Ref: AJN-2024-023-CALC (Rev A)

YARDTOPIA FREMANTLE GAZEBO
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/m^2)
Self-weight	as per material density
Roof	0.2

Table 2. Design Dead Loads

1.2.2 Imposed actions (Q)

Description	Dead Load (kN/m^2)
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.

STRUCTURAL ANALYSIS AND DESIGN

v1.0

WIND SPEED CALCULATION
(AS/NZS 1170.2)

Project No.	2024-023	Project Name	Yardtopia Fremantle Gazebo
Designed by	AN	Date	16 December 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 Recurrance Interval, R	(ULS)	100	years	*for Ultimate Limit State*
Average Recurrance 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*

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

AS/NZS 1170.2 Sec 2.3

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)

Project No.	2024-023	Project Name	Yardtopia Fremantle Gazebo
Designed by	AN	Date	16 December 2024

1. Design Information

Roof Pitch	25	°	
Knee Height	2.15	m	
Building Width, d	3	m	
Building Length, L	3.6	m	
Average Height, h	2.85	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 (θ = 0°)

Roof, Set 1

Pressure coefficient (windward), $C_{p,w}$	-0.8
Pressure coefficient (leeward), $C_{p,l}$	-1.2

Roof, Set 2

Pressure coefficient (windward), $C_{p,w}$	-0.8
Pressure coefficient (leeward), $C_{p,l}$	-1.2

c. Longitudinal Wind (θ = 90°)

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

4. Dynamic Response Factor, C_{dyn}

1.0 *AS/NZS 1170.2 Sec 6.1*

WIND PRESSURES FOR PITCHED FREE ROOF

(AS/NZS 1170.2)

Project No.	2024-023	Project Name	Yardtopia Fremantle Gazebo
Designed by	AN	Date	16 December 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, $V_{des,\theta}$	(ULS)	40.59 m/s	*for Ultimate Limit State*

a. Transverse Wind (θ = 0°)

Roof, Set 1

Design wind pressure, p_u (windward half)	-0.76 kPa
Design wind pressure, p_u (leeward half)	-1.15 kPa

Roof, Set 2

Design wind pressure, p_u (windward half)	-0.76 kPa
Design wind pressure, p_u (leeward half)	-1.15 kPa

c. Longitudinal Wind (θ = 90°)

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, $V_{des,\theta}$	(SLS)	36.63 m/s	*for Serviceability Limit State*

a. Transverse Wind (θ = 0°)

Roof, Set 1

Service wind pressure, p_s (windward half)	-0.62 kPa
Service wind pressure, p_s (leeward half)	-0.94 kPa

Roof, Set 2

Service wind pressure, p_s (windward half)	-0.62 kPa
Service wind pressure, p_s (leeward half)	-0.94 kPa

c. Longitudinal Wind (θ = 90°)

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

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DESIGN LOADING
(AS/NZS 1170.2)

Project No.	2024-023	Project Name	Yardtopia Fremantle Gazebo
Designed by	AN	Date	16 December 2024

1. Design Information

Tributary Width 1.55 m

2. Permanent Actions (G)

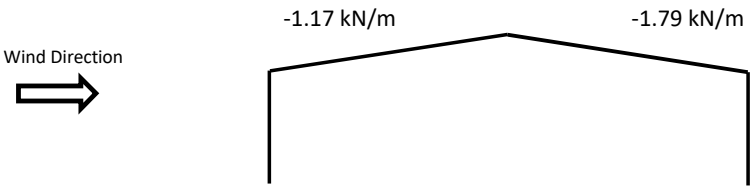
Selfweight

Roof 0.25 kPa x 1.55m = 0.39 kN/m

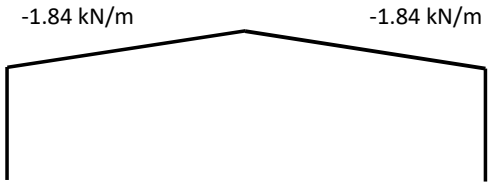
3. Imposed Actions (Q) 0.25 kPa x 1.55m = 0.39 kN/m

4. Wind Actions (W)

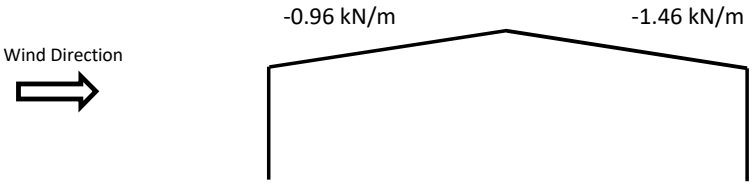
Design Transverse Wind Force (θ = 0°) *for Ultimate Limit State*



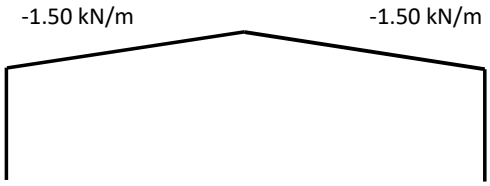
Design Longitudinal Wind Force (θ = 90°) *for Ultimate Limit State*



Service Transverse Wind Force (θ = 0°) *for Serviceability Limit State*



Service Longitudinal Wind Force (θ = 90°) *for Serviceability Limit State*



Job Information

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

Structure Type	SPACE FRAME

Number of Nodes	28	Highest Node	38
Number of Elements	44	Highest Beam	61

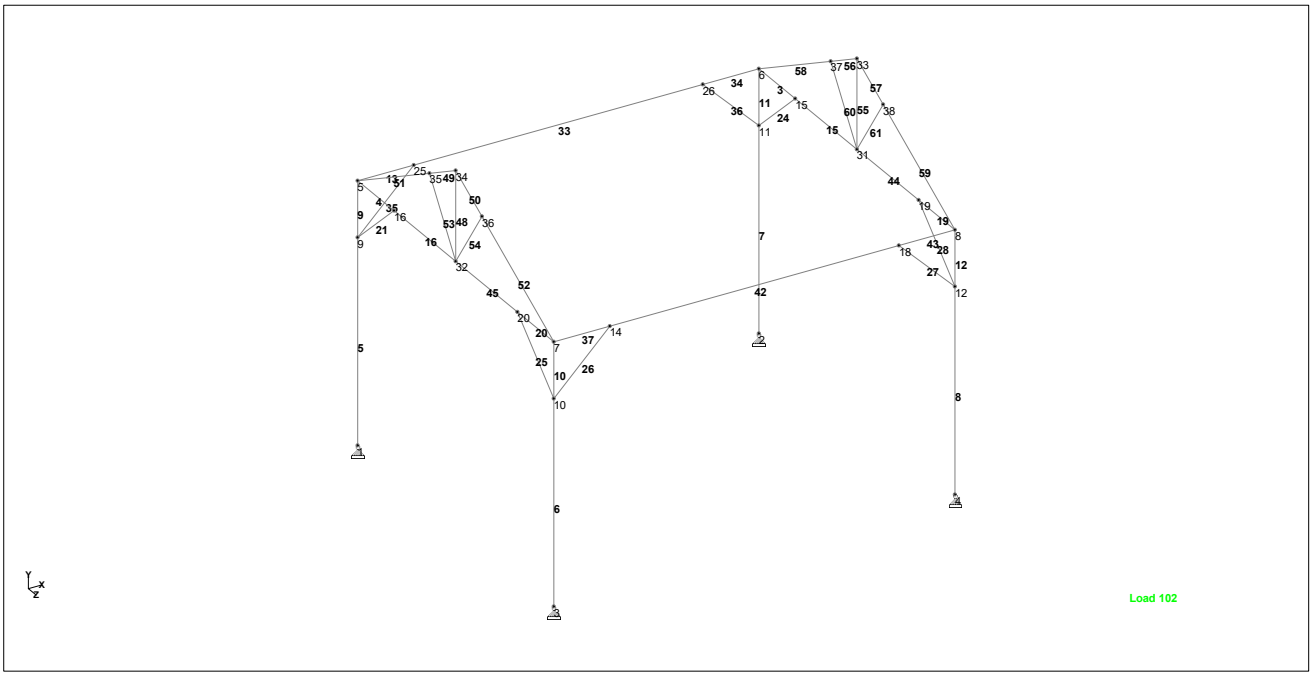
Number of Basic Load Cases	4
Number of Combination Load Cases	10

Included in this printout are data for:

All	The Whole Structure

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
14	0.450	2.100	2.700
15	3.220	2.100	0.500
16	0.000	2.100	0.500
18	2.770	2.100	2.700
19	3.220	2.100	2.200
20	0.000	2.100	2.200
25	0.450	2.100	0.000
26	2.770	2.100	0.000
31	3.220	2.100	1.350
32	0.000	2.100	1.350
33	3.220	2.820	1.350
34	0.000	2.820	1.350
35	0.000	2.627	0.988
36	0.000	2.627	1.712
37	3.220	2.627	0.988
38	3.220	2.627	1.712

Beams

Beam	Node A	Node B	Length (m)	Property	β (degrees)
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	5	25	0.450	1	0
15	15	31	0.850	1	0
16	16	32	0.850	1	0
19	19	8	0.500	1	0
20	20	7	0.500	1	0
21	9	16	0.673	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

Beams Cont...

Beam	Node A	Node B	Length (m)	Property	β (degrees)
28	12	19	0.673	2	0
33	25	26	2.320	1	0
34	26	6	0.450	1	0
35	9	25	0.636	2	0
36	11	26	0.636	2	0
37	7	14	0.450	1	0
42	14	18	2.320	1	0
43	18	8	0.450	1	0
44	31	19	0.850	1	0
45	32	20	0.850	1	0
48	34	32	0.720	4	90
49	34	35	0.410	1	0
50	34	36	0.410	1	0
51	35	5	1.120	1	0
52	36	7	1.120	1	0
53	35	32	0.639	4	0
54	36	32	0.639	4	0
55	33	31	0.720	4	90
56	33	37	0.410	1	0
57	33	38	0.410	1	0
58	37	6	1.120	1	0
59	38	8	1.120	1	0
60	37	31	0.639	4	0
61	38	31	0.639	4	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
4	Rect 0.08x0.04	28.800	31.104	153.600	89.265	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
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)
13	UNI kN/m	GY	-0.390	-	-	-	-
33	UNI kN/m	GY	-0.390	-	-	-	-
34	UNI kN/m	GY	-0.390	-	-	-	-
37	UNI kN/m	GY	-0.390	-	-	-	-
42	UNI kN/m	GY	-0.390	-	-	-	-
43	UNI kN/m	GY	-0.390	-	-	-	-
49	UNI kN/m	GY	-0.090	-	-	-	-
50	UNI kN/m	GY	-0.090	-	-	-	-
51	UNI kN/m	GY	-0.090	-	-	-	-
52	UNI kN/m	GY	-0.090	-	-	-	-
56	UNI kN/m	GY	-0.090	-	-	-	-
57	UNI kN/m	GY	-0.090	-	-	-	-
58	UNI kN/m	GY	-0.090	-	-	-	-
59	UNI kN/m	GY	-0.090	-	-	-	-

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)
13	UNI kN/m	GY	-0.390	-	-	-	-
33	UNI kN/m	GY	-0.390	-	-	-	-
34	UNI kN/m	GY	-0.390	-	-	-	-
37	UNI kN/m	GY	-0.390	-	-	-	-
42	UNI kN/m	GY	-0.390	-	-	-	-
43	UNI kN/m	GY	-0.390	-	-	-	-
49	UNI kN/m	GY	-0.090	-	-	-	-
50	UNI kN/m	GY	-0.090	-	-	-	-
51	UNI kN/m	GY	-0.090	-	-	-	-
52	UNI kN/m	GY	-0.090	-	-	-	-
56	UNI kN/m	GY	-0.090	-	-	-	-
57	UNI kN/m	GY	-0.090	-	-	-	-
58	UNI kN/m	GY	-0.090	-	-	-	-
59	UNI kN/m	GY	-0.090	-	-	-	-

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

Beam	Type	Direction	Fa	Da (m)	Fb	Db	Ecc. (m)
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	1.170	-	-	-	-
33	UNI kN/m	Y	1.170	-	-	-	-
34	UNI kN/m	Y	1.170	-	-	-	-
37	UNI kN/m	Y	1.790	-	-	-	-
42	UNI kN/m	Y	1.790	-	-	-	-
43	UNI kN/m	Y	1.790	-	-	-	-
49	UNI kN/m	Y	0.260	-	-	-	-
50	UNI kN/m	Y	0.390	-	-	-	-
51	UNI kN/m	Y	0.260	-	-	-	-
52	UNI kN/m	Y	0.390	-	-	-	-
56	UNI kN/m	Y	0.260	-	-	-	-
57	UNI kN/m	Y	0.390	-	-	-	-
58	UNI kN/m	Y	0.260	-	-	-	-
59	UNI kN/m	Y	0.390	-	-	-	-

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

Beam	Type	Direction	Fa	Da (m)	Fb	Db	Ecc. (m)
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	1.840	-	-	-	-
33	UNI kN/m	Y	1.840	-	-	-	-
34	UNI kN/m	Y	1.840	-	-	-	-
37	UNI kN/m	Y	1.840	-	-	-	-
42	UNI kN/m	Y	1.840	-	-	-	-
43	UNI kN/m	Y	1.840	-	-	-	-
49	UNI kN/m	Y	0.400	-	-	-	-
50	UNI kN/m	Y	0.400	-	-	-	-
51	UNI kN/m	Y	0.400	-	-	-	-
52	UNI kN/m	Y	0.400	-	-	-	-
56	UNI kN/m	Y	0.400	-	-	-	-
57	UNI kN/m	Y	0.400	-	-	-	-
58	UNI kN/m	Y	0.400	-	-	-	-
59	UNI kN/m	Y	0.400	-	-	-	-

Reactions

		Horizontal	Vertical	Horizontal	Moment		
Node	L/C	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
1	1:PERMANEN	0.186	0.944	0.009	0.000	0.000	0.000
	2:IMPOSED A(	0.178	0.766	0.005	0.000	0.000	0.000
	3:DESIGN WIN	-0.535	-2.560	-0.317	0.000	0.000	0.000
	5:DESIGN WIN	-1.092	-3.667	-0.023	0.000	0.000	0.000
	101:1.35G	0.251	1.275	0.012	0.000	0.000	0.000
	102:1.2G + 1.5	0.490	2.282	0.018	0.000	0.000	0.000
	103:1.2G + WL	-0.312	-1.427	-0.307	0.000	0.000	0.000
	105:1.2G + WL	-0.869	-2.534	-0.012	0.000	0.000	0.000
	107:0.9G + WL	-0.368	-1.710	-0.310	0.000	0.000	0.000
	109:0.9G + WL	-0.925	-2.817	-0.015	0.000	0.000	0.000
	201:0.7Q	0.125	0.536	0.004	0.000	0.000	0.000
	202:G + 0.4Q	0.257	1.251	0.011	0.000	0.000	0.000
	203:G + WS (S	-0.178	-0.796	-0.207	0.000	0.000	0.000
	205:G + WS (S	-0.557	-1.549	-0.007	0.000	0.000	0.000
2	1:PERMANEN	-0.186	0.944	0.009	0.000	0.000	0.000
	2:IMPOSED A(	-0.178	0.766	0.005	0.000	0.000	0.000
	3:DESIGN WIN	0.535	-2.560	-0.317	0.000	0.000	0.000
	5:DESIGN WIN	0.588	-3.338	-0.023	0.000	0.000	0.000
	101:1.35G	-0.251	1.275	0.012	0.000	0.000	0.000
	102:1.2G + 1.5	-0.490	2.282	0.018	0.000	0.000	0.000
	103:1.2G + WL	0.312	-1.427	-0.307	0.000	0.000	0.000
	105:1.2G + WL	0.365	-2.205	-0.013	0.000	0.000	0.000
	107:0.9G + WL	0.368	-1.710	-0.310	0.000	0.000	0.000
	109:0.9G + WL	0.421	-2.488	-0.015	0.000	0.000	0.000
	201:0.7Q	-0.125	0.536	0.004	0.000	0.000	0.000

Reactions Cont...

		Horizontal	Vertical	Horizontal	Moment		
Node	L/C	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
	202:G + 0.4Q	-0.257	1.251	0.011	0.000	0.000	0.000
	203:G + WS (S	0.178	-0.796	-0.207	0.000	0.000	0.000
	205:G + WS (S	0.214	-1.326	-0.007	0.000	0.000	0.000
3	1:PERMANEN	0.186	0.944	-0.009	0.000	0.000	0.000
	2:IMPOSED A(	0.178	0.766	-0.005	0.000	0.000	0.000
	3:DESIGN WIN	-0.816	-3.083	-0.280	0.000	0.000	0.000
	5:DESIGN WIN	-1.092	-3.667	0.023	0.000	0.000	0.000
	101:1.35G	0.251	1.275	-0.012	0.000	0.000	0.000
	102:1.2G + 1.5	0.490	2.282	-0.018	0.000	0.000	0.000
	103:1.2G + WL	-0.594	-1.950	-0.291	0.000	0.000	0.000
	105:1.2G + WL	-0.869	-2.534	0.012	0.000	0.000	0.000
	107:0.9G + WL	-0.649	-2.233	-0.288	0.000	0.000	0.000
	109:0.9G + WL	-0.925	-2.817	0.015	0.000	0.000	0.000
	201:0.7Q	0.125	0.536	-0.004	0.000	0.000	0.000
	202:G + 0.4Q	0.257	1.251	-0.011	0.000	0.000	0.000
	203:G + WS (S	-0.369	-1.152	-0.199	0.000	0.000	0.000
	205:G + WS (S	-0.557	-1.549	0.007	0.000	0.000	0.000
4	1:PERMANEN	-0.186	0.944	-0.009	0.000	0.000	0.000
	2:IMPOSED A(	-0.178	0.766	-0.005	0.000	0.000	0.000
	3:DESIGN WIN	0.816	-3.083	-0.280	0.000	0.000	0.000
	5:DESIGN WIN	0.588	-3.338	0.023	0.000	0.000	0.000
	101:1.35G	-0.251	1.275	-0.012	0.000	0.000	0.000
	102:1.2G + 1.5	-0.490	2.282	-0.018	0.000	0.000	0.000
	103:1.2G + WL	0.594	-1.950	-0.291	0.000	0.000	0.000
	105:1.2G + WL	0.365	-2.205	0.013	0.000	0.000	0.000
	107:0.9G + WL	0.649	-2.233	-0.288	0.000	0.000	0.000
	109:0.9G + WL	0.421	-2.488	0.015	0.000	0.000	0.000
	201:0.7Q	-0.125	0.536	-0.004	0.000	0.000	0.000
	202:G + 0.4Q	-0.257	1.251	-0.011	0.000	0.000	0.000
	203:G + WS (S	0.369	-1.152	-0.199	0.000	0.000	0.000
	205:G + WS (S	0.214	-1.326	0.007	0.000	0.000	0.000

Reaction Summary

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
Max FX	4	3:DESIGN WIN	**0.816**	-3.083	-0.280	0.000	0.000	0.000
Min FX	1	5:DESIGN WIN	**-1.092**	-3.667	-0.023	0.000	0.000	0.000
Max FY	1	102:1.2G + 1.5	0.490	**2.282**	0.018	0.000	0.000	0.000
Min FY	1	5:DESIGN WIN	-1.092	**-3.667**	-0.023	0.000	0.000	0.000
Max FZ	4	5:DESIGN WIN	0.588	-3.338	**0.023**	0.000	0.000	0.000
Min FZ	1	3:DESIGN WIN	-0.535	-2.560	**-0.317**	0.000	0.000	0.000
Max MX	1	1:PERMANEN	0.186	0.944	0.009	**0.000**	0.000	0.000
Min MX	1	1:PERMANEN	0.186	0.944	0.009	**0.000**	0.000	0.000
Max MY	1	1:PERMANEN	0.186	0.944	0.009	0.000	**0.000**	0.000
Min MY	1	1:PERMANEN	0.186	0.944	0.009	0.000	**0.000**	0.000
Max MZ	1	1:PERMANEN	0.186	0.944	0.009	0.000	0.000	**0.000**
Min MZ	1	1:PERMANEN	0.186	0.944	0.009	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.

				Axial	Shear		Torsion	Bending	
	Beam	L/C	d	Fx	Fy	Fz	Mx	My	Mz
			(m)	(kN)	(kN)	(kN)	(kNm)	(kNm)	(kNm)
Max Fx	27	102:1.2G + 1.5	0.000	**2.724**	-0.046	-0.002	0.000	0.001	0.102
Min Fx	26	109:0.9G + WL	0.636	**-4.406**	0.156	-0.003	0.000	-0.000	-0.261
Max Fy	12	107:0.9G + WL	0.000	-0.245	**1.933**	0.460	-0.008	-0.278	0.930
Min Fy	9	109:0.9G + WL	0.450	0.104	**-2.530**	-0.027	-0.007	-0.032	-0.066
Max Fz	10	103:1.2G + WL	0.450	-0.226	-1.768	**0.514**	0.007	-0.062	-0.055
Min Fz	5	107:0.9G + WL	0.000	-1.710	0.368	**-0.310**	0.000	0.000	0.000
Max Mx	10	107:0.9G + WL	0.000	-0.245	-1.933	0.460	**0.008**	-0.278	-0.930
Min Mx	12	107:0.9G + WL	0.000	-0.245	1.933	0.460	**-0.008**	-0.278	0.930
Max My	10	109:0.9G + WL	0.450	0.104	-2.530	0.027	0.007	**0.032**	-0.066
Min My	5	107:0.9G + WL	1.650	-1.770	0.368	-0.112	-0.000	**-0.348**	-0.607
Max Mz	8	107:0.9G + WL	1.650	-2.293	-0.649	-0.090	-0.000	-0.312	**1.071**
Min Mz	5	109:0.9G + WL	1.650	-2.877	0.727	-0.015	-0.000	-0.025	**-1.363**

Beam Maximum Forces by Section Property

		Axial	Shear		Torsion	Bending	
Section		Max Fx	Max Fy	Max Fz	Max Mx	Max My	Max Mz
		(kN)	(kN)	(kN)	(kNm)	(kNm)	(kNm)
Rect 0.12x0.04	Max +ve	2.553	1.654	0.023	0.001	0.005	0.502
	Max -ve	-1.469	-1.876	-0.023	-0.001	-0.007	-0.686
Rect 0.11x0.04	Max +ve	2.724	0.162	0.023	0.002	0.013	0.133
	Max -ve	-4.406	-0.053	-0.023	-0.002	-0.013	-0.261
COLUMN140X140	Max +ve	2.282	1.933	0.514	0.008	0.032	1.071
	Max -ve	-2.877	-2.530	-0.310	-0.008	-0.348	-1.363
Rect 0.08x0.04	Max +ve	0.332	0.086	0.001	0.000	0.001	0.041
	Max -ve	-0.395	-0.107	-0.001	-0.000	-0.001	-0.036

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.

				Axial	Shear		Torsion	Bending	
	Beam	Node	L/C	Fx	Fy	Fz	Mx	My	Mz
				(kN)	(kN)	(kN)	(kNm)	(kNm)	(kNm)
Max Fx	27	12	102:1.2G + 1.5	**2.724**	-0.046	-0.002	0.000	0.001	0.102
Min Fx	26	14	109:0.9G + WL	**-4.406**	0.156	-0.003	0.000	-0.000	-0.261
Max Fy	12	12	107:0.9G + WL	-0.245	**1.933**	0.460	-0.008	-0.278	0.930
Min Fy	9	5	109:0.9G + WL	0.104	**-2.530**	-0.027	-0.007	-0.032	-0.066
Max Fz	10	7	103:1.2G + WL	-0.226	-1.768	**0.514**	0.007	-0.062	-0.055
Min Fz	5	1	107:0.9G + WL	-1.710	0.368	**-0.310**	0.000	0.000	0.000
Max Mx	10	10	107:0.9G + WL	-0.245	-1.933	0.460	**0.008**	-0.278	-0.930
Min Mx	12	12	107:0.9G + WL	-0.245	1.933	0.460	**-0.008**	-0.278	0.930
Max My	10	7	109:0.9G + WL	0.104	-2.530	0.027	0.007	**0.032**	-0.066
Min My	5	9	107:0.9G + WL	-1.770	0.368	-0.112	-0.000	**-0.348**	-0.607
Max Mz	8	12	107:0.9G + WL	-2.293	-0.649	-0.090	-0.000	-0.312	**1.071**
Min Mz	5	9	109:0.9G + WL	-2.877	0.727	-0.015	-0.000	-0.025	**-1.363**

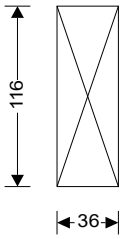
	Project				Job no.	
	Yardtopia Fremantle Gazebo (3x3.6m)				2024-023	
	Calcs for				Start page no./Revision	
	B1 Beam Design				1	
	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
	AN	18/12/2024				

TIMBER MEMBER DESIGN TO AS1720.1-2010

Tedds calculation version 1.5.05

Analysis results

Design moment in major axis	M^*_x = **0.686** kNm
Design shear	V^* = **1.880** kN
Design axial compression	N^*_c = **2.550** kN



Timber section details

Breadth of timber sections	b = **36** mm
Depth of timber sections	d = **116** mm
Number of timber sections in member	N = **1**
Overall breadth of timber member	b_b = N × b = **36** 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** mm
Effective length factor - Table 3.2	g_{13} = **1**
Distance between lateral restraints in major axis	L_{ax} = **2200** mm
Distance between lateral restraints in minor axis	L_{ay} = **900** mm

Section properties

Cross sectional area of member	A = N × b × d = **4176** mm^2
Section modulus	Z_x = N × b × d^2 / 6 = **80736** mm^3
	Z_y = d × (N × b)^2 / 6 = **25056** mm^3
Second moment of area	I_x = N × b × d^3 / 12 = **4682688** mm^4
	I_y = d × (N × b)^3 / 12 = **451008** mm^4
Radius of gyration	r_x = √(I_x / A) = **33.5** mm
	r_y = √(I_y / A) = **10.4** 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)	ρ_b = 14.71 × (E / f'_b)$^{-0.480}$ × $r^{-0.061}$ = **0.80**
Distance between discrete lateral restraints	L_{ay} = **900** mm L_{ay} / d < 64 × [N × b / (ρ_b × 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**

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) $S_3 = L_{ax} / d$ = **18.97**

Major axis comp.stability factor - exp.3.3(11b) $k_{12cx} = 1.5 - 0.05 \times \rho_c \times S_3$ = **0.68**

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 ϕ_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** kNm

PASS - Design capacity in bending exceeds design bending moment

Compressive strength - cl.3.3.1

Capacity factor - Table 2.1 ϕ_c = **0.9**

Cross-sectional area of member $A_c = N \times b \times d$ = **4176** mm^2

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

$\phi N_{cx} = \phi_c \times k_1 \times k_4 \times k_6 \times k_{12cx} \times f'_c \times A_c$ = **21.914** 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** 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)

$[M^*_x / \phi M_x]^2 + [N^*_c / \phi N_{cy}]$ = **0.804** < 1

$[M^*_x / \phi M_x] + [N^*_c / \phi N_{cx}]$ = **0.903** < 1

PASS - Beam design meets combined bending and compression criteria

Flexural shear strength - cl.3.2.5

Capacity factor - Table 2.1 ϕ_s = **0.9**

Shear plane area $A_s = N \times b \times d \times 2 / 3$ = **2784** 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** kN

PASS - Design shear capacity exceeds design shear force

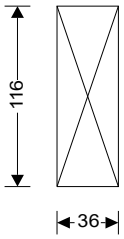
	Project				Job no.	
	Yardtopia Fremantle Gazebo (3x3.6m)				2024-023	
	Calcs for				Start page no./Revision	
	B2 Beam Design				1	
	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
	AN	18/12/2024				

TIMBER MEMBER DESIGN TO AS1720.1-2010

Tedds calculation version 1.5.05

Analysis results

Design moment in major axis	M^*_x = **0.147** kNm
Design shear	V^* = **0.284** kN
Design axial compression	N^*_c = **0.607** kN



Timber section details

Breadth of timber sections	b = **36** mm
Depth of timber sections	d = **116** mm
Number of timber sections in member	N = **1**
Overall breadth of timber member	b_b = N × b = **36** 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** mm
Effective length factor - Table 3.2	g_{13} = **1**
Distance between lateral restraints in major axis	L_{ax} = **1690** mm
Distance between lateral restraints in minor axis	L_{ay} = **900** mm

Section properties

Cross sectional area of member	A = N × b × d = **4176** mm^2
Section modulus	Z_x = N × b × d^2 / 6 = **80736** mm^3
	Z_y = d × (N × b)^2 / 6 = **25056** mm^3
Second moment of area	I_x = N × b × d^3 / 12 = **4682688** mm^4
	I_y = d × (N × b)^3 / 12 = **451008** mm^4
Radius of gyration	r_x = √(I_x / A) = **33.5** mm
	r_y = √(I_y / A) = **10.4** 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)	ρ_b = 14.71 × (E / f'_b)$^{-0.480}$ × $r^{-0.061}$ = **0.80**
Distance between discrete lateral restraints	L_{ay} = **900** mm L_{ay} / d < 64 × [N × b / (ρ_b × 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**

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) $S_3 = L_{ax} / d$ = **14.57**

Major axis comp.stability factor - exp.3.3(11b) $k_{12cx} = 1.5 - 0.05 \times \rho_c \times S_3$ = **0.87**

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 ϕ_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** kNm

PASS - Design capacity in bending exceeds design bending moment

Compressive strength - cl.3.3.1

Capacity factor - Table 2.1 ϕ_c = **0.9**

Cross-sectional area of member $A_c = N \times b \times d$ = **4176** mm^2

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

$\phi N_{cx} = \phi_c \times k_1 \times k_4 \times k_6 \times k_{12cx} \times f'_c \times A_c$ = **28.074** 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** 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)

$[M^*_x / \phi M_x]^2 + [N^*_c / \phi N_{cy}]$ = **0.073** < 1

$[M^*_x / \phi M_x] + [N^*_c / \phi N_{cx}]$ = **0.190** < 1

PASS - Beam design meets combined bending and compression criteria

Flexural shear strength - cl.3.2.5

Capacity factor - Table 2.1 ϕ_s = **0.9**

Shear plane area $A_s = N \times b \times d \times 2 / 3$ = **2784** 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** kN

PASS - Design shear capacity exceeds design shear force

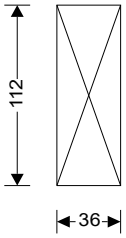
	Project				Job no.	
	Yardtopia Fremantle Gazebo (3x3.6m)				2024-023	
	Calcs for				Start page no./Revision	
	BR1 Knee Brace Design				1	
	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
	AN	18/12/2024				

TIMBER MEMBER DESIGN TO AS1720.1-2010

Tedds calculation version 1.5.05

Analysis results

Design moment in major axis	M^*_x = **0.260** kNm
Design shear	V^* = **0.160** kN
Design axial compression	N^*_c = **4.410** kN



Timber section details

Breadth of timber sections	b = **36** mm
Depth of timber sections	d = **112** mm
Number of timber sections in member	N = **1**
Overall breadth of timber member	b_b = N × b = **36** 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** mm
Effective length factor - Table 3.2	g_{13} = **1**
Distance between lateral restraints in major axis	L_{ax} = **800** mm
Distance between lateral restraints in minor axis	L_{ay} = **800** mm

Section properties

Cross sectional area of member	A = N × b × d = **4032** mm^2
Section modulus	Z_x = N × b × d^2 / 6 = **75264** mm^3
	Z_y = d × (N × b)^2 / 6 = **24192** mm^3
Second moment of area	I_x = N × b × d^3 / 12 = **4214784** mm^4
	I_y = d × (N × b)^3 / 12 = **435456** mm^4
Radius of gyration	r_x = √(I_x / A) = **32.3** mm
	r_y = √(I_y / A) = **10.4** 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)	ρ_b = 14.71 × (E / f'_b)$^{-0.480}$ × $r^{-0.061}$ = **0.80**
Distance between discrete lateral restraints	L_{ay} = **800** mm L_{ay} / d < 64 × [N × b / (ρ_b × 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**

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) $S_3 = L_{ax} / d$ = **7.14**

Major axis comp.stability factor - exp.3.3(11a) k_{12cx} = **1.00**

Minor axis slenderness coeff. - exp.3.3(8) & (9) $S_4 = \min(L_{ay} / (N \times b), g_{13} \times L_x / (N \times b))$ = **22.22**

Minor axis comp.stability factor - exp.3.3(11b) $k_{12cy} = 1.5 - 0.05 \times \rho_c \times S_4$ = **0.54**

Bending strength - cl.3.2.1

Capacity factor - Table 2.1 ϕ_b = **0.9**

Design capacity in major axis bending - cl.3.2(2) $\phi M_x = \phi_b \times k_1 \times k_4 \times k_6 \times k_9 \times k_{12bx} \times f'_b \times Z_x$ = **0.813** kNm

PASS - Design capacity in bending exceeds design bending moment

Compressive strength - cl.3.3.1

Capacity factor - Table 2.1 ϕ_c = **0.9**

Cross-sectional area of member $A_c = N \times b \times d$ = **4032** mm^2

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

$\phi N_{cx} = \phi_c \times k_1 \times k_4 \times k_6 \times k_{12cx} \times f'_c \times A_c$ = **31.208** 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** 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)

$[M^*_x / \phi M_x]^2 + [N^*_c / \phi N_{cy}]$ = **0.366** < 1

$[M^*_x / \phi M_x] + [N^*_c / \phi N_{cx}]$ = **0.461** < 1

PASS - Beam design meets combined bending and compression criteria

Flexural shear strength - cl.3.2.5

Capacity factor - Table 2.1 ϕ_s = **0.9**

Shear plane area $A_s = N \times b \times d \times 2 / 3$ = **2688** mm^2

Design shear capacity - exp.3.2(14) $\phi V = \phi_s \times k_1 \times k_4 \times k_6 \times f'_s \times A_s$ = **3.145** kN

PASS - Design shear capacity exceeds design shear force

v1.0

TIMBER DESIGN
(AS/NZS 1664.1)

Project No.	2024-023	Project Name	Yardtopia Fremantle Gazebo
Designed by	AN	Date	16 December 2024

SUMMARY OF RESULTS

Utilization Ratios:		
Compression	6.9%	
Bending, x-axis	53.4%	
Bending, y-axis	13.7%	**OK**
Combined Compression and Bending	35.4%	
Combined Tension and Bending	60.3%	

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 x-axis, I_{yy}	26,545,833	mm^4
Readius of gyration about buckling axis (X), r_x	48.05	mm
Readius 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	

TIMBER DESIGN
(AS/NZS 1664.1)

Project No.	2024-023	Project Name	Yardtopia Fremantle Gazebo
Designed by	AN	Date	16 December 2024

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	2.88	kN

Maximum bending moments

Bending about x-axis, M_x	1.36	kN-m
Bending about y-axis, M_y	0.35	kN-m

Maximum shear force, V	2.53	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 / $N_{d,c}$ =**	**6.9%**		

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

	$M_{d,x}$	**>**	**M_x**	**PASS**
Utilization Ratio	**M_x / $M_{d,x}$ =**	**53.4%**		

c. Bending about y-axis

$M_{d,y} = \phi k_1 k_4 k_6 k_9 k_{12by} f'_b Z_y$ $M_{d,x}$ = 2.55 kNm

	$M_{d,y}$	**>**	**M_y**	**PASS**
Utilization Ratio	**M_y / $M_{d,y}$ =**	**13.7%**		

TIMBER DESIGN
(AS/NZS 1664.1)

Project No.	2024-023	Project Name	Yardtopia Fremantle Gazebo
Designed by	AN	Date	16 December 2024

Combined Actions

f. Combined compression and bending

$$\left(\frac{M_x^*}{M_{d,x}}\right)^2 + \frac{N_c^*}{N_{d,cy}} = \mathbf{0.35} \quad \leq \mathbf{1.0} \quad \mathbf{PASS}$$

g. Combined tension and bending

$$\frac{M_x^*}{M_{d,x}} + \frac{N_c^*}{N_{d,cx}} = \mathbf{0.60} \quad \leq \mathbf{1.0} \quad \mathbf{PASS}$$

FOOTING DESIGN

v1.0

PILE DESIGN

Project No.	2024-023	Project Name	Yardtopia Fremantle Gazebo
Designed by	AN	Date	16 December 2024

SUMMARY OF RESULTS

Required Pile Size	**450mm dia. x 1200mm deep**	
Required Ultimate Bearing Capacity of Soil	**100 kPa**	
Utilization Ratios:		
Uplift	68.4%	**OK**
Soil Bearing Pressure	28.7%	

1. Pile Properties

Diameter, D	450	mm
Depth, L	1200	mm
Cross Sectional Area, A	0.16	m^2
Unit Weight of Concrete, γ_{conc}	24	kN/m^3
Unit Weight of Soil, γ_{soil}	18	kN/m^3
Ultimate Bearing Capacity of Soil, B_n	100	kPa

2. Design Forces and Stresses

Maximum support reactions

Tension, T	2.82	kN
Compression, P	2.28	kN

3. Check against uplift

Strength reduction factor (concrete), Φ_{conc}		0.9			
Factored Weight of Concrete, ΦW_{conc}		4.12	kN		
	ΦW_{conc}	**>**		**T**	**PASS**
Utilization Ratio	**ΦW_{conc} / T =**	**68.4%**			

4. Check soil bearing capacity

Maximum bearing pressure in soil, p		14.34	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	**ΦB_n / p =**	**28.7%**			