18 kN/m³

Ultimate Bearing Capacity of Soil, B_n 100 kPa

2. Design Forces and Stresses

Maximum support reactions
Tension, T 4.26 kN
Compression, P 3.53 kN

3. Check against uplift

Strength reduction factor (concrete), Φ_{conc} 0.9
Factored Weight of Concrete, ΦW_{conc} 4.47 kN

	ΦW_{conc}	>	T	PASS
Utilization Ratio	$\Phi W_{conc} / T =$	95.4%		

4. Check soil bearing capacity

Maximum bearing pressure in soil, p 22.20 kPa

Strength reduction factor (soil), Φ_{soil} 0.5
Factored Ultimate Bearing Capacity of Soil, ΦB_n 50 kPa

	ΦB_n	>	p	PASS
Utilization Ratio	$\Phi B_n / p =$	44.4%		