Building Act 1993
Section 238(1)(a)
Building Regulations 2018
Regulation 126

CERTIFICATE OF COMPLIANCE FOR PROPOSED BUILDING WORK

This certificate is issued to Edco International Trading Corporation

Postal address:

Postcode

This certificate is issued in relation to the proposed building work at:

Various in the state Postcode

Nature of proposed building work

Construction of a *Gazebo (**3.62x3.30x2.78**)

*Storeys contained: 1

*Rise in storeys (for Class 2-9 building only):1

Version of BCA applicable to certificate: NCC Volume One 2019

AS1170, AS4100, AS/NZS1170.0, AS/NZS1170.1, AS/NZS1170.2, AS1720.1, AS1664

Building classification

Part of building: Gazebo **Class 10a**

Prescribed class of building work for which this certificate is issued: Structural Matter

Design or part of the design of building work relating to *Structural matter/*Sewage matter/*Water matter/* Drainage matter/*Mechanical (including hydraulic services within a building) matter/*Electrical matter/*Fire safety matter

Documents setting out the design that is certified by this certificate

Document no.	Document date	Type of document (e.g. drawings, computations, specifications, calculations etc.)	Number of pages	Prepared by
1	15-12-2021	STRUCTURAL DESIGN CALCULATIONS FOR Mullaloo Timber Look Gazebo (3.62x3.30x2.78) 15-12-2021	*29*	*OPS*

The design certified by this certificate complies with the following provisions of Building Act 1993, Building Regulations 2018 or National Construction Code

Act, Regulation or NCC	Section, Regulation, Part, Performance Requirement or other provision
NCC 2019 Volume 1,	Section B – Part B1 Structural provisions

*I prepared the design, or part of the design, set out in the documents listed above.

I certify that the design set out in the documents listed above complies with the provisions set out above.

I believe that I hold the required skills, experience and knowledge to issue this certificate and can demonstrate this if requested to do so.

Name: SALMAN AMJAD

Address: UNIT 157 / 61 KARALTA ROAD ERINA

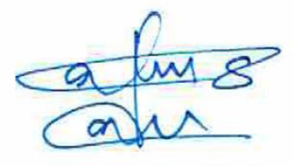
Email: info@oprojectservices.com

Endorsed Building Engineer Area of Engineering: Civil

Endorsed Building Engineer Registration No. PE0000901

Date of issue of certificate: 15/12/2021

Signature:



STRUCTURAL DESIGN CALCULATIONS

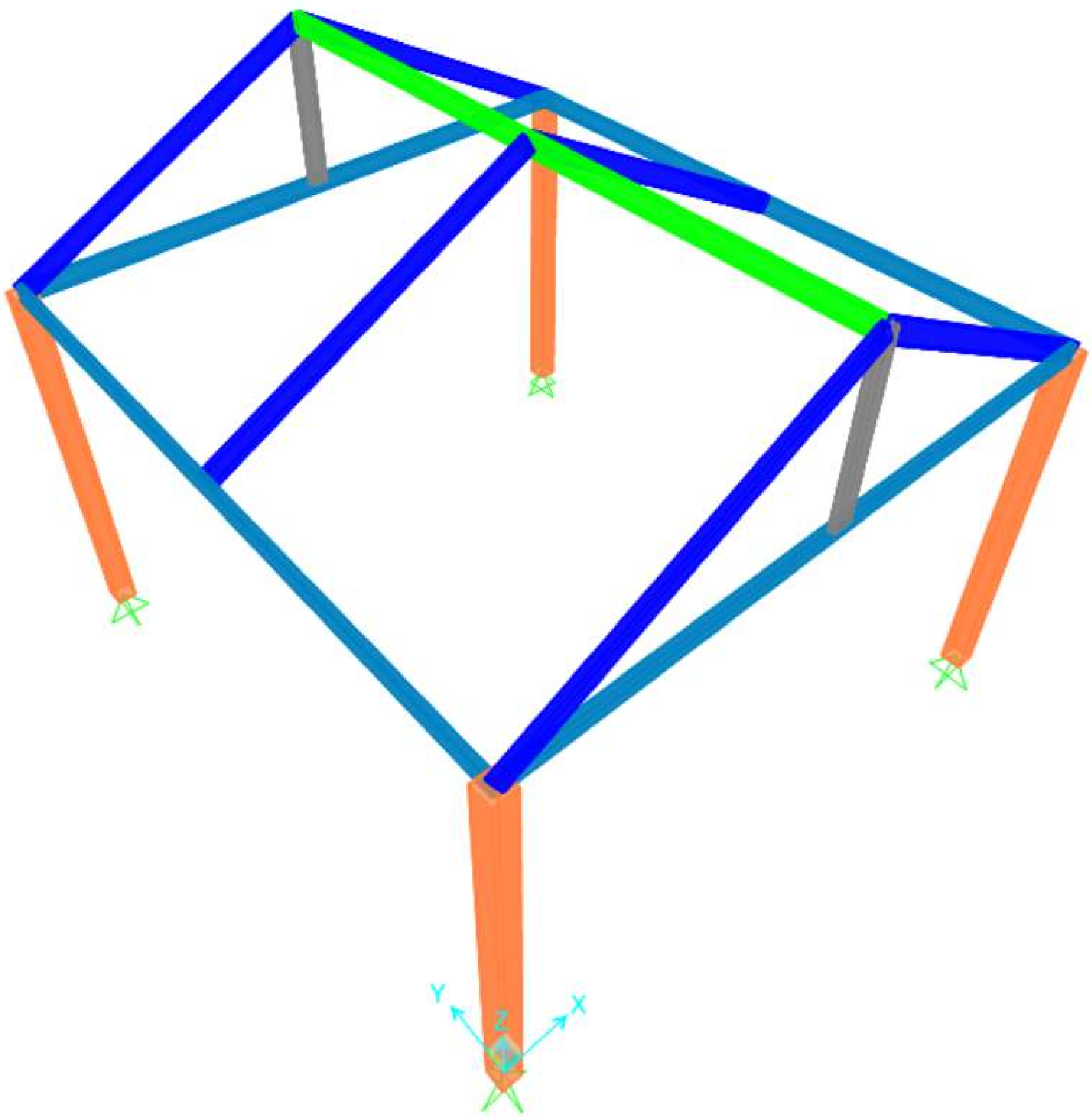
MIMOSA GAZEBO DESIGN

(3.62 x 3.30m)

MULLALOO TIMBER LOOK GAZEBO

PREPARED BY: **Engr. Salman Amjad**

1. 3D VIEW OF ANALYSIS MODEL


Y
Z
X

2. INPUT PARAMETERS

2.1. DESIGN LOADINGS & LOAD COMBINATIONS

Following floor loadings have considered for design;

Dead Loadings:	Self-weight of Elements
Wind Loadings:	**(Refer to below Wind Calculations)**
Load Combinations:	Dead Load
	Dead Load + Wind Load
	1.35 x Dead Load
	1.20 x Dead Load + 1.0 x Wind Load

2.2. MATERIAL STRENGTH

Following material strength have considered for design;

Material Properties of: Alloy 6063-T5

Compressive Yield Strength, f_{cy} = 110 MPa

Tensile Yield Strength, f_{ty} = 110 MPa

Tensile Ultimate Strength, f_{tu} = 152 MPa

Shear Ultimate Strength, f_{su} = 90 MPa

Refer to AS1664.1 table 3.3A

Design Code: AS1664

2.3. APPLIED LOADING

WIND PRESSURE CALCULATIONS

OMEGA PROJECT SERVICES Professional - Committed - Reliable	Job No:		Sheet:	
	Job Title:	GAZEBO DESIGN	Rev:	0
	Subject: WIND PRESSURE CALCULATION			
	Client: Mullaloo Timber Look Gazebo		Made By:	AA
			Checked By:	SA
			Date:	2/12/2021

Design Calculation sheet

WIND PRESSURE CALCULATION AS PER AS1170

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

Design Forces on Surface= $F = \sum(p_z\ A_z)$

where

p_z = design wind pressure in pascals (normal to the surface) at height z, calculated in Clause 2.4.1

NOTE: The sign convention for pressures leads to forces towards the surface for positive pressures and forces away from the surface for negative pressures.

A_z = a reference area, in square metres, at height z, upon which the pressure at that height (p_z) acts

REGIONAL WIND SPEED

TABLE 3.1

REGIONAL WIND SPEEDS

Regional wind speed (m/s)	Region				
	Non-cyclonic			Cyclonic	
	A (1 to 7)	W	B	C	D
V_1	30	34	26	$23\times F_C$	$23\times F_D$
V_5	32	39	28	$33\times F_C$	$35\times F_D$
V_{10}	34	41	33	$39\times F_C$	$43\times F_D$
V_{20}	37	43	38	$45\times F_C$	$51\times F_D$
V_{25}	37	43	39	$47\times F_C$	$53\times F_D$
V_{50}	39	45	44	$52\times F_C$	$60\times F_D$
V_{100}	41	47	48	$56\times F_C$	$66\times F_D$
V_{200}	43	49	52	$61\times F_C$	$72\times F_D$
V_{250}	43	49	53	$62\times F_C$	$74\times F_D$
V_{500}	45	51	57	$66\times F_C$	$80\times F_D$
V_{1000}	46	53	60	$70\times F_C$	$85\times F_D$
V_{2000}	48	54	63	$73\times F_C$	$90\times F_D$
V_{2500}	48	55	64	$74\times F_C$	$91\times F_D$
V_{5000}	50	56	67	$78\times F_C$	$95\times F_D$
V_{10000}	51	58	69	$81\times F_C$	$99\times F_D$
V_R ($R \geq 5$ years)	$67-41R^{-0.1}$	$104-70R^{-0.045}$	$106-92R^{-0.1}$	$F_C\ (122-104R^{-0.1})$	$F_D\ (156-142R^{-0.1})$

V100 =	48.0	m/s	Design Wind Speed
V25 =	39.0	m/s	Serviceiability Wind Speed

WIND PRESSURE CALCULATION AS PER AS1170

DESIGN WIND SPEED

Constants		
Density of air	1.2	kg/m^3
Location & Hazard Design		
Region Site Exposure Classification	B	Non-cyclonic
Average Recurrence Interval, R	100	years
Terrain category (TC)	1.00	
Probability of exceedance, P=1/R	0.01	
Regional wind speed, V_R	48.0	m/s
Site wind speed, V_site,β	48.0	m/s
Design wind speed, V_des,ϴ	48.0	m/s
Wind Speed Multipliers		
Wind direction multiplier, M_d	1.00	(Likely possible)
	0.99	(Largest possible)
Terrain/height multiplier, M_z,cat	1.00	
Shielding multiplier, M_s	1.00	
Terrain multiplier, M_t	1.00	

SERVICEIABILITY WIND SPEED

Constants		
Density of air	1.2	kg/m^3
Location & Hazard Design		
Region Site Exposure Classification	B	Non-cyclonic
Average Recurrence Interval, R	100	years
Terrain category (TC)	1.00	
Probability of exceedance, P=1/R	0.01	
Regional wind speed, V_R	39.0	m/s
Site wind speed, V_site,β	39.0	m/s
Design wind speed, V_des,ϴ	39.0	m/s
Wind Speed Multipliers		
Wind direction multiplier, M_d	1.00	(Likely possible)
	0.99	(Largest possible)
Terrain/height multiplier, M_z,cat	1.00	
Shielding multiplier, M_s	1.00	
Terrain multiplier, M_t	1.00	

WIND PRESSURE CALCULATION AS PER AS1170

WIND DIRECTIONALITY MULTIPLIER, Md

TABLE 3.2

WIND DIRECTION MULTIPLIER (M_d)

Cardinal directions	Region A1	Region A2	Region A3	Region A4	Region A5	Region A6	Region A7	Region W
N	0.90	0.80	0.85	0.90	1.00	0.85	0.90	1.00
NE	0.80	0.80	0.80	0.85	0.85	0.95	0.90	0.95
E	0.80	0.80	0.80	0.90	0.80	1.00	0.80	0.80
SE	0.80	0.95	0.80	0.90	0.80	0.95	0.90	0.90
S	0.85	0.90	0.80	0.95	0.85	0.85	0.90	1.00
SW	0.95	0.95	0.85	0.95	0.90	0.95	0.90	1.00
W	1.00	1.00	0.90	0.95	1.00	1.00	1.00	0.90
NW	0.95	0.95	1.00	0.90	0.95	0.95	1.00	0.95
Any direction	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Md = 1.00

TERRAIN/HEIGHT MULTIPLIER, Mz,cat

TABLE 4.1

TERRAIN/HEIGHT MULTIPLIERS FOR GUST WIND SPEEDS IN FULLY DEVELOPED TERRAINS—ALL REGIONS

Height (z) m	Terrain/height multiplier ($M_{z,cat}$)			
	Terrain category 1	Terrain category 2	Terrain category 3	Terrain category 4
≤3	0.99	0.91	0.83	0.75
5	1.05	0.91	0.83	0.75
10	1.12	1.00	0.83	0.75
15	1.16	1.05	0.89	0.75
20	1.19	1.08	0.94	0.75
30	1.22	1.12	1.00	0.80
40	1.24	1.16	1.04	0.85
50	1.25	1.18	1.07	0.90
75	1.27	1.22	1.12	0.98
100	1.29	1.24	1.16	1.03
150	1.31	1.27	1.21	1.11
200	1.32	1.29	1.24	1.16

NOTE: For intermediate values of height z and terrain category, use linear interpolation.

Terrain Catagorey= 1
Height, Z (m)= 3

Mz,cat= 1.00

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			Checked By:	SA
			Date:	2/12/2021

Design Calculation sheet

WIND PRESSURE CALCULATION AS PER AS1170

SHIELDING MULTIPLIER, Ms

Ms = 1.00

TOPOGRAPHIC MULTIPLIER, Mt

Mt = 1.00

DYNAMIC RESPONSE FACTOR, Cdyn

Cdyn = 1.00

EXTERNAL PRESSURE COEFFICENT

TABLE D5

NET PRESSURE COEFFICIENTS ($C_{p,n}$) FOR PITCHED FREE ROOFS—0.25 ≤ h/d ≤ 1 (see Figure D3)

Roof pitch (α) degrees	$\theta = 0°$			
	$C_{p,w}$		$C_{p,\ell}$	
	Empty under	Blocked under	Empty under	Blocked under
≤15	−0.3, 0.4	−1.2	−0.4, 0.0	−0.9
22.5	−0.3, 0.6	−0.9	−0.6, 0.0	−1.1
30	−0.3, 0.8	−0.5	−0.7, 0.0	−1.3

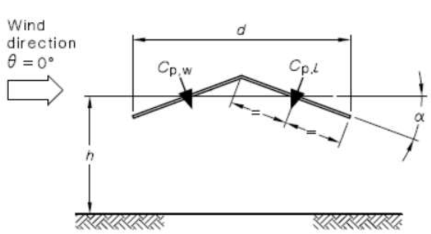

FIGURE D3 PITCHED FREE ROOFS

Roof Pressure Coefficent at WW, Cpww = (-0.3, 0.8)

Roof Pressure Coefficent at LW, Cplw = (-0.7, 0.0)

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Design Calculation sheet

WIND PRESSURE CALCULATION AS PER AS1170

AERO-DYNAMIC SHAPE FACTOR, C_{fig}

$C_{fig,e}$ = $C_{p,e}$ K_a $K_{c,e}$ K_l K_p

Area Reduction Factor, Ka = 1.0

External Combination Factor, Kc,e 1.0

Local Pressure Factor, Kl = 1.0

Net Porosity Factor, Kp = 1.0

$C_{fig,e}$ = 1.0

Design Wind Pressure, pu=

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

P u= $0.5 \times 1.2 \times 48^2 \times 1.0 \times 1.0 / 1000$

Pu = 1.382 kPa

Service Wind Pressure, ps=

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

Ps = $0.5 \times 1.2 \times 39^2 \times 1.0 \times 1.0 / 1000$

P s= 0.913 kPa

OMEGA PROJECT SERVICES Professional - Committed - Reliable	Job No:		Sheet:	
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	Subject: WIND PRESSURE CALCULATION			
	Client: Mullaloo Timber Look Gazebo		Made By:	AA
			Checked By:	SA
			Date:	2/12/2021

Design Calculation sheet

WIND PRESSURE CALCULATION AS PER AS1170

Applied Ultimate Wind Pressure, Wu=

Wu, wwroof =	**1.382 x - 0.3 = - 0.415 kPa**	**Case-1**	**Upward**
Wu, lwroof =	**1.382 x - 0.7 = - 0.97 kPa**	**Case-1**	**Upward**
Wu, wwroof =	**1.382 x 0.8 = + 1.11 kPa**	**Case-2**	**Downward**
Wu, lwroof =	**1.382 x 0.0 = + 0.00 kPa**	**Case-2**	**Downward**
Wu, wall =	**1.3 x 1.382 = 1.80 kPa**	**Both Cases**	**Side Wall**

Applied Service Wind Pressure, Ws=

Ws, wwroof =	**0.913 x - 0.3 = - 0.274 kPa**	**Case-1**	**Upward**
Ws, wwroof =	**0.913 x 0.8 = + 0.733 kPa**	**Case-2**	**Downward**
Ws, lwroof =	**0.913 x - 0.7 = - 0.64 kPa**	**Case-1**	**Upward**
Ws, lwroof =	**0.913 x 0.0 = + 0.00 kPa**	**Case-2**	**Downward**
Ws, wall =	**1.3 x 0.913 = 1.19 kPa**	**Both Cases**	**Side Wall**

Applied Member Loadings

Column Section= 110 x 110 x 1.2 SHS

Main Beam Section= 100 x 30 x 1.2 RHS

Secondary Beam Section= 100 x 30 x 1.2 RHS

a) Applied Ultimate Wind Loadings

Line Loading on Column = 1.80 x 0.110 =0.20 kN/m

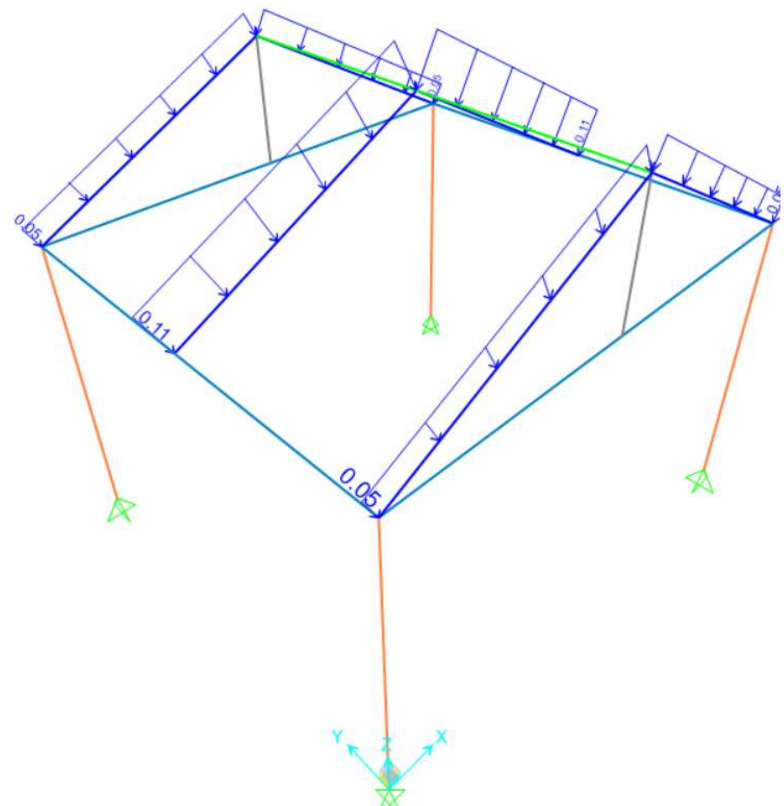
Line Loading on WW side for MB =	0.03 x -0.415 x 1.81 = - 0.023 kN/m	Case-1
Line Loading on LW side for MB =	0.03 x -0.97 x 1.81 = - 0.053 kN/m	Case-1
Line Loading on WW side for MB =	0.03 x 1.11 x 1.81 = 0.060 kN/m	Case-2
Line Loading on LW side for MB =	0.03 x 0.00 x 1.81 = 0.00 kN/m	Case-2
Line Loading on Side Beam =	1.11 x 0.10 =0.11 kN/m	

b) Applied Service Wind Loadings

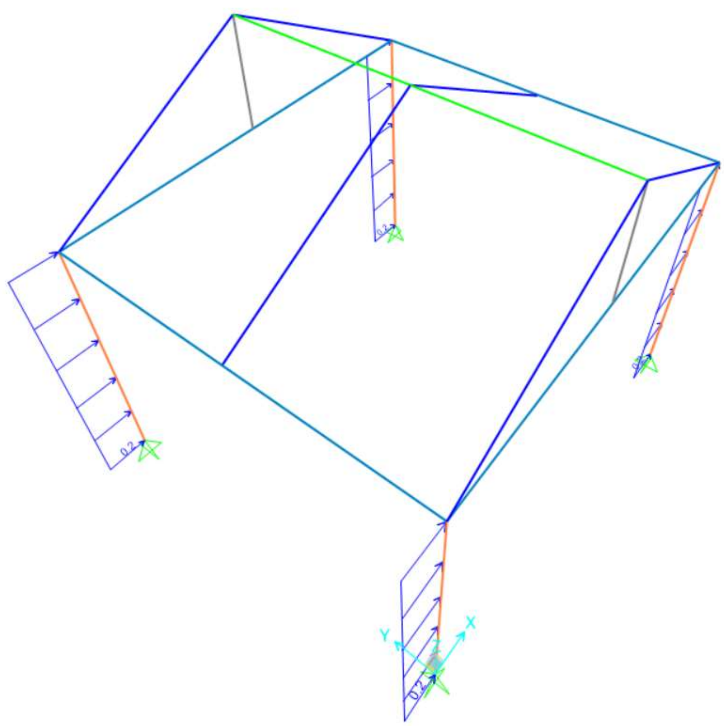
Line Loading on Column = 1.19 x 0.110 =0.13 kN/m

Line Loading on WW side for MB =	0.03 x -0.274 x 1.81= - 0.015 kN/m	Case-1
Line Loading on LW side for MB =	0.03 x -0.64 x 1.81 = - 0.034 kN/m	Case-1
Line Loading on WW side for MB =	0.03 x 0.733 x 1.81= 0.039 kN/m	Case-2
Line Loading on LW side for MB =	0.03 x 0.00 x 1.81 = 0.00 kN/m	Case-2
Line Loading on Side Beam =	0.733 x 0.10 =0.073 kN/m	

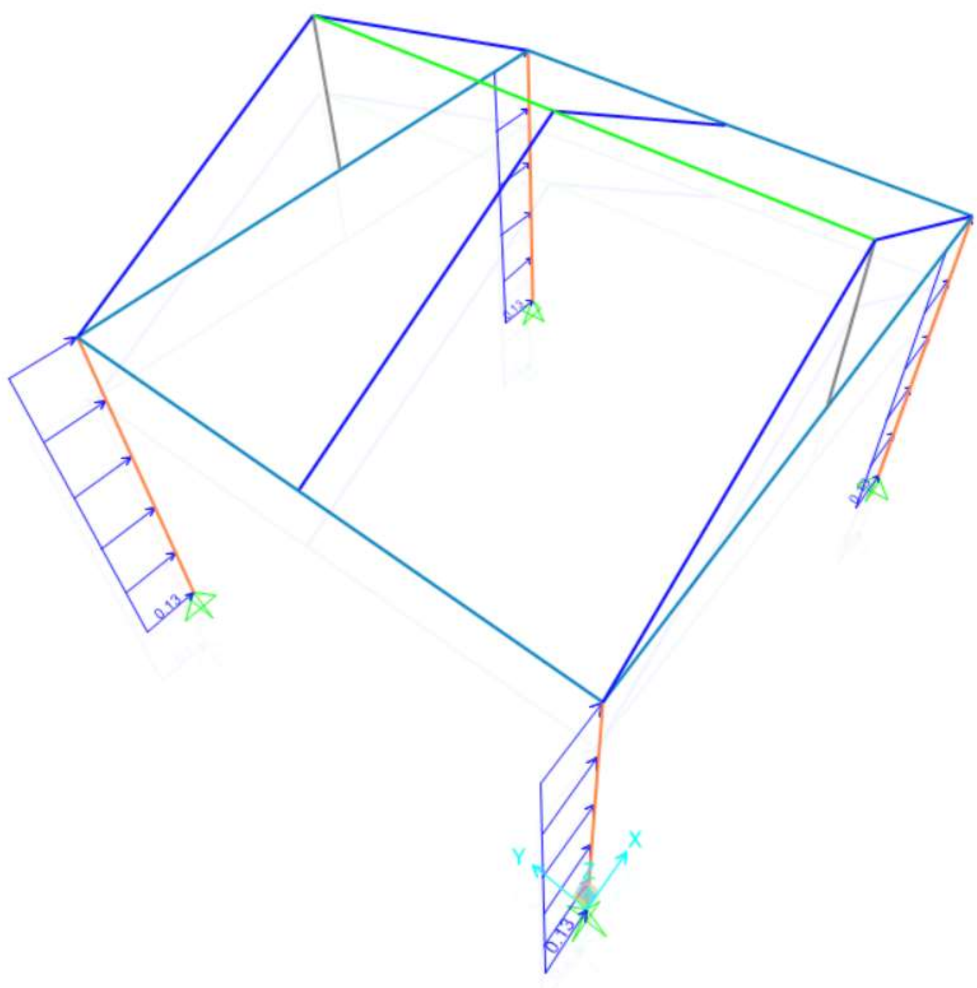
Applied Dead Loadings (kN/m)



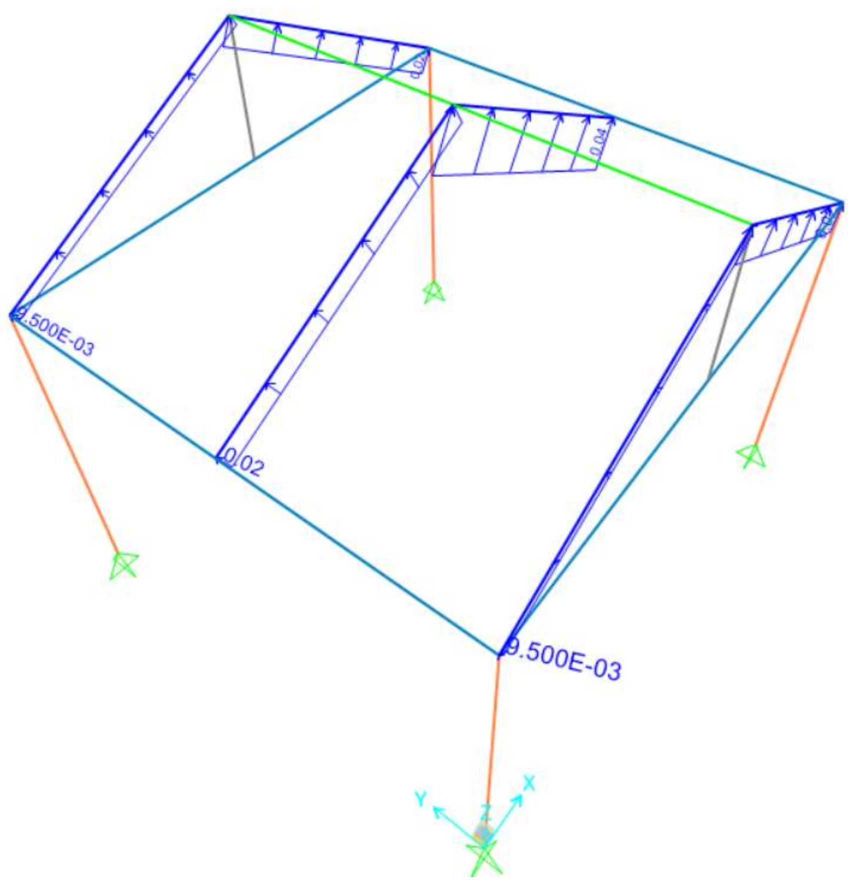
Ultimate Wind Loadings Applied on Sides (kN/m)



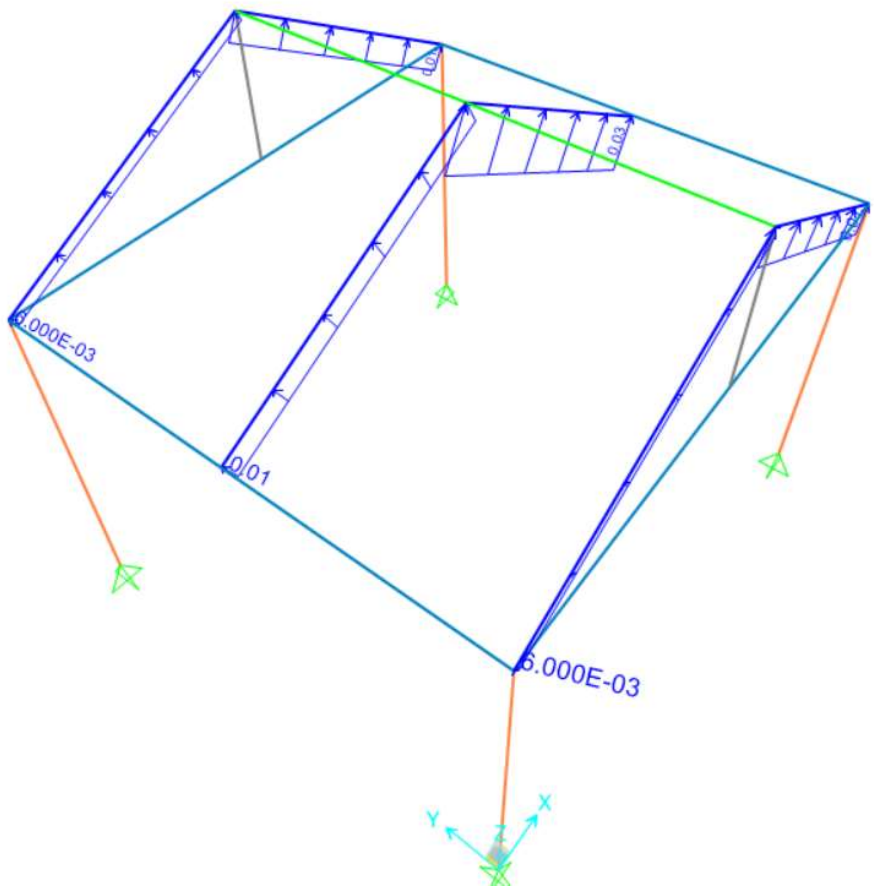
Service Wind Loadings Applied on Sides (kN/m)



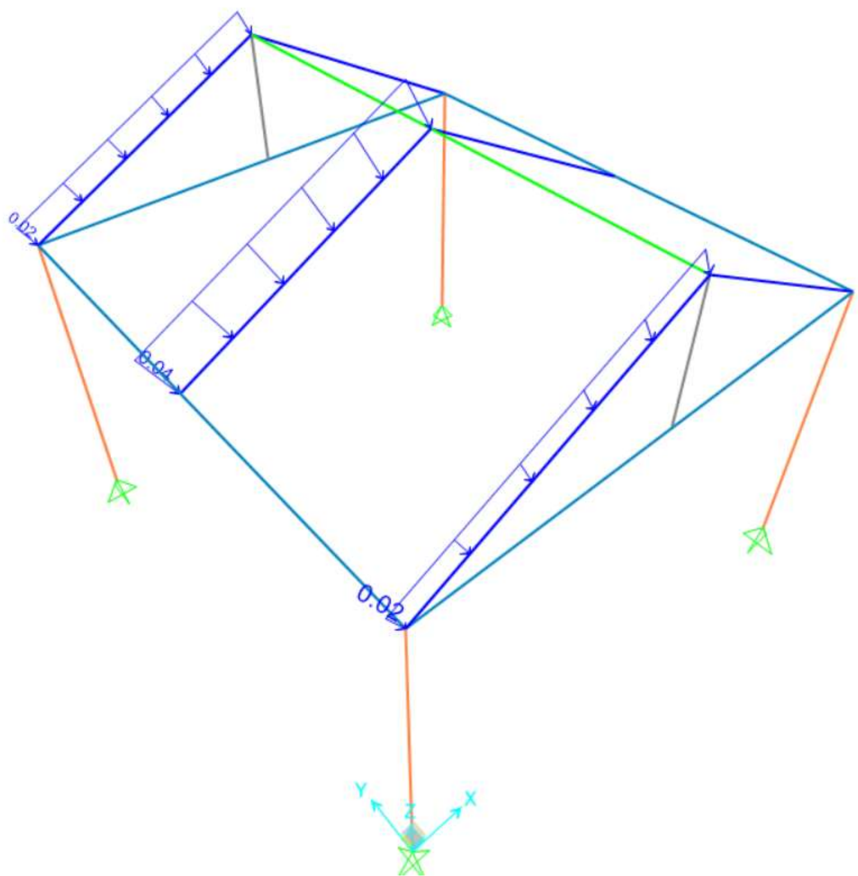
Ultimate Uplift Wind Loadings Applied on Roof (kN/m)



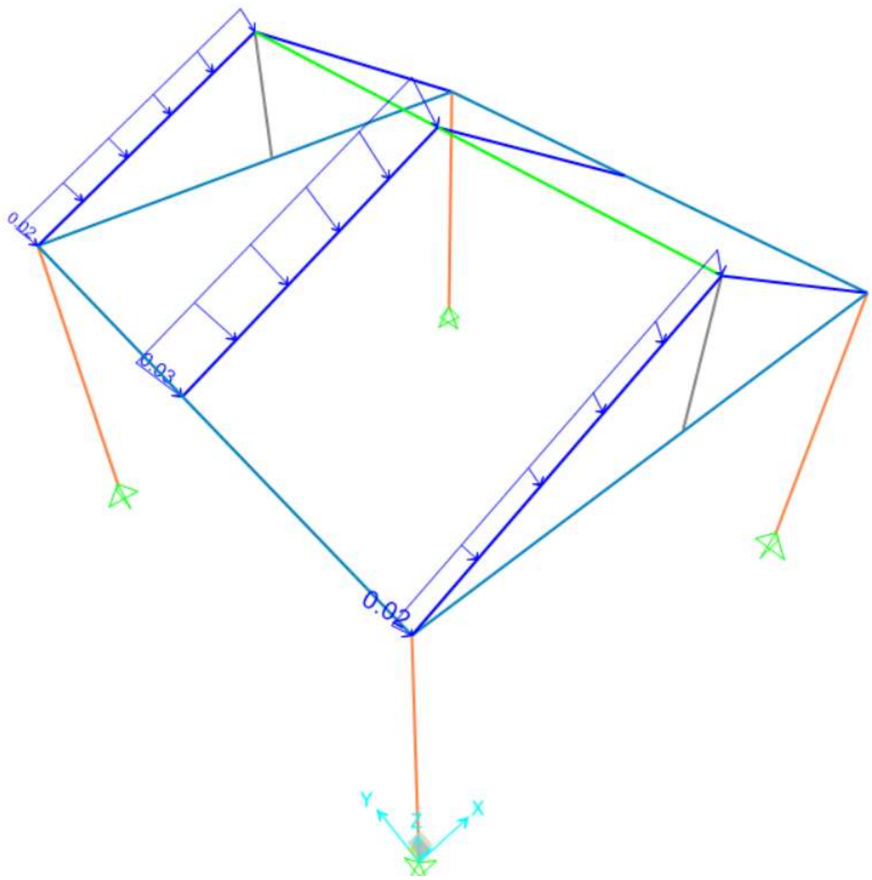
Service Uplift Wind Loadings Applied on Roof (kN/m)



Ultimate Downward Wind Loadings Applied on Roof (kN/m)



Service Downward Wind Loadings Applied on Roof (kN/m)



3. CRITICAL ELEMENTS DESIGN

3.1. BEAM DESIGN

Member Size = 100 x 30 x 1.2

Loading Span = 2.95m

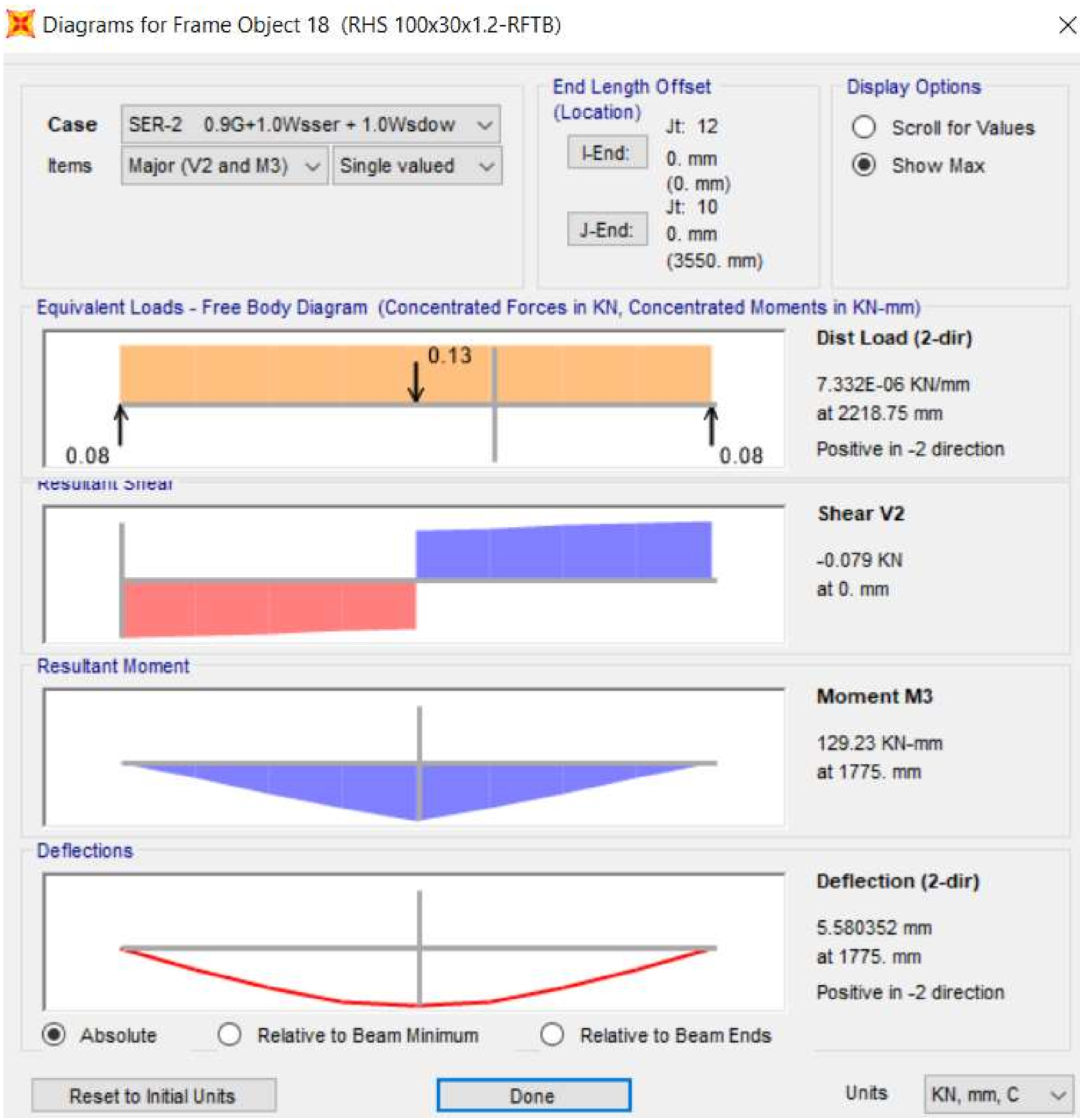
Panel Distributary Width = 1.475m

Dead Load = 0.07 kN/m^2

(From Self-weight of 100 x 30 x 1.2)

= 0.07 x 1.475 = 0.105 kN/m

A) DEFLECTION CHECK



Maximum Deflection Value, δ =5.56mm

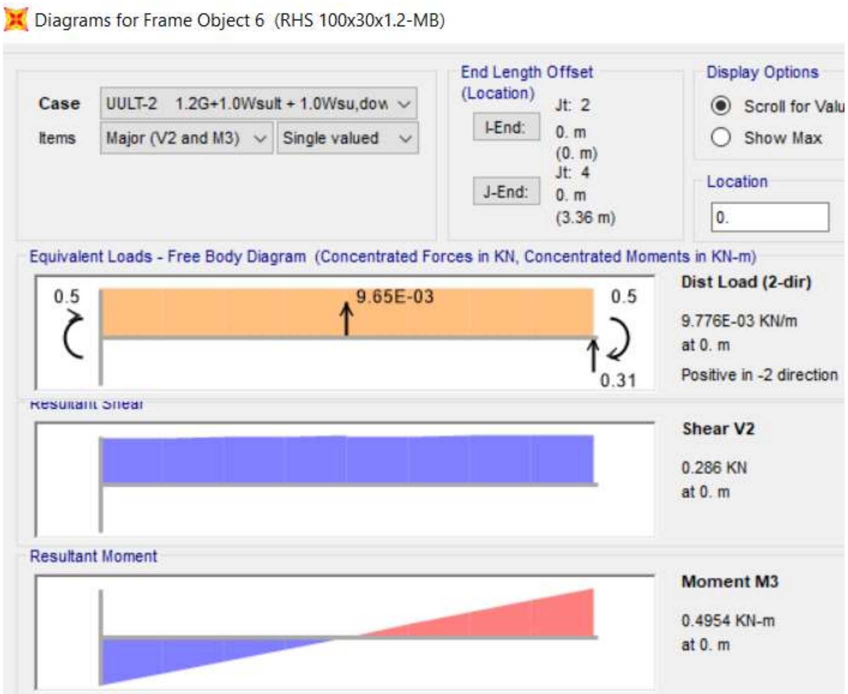
Allowable Deflection Limit = 3620/180 = 20.11mm

Allowable Deflection Limit = L/180

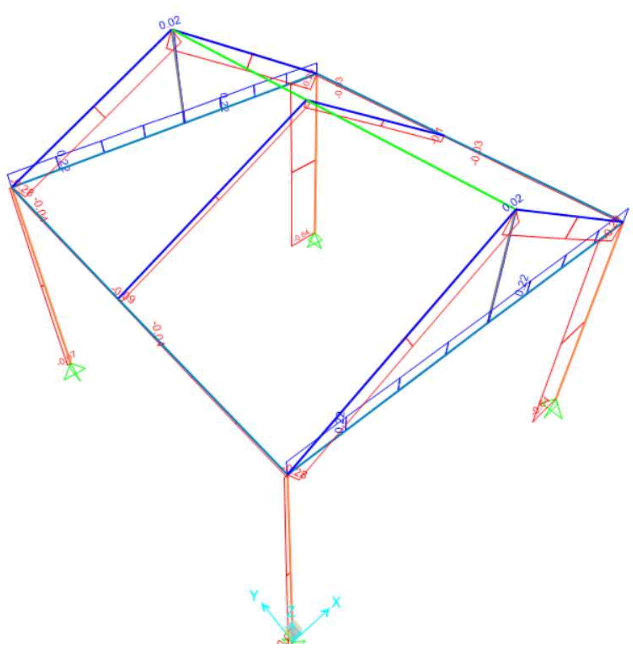
Therefore, member size (100 x 30 x 1.2) is adequate.

B) STRENGTH CHECK

MAJOR DIRECTION BENDING MOMENT AND SHEAR FORCE



AXIAL FORCE DIAGRAM



In conclusion, following are the design forces

Ultimate Bending Moment (Major Direction), Mu = 0.496 kN-m

Ultimate Shear Force (Major Direction), Vu = 0.310 kN

Ultimate Axial Force, Pu = 0.22 kN

C) Design Stresses Check

Bending Stress Check

Gross sectional area, Ag = 306 mm^2

In plane Elastic Section Modulus, Zy = 7233 mm^3

Stress from axial force = fa = P/Ag = 220 /306

= 0.719 MPa

Stress from in-plane fby = My/Zy = 0.496x 10^6/7233

= 68.57 MPa

Compression in beam Eq 3.4.15

Unsupported Length of Member, major = Lmaj = 3.60 m

Unsupported Length of Member, minor = Lmin = 3.60/23 = 0.156m

Effective length factor = k = 1

Radius of gyration about buckling axis (Y) = r_y = 34.36mm

Radius of gyration about buckling axis (z) = rz = 13.27mm

Slenderness ratio = kLb/r_y = 3620/34.36 = 105.35

Slenderness ratio = kLb/rz = 156/13.27 = 11.75

Bc = 119.3 MPa REFER AS1664.1 TABLE 3.3D

Dc = 0.492 MPa REFER AS1664.1 TABLE 3.3D

Cc = 99.38 REFER AS1664.1 TABLE 3.3D

S1 = 21.51

S2 = 3857.96

J = 152285 mm^4

Iy = 54000 mm^4

Zc = 9272 mm^3

Lb x Zc/[0.5 x (Iy x J)$^{1/2}$] = 0.67 < S1 Therefore

ϕFL = ϕ_b x Fcy

= 0.85 x 110 = 93.5 MPa > 68.57 MPa

Utilization Ratio = 68.57 / 93.5 = 0.733

Shear Stress Check

Clear depth = h	= 100mm
Thickness = t	= 1.2mm
h/t = 100/1.2	= 83.330

Bs = 72.83 REFER AS1664.1 TABLE 3.3

Ds = 0.232 REFER AS1664.1 TABLE 3.3

Cs = 128.47 REFER AS1664.1 TABLE 3.3

S1 =33.31 REFER AS1664.1 TABLE 3.3

ϕFL = ϕyFsy = 0.95 x 62 = 58.9 MPa

Shear Stress, v_u = 310 / (100 x 1.2 x 2) = 1.29 MPa

As Shear Stress, vu < ϕFL Therefore, the provided section is adequate.

3.2. COLUMN DESIGN

Member Size = 110 x 110 x 1.2

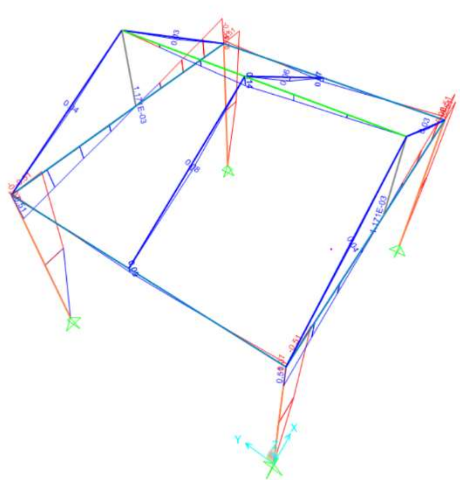
Member Span = 2.050 m

Design Forces

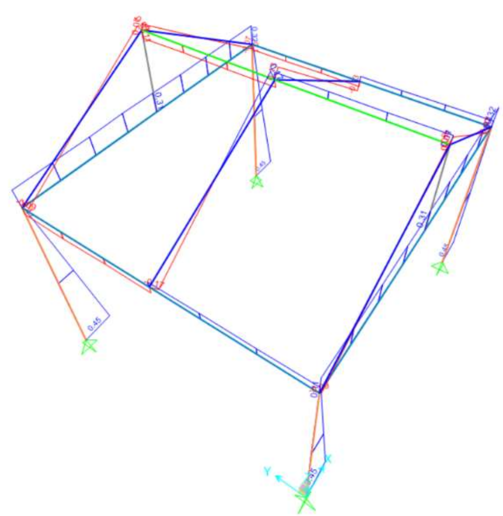
Ultimate Bending Moment (Major Direction), Mu = 0.495 kN-m

Ultimate Shear Force (Major Direction), Vu = 0.45 kN

Ultimate Axial Force, Pu = 0.64 kN



BENDING MOMENT DIAGRAM



SHEAR FORCE DIAGRAM

Bending Stress Check

Gross sectional area, Ag = 522 mm^2

In plane Elastic Section Modulus, Zy = 18735 mm^3

Stress from axial force = fa = P/Ag = 640 /522

= 1.225 MPa

Stress from in-plane fby = My/Zy = 0.51x 10^6/18735

= 26.42 MPa

Compression in beam Eq 3.4.15

Unsupported Length of Member, major = Lmaj = 2.050 m

Unsupported Length of Member, minor = Lmin = 2.050m

Effective length factor = k = 1

Radius of gyration about buckling axis (Y) = r_y = 44.42mm

Radius of gyration about buckling axis (z) = rz = 44.42mm

Slenderness ratio = kLb/r_y = 2050/44.42 = 46.15

Slenderness ratio = kLb/rz = 2050/44.42 = 46.15

Bc = 119.3 MPa REFER AS1664.1 TABLE 3.3D

Dc = 0.492 MPa REFER AS1664.1 TABLE 3.3D

Cc = 99.38 REFER AS1664.1 TABLE 3.3D

S1 = 21.51

S2 = 3857.96

J = 1545496 mm^4

$Iy = 1030456\ mm^4$

$Zc = 21308\ mm^3$

$Lb \times Zc/[0.5 \times (Iy \times J)^{1/2}]$ = S2 > 72.80 > S1 Therefore

$\phi FL = \phi_b \times Fcy$

$\phi FL = \phi b \times (Bc - 1.6Dc \times (Lb \times Zc/0.5 \times (Iy \times J)^{1/2})$

$\phi FL = 0.85 \times 61.4 = 52.18$ MPa

Total Stresses =1.225 + 26.42 = 27.65 MPa < 52.18 MPa

Therefore, the provided section is adequate.

Shear Stress Check

Clear depth = h	= 110mm
Thickness = t	= 1.2mm
h/t = 110/1.2	= 91.70

Bs = 75.83 REFER AS1664.1 TABLE 3.3

Ds = 0.242 REFER AS1664.1 TABLE 3.3

Cs = 128.47 REFER AS1664.1 TABLE 3.3

S1 =34.31 REFER AS1664.1 TABLE 3.3

$\phi FL = \phi yFsy$ = 0.95 x 62 = 58.9 MPa

Shear Stress, v_u = 640 / (110 x 1.2 x 2) = 2.42 MPa

As Shear Stress, vu < ϕFL Therefore, the provided section is adequate.

3.3. UTILIZATION RATIO FROM THE SOFTWARE