PORT OF NEWCASTLE

Advertising Signage Structures

Structural Feasibility Assessment Calculations

CLIENT

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A.1 Design Methodology

This report details the structural design of a proposed monopole structure which will carry two (2) signboxes (one for digital sign and another for static sign) for the Ultimate Limit State and Serviceability Limit State cases

Wind loading used in the assessment is as per AS 1170.2: 2021 with the appropriate factors and wind speed for the region.

The digital signbox loads were considered to be similar to the previous signage projects with the digital screen weight of 45 kg per sqm. The static sign box is assumed to carry signage weight of 0.1 kPa. Ladders and other accessories are added as superimposed dead loads on the structure. Live loads on the platform and ladder are also considered in accordance with AS1657.

The design check of the signbox members was done using the Microstran software. Steel connections were also checked using Limcon software and manual calculations for the supplementary local checks.

For the foundation, the monopole baseplate was checked using shell elements in ETABS. Baseplate bolts were checked in Hilti. The 4m x 4m x 0.8m pile cap was analysed using RAM Concept and designed using in-house spreadsheets for the Ultimate Limit State and Serviceability Limit States. A preliminary pile design was also checked in TEDDS based on assumed shaft resistance and end bearing capacity. Pile reactions used were based on the pile group analysis carried out using ETABS.

Lastly, the concrete pedestal was designed using RAPT software using the base reactions extracted from Microstran analysis.

A.2 Notes and Assumptions

The following notes and assumptions used in the assessment of the existing structure are listed below:

A.2.1. Section sizes of the previous digital signbox projects are adopted to support the digital sign box. The geometry of the static signbox is based on a similar project in City West Link. Due to the exposure of the structure to coastal environment, the minimum steel thickness used for the members is 4mm for durability considerations.

A.2.2. The pedestal and foundation geometry was adopted from the same signage project in City West Link, which consists of 4 750mm diameter piles and 4m x 4m x 0.8m pile cap. On top of the pile cap is a 1.4m x 1.4m pedestal which was assumed to be at most 900mm high. The average pile shaft resistance was assumed to be 30kPa and end bearing capacity to be 1.2MPa since no values were specified in the geotechnical report.

A.2.3. Due to the presence of Potential Acid Sulfate Soils, concrete grade of the concrete members was proposed to be minimum of 50MPa.

A.3 Summary of Results

All steel members for the digital and static signboxes are adequate for Ultimate Limit State and Serviceability Limit State. However, it should be noted that the member sizes of the static signbox were changed to SHS and RHS sections with at least 4mm thickness due to exposure to coastal environment.

For the monopole and support frame which will hold the signboxes, the steel sections used in the City West Link signage project can be adopted. It consists of a 610x12.7 CHS monopole and SHS/RHS sections welded to the top of the monopole which are also adequate for Ultimate Limit State and Serviceability Limit State.

All displacements were within the serviceability limit states specified in AS 1170.0.

The base plate, stiffeners, and anchors in the connection between the monopole and pedestal were checked and were found adequate.

For the pedestal, a 1400mm x 1400mm with assumed height of 900mm is adequate with N20-200 vertical bars each face and N16-200 ties.

The 4000mm x 4000mm x 800mm pile cap should be reinforced with N20-250 top and bottom bars in both directions. N16-250 links with 6 legs should also be provided.

Based on assumed 30kPa shaft resistance and 1.2MPa end bearing capacity, 4 nos. of 750mm circular piles with 10m embedment will be required.

B.1 Design Parameters

Steel Parameters

E = 200 000 MPa
Yield strength of plates = 250 MPa
Yield strength of hollow sections = 350 MPa
Yield strength of all other members = 300 MPa
Weld yield strength = 410 MPa

Design Codes and References

AS/NZS 1170.0-2002 Structural design actions - Part 0: General principles
AS/NZS 1170.1-2002 Structural design actions - Part 1: Permanent imposed and other actions
AS/NZS 1170.2-2021 Structural design actions - Part 2: Wind loads
AS 4100-2020 Steel Structures

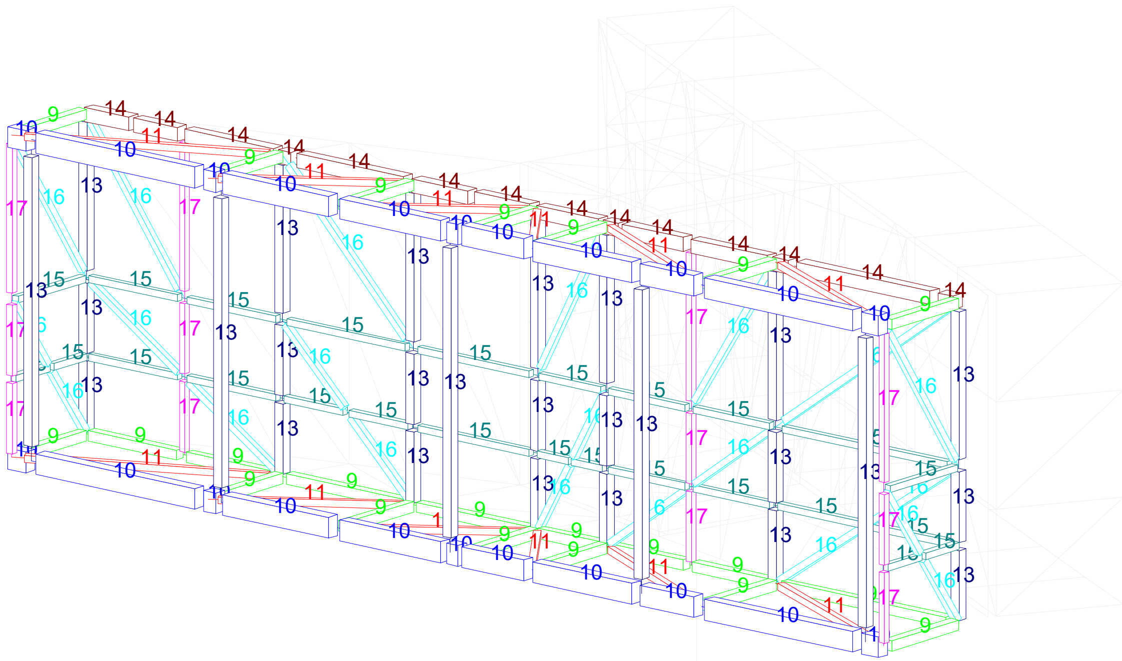
Load Combinations

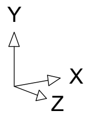
Load combinations are based on the requirements of AS1170.0.
Refer to Microstran Input (Section D.2) for load combinations used in this assessment.

B.2 MODEL GEOMETRY

Microstran
CONNECT Edition

Sections:
1 610.0X12.7CHS Y
2 125X75X6.0RHS Y
3 75X75X6.0SHS Y
4 125X75X6.0RHS Y
5 75X75X6.0SHS Y
7 50X50X5.0SHS Y
8 200X200X10.0SHS Y
9 75X75X5.0SHS Y
10 150X100X5.0RHS Y
11 50X50X4.0SHS Y
12 100X100X10.0SHS Y
13 75X75X5.0SHS Y
14 100X100X5.0SHS Y
15 50X50X4.0SHS Y
16 50X50X4.0SHS Y
17 50X50X4.0SHS Y
18 100X100X10.0SHS Y
19 65X35X4.0RHS Y
20 50X50X4.0SHS Y
21 65X35X4.0RHS Y
22 65X65X4.0SHS Y
23 50X50X4.0SHS Y
24 50X50X4.0SHS Y





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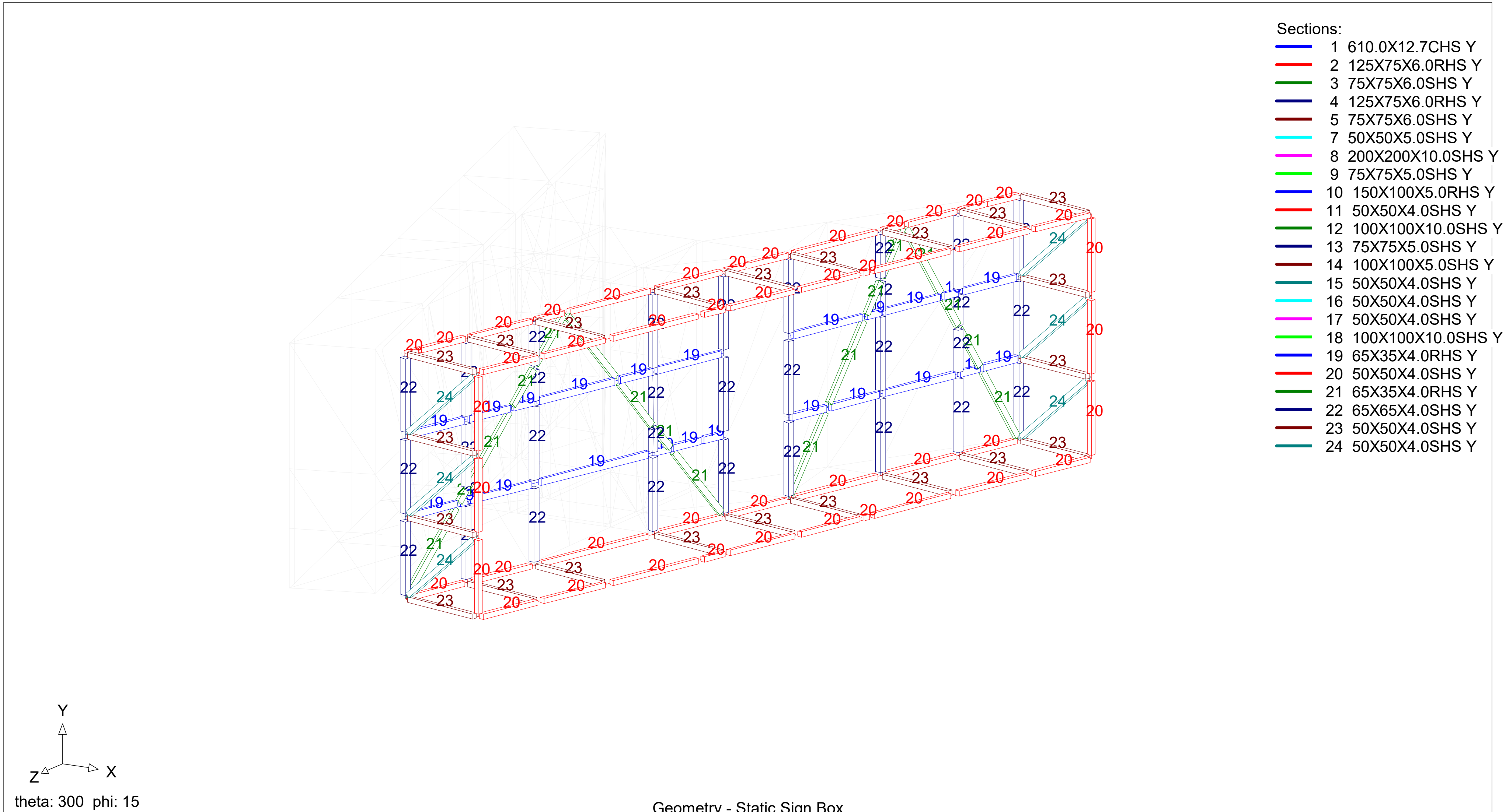
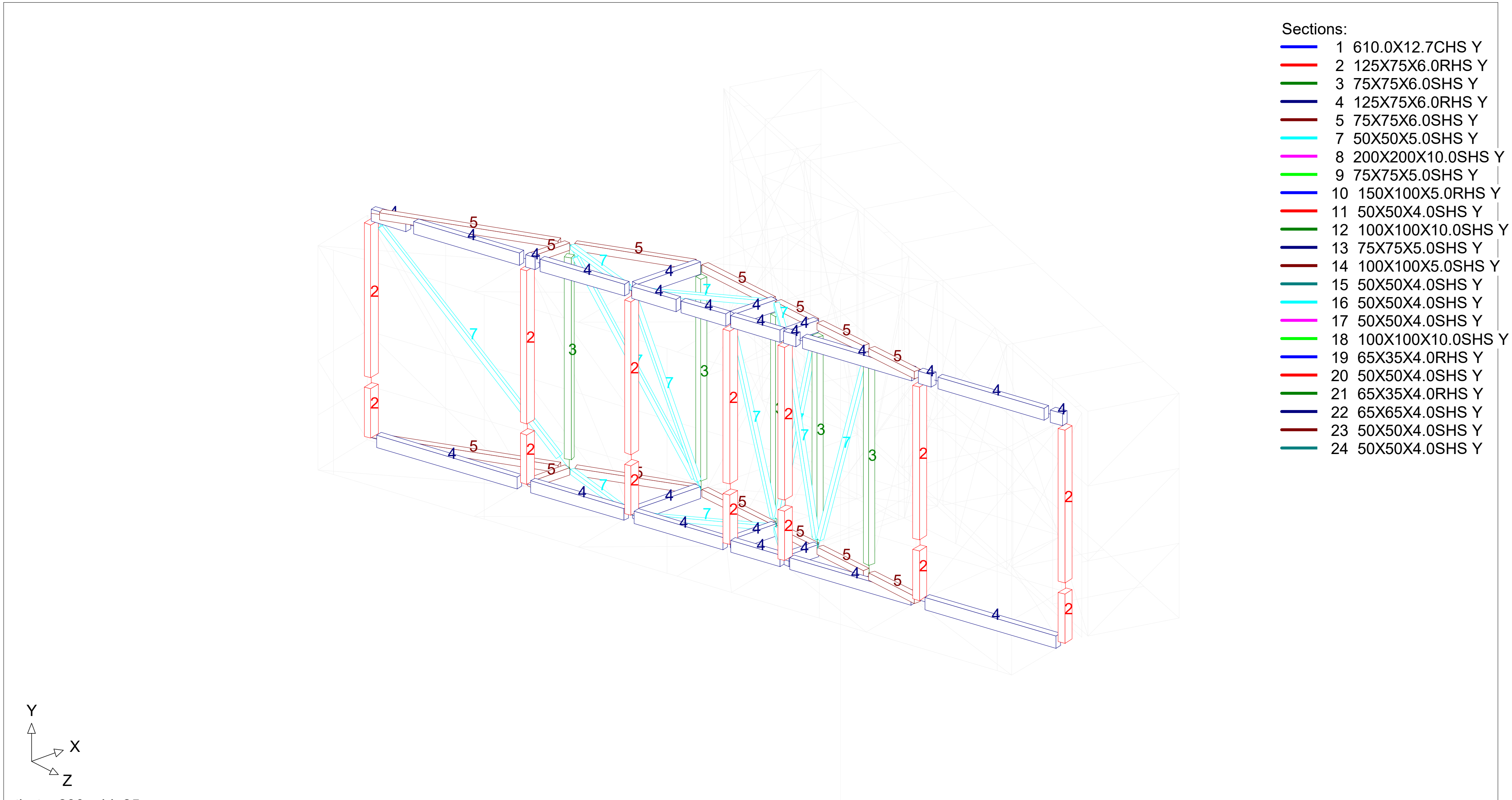
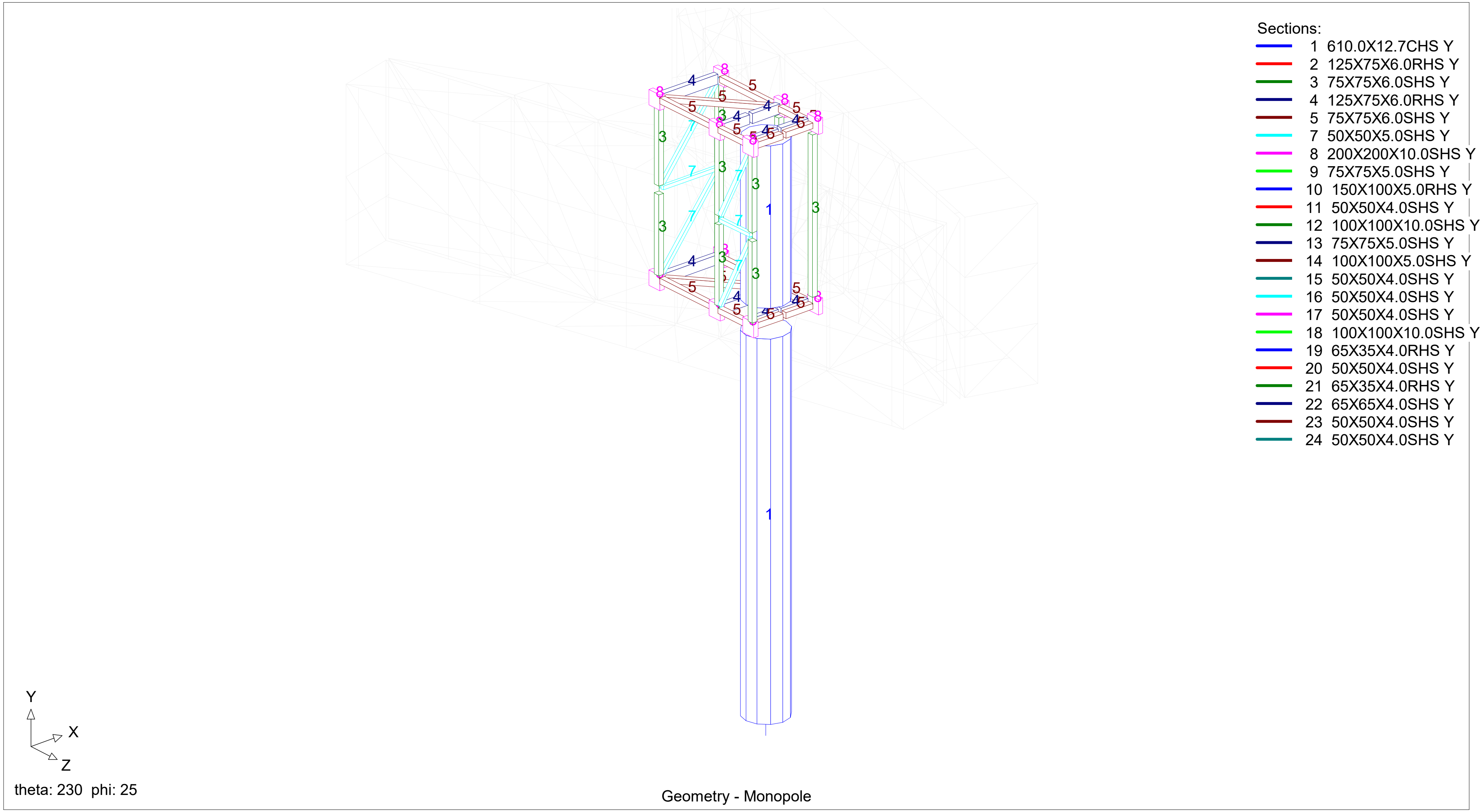
Geometry - Digital Sign Box



Geometry - Static Sign Box



Geometry - Back Support (Mirror on Other Side)



Geometry - Monopole

Wind Loading (AS/NZS 1170.2 : 2011)

Ultimate Design Wind Speed, V_{500}	=	44.62	m/s	for Mzcat = 0.97
Serviceability Design Wind Speed, V_{25}	=	35.89	m/s	
Wind Region	=	A2		
Topographic Multiplier, M_t	=	1		
Shielding Multiplier, M_s	=	1		
Terrain Category	=	2		
Importance Level	=	3		
Ultimate Regional Wind Speed, V_{1000}	=	46	1000 years Annual Probability	
Serviceability Regional Wind Speed, V_{25}	=	37	25 years Annual Probability	

Direction Multiplier, M_d

Wind Direction	Md
N	0.95
NE	0.8
E	0.8
SE	0.8
S	0.8
SW	0.95
W	1
NW	0.95

Use M_d = 1
Cfig = Cp,n
Cdyn = 1.0

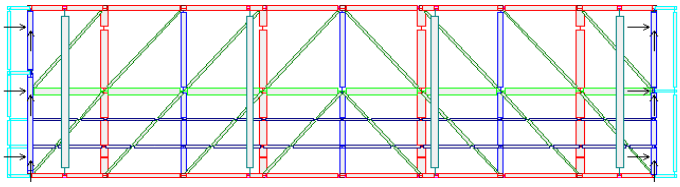
At θ = 0,

height from ground, h = 8.2

b = 8.48

b/c = 3.56

c/h = 0.29



c = 2.38

NET PRESSURE COEFFICIENTS ($C_{p,n}$)—HOARDINGS AND FREESTANDING WALLS—WIND NORMAL TO HOARDING OR WALL, $\theta = 0°$

b/c	*c/h*	$C_{p,n}$	*e*
0.5 to 5	0.2 to 1	$1.3 + 0.5(0.3 + \log_{10}(b/c))(0.8 - c/h)$	0
>5		$1.7 - 0.5\, c/h$	0
all	<0.2	$1.4 + 0.3\log_{10}(b/c)$	0

Cp,n = $1.3 + 0.5\,(0.3 + \log_{10}(b/c))(0.8 - c/h)$

Cp,n = 1.52 Ka = 1

WIND PRESSURES (WINDWARD) - NORMAL TO WALL $p = (0.5\,\rho_{air})\,[V_{des,\theta}]^2\, C_{fig}\, C_{dyn}$

Puls = 0.5 * 1.2 * 44.62 ^2 * 1.0 * 1.52 Wind pressure for Ultimate Limit State
Puls = **1.82** kPa

Psls = 0.5 * 1.2 * 35.89 ^2 * 1.0 * 1.52 Wind pressure for Service Limit State
Psls = **1.17** kPa
*You may multiply ULS wind by a factor of V_{SLS}^2/V_{ULS}^2 = **0.65**

Wind Loading (AS/NZS 1170.2 : 2011)

Ultimate Design Wind Speed, V_{500}	=	44.62	m/s	for Mzcat = 0.97
Serviceability Design Wind Speed, V_{25}	=	35.89	m/s	
Wind Region	=	A2		
Topographic Multiplier, M_t	=	1		
Shielding Multiplier, M_s	=	1		
Terrain Category	=	2		
Importance Level	=	3		
Ultimate Regional Wind Speed, V_{1000}	=	46	1000 years Annual Probability	
Serviceability Regional Wind Speed, V_{25}	=	37	25 years Annual Probability	

Direction Multiplier, M_d

Wind Direction	Md
N	0.95
NE	0.8
E	0.8
SE	0.8
S	0.8
SW	0.95
W	1
NW	0.95

Use M_d = 1

Cfig = Cp,n

Cdyn = 1.0

At θ = 0,

height from ground, h = 8.2

b = 8.48

b/c = 3.56

c/h = 0.29

c = 2.38

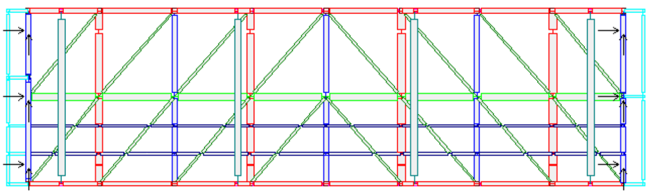


Table B.2(B) — Net pressure coefficients ($C_{p,n}$) — Hoardings and freestanding walls — Wind at 45° to hoarding or wall, θ = 45°

b/c	c/h	$C_{p,n}$	e
0.5 to 5 inclusive	0.2 to 1	$1.3 + 0.5[0.3 + \log_{10}(b/c)](0.8 - c/h)$	$0.2b$
	< 0.2	$1.4 + 0.3\log_{10}(b/c)$	$0.2b$

Cp,n = $1.3 + 0.5\,(0.3 + \log_{10}(b/c))(0.8 - c/h)$

Cp,n = 1.52 Ka = 1

WIND PRESSURES (WINDWARD) - 45 DEGREES TO WALL $p = (0.5\,\rho_{air})\,[V_{des,\theta}]^2\,C_{fig}\,C_{dyn}$

Puls = 0.5 * 1.2 * 44.62 ^2 * 1.0 * 1.52 Wind pressure for Ultimate Limit State

Puls = **1.82** kPa

Psls = 0.5 * 1.2 * 35.89 ^2 * 1.0 * 1.52 Wind pressure for Service Limit State

Psls = **1.17** kPa

*You may multiply ULS wind by a factor of V_{SLS}^2/V_{ULS}^2 = **0.65**

Wind Loading (AS/NZS 1170.2 : 2011)

Ultimate Design Wind Speed, V_{500}	=	44.62	m/s	for Mzcat =	0.97
Serviceability Design Wind Speed, V_{25}	=	35.89	m/s		
Wind Region	=	A2			
Topographic Multiplier, M_t	=	1			
Shielding Multiplier, M_s	=	1			
Terrain Category	=	2			
Importance Level	=	3			
Ultimate Regional Wind Speed, V_{1000}	=	46	1000 years Annual Probability		
Serviceability Regional Wind Speed, V_{25}	=	37	25 years Annual Probability		

Direction Multiplier, M_d

Wind Direction	Md
N	0.95
NE	0.8
E	0.8
SE	0.8
S	0.8
SW	0.95
W	1
NW	0.95

Use M_d = 1

Cfig = Cp,n

Cdyn = 1.0

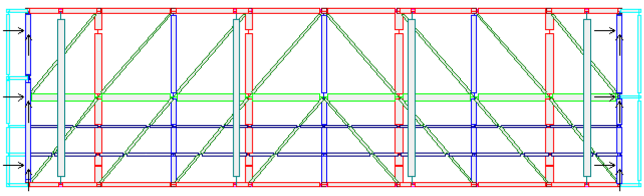
At θ = 0,

height from ground, h = 8.2

b = 8.48

b/c = 3.56

c/h = 0.29



c = 2.38

Table B.2(D) — Net pressure coefficients ($C_{p,n}$) — Hoardings and freestanding walls — Wind parallel to hoarding or wall, $\theta = 90°$

b/c	c/h	Distance from windward free end	$C_{p,n}$ (see Note)
All	≤ 0.7	0 to $2c$	±1.2
		$2c$ to $4c$	±0.6
		> $4c$	±0.3
	> 0.7	0 to $2h$	±1.0
		$2h$ to $4h$	±0.25
		> $4h$	±0.25
NOTE Take values of $C_{p,n}$ of the same sign.			

Cp,n = 1.20   Ka = 1

WIND PRESSURES (WINDWARD) - PARALLEL TO WALL

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

Puls = 0.5 * 1.2 * 44.62 ^2 * 1.0 * 1.2   Wind pressure for Ultimate Limit State

Puls = **1.43** kPa

Psls = 0.5 * 1.2 * 35.89 ^2 * 1.0 * 1.2   Wind pressure for Service Limit State

Psls = **0.93** kPa

*You may multiply ULS wind by a factor of V_{SLS}^2/V_{ULS}^2 = **0.65**

Wind Loading (AS/NZS 1170.2 : 2011)

Ultimate Design Wind Speed, V_{500}	=	44.62	m/s	for Mzcat =	0.97
Serviceability Design Wind Speed, V_{25}	=	35.89	m/s		
Wind Region	=	A2			
Topographic Multiplier, M_t	=	1			
Shielding Multiplier, M_s	=	1			
Terrain Category	=	2			
Importance Level	=	3			
Ultimate Regional Wind Speed, V_{1000}	=	46	1000 years Annual Probability		
Serviceability Regional Wind Speed, V_{25}	=	37	25 years Annual Probability		

Direction Multiplier, M_d

Wind Direction	Md
N	0.95
NE	0.8
E	0.8
SE	0.8
S	0.8
SW	0.95
W	1
NW	0.95

Use M_d = 1

Cfig = Cp,n

Cdyn = 1.0

At θ = 0,

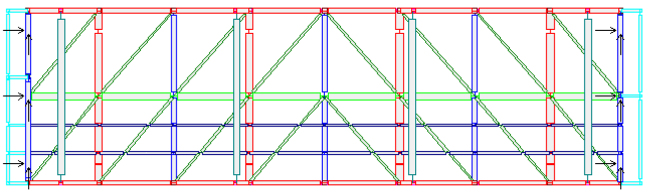
height from ground, h = 8.2

b = 8.48

b/c = 3.56

c/h = 0.29

c = 2.38



NET PRESSURE COEFFICIENTS ($C_{p,n}$)—HOARDINGS AND FREESTANDING WALLS—WIND NORMAL TO HOARDING OR WALL, $\theta = 0°$

b/c	c/h	$C_{p,n}$	e
0.5 to 5	0.2 to 1	$1.3 + 0.5(0.3 + \log_{10}(b/c))(0.8 - c/h)$	0
>5		$1.7 - 0.5\,c/h$	0
all	<0.2	$1.4 + 0.3\log_{10}(b/c)$	0

Cp,n = $1.3 + 0.5\,(0.3 + \log_{10}(b/c))(0.8 - c/h)$

Cp,n = 1.52 Ksh = 0.2

WIND PRESSURES (LEEWARD/SHIELDED - NORMAL TO WALL)

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

Puls = 0.5 * 1.2 * 44.62 ^2 * 1.0 * 1.52 * 0.2 Wind pressure for Ultimate Limit State

Puls = **0.363** kPa

Psls = 0.5 * 1.2 * 35.89 ^2 * 1.0 * 1.52 * 0.2 Wind pressure for Service Limit State

Psls = **0.235** kPa

*You may multiply ULS wind by a factor of V_{SLS}^2/V_{ULS}^2 = **0.65**

Wind Loading (AS/NZS 1170.2 : 2011)

Ultimate Design Wind Speed, V_{500}	=	44.62	m/s	for Mzcat =	0.97
Serviceability Design Wind Speed, V_{25}	=	35.89	m/s		
Wind Region	=	A2			
Topographic Multiplier, M_t	=	1			
Shielding Multiplier, M_s	=	1			
Terrain Category	=	2			
Importance Level	=	3			
Ultimate Regional Wind Speed, V_{1000}	=	46	1000 years Annual Probability		
Serviceability Regional Wind Speed, V_{25}	=	37	25 years Annual Probability		

Direction Multiplier, M_d

Wind Direction	Md
N	0.95
NE	0.8
E	0.8
SE	0.8
S	0.8
SW	0.95
W	1
NW	0.95

Use M_d = 1

Cfig = Cp,n

Cdyn = 1.0

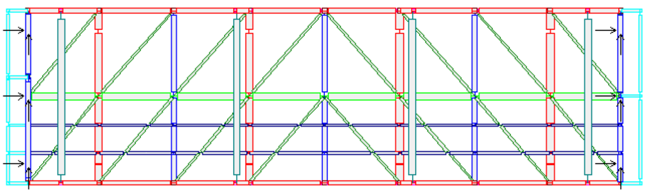
At θ = 0,

height from ground, h = 8.2

b = 8.48

b/c = 3.56

c/h = 0.29



c = 2.38

NET PRESSURE COEFFICIENTS ($C_{p,n}$)—HOARDINGS AND FREESTANDING WALLS—WIND NORMAL TO HOARDING OR WALL, θ = 0°

b/c	c/h	$C_{p,n}$	e
0.5 to 5	0.2 to 1	$1.3 + 0.5(0.3 + \log_{10}(b/c))(0.8 - c/h)$	0
>5		$1.7 - 0.5\,c/h$	0
all	<0.2	$1.4 + 0.3\log_{10}(b/c)$	0

Cp,n = $1.3 + 0.5\,(0.3 + \log_{10}(b/c))(0.8 - c/h)$

Cp,n = 1.52   Ksh = 0.3

WIND PRESSURES (LEEWARD/SHIELDED - 45 DEGREES)

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

Puls = 0.5 * 1.2 * 44.62 ^2 * 1.0 * 1.52 * 0.3   Wind pressure for Ultimate Limit State

Puls = **0.54** kPa

Psls = 0.5 * 1.2 * 35.89 ^2 * 1.0 * 1.52 * 0.3   Wind pressure for Service Limit State

Psls = **0.35** kPa

*You may multiply ULS wind by a factor of V_{SLS}^2/V_{ULS}^2 = **0.65**

Wind Loading (AS/NZS 1170.2 : 2011)

Ultimate Design Wind Speed, V_{500}	=	44.62	m/s	for Mzcat =	0.97
Serviceability Design Wind Speed, V_{25}	=	35.89	m/s		
Wind Region	=	A2			
Topographic Multiplier, M_t	=	1			
Shielding Multiplier, M_s	=	1			
Terrain Category	=	2			
Importance Level	=	3			
Ultimate Regional Wind Speed, V_{1000}	=	46	1000 years Annual Probability		
Serviceability Regional Wind Speed, V_{25}	=	37	25 years Annual Probability		

Direction Multiplier, M_d

Wind Direction	Md
N	0.95
NE	0.8
E	0.8
SE	0.8
S	0.8
SW	0.95
W	1
NW	0.95

Use M_d = 1

Cfig = Cp,n

Cdyn = 1.0

At θ = 0,

height from ground, h = 8.2

b = 8.48

b/c = 3.56

c/h = 0.29

c = 2.38

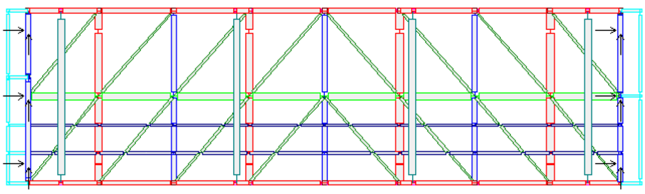


Table B.3 — Frictional drag coefficient (C_f)

Surface description	C_f
Surfaces with ribs across the wind direction	0.04
Surfaces with corrugations across the wind direction	0.02
Smooth surfaces without corrugations or ribs, or with corrugations or ribs parallel to the wind direction	0.01

Cf = 0.01

FRICTIONAL DRAG PRESSURE (ALL DIRECTIONS)

$$f = (0.5\rho_{air})[V_{des,\theta}]^2 C_{shp}$$

f,uls = 0.5 * 1.2 * 44.62 ^2 * 0.01 — Wind pressure for Ultimate Limit State

f,uls = **0.0119** kPa

f,sls = 0.5 * 1.2 * 35.89 ^2 * 0.01 — Wind pressure for Service Limit State

f,sls = **0.0077** kPa

*You may multiply ULS wind by a factor of V_{SLS}^2/V_{ULS}^2 = **0.65**

Wind Loading (AS/NZS 1170.2 : 2011)

CASES 1A AND 1B: 0 DEGREES

MICROSTRAN INPUT FOR WIND LOAD (WU) - DIGITAL SIGN COLUMNS

*at cladding

Puls (kPa)	f,uls (kPa)	Trib. Width (m)	Normal Load (kN/m)	Drag Load (kN/m)	
1.82	0.0119	1.150	**2.089**	**0.014**	WINDWARD
1.82	0.0119	1.925	**3.496**	**0.023**	WINDWARD
1.82	0.0119	2.000	**3.632**	**0.024**	WINDWARD
0.36	0.0119	1.150	**0.418**	**0.014**	LEEWARD
0.36	0.0119	1.925	**0.7**	**0.023**	LEEWARD
0.36	0.0119	2.000	**0.727**	**0.024**	LEEWARD

MICROSTRAN INPUT FOR WIND LOAD (WS) - DIGITAL SIGN COLUMNS

Psls (kPa)	f,sls (kPa)	Trib. Width (m)	Normal Load (kN/m)	Drag Friction (kN/m)	
1.17	0.0077	1.150	**1.351**	**0.009**	WINDWARD
1.17	0.0077	1.925	**2.262**	**0.015**	WINDWARD
1.17	0.0077	2.000	**2.35**	**0.016**	WINDWARD
0.23	0.0077	1.150	**0.271**	**0.009**	LEEWARD
0.23	0.0077	1.925	**0.453**	**0.015**	LEEWARD
0.23	0.0077	2.000	**0.47**	**0.016**	LEEWARD

MICROSTRAN INPUT FOR WIND LOAD (WU) - STATIC SIGN BEAMS

*at cladding

Puls (kPa)	f,uls (kPa)	Trib. Width (m)	Normal Load (kN/m)	Drag Load (kN/m)	
1.82	0.0119	1.170	**2.125**	**0.014**	WINDWARD
0.36	0.0119	1.170	**0.425**	**0.014**	LEEWARD

MICROSTRAN INPUT FOR WIND LOAD (WS) - STATIC SIGN BEAMS

*at cladding

Puls (kPa)	f,uls (kPa)	Trib. Width (m)	Normal Load (kN/m)	Drag Load (kN/m)	
1.17	0.0077	1.170	**1.375**	**0.010**	WINDWARD
0.23	0.0077	1.170	**0.275**	**0.010**	LEEWARD

NET PRESSURE COEFFICIENTS ($C_{p,n}$)—HOARDINGS AND FREESTANDING WALLS—WIND AT 45° TO HOARDING OR WALL, θ = 45°

b/c	c/h	$C_{p,n}$	e
0.5 to 5 inclusive	0.2 to 1	$1.3 + 0.5(0.3 + \log_{10}(b/c))(0.8 - c/h)$	$0.2b$
	<0.2	$1.4 + 0.3\log_{10}(b/c)$	$0.2b$

CASES 2A, 2B - ECCENTRIC WIND LOADING (45 DEGREES -SE / SW - WIND DIRECTION)

MICROSTRAN INPUT FOR WIND LOAD (W_U) - WINDWARD

*at cladding

w_u = 1.82 kPa   e = 1.70 m

w_{equiv} = 3.03 kPa b_{loaded} = 5.088 m

MICROSTRAN INPUT FOR WIND LOAD (W_U) - LEEWARD

*at cladding

w_u = 0.36 kPa

Puls (kPa)	Width (m)	Line Load (kN/m)	
3.03	1.150	**3.480**	WINDWARD
3.03	1.925	**5.826**	WINDWARD
3.03	2.000	**6.052**	WINDWARD
0.36	1.150	**0.418**	LEEWARD (WITH SHIELDING FACTOR)
0.36	1.925	**0.699**	LEEWARD (WITH SHIELDING FACTOR)
0.36	2.000	**0.726**	LEEWARD (WITH SHIELDING FACTOR)

Puls (kPa)	Width (m)	Line Load (kN/m)	
3.03	1.170	**3.541**	WINDWARD
0.36	1.170	**0.425**	LEEWARD (WITH SHIELDING FACTOR)

MICROSTRAN INPUT FOR WIND LOAD (W_S) - WINDWARD

*at cladding

w_s = 1.17 kPa

w_{equiv} = 1.96 kPa

MICROSTRAN INPUT FOR WIND LOAD (W_S) - LEEWARD

*at cladding

w_s = 0.23 kPa

Psls (kPa)	Width (m)	Line Load (kN/m)	
1.96	1.150	**2.252**	WINDWARD
1.96	1.925	**3.769**	WINDWARD
1.96	2.000	**3.916**	WINDWARD
0.23	1.150	**0.270**	LEEWARD (WITH SHIELDING FACTOR)
0.23	1.925	**0.452**	LEEWARD (WITH SHIELDING FACTOR)
0.23	2.000	**0.470**	LEEWARD (WITH SHIELDING FACTOR)

Psls (kPa)	Width (m)	Line Load (kN/m)	
1.96	1.170	**2.291**	WINDWARD
0.23	1.170	**0.275**	LEEWARD (WITH SHIELDING FACTOR)

Wind Loading (AS/NZS 1170.2 : 2011)

CASES 3A AND 3B: 90 DEGREES

MICROSTRAN INPUT FOR WIND LOAD (WU) - DIGITAL SIGN COLUMNS

*at cladding

Puls (kPa)	f,uls (kPa)	Trib. Width (m)	Normal Load (kN/m)	Drag Load (kN/m)	
1.43	0.0119	1.150	**1.649**	**0.014**	BOTH SIGNS
1.43	0.0119	1.925	**2.76**	**0.023**	BOTH SIGNS
1.43	0.0119	2.000	**2.867**	**0.024**	BOTH SIGNS

MICROSTRAN INPUT FOR WIND LOAD (WS) - DIGITAL SIGN COLUMNS

Psls (kPa)	f,sls (kPa)	Trib. Width (m)	Normal Load (kN/m)	Drag Friction (kN/m)	
0.93	0.0077	1.150	**1.067**	**0.009**	BOTH SIGNS
0.93	0.0077	1.925	**1.786**	**0.015**	BOTH SIGNS
0.93	0.0077	2.000	**1.855**	**0.016**	BOTH SIGNS

MICROSTRAN INPUT FOR WIND LOAD (WU) - STATIC SIGN BEAMS

*at cladding

Puls (kPa)	f,uls (kPa)	Trib. Width (m)	Normal Load (kN/m)	Drag Load (kN/m)	
1.43	0.0119	1.170	**1.678**	**0.014**	BOTH SIGNS

MICROSTRAN INPUT FOR WIND LOAD (WS) - STATIC SIGN BEAMS

*at cladding

Puls (kPa)	f,uls (kPa)	Trib. Width (m)	Normal Load (kN/m)	Drag Load (kN/m)	
0.93	0.0077	1.170	**1.086**	**0.010**	BOTH SIGNS

NET PRESSURE COEFFICIENTS ($C_{p,n}$)—HOARDINGS AND FREESTANDING WALLS—WIND AT 45° TO HOARDING OR WALL, θ = 45°

b/c	c/h	$C_{p,n}$	e
0.5 to 5 inclusive	0.2 to 1	$1.3 + 0.5(0.3 + \log_{10}(b/c))(0.8 - c/h)$	$0.2b$
	<0.2	$1.4 + 0.3\log_{10}(b/c)$	$0.2b$

CASES 4A, 4B - ECCENTRIC WIND LOADING (45 DEGREES - NE/NW - WIND DIRECTION)

MICROSTRAN INPUT FOR WIND LOAD (W_U) - WINDWARD

*at cladding

w_u = 1.82 kPa   e = 1.70 m

w_{equiv} = 3.03 kPa b_{loaded} = 5.088 m

MICROSTRAN INPUT FOR WIND LOAD (W_U) - LEEWARD

*at cladding

w_u = 0.54 kPa

Puls (kPa)	Width (m)	Line Load (kN/m)	
3.03	1.150	**3.480**	WINDWARD
3.03	1.925	**5.826**	WINDWARD
3.03	2.000	**6.052**	WINDWARD
0.54	1.150	**0.626**	LEEWARD (WITH SHIELDING FACTOR)
0.54	1.925	**1.049**	LEEWARD (WITH SHIELDING FACTOR)
0.54	2.000	**1.089**	LEEWARD (WITH SHIELDING FACTOR)

Puls (kPa)	Width (m)	Line Load (kN/m)	
3.03	1.170	**3.541**	WINDWARD
0.54	1.170	**0.637**	LEEWARD (WITH SHIELDING FACTOR)

MICROSTRAN INPUT FOR WIND LOAD (W_S) - WINDWARD

*at cladding

w_s = 1.17 kPa

w_{equiv} = 1.96 kPa

MICROSTRAN INPUT FOR WIND LOAD (W_S) - LEEWARD

*at cladding

w_s = 0.35 kPa

Psls (kPa)	Width (m)	Line Load (kN/m)	
1.96	1.150	**2.252**	WINDWARD
1.96	1.925	**3.769**	WINDWARD
1.96	2.000	**3.916**	WINDWARD
0.35	1.150	**0.405**	LEEWARD (WITH SHIELDING FACTOR)
0.35	1.925	**0.555**	LEEWARD (WITH SHIELDING FACTOR)
0.35	2.000	**0.705**	LEEWARD (WITH SHIELDING FACTOR)

Psls (kPa)	Width (m)	Line Load (kN/m)	
1.96	1.170	**2.291**	WINDWARD
0.35	1.170	**0.412**	LEEWARD (WITH SHIELDING FACTOR)

Wind Loading (AS/NZS 1170.2 : 2011)

WIND LOAD AT EXPOSED FRAMES

Cf = 1.2 = Cfig *<T E3>*

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

Puls = 0.5 * 1.2 * 44.62 ^2 * 1.0 * 1.2 Wind pressure for Ultimate Limit State

Puls = **1.43** kPa

Psls = 0.5 * 1.2 * 35.89 ^2 * 1.0 * 1.2 Wind pressure for Service Limit State

Psls = **0.93** kPa

MICROSTRAN INPUT FOR WIND LOAD (WU) AT EXPOSED FRAMES

*at exposed frames:

Puls (kPa)	Trib. Width (m)	Line Load (kN/m)	
1.43	0.61	**0.880**	C1
1.43	0.125	**0.180**	V1, H1
1.43	0.075	**0.110**	R1, V2, H2
1.43	0.05	**0.080**	BR1, V3

MICROSTRAN INPUT FOR WIND LOAD (WS) AT EXPOSED FRAMES

*at exposed frames:

Psls (kPa)	Trib. Width (m)	Line Load (kN/m)	
0.93	0.61	**0.570**	C1
0.93	0.125	**0.120**	V1, H1
0.93	0.075	**0.070**	R1, V2, H2
0.93	0.05	**0.050**	BR1, V3

Superimposed Dead Loads

MICROSTRAN INPUT FOR SDL (DIGITAL SIGN)

*at cladding

w_u = 45.00 kg/m^2
= 0.441 kPa

MICROSTRAN INPUT FOR SDL (DIGITAL SIGN)

*at cladding

SDL (kPa)	Trib. Width (m)	Normal Load (kN/m)
0.44	1.150	**0.508**
0.44	1.925	**0.850**
0.44	2.000	**0.883**

MICROSTRAN INPUT FOR SDL (STATIC SIGN)

*at cladding

w_u = 0.100 kPa

MICROSTRAN INPUT FOR SDL (STATIC SIGN)

*at cladding

SDL (kPa)	Trib. Width (m)	Normal Load (kN/m)
0.44	1.170	**0.517**

MICROSTRAN INPUT FOR SDL (LADDER)

w_u = 0.33 kN/m
Length = 2.34 m
Equiv. Point Load = 0.772 kN

MICROSTRAN INPUT FOR SDL (FLOOR GRATING)

w_u = 0.20 kPa

MICROSTRAN INPUT FOR SDL (FLOOR GRATING - DIGITAL SIGN BOX)

SDL (kPa)	Trib. Width (m)	Normal Load (kN/m)
0.20	0.900	**0.180**
0.20	1.500	**0.300**
0.20	1.170	**0.234**
0.20	0.886	**0.178**
0.20	1.092	**0.219**
0.20	1.614	**0.323**
0.20	0.838	**0.168**

MICROSTRAN INPUT FOR SDL (FLOOR GRATING - STATIC SIGN BOX)

SDL (kPa)	Trib. Width (m)	Normal Load (kN/m)
0.20	0.395	**0.079**
0.20	0.839	**0.168**
0.20	1.220	**0.244**
0.20	1.237	**0.248**
0.20	0.886	**0.178**
0.20	1.025	**0.205**
0.20	1.105	**0.221**
0.20	0.900	**0.180**

Live Load

MICROSTRAN INPUT FOR LL (MAINTENANCE)

w_u = 2.50 kPa

MICROSTRAN INPUT FOR SDL (FLOOR GRATING - DIGITAL SIGN BOX)

LL (kPa)	Trib. Width (m)	Normal Load (kN/m)
2.50	0.900	**2.250**
2.50	1.500	**3.750**
2.50	1.170	**2.924**
2.50	0.886	**2.214**
2.50	1.092	**2.730**
2.50	1.614	**4.035**
2.50	0.838	**2.095**

MICROSTRAN INPUT FOR SDL (FLOOR GRATING - STATIC SIGN BOX)

LL (kPa)	Trib. Width (m)	Normal Load (kN/m)
2.50	0.395	**0.988**
2.50	0.839	**2.097**
2.50	1.220	**3.050**
2.50	1.237	**3.093**
2.50	0.886	**2.214**
2.50	1.025	**2.563**
2.50	1.105	**2.763**
2.50	0.900	**2.250**

MICROSTRAN INPUT FOR LL (LADDER)

w_u = 1.50 kN

D MICROSTRAN INPUT

D.1 MICROSTRAN LOAD APPLICATION

Microstran
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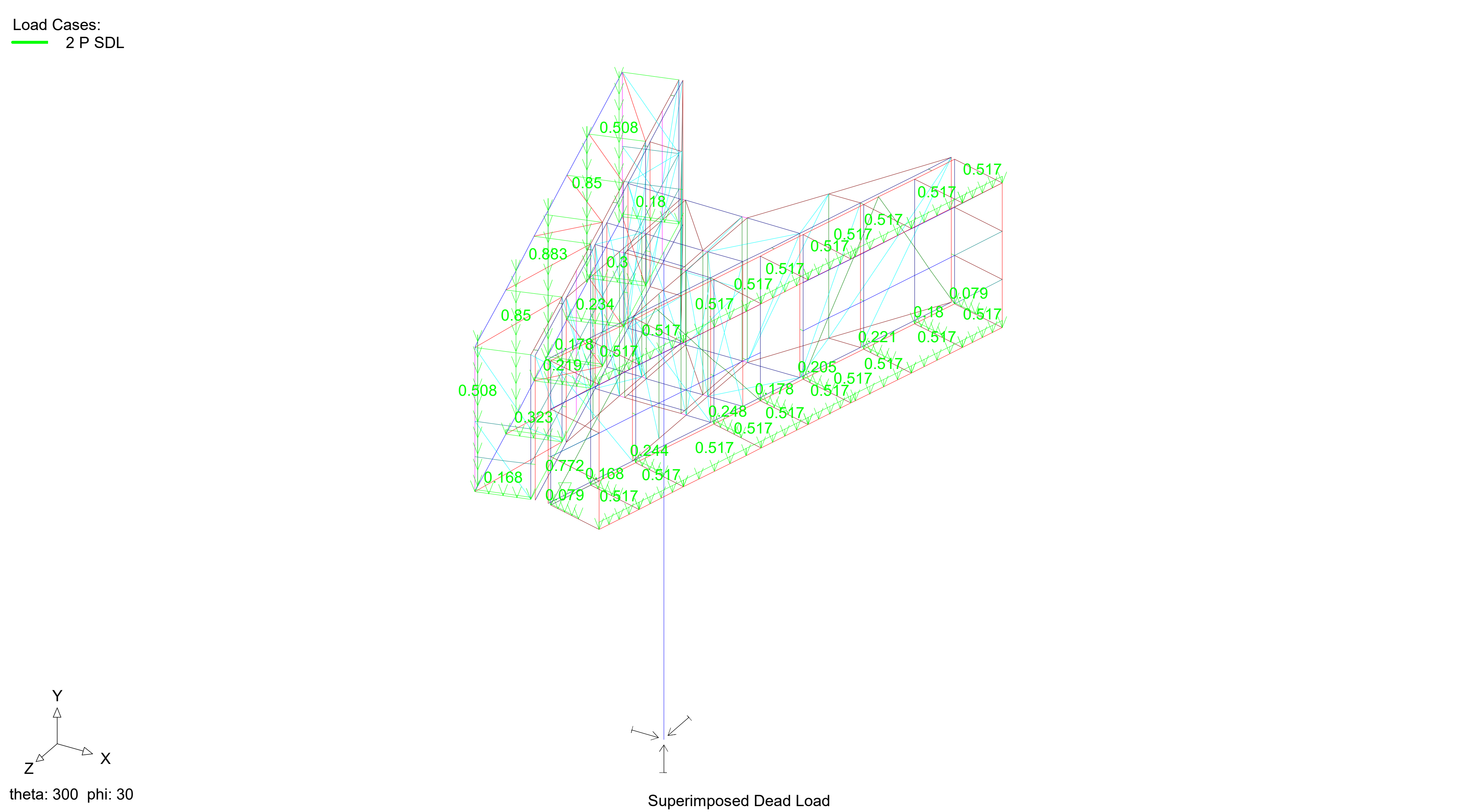
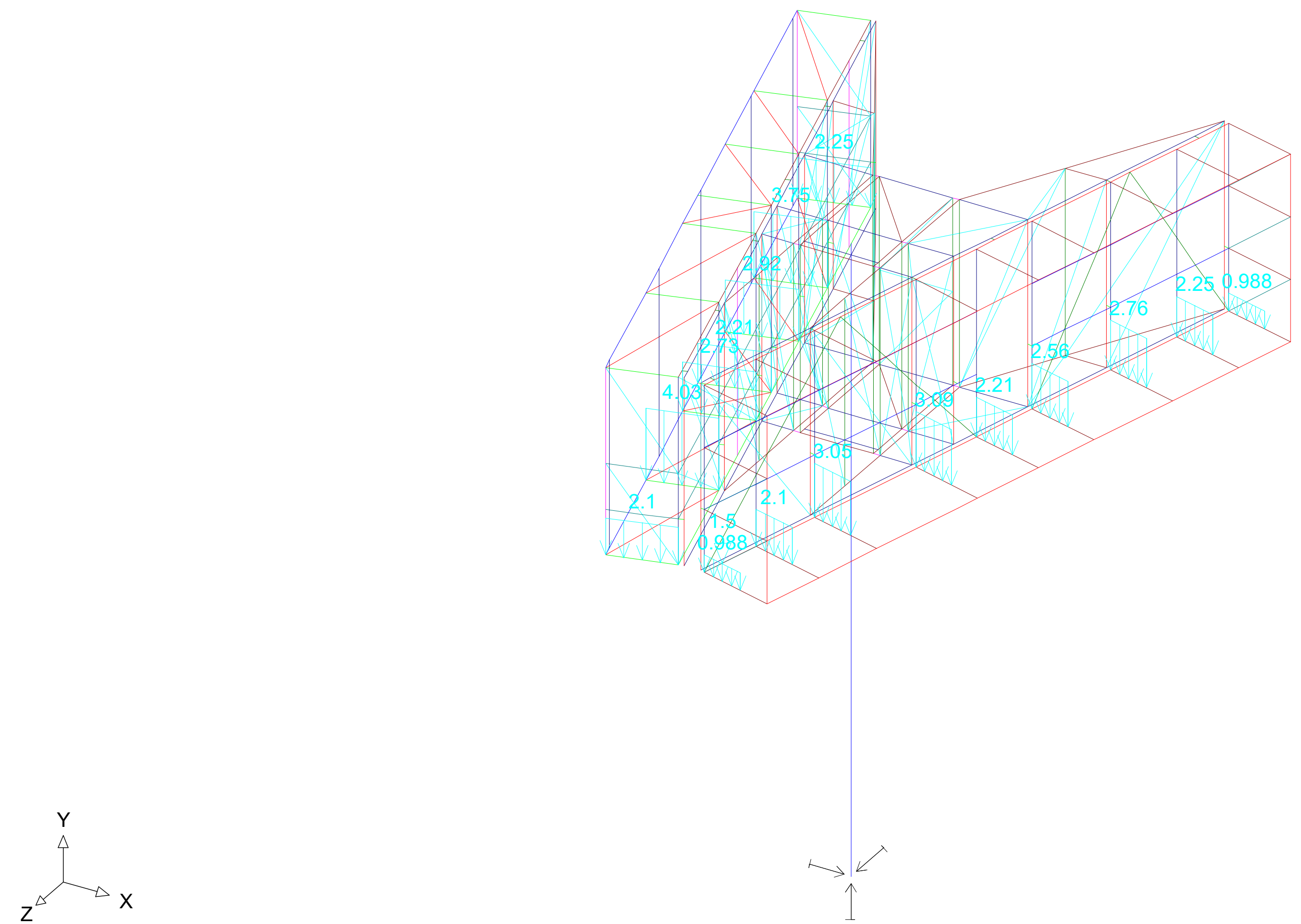
ballonc3616
Job: Port of NewCastle - Teal St. REV6
ND

04/04/2022
10:42:43 am



Superimposed Dead Load

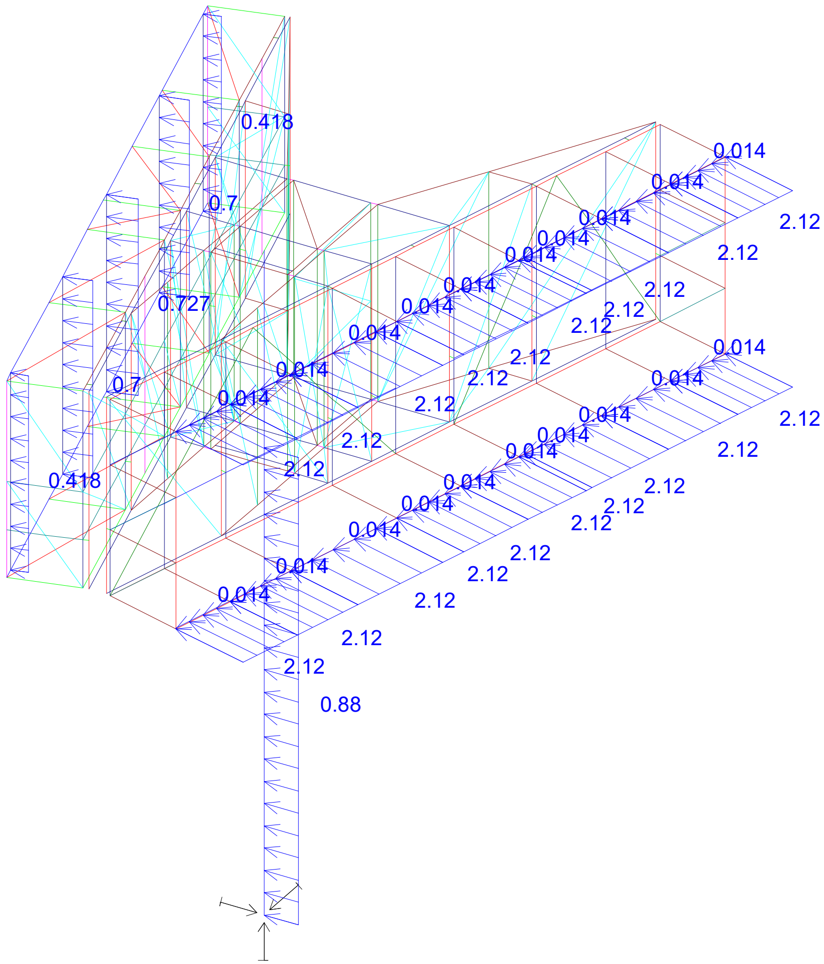
Load Cases:
3 P Q



theta: 300 phi: 30

Live Load

Load Cases:
32 P Wux 90 Degrees Case 1a

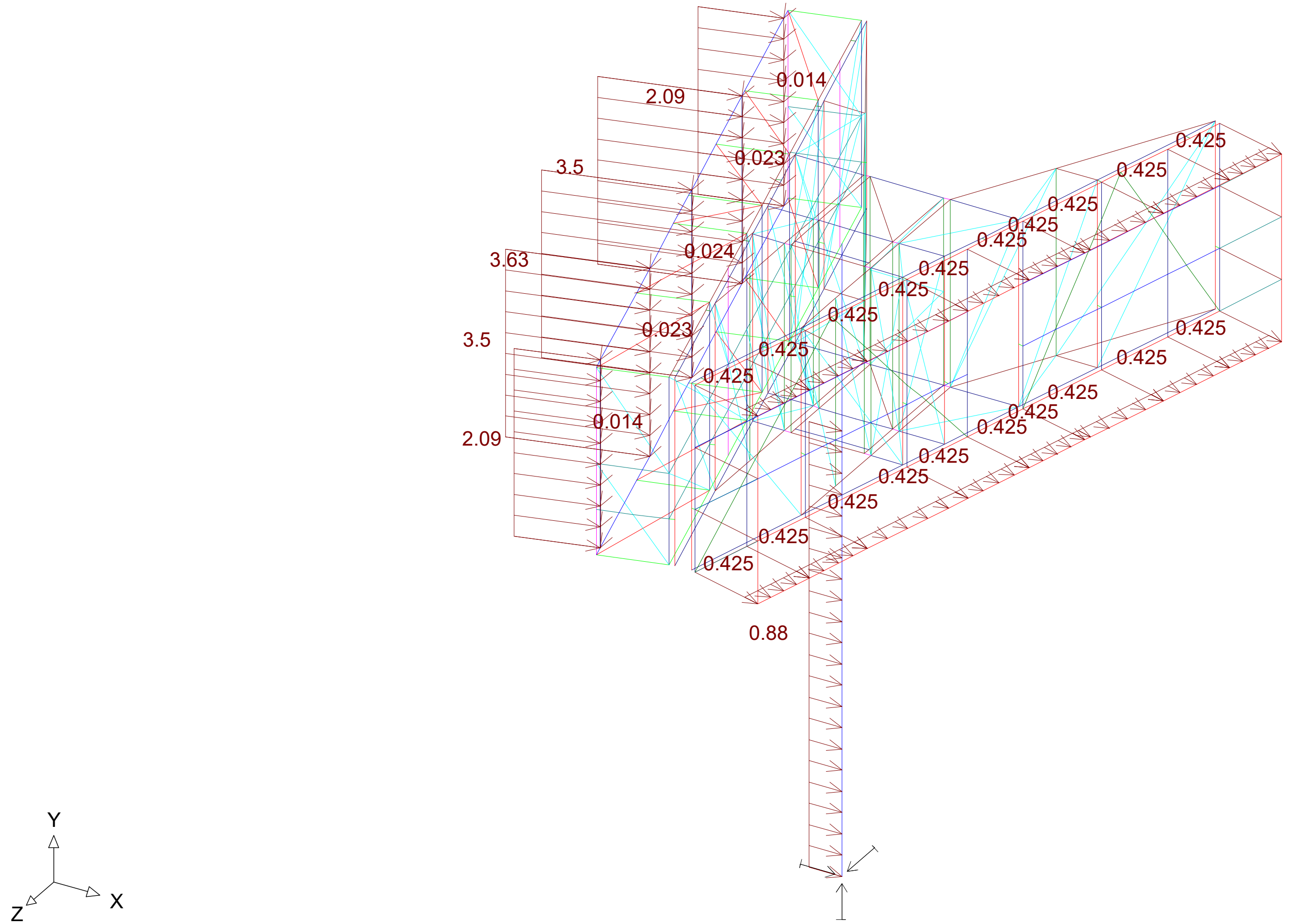


A factor of 0.65 has been applied to the ULS wind loads to obtain the SLS wind loads.

Y
Z X
theta: 300 phi: 30

Ultimate Wind Load (Case 1a)

Load Cases:
33 P Wu-x 90 Degrees Case 1b

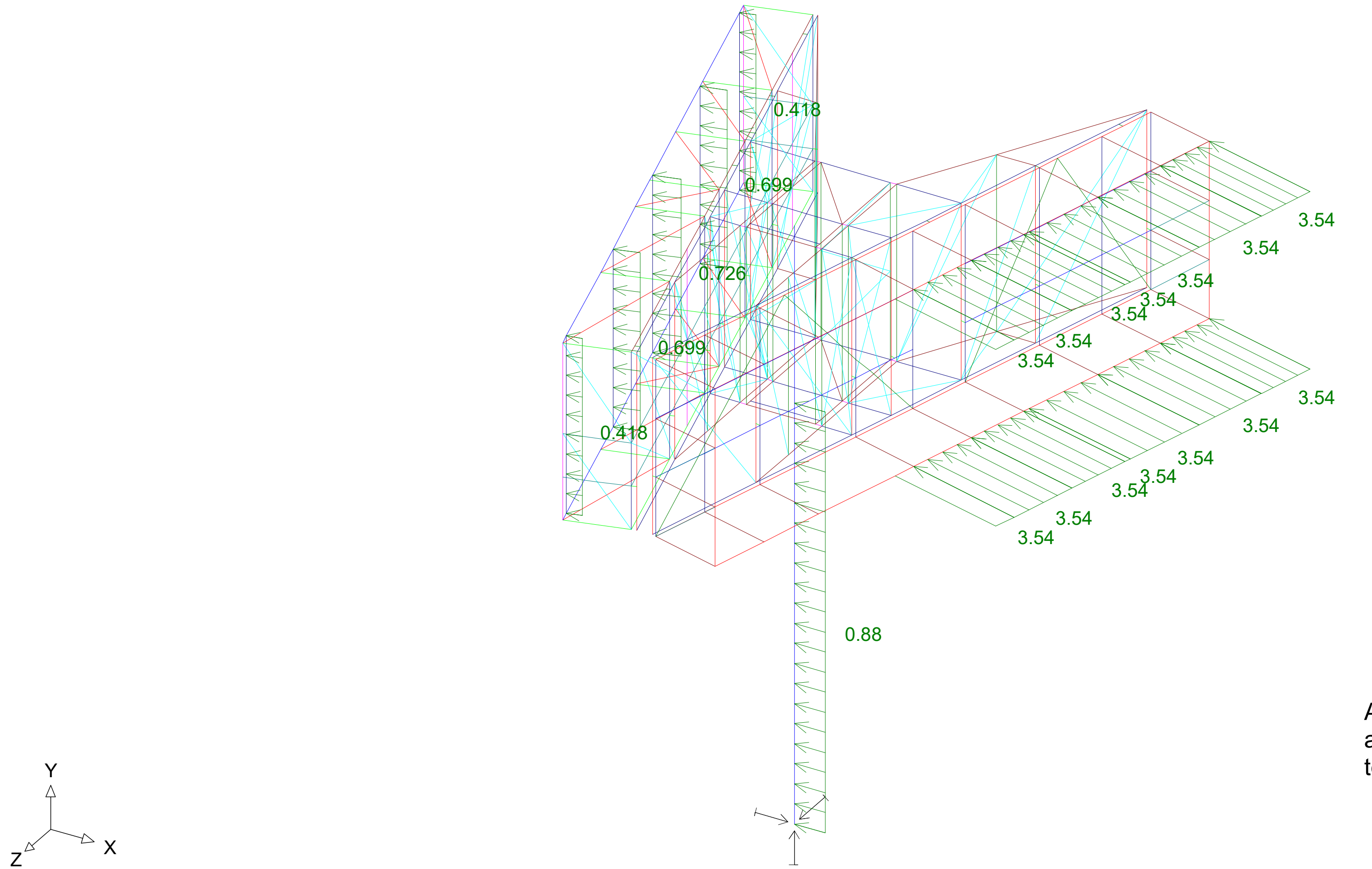


A factor of 0.65 has been applied to the ULS wind loads to obtain the SLS wind loads.

theta: 300 phi: 30

Ultimate Wind Load (Case 1b)

Load Cases:
31 P Wux 45 Degrees Case 2a

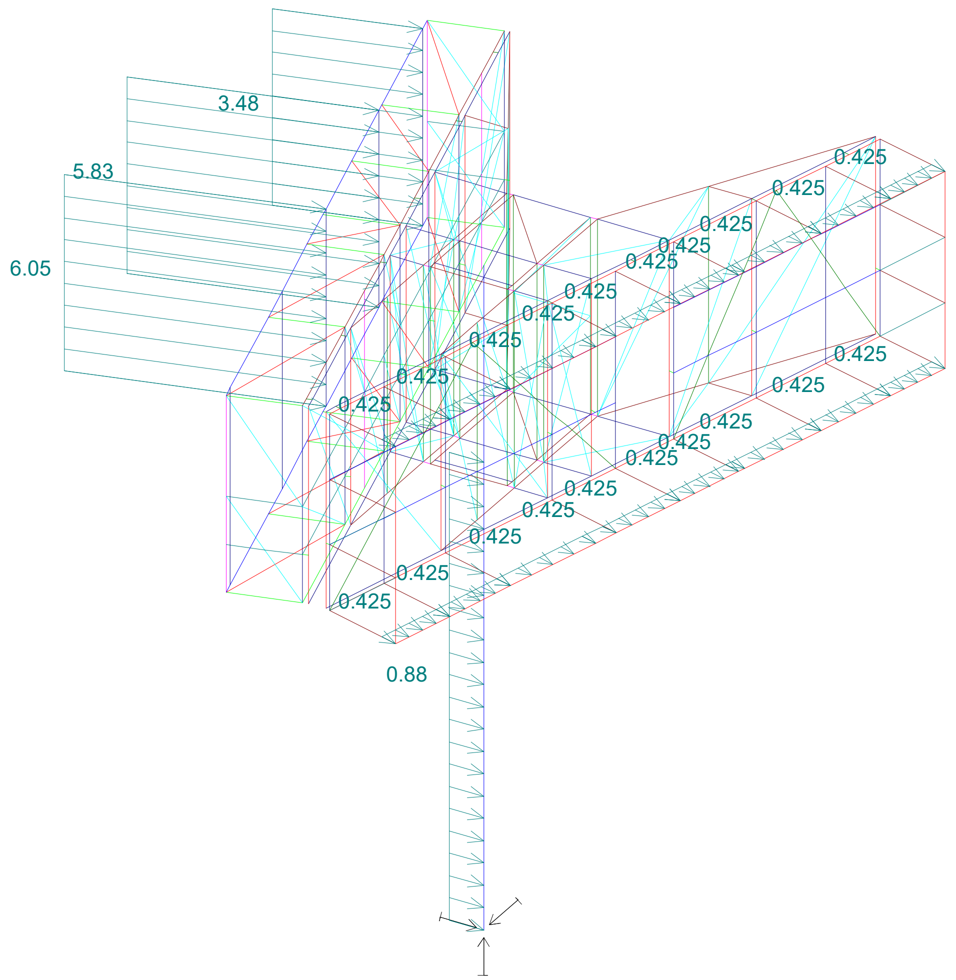


A factor of 0.65 has been applied to the ULS wind loads to obtain the SLS wind loads.

theta: 300 phi: 30

Ultimate Wind Load (Case 2a)

Load Cases:
34 P Wu-x 45 Degrees Case 2b

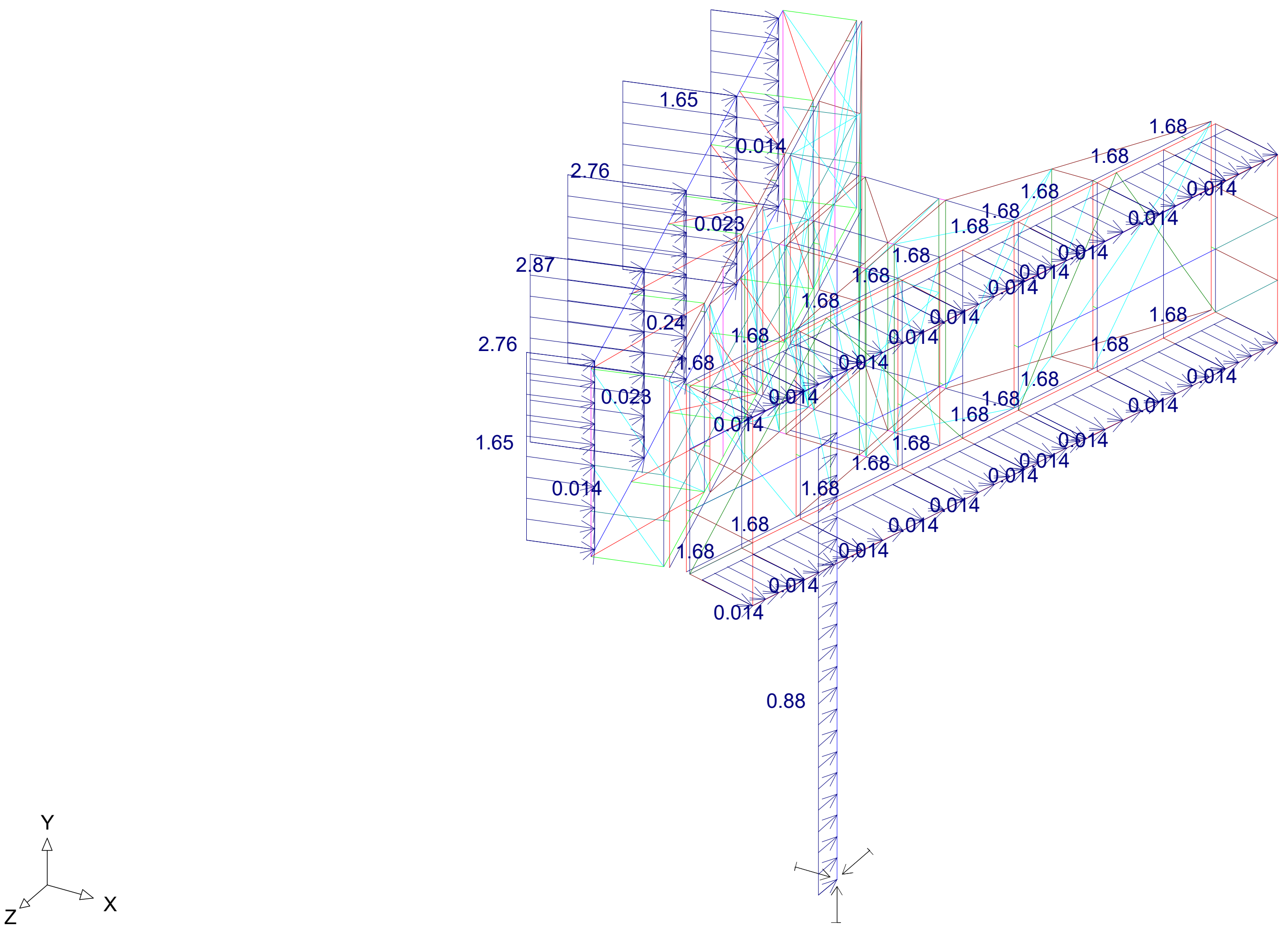


A factor of 0.65 has been applied to the ULS wind loads to obtain the SLS wind loads.

theta: 300 phi: 30

Ultimate Wind Load (Case 2b)

Load Cases:
35 P Wuz 0 Degrees Case 3a

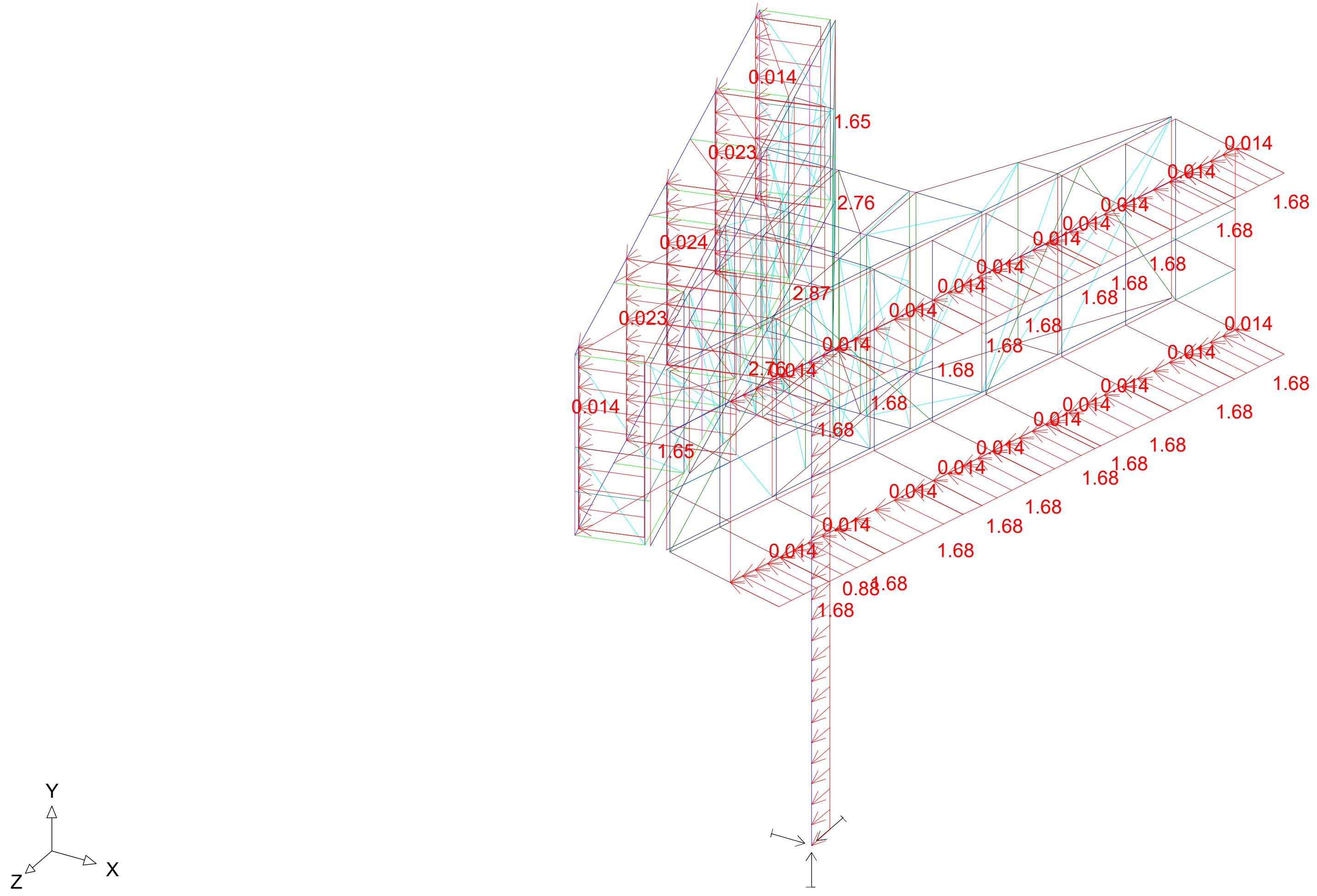


theta: 300 phi: 30

Ultimate Wind Load (Case 3a)

A factor of 0.65 has been applied to the ULS wind loads to obtain the SLS wind loads.

Load Cases:
30 P Wu-z 0 Degrees Case 3b

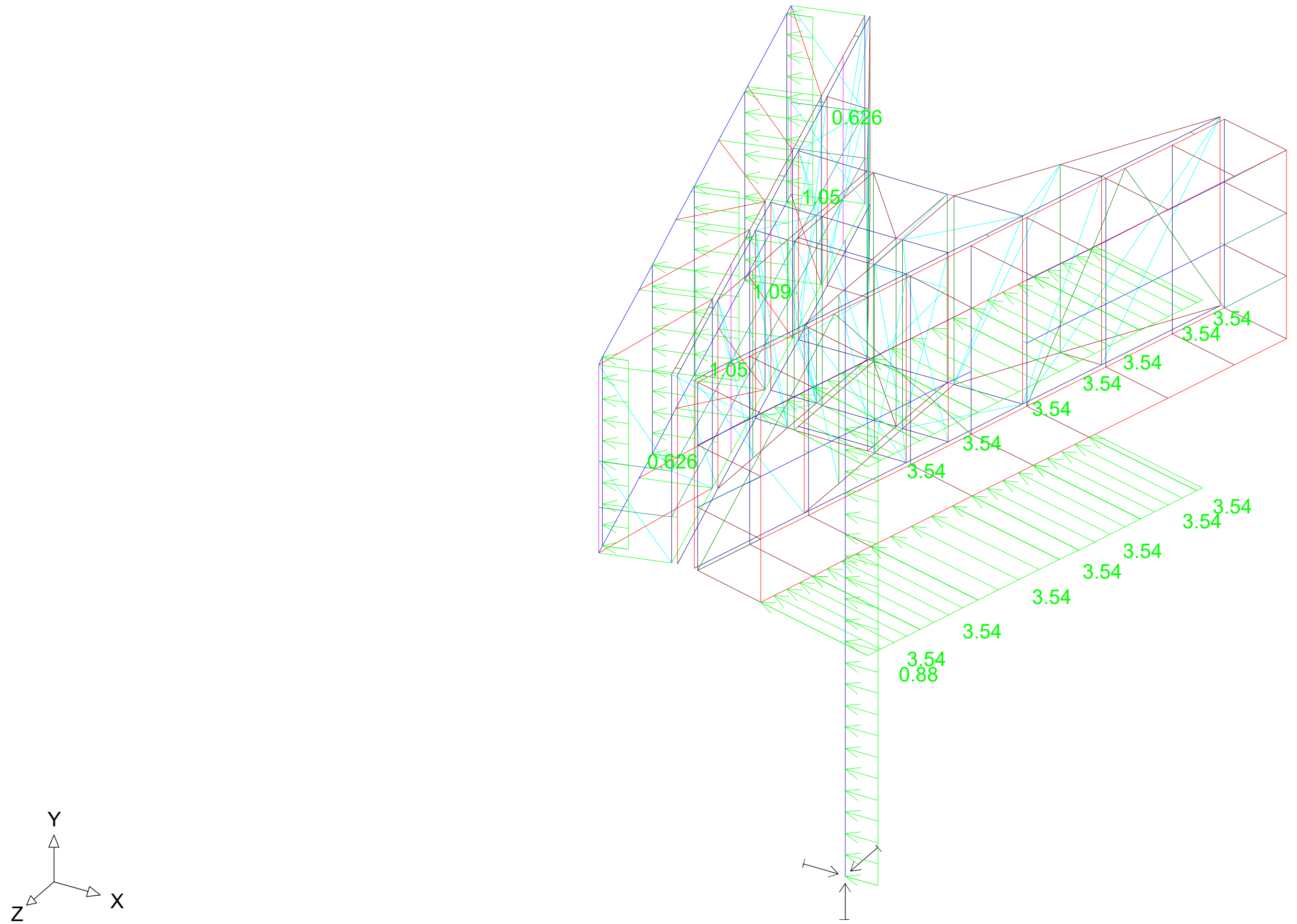


A factor of 0.65 has been applied to the ULS wind loads to obtain the SLS wind loads.

theta: 300 phi: 30

Ultimate Wind Load (Case 3b)

Load Cases:
37 P Wuz 45 Degrees Case 4a

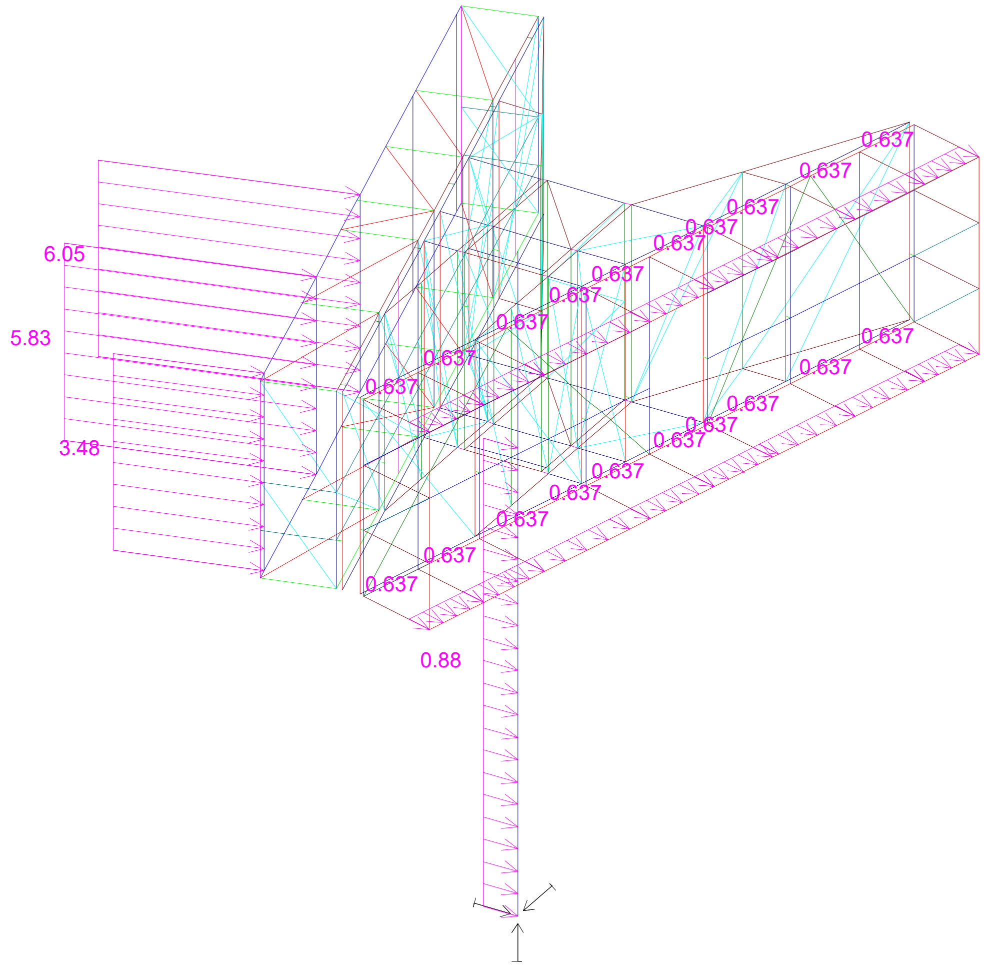


theta: 300 phi: 30

A factor of 0.65 has been applied to the ULS wind loads to obtain the SLS wind loads.

Ultimate Wind Load (Case 4a)

Load Cases:
36 P Wu-z 45 Degrees Case 4b



theta: 300 phi: 30

A factor of 0.65 has been applied to the ULS wind loads to obtain the SLS wind loads.

Ultimate Wind Load (Case 4b)

D.2 LOAD CASES AND COMBINATIONS

The load cases considered include the gravity loads (dead loads and the superimposed dead loads) and the wind load cases.

Main Frame Only:

LOAD CASES

No.	Type	Title
1	P	SW
2	P	SDL
3	P	Q
30	P	Wu-z 0 Degrees Case 3b
31	P	Wux 45 Degrees Case 2a
32	P	Wux 90 Degrees Case 1a
33	P	Wu-x 90 Degrees Case 1b
34	P	Wu-x 45 Degrees Case 2b
35	P	Wuz 0 Degrees Case 3a
36	P	Wu-z 45 Degrees Case 4b
37	P	Wuz 45 Degrees Case 4a

LOAD COMBINATIONS (ULS)

100	C	ULS01: 1.35(SW + SDL)
110	C	ULS02: 1.2SW + 1.5Q + 1.2SDL
140	C	ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
141	C	ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
142	C	ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
143	C	ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
144	C	ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
145	C	ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
146	C	ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
147	C	ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
150	C	ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
151	C	ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
152	C	ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
153	C	ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
154	C	ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
155	C	ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
156	C	ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
157	C	ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees

LOAD COMBINATIONS (SLS)

200	C	SLS10: SW + SDL
210	C	SLS11: SW + SDL + Q
220	C	SLS12: SW + SDL + 0.4Q
230	C	SLS200: SW + SDL + 0.4Q + Ws-z 0 Degrees
231	C	SLS201: SW + SDL + 0.4Q + Ws-z +45 Degrees
232	C	SLS202: SW + SDL + 0.4Q + Wsx +90 Degrees
233	C	SLS203: SW + SDL + 0.4Q + Wsx -90 Degrees
234	C	SLS204: SW + SDL + 0.4Q + Wsz -45 Degrees
235	C	SLS205: SW + SDL + 0.4Q + Wsz 0 Degrees
236	C	SLS206: SW + SDL + 0.4Q + Ws-z -45 Degrees
237	C	SLS207: SW + SDL + 0.4Q + Wsz +45 Degrees
240	C	SLS300: 0.9SW + 0.9SDL + Ws-z 0 Degrees
241	C	SLS301: 0.9SW + 0.9SDL + Ws-z +45 Degrees
242	C	SLS302: 0.9SW + 0.9SDL + Wsx +90 Degrees
243	C	SLS303: 0.9SW + 0.9SDL + Wsx -90 Degrees
244	C	SLS304: 0.9SW + 0.9SDL + Wsz -45 Degrees
245	C	SLS305: 0.9SW + 0.9SDL + Wsz 0 Degrees
246	C	SLS306: 0.9SW + 0.9SDL + Ws-z -45 Degrees
247	C	SLS307: 0.9SW + 0.9SDL + Wsz +45 Degrees

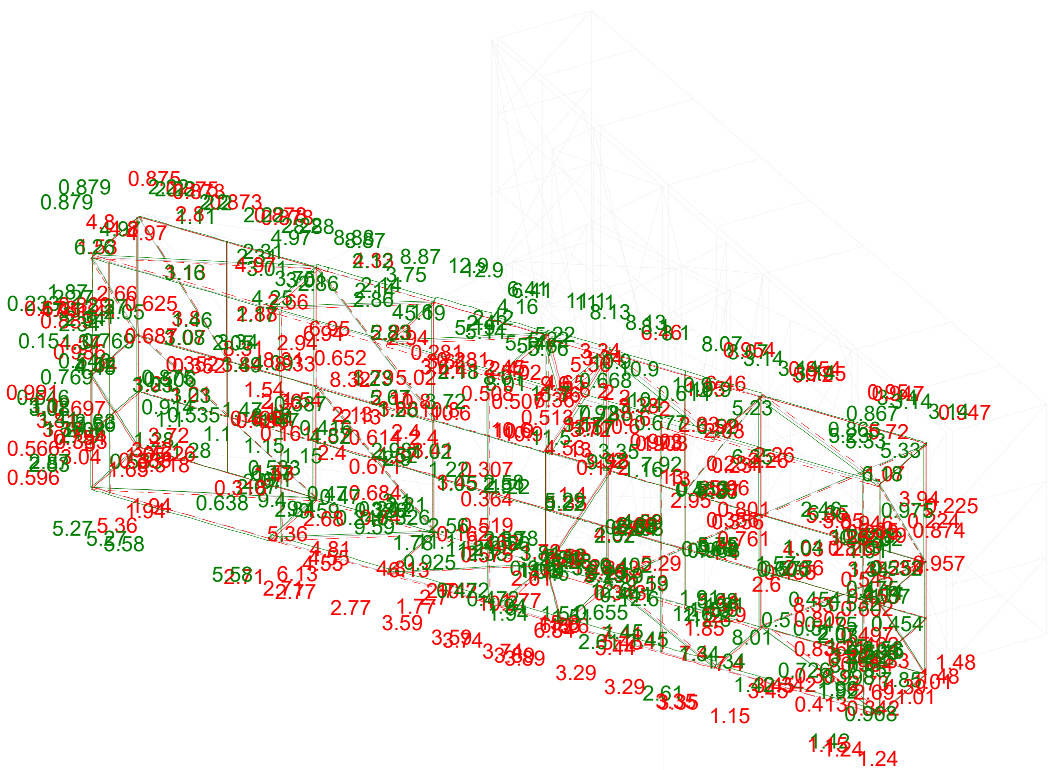
(with eccentricity) - Wind load at 45 degrees

Microstran
CONNECT Edition

ballonc3616
Job: Port of NewCastle - Teal St. REV6
ND

04/04/2022
11:23:31 am

Envelope for Axial Force
Maximum
Minimum
Enveloped Cases:
100 C ULS01: 1.35(SW + SDL)
110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees



Y
X
Z

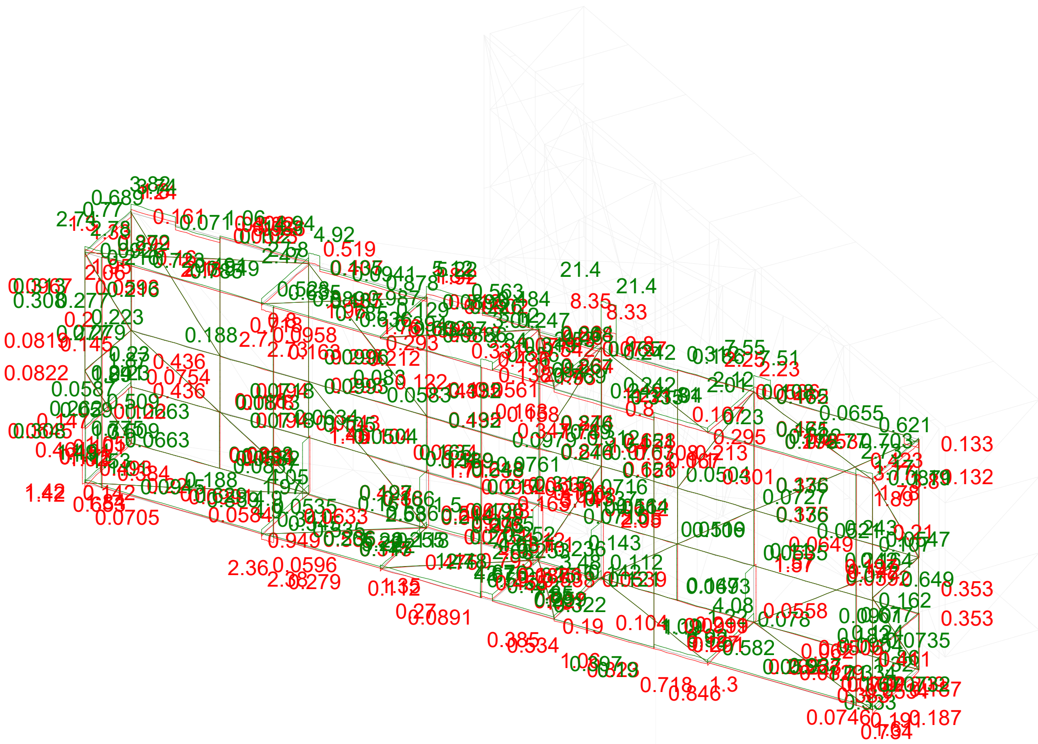
theta: 225 phi: 30

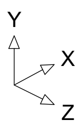
Axial Force, Fx (Digital Signbox)

Axial Force, Fx

Envelope for Shear Fy
- Maximum
- Minimum

Enveloped Cases:
- 100 C ULS01: 1.35(SW + SDL)
- 110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
- 140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
- 141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
- 142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
- 143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
- 144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
- 145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
- 146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
- 147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
- 150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
- 151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
- 152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
- 153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
- 154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
- 155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
- 156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
- 157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees



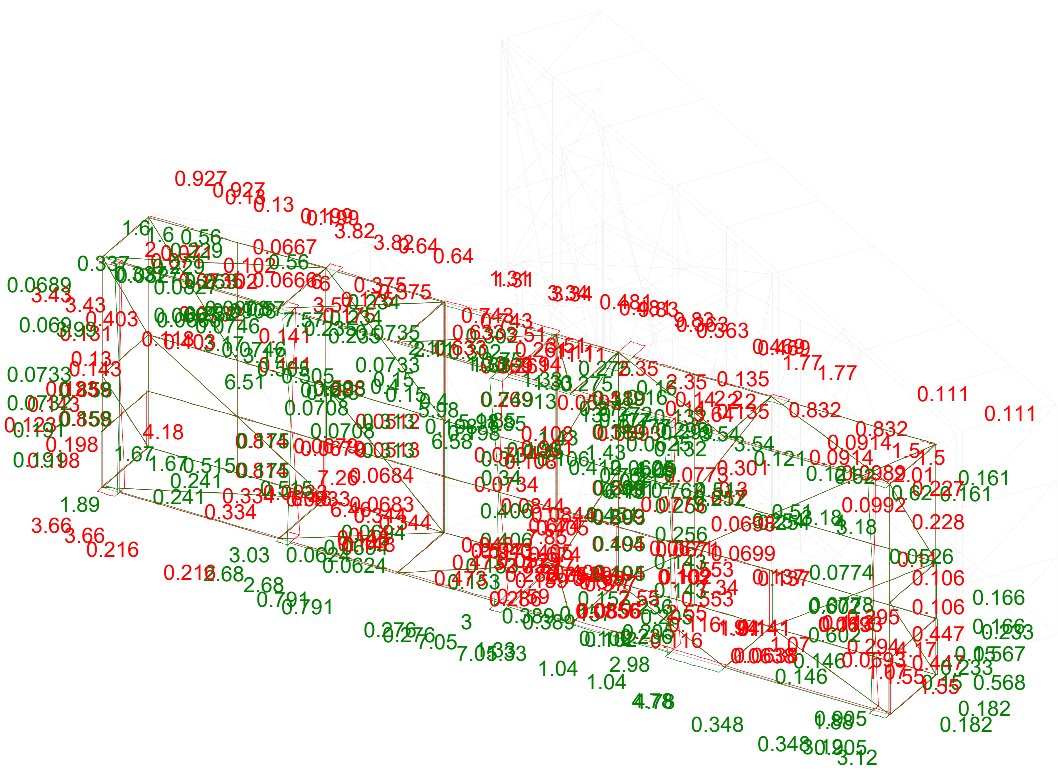


theta: 225 phi: 30

Shear Force, Fy (Digital Signbox)

Shear Force, Fy

Envelope for Shear Fz
Maximum
Minimum
Enveloped Cases:
100 C ULS01: 1.35(SW + SDL)
110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees



Y
X
Z
theta: 225 phi: 30

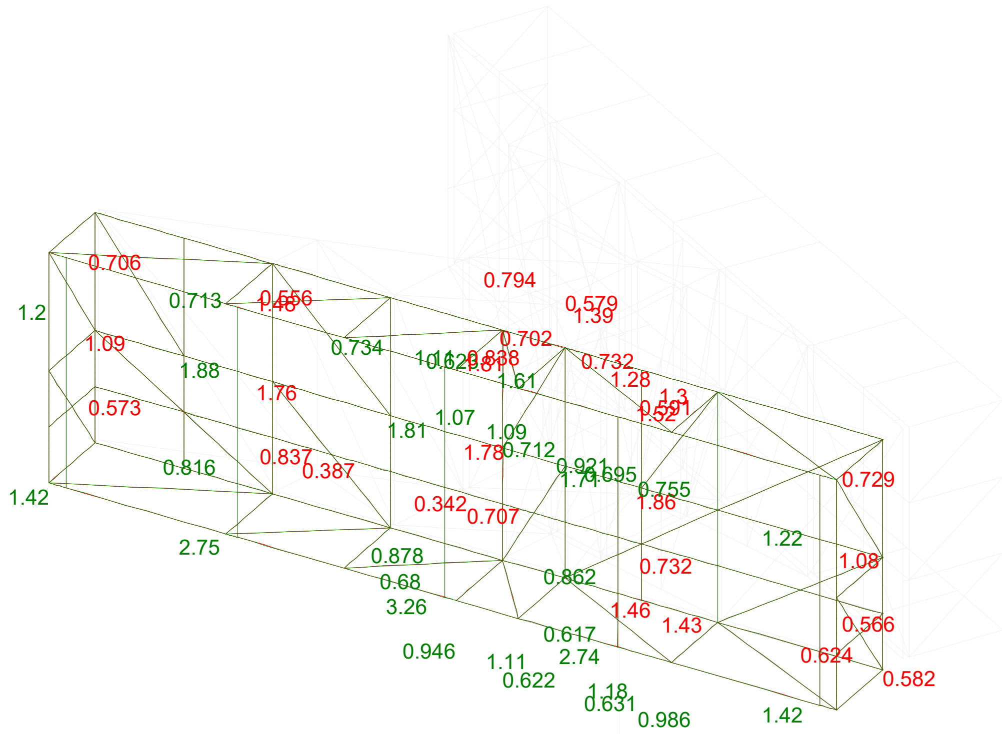
Shear Force, Fz (Digital Signbox)

Shear Force, Fz

ballonc3616
Job: Port of NewCastle - Teal St. REV6
ND

04/04/2022
11:24:25 am

Envelope for Moment My
Maximum
Minimum
Enveloped Cases:
100 C ULS01: 1.35(SW + SDL)
110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees

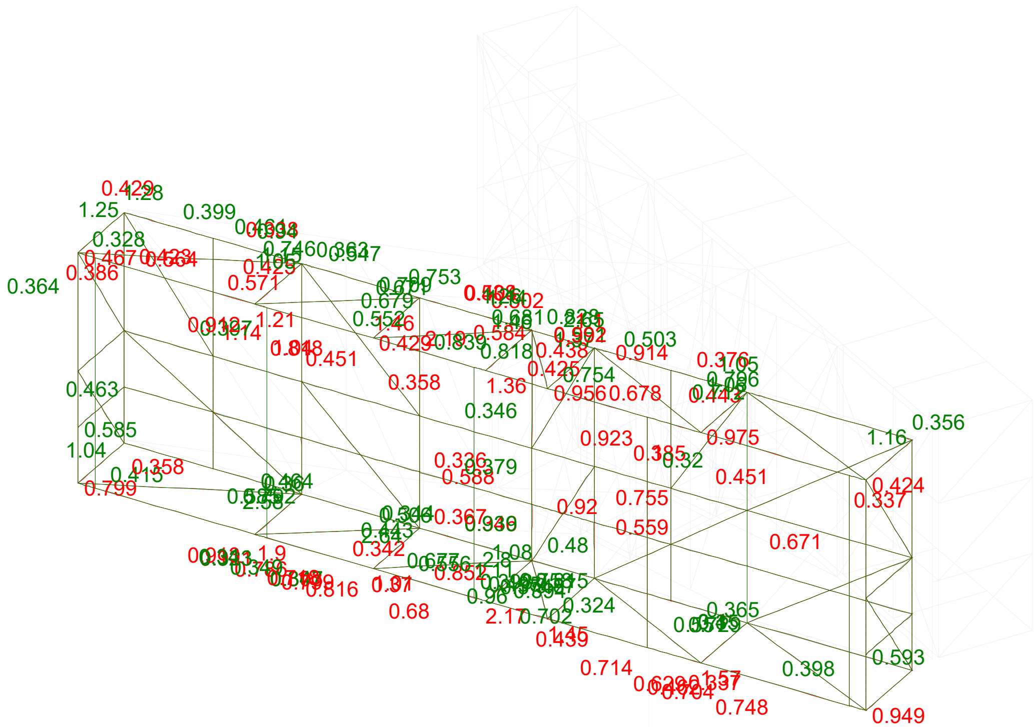


Y
X
Z
theta: 225 phi: 30

Bending Moment, My (Digital Signbox)

Bending Moment, My

Envelope for Moment Mz
Maximum
Minimum
Enveloped Cases:
100 C ULS01: 1.35(SW + SDL)
110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees

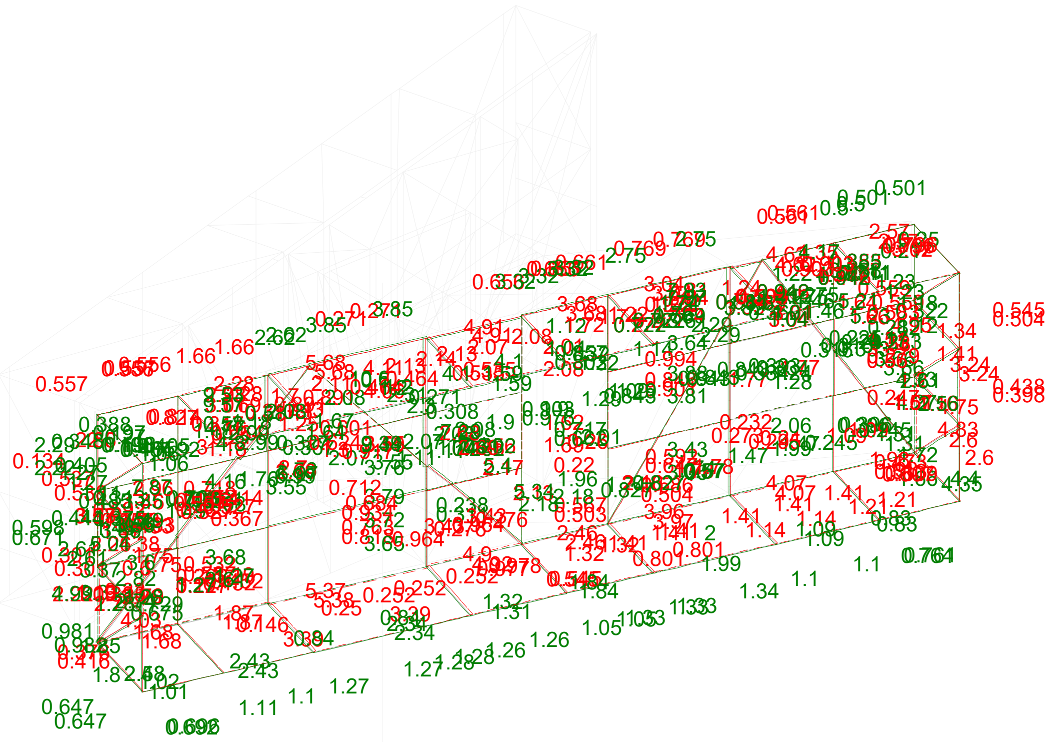


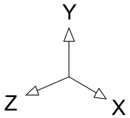
Y
X
Z
theta: 225 phi: 30

Bending Moment, Mz (Digital Signbox)

Bending Moment, Mz

Envelope for Axial Force
Maximum
Minimum
Enveloped Cases:
- 100 C ULS01: 1.35(SW + SDL)
- 110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
- 140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
- 141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
- 142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
- 143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
- 144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
- 145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
- 146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
- 147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
- 150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
- 151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
- 152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
- 153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
- 154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
- 155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
- 156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
- 157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees



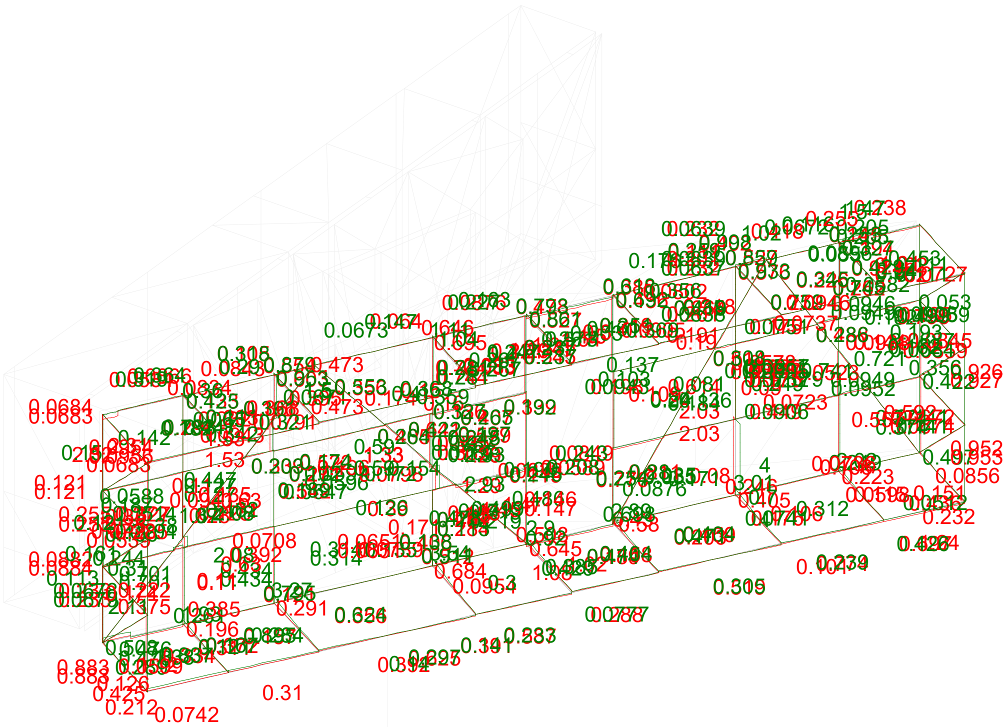


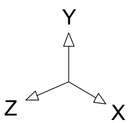
theta: 320 phi: 30

Axial Force, Fx (Static Signbox)

Axial Force, Fx

Envelope for Shear Fy
Maximum
Minimum
Enveloped Cases:
- 100 C ULS01: 1.35(SW + SDL)
- 110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
- 140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
- 141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
- 142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
- 143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
- 144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
- 145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
- 146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
- 147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
- 150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
- 151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
- 152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
- 153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
- 154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
- 155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
- 156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
- 157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees



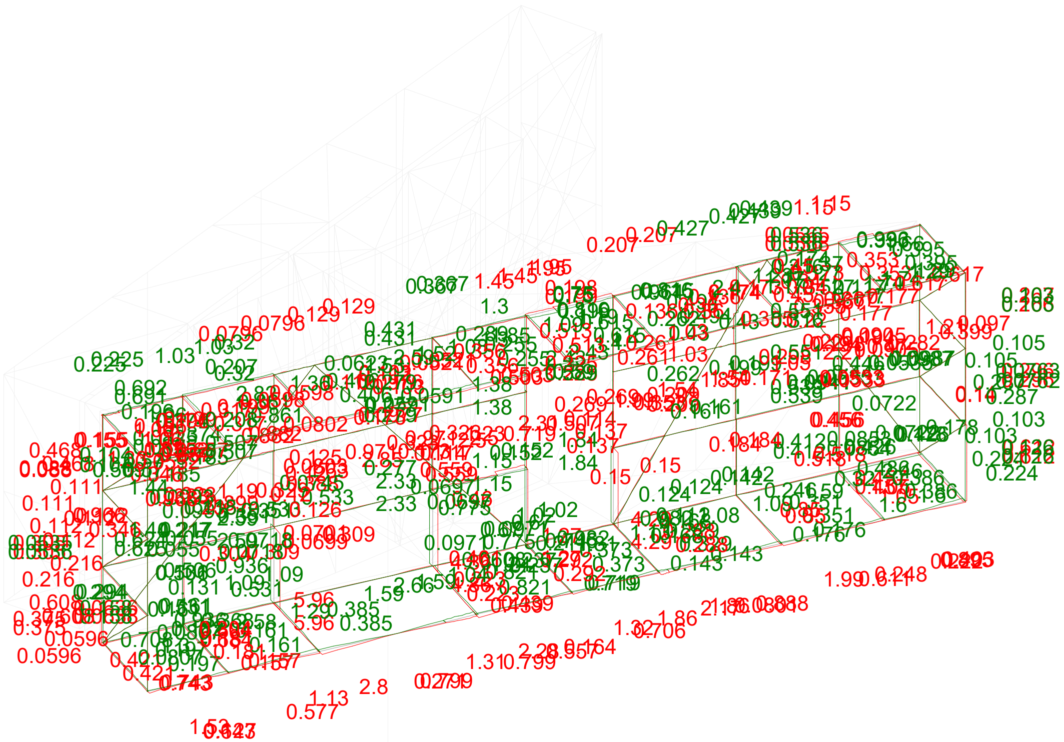


theta: 320 phi: 30

Shear Force, Fy (Static Signbox)

Shear Force, Fy

Envelope for Shear Fz
Maximum
Minimum
Enveloped Cases:
100 C ULS01: 1.35(SW + SDL)
110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees

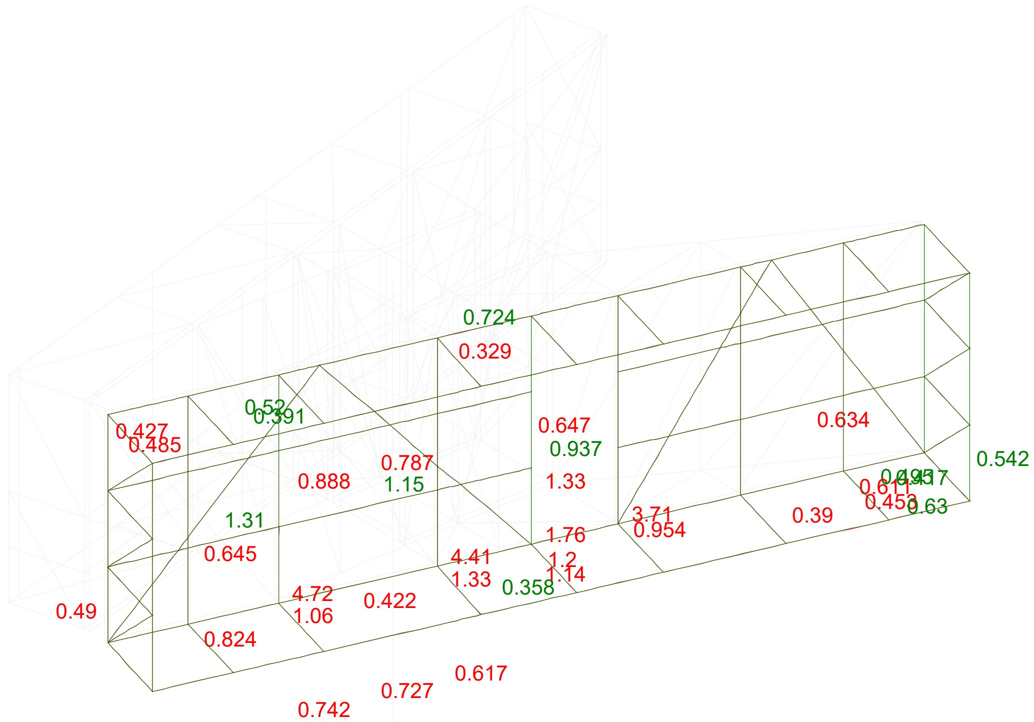


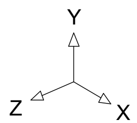
Y
Z X
theta: 320 phi: 30

Shear Force, Fz (Static Signbox)

Shear Force, Fz

Envelope for Moment My
Maximum
Minimum
Enveloped Cases:
- 100 C ULS01: 1.35(SW + SDL)
- 110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
- 140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
- 141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
- 142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
- 143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
- 144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
- 145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
- 146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
- 147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
- 150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
- 151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
- 152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
- 153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
- 154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
- 155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
- 156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
- 157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees



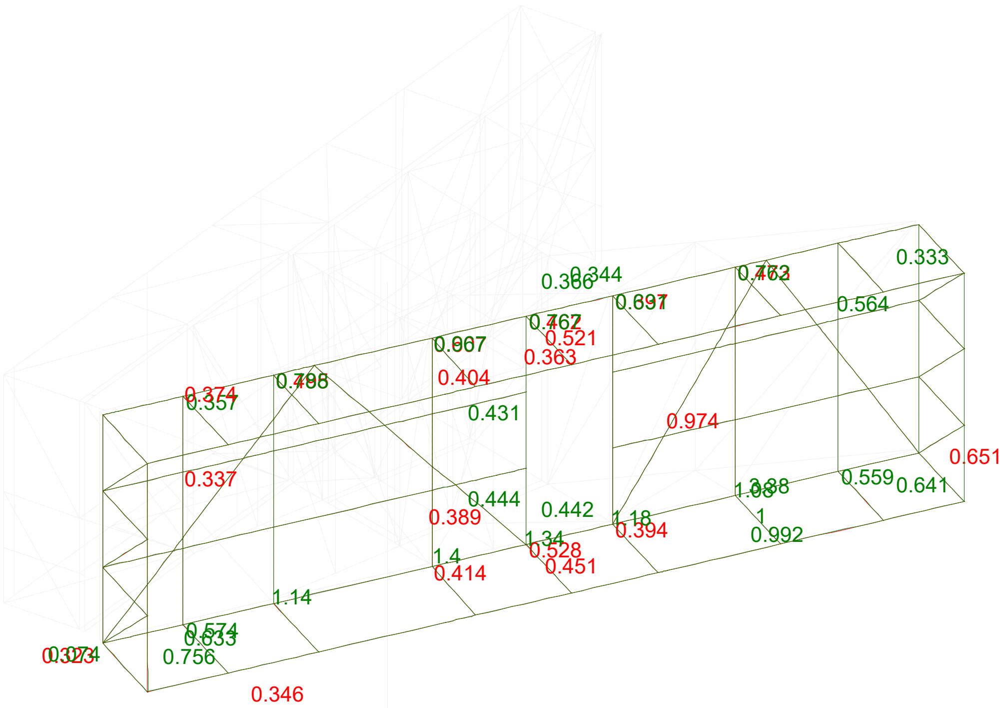


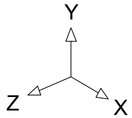
theta: 320 phi: 30

Bending Moment, My (Static Signbox)

Bending Moment, My

Envelope for Moment Mz
Maximum
Minimum
Enveloped Cases:
100 C ULS01: 1.35(SW + SDL)
110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees



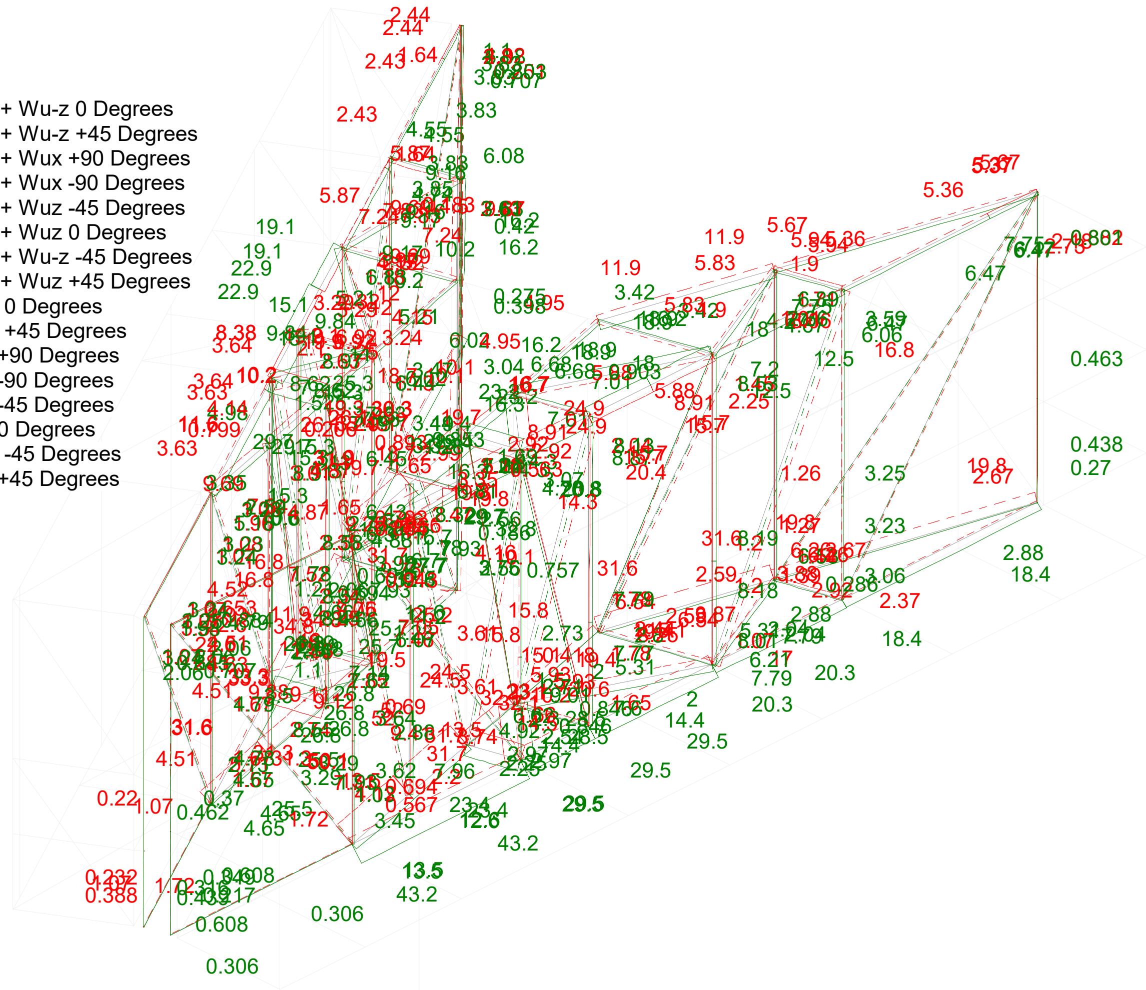


theta: 320 phi: 30

Bending Moment, Mz (Static Signbox)

Bending Moment, Mz

Envelope for Axial Force
Maximum
Minimum
Enveloped Cases:
100 C ULS01: 1.35(SW + SDL)
110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees



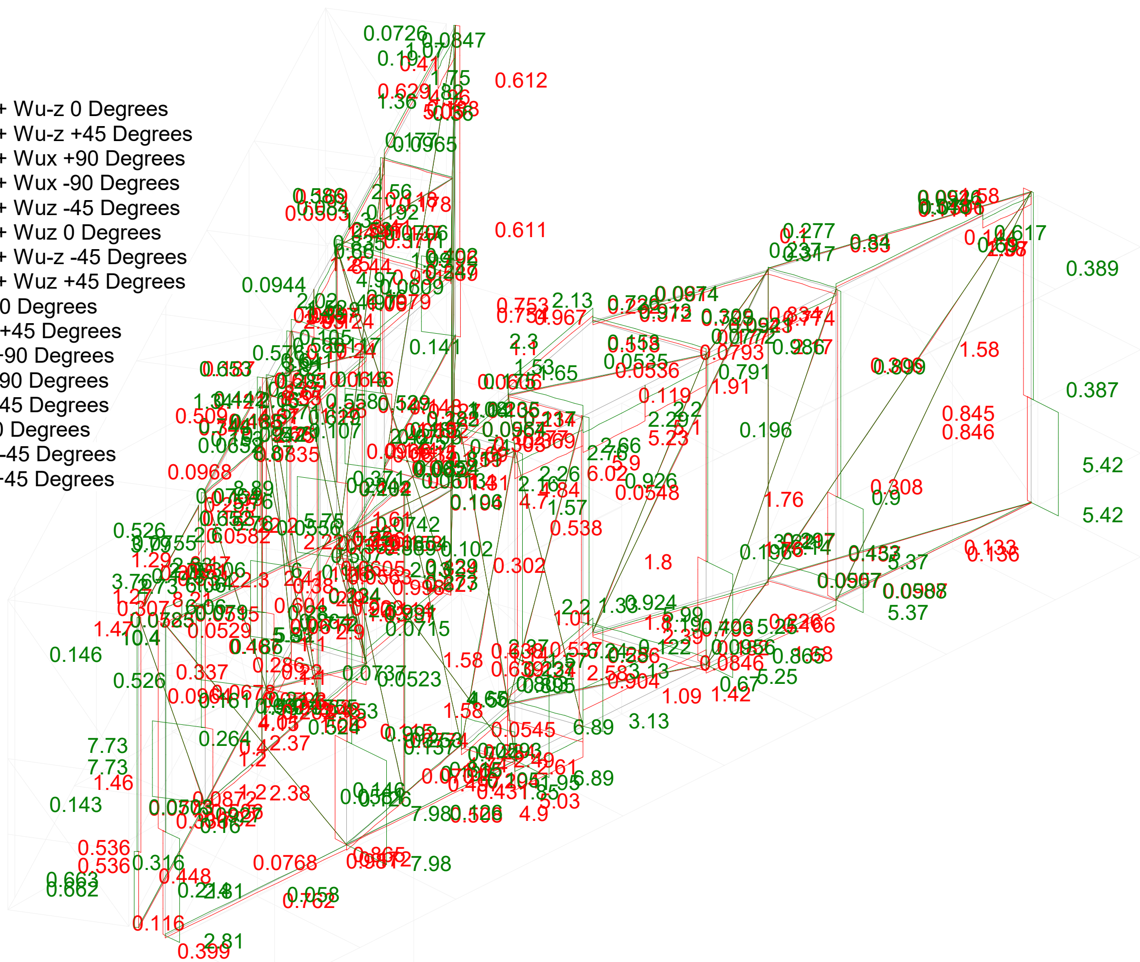
Y
Z X
theta: 300 phi: 30

Axial Force, Fx (Back Frame)

Axial Force, Fx

Envelope for Shear Fy
- Maximum
- Minimum

Enveloped Cases:
- 100 C ULS01: 1.35(SW + SDL)
- 110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
- 140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
- 141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
- 142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
- 143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
- 144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
- 145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
- 146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
- 147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
- 150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
- 151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
- 152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
- 153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
- 154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
- 155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
- 156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
- 157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees



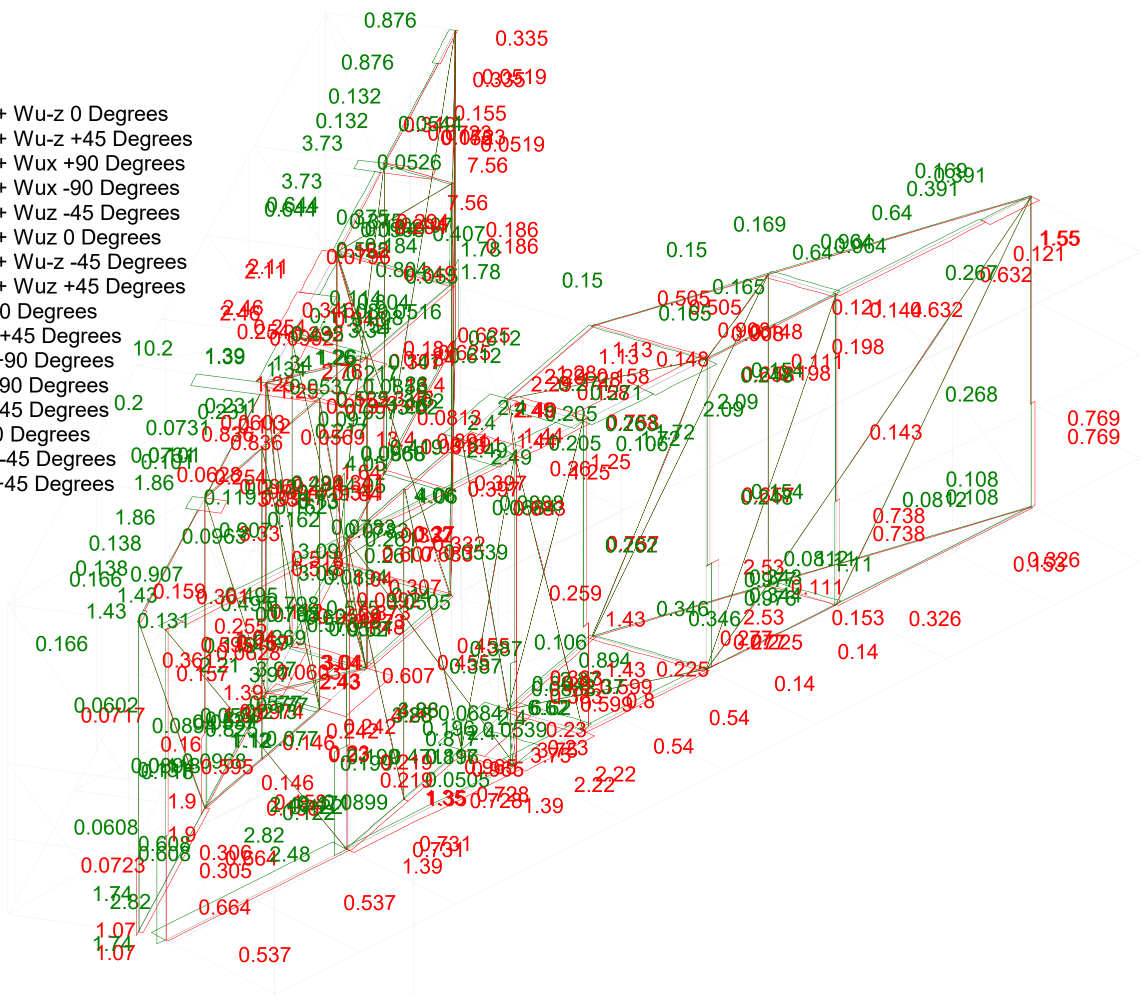
Y X Z

theta: 300 phi: 30

Shear Force, Fy (Back Frame)

Shear Force, Fy

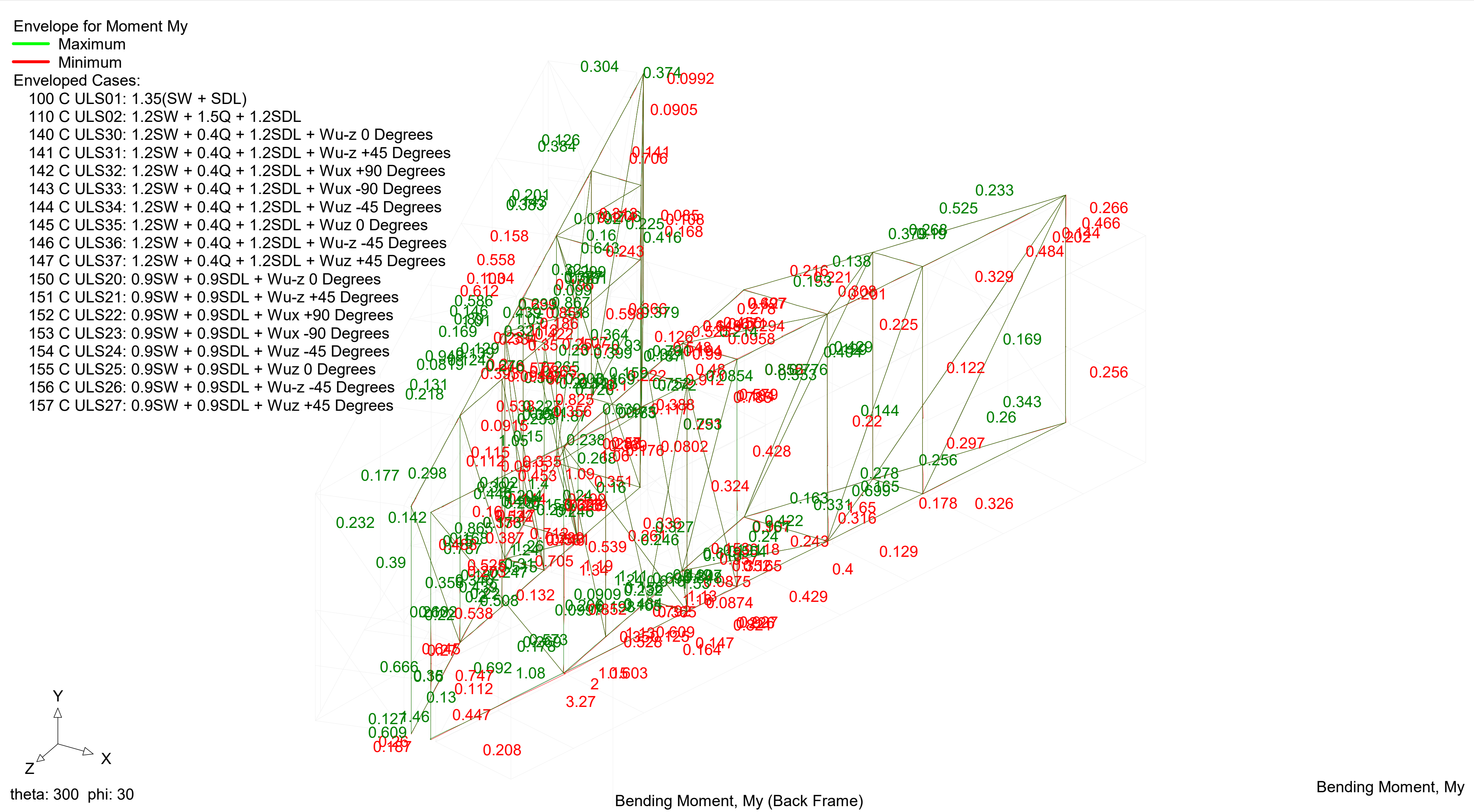
Envelope for Shear Fz
Maximum
Minimum
Enveloped Cases:
- 100 C ULS01: 1.35(SW + SDL)
- 110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
- 140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
- 141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
- 142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
- 143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
- 144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
- 145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
- 146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
- 147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
- 150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
- 151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
- 152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
- 153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
- 154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
- 155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
- 156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
- 157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees



Y
Z X
theta: 300 phi: 30

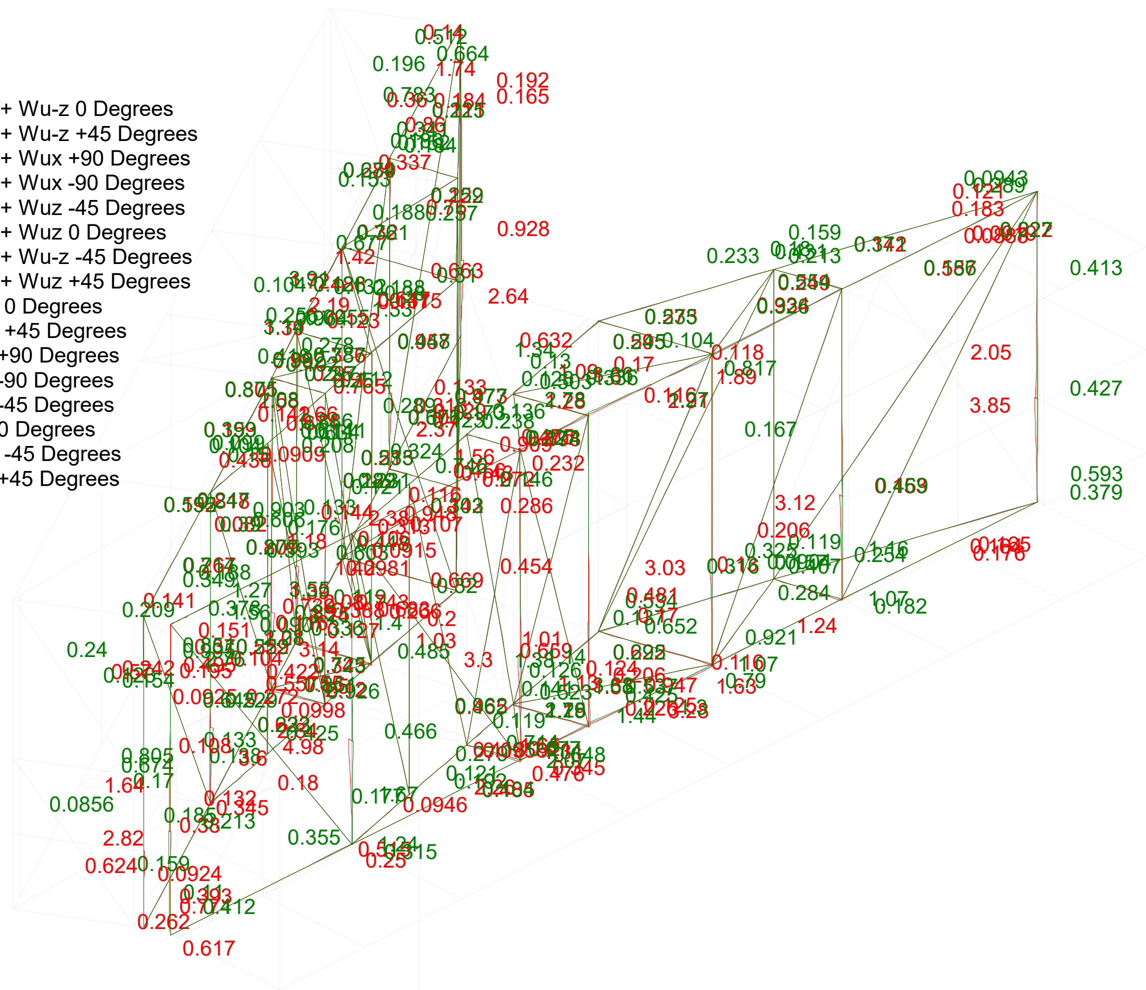
Shear Force, Fz (Back Frame)

Shear Force, Fz



Bending Moment, My (Back Frame)

Envelope for Moment Mz
Maximum
Minimum
Enveloped Cases:
- 100 C ULS01: 1.35(SW + SDL)
- 110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
- 140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
- 141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
- 142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
- 143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
- 144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
- 145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
- 146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
- 147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
- 150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
- 151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
- 152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
- 153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
- 154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
- 155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
- 156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
- 157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees



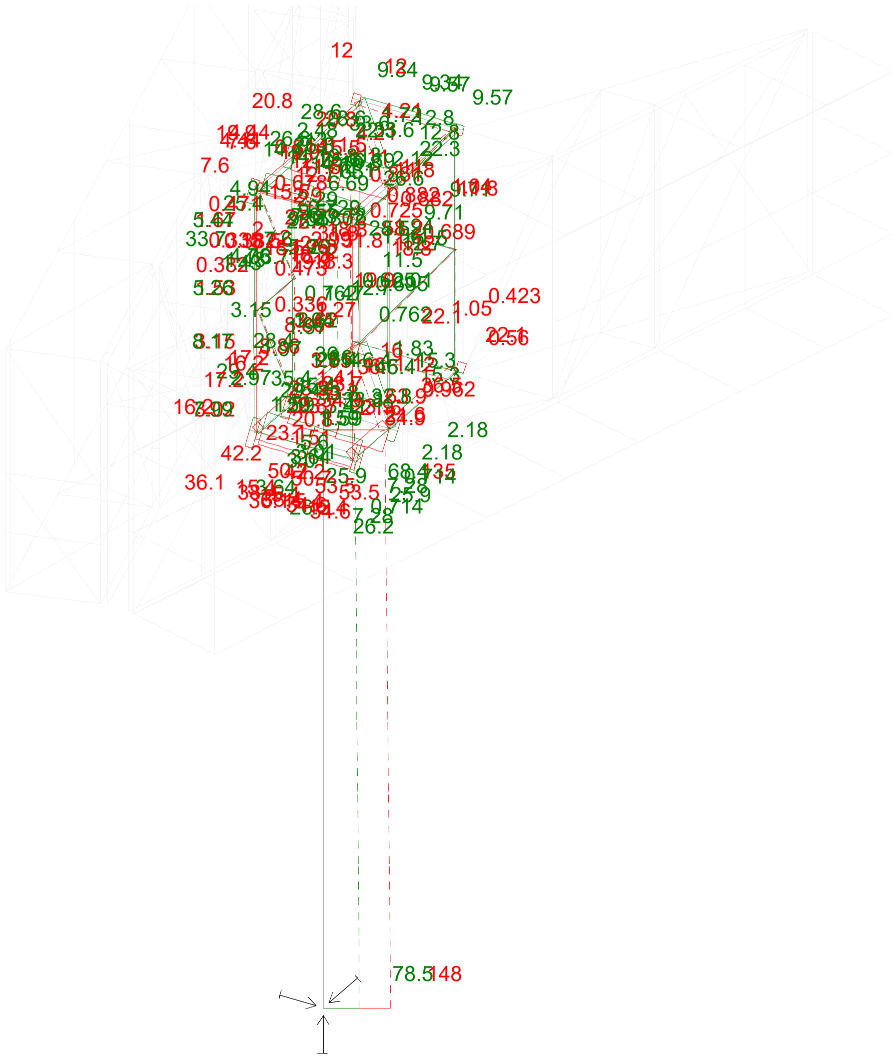
theta: 300 phi: 30

Bending Moment, Mz (Back Frame)

Bending Moment, Mz

Envelope for Axial Force
- Maximum
- Minimum

Enveloped Cases:
- 100 C ULS01: 1.35(SW + SDL)
- 110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
- 140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
- 141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
- 142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
- 143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
- 144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
- 145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
- 146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
- 147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
- 150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
- 151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
- 152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
- 153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
- 154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
- 155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
- 156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
- 157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees

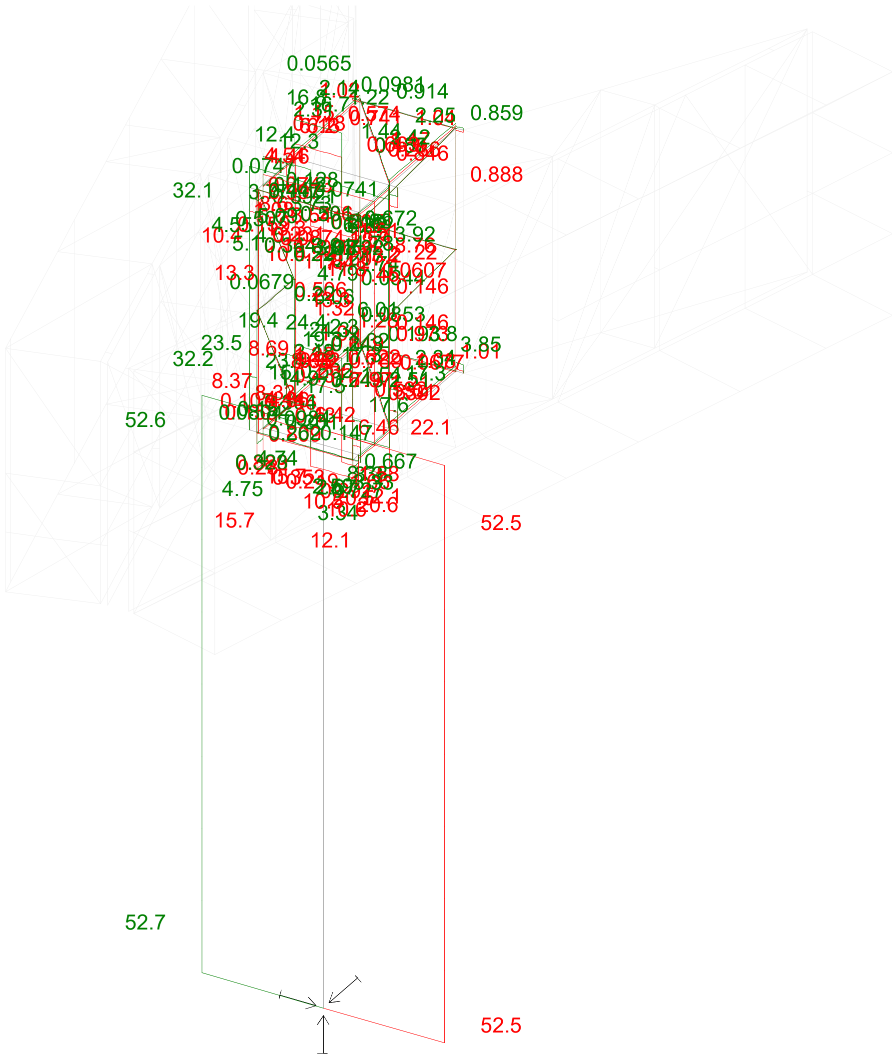


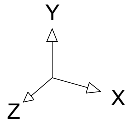
theta: 300 phi: 30

Axial Force, Fx (Monopole)

Axial Force, Fx

Envelope for Shear Fy
Maximum
Minimum
Enveloped Cases:
- 100 C ULS01: 1.35(SW + SDL)
- 110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
- 140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
- 141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
- 142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
- 143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
- 144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
- 145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
- 146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
- 147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
- 150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
- 151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
- 152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
- 153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
- 154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
- 155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
- 156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
- 157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees



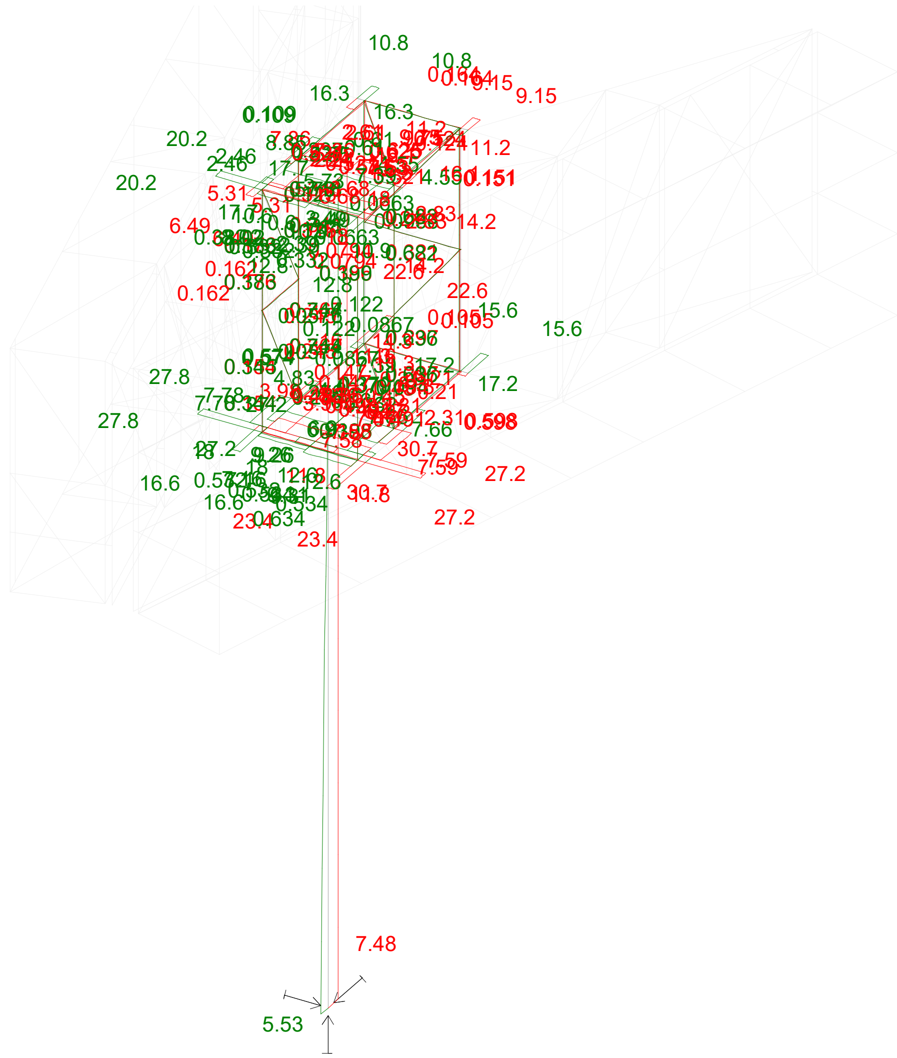


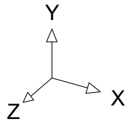
theta: 300 phi: 30

Shear Force, Fy (Monopole)

Shear Force, Fy

Envelope for Shear Fz
Maximum
Minimum
Enveloped Cases:
- 100 C ULS01: 1.35(SW + SDL)
- 110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
- 140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
- 141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
- 142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
- 143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
- 144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
- 145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
- 146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
- 147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
- 150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
- 151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
- 152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
- 153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
- 154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
- 155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
- 156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
- 157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees





theta: 300 phi: 30

Shear Force, Fz (Monopole)

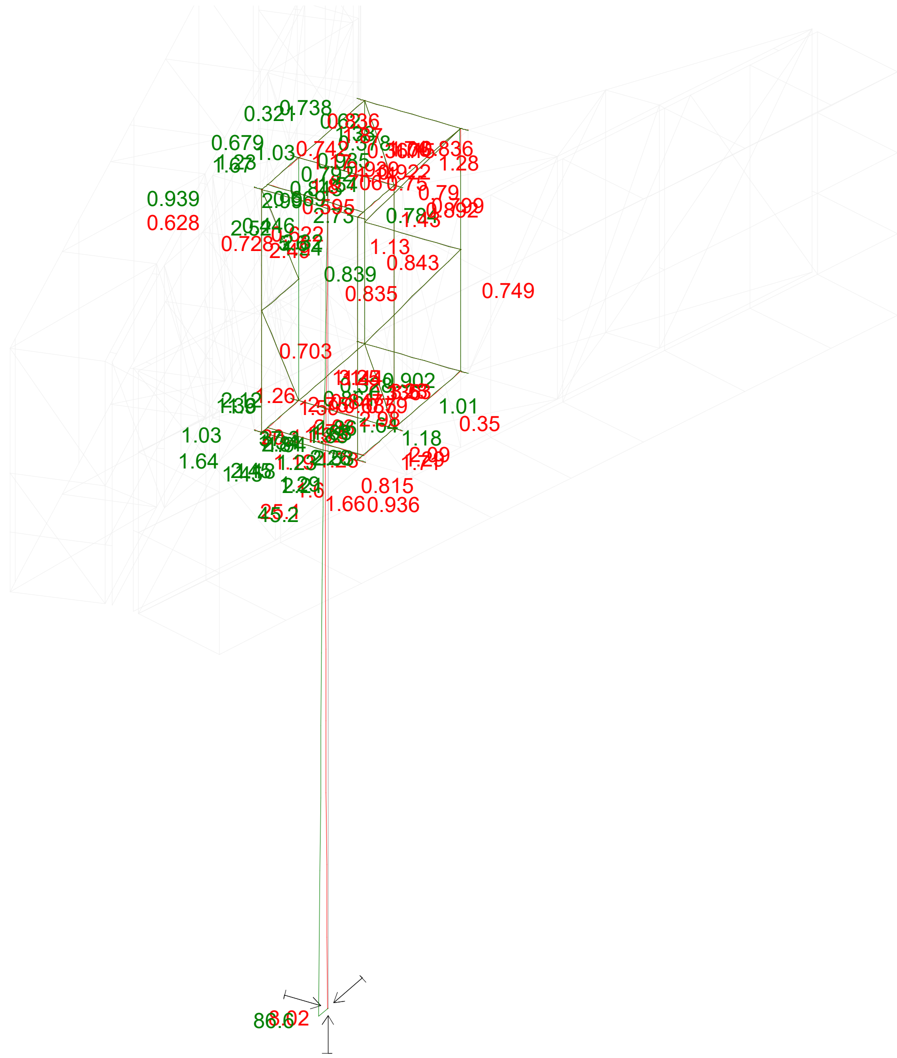
Shear Force, Fz

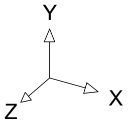
Microstran CONNECT Edition

ballonc3616
Job: Port of NewCastle - Teal St. REV6
ND

04/04/2022
11:19:53 am

Envelope for Moment My
Maximum
Minimum
Enveloped Cases:
100 C ULS01: 1.35(SW + SDL)
110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees



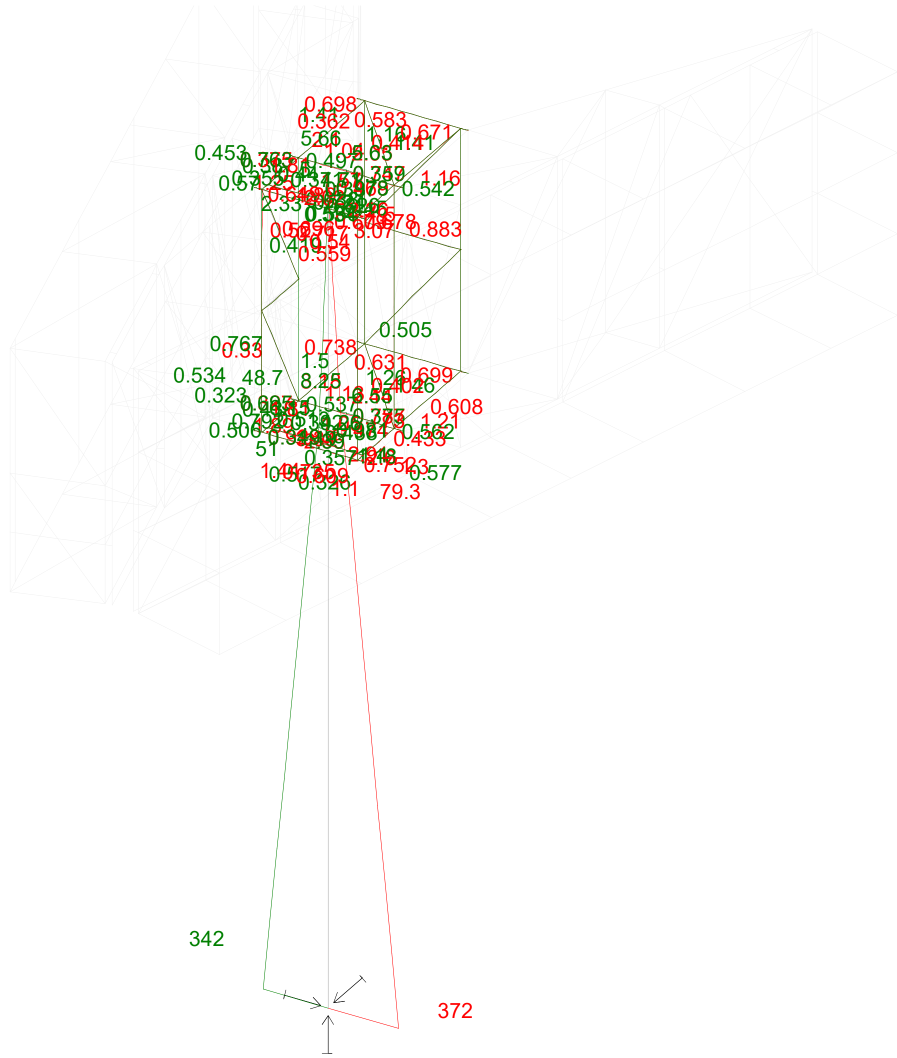


theta: 300 phi: 30

Bending Moment, My (Monopole)

Bending Moment, My

Envelope for Moment Mz
Maximum
Minimum
Enveloped Cases:
- 100 C ULS01: 1.35(SW + SDL)
- 110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
- 140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
- 141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
- 142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
- 143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
- 144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
- 145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
- 146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
- 147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
- 150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
- 151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
- 152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
- 153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
- 154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
- 155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
- 156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
- 157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees

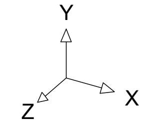


Y
X
Z
theta: 300 phi: 30

Bending Moment, Mz (Monopole)

Bending Moment, Mz

Envelope for Torque Mx
Maximum
Minimum
Enveloped Cases:
100 C ULS01: 1.35(SW + SDL)
110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees



theta: 300 phi: 30

Torsion, Mx (Monopole)

Torque, Mx

E.2 SUPPORT REACTIONS

Microstran
CONNECT Edition

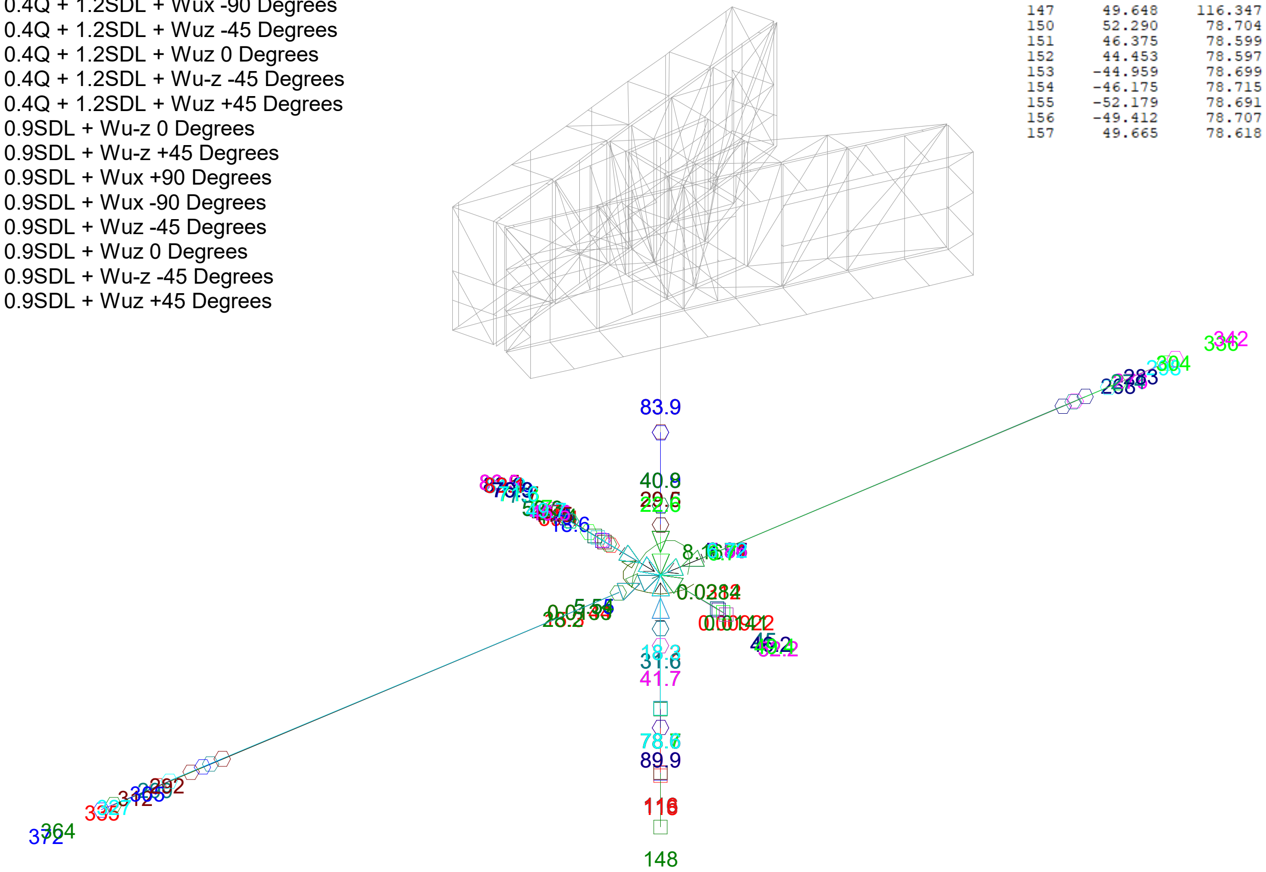
ballonc3616
Job: Port of NewCastle - Teal St. REV6
ND

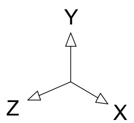
04/04/2022
11:29:44 am

Load Cases:
- 100 C ULS01: 1.35(SW + SDL)
- 110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
- 140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
- 141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
- 142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
- 143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
- 144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
- 145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
- 146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
- 147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
- 150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
- 151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
- 152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
- 153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
- 154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
- 155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
- 156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
- 157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees

NODE REACTIONS - Node: 1 Restraint Code: 111111

Case	Fx	Fy	Fz	Mx	My	Mz
100	-0.009	117.830	-0.014	39.127	-0.031	-15.284
110	-0.014	148.015	-0.013	41.377	-0.028	-28.185
140	52.271	116.436	-5.546	18.622	-40.865	-372.112
141	46.357	116.326	7.370	86.522	-83.945	-312.454
142	44.436	116.324	6.744	82.323	-29.587	-299.436
143	-44.953	116.415	6.910	83.596	31.634	267.648
144	-46.169	116.432	7.357	86.870	89.929	275.845
145	-52.170	116.411	5.852	57.017	41.704	335.851
146	-49.405	116.421	6.695	81.916	-22.565	297.826
147	49.648	116.347	6.713	82.149	18.202	-334.717
150	52.290	78.704	-5.542	8.163	-40.797	-364.104
151	46.375	78.599	7.374	75.936	-83.886	-304.599
152	44.453	78.597	6.751	71.742	-29.533	-291.587
153	-44.959	78.699	6.917	72.989	31.600	274.377
154	-46.175	78.715	7.364	76.254	89.892	282.563
155	-52.179	78.691	5.859	46.467	41.660	342.440
156	-49.412	78.707	6.703	71.315	-22.601	304.492
157	49.665	78.618	6.722	71.569	18.258	-326.795





theta: 320 phi: 30

Support Reactions

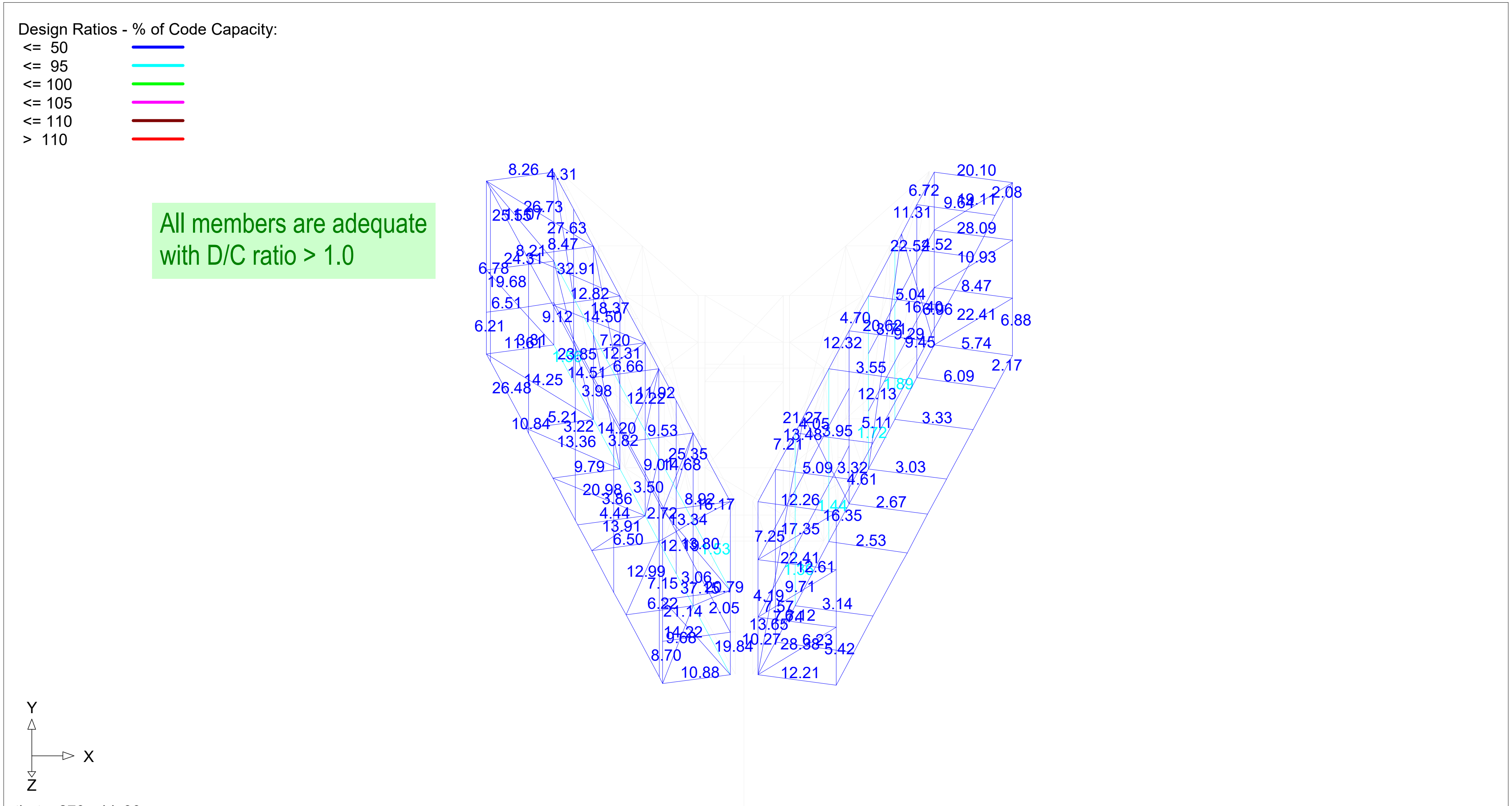
Support Reactions

E.3 STRENGTH UTILIZATION CHECK

Microstran
CONNECT Edition

ballonc3616
Job: Port of NewCastle - Teal St. REV6
ND

04/04/2022
11:32:29 am

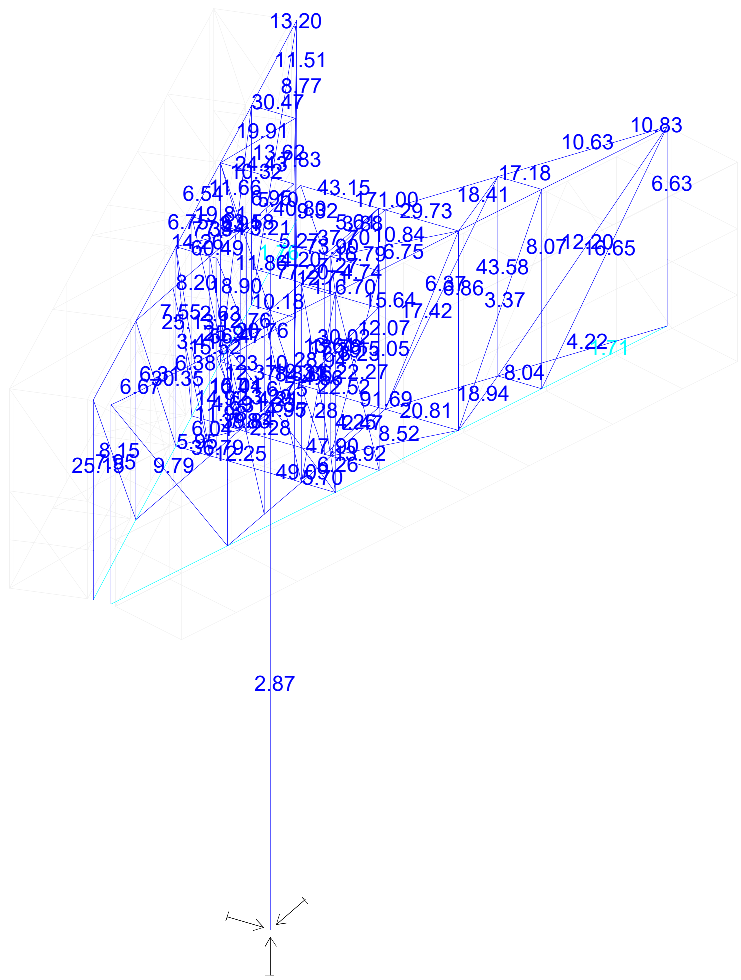


Utilization Ratio - Signbox

Design Ratios - % of Code Capacity:

<= 50	blue
<= 95	cyan
<= 100	green
<= 105	magenta
<= 110	dark red
> 110	red

All members are adequate with D/C ratio > 1.0



Y
X
Z
theta: 300 phi: 30

Utilization Ratio - Support Frame and Monopole

E.4 SIGNBOX DEFLECTION CHECK

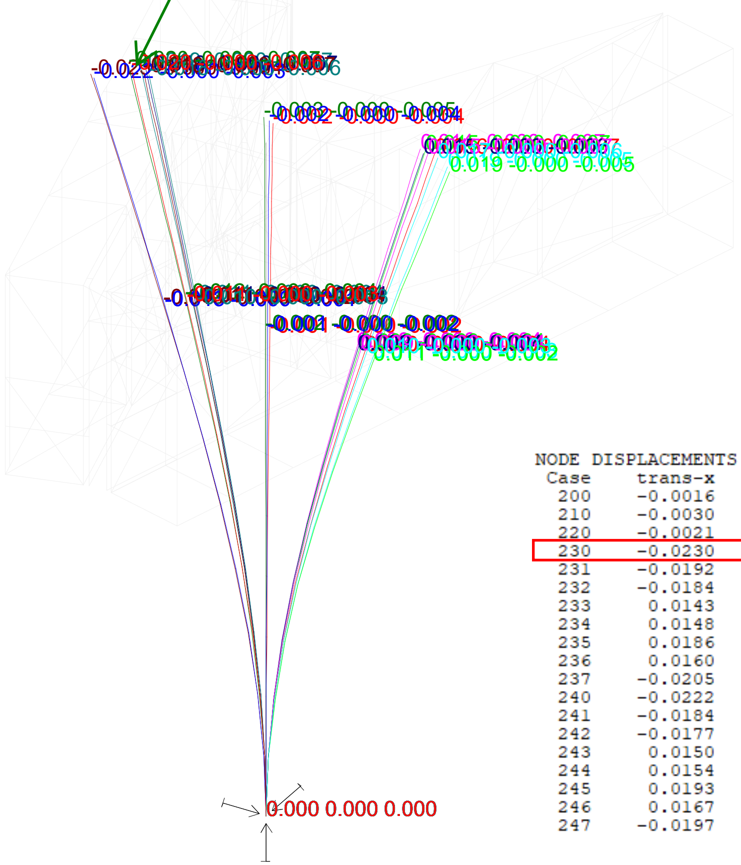
Microstran
CONNECT Edition

ballonc3616
Job: Port of NewCastle - Teal St. REV6
ND

04/04/2022
11:35:51 am

Load Cases:
- 200 C SLS10: SW + SDL
- 210 C SLS11: SW + SDL + Q
- 220 C SLS12: SW + SDL + 0.4Q
- 230 C SLS200: SW + SDL + 0.4Q + Ws-z 0 Degrees
- 231 C SLS201: SW + SDL + 0.4Q + Ws-z +45 Degrees
- 232 C SLS202: SW + SDL + 0.4Q + Wsx +90 Degrees
- 233 C SLS203: SW + SDL + 0.4Q + Wsx -90 Degrees
- 234 C SLS204: SW + SDL + 0.4Q + Wsz -45 Degrees
- 235 C SLS205: SW + SDL + 0.4Q + Wsz 0 Degrees
- 236 C SLS206: SW + SDL + 0.4Q + Ws-z -45 Degrees
- 237 C SLS207: SW + SDL + 0.4Q + Wsz +45 Degrees
- 240 C SLS300: 0.9SW + 0.9SDL + Ws-z 0 Degrees
- 241 C SLS301: 0.9SW + 0.9SDL + Ws-z +45 Degrees
- 242 C SLS302: 0.9SW + 0.9SDL + Wsx +90 Degrees
- 243 C SLS303: 0.9SW + 0.9SDL + Wsx -90 Degrees
- 244 C SLS304: 0.9SW + 0.9SDL + Wsz -45 Degrees
- 245 C SLS305: 0.9SW + 0.9SDL + Wsz 0 Degrees
- 246 C SLS306: 0.9SW + 0.9SDL + Ws-z -45 Degrees
- 247 C SLS307: 0.9SW + 0.9SDL + Wsz +45 Degrees

Maximum deflection at top of monopole is 23mm < limit of 7900/125 = 63.2mm



NODE DISPLACEMENTS - Node: 2 Restraint Code: 000000

Case	trans-x	trans-y	trans-z	rot-x	rot-y	rot-z
200	-0.0016	-0.0001	-0.0041	-0.0009	-0.0000	0.0004
210	-0.0030	-0.0002	-0.0047	-0.0010	0.0000	0.0007
220	-0.0021	-0.0001	-0.0043	-0.0010	-0.0000	0.0005
230	-0.0230	-0.0002	-0.0036	-0.0008	0.0010	0.0042
231	-0.0192	-0.0002	-0.0073	-0.0015	0.0021	0.0035
232	-0.0184	-0.0002	-0.0070	-0.0014	0.0007	0.0034
233	0.0143	-0.0001	-0.0071	-0.0015	-0.0008	-0.0025
234	0.0148	-0.0001	-0.0073	-0.0015	-0.0022	-0.0026
235	0.0186	-0.0002	-0.0052	-0.0011	-0.0010	-0.0033
236	0.0160	-0.0001	-0.0070	-0.0014	0.0006	-0.0028
237	-0.0205	-0.0002	-0.0070	-0.0014	-0.0005	0.0038
240	-0.0222	-0.0001	-0.0029	-0.0007	0.0010	0.0041
241	-0.0184	-0.0001	-0.0066	-0.0013	0.0021	0.0034
242	-0.0177	-0.0001	-0.0064	-0.0013	0.0007	0.0032
243	0.0150	-0.0001	-0.0064	-0.0013	-0.0008	-0.0026
244	0.0154	-0.0001	-0.0066	-0.0014	-0.0022	-0.0027
245	0.0193	-0.0001	-0.0046	-0.0010	-0.0010	-0.0034
246	0.0167	-0.0001	-0.0063	-0.0013	0.0006	-0.0029
247	-0.0197	-0.0001	-0.0063	-0.0013	-0.0005	0.0036

Y X Z

theta: 300 phi: 30

Deflection - Monopole

Displaced Shape

Load Cases:
- 200 C SLS10: SW + SDL
- 210 C SLS11: SW + SDL + Q
- 220 C SLS12: SW + SDL + 0.4Q
- 230 C SLS200: SW + SDL + 0.4Q + Ws-z 0 Degrees
- 231 C SLS201: SW + SDL + 0.4Q + Ws-z +45 Degrees
- 232 C SLS202: SW + SDL + 0.4Q + Wsx +90 Degrees
- 233 C SLS203: SW + SDL + 0.4Q + Wsx -90 Degrees
- 234 C SLS204: SW + SDL + 0.4Q + Wsz -45 Degrees
- 235 C SLS205: SW + SDL + 0.4Q + Wsz 0 Degrees
- 236 C SLS206: SW + SDL + 0.4Q + Ws-z -45 Degrees
- 237 C SLS207: SW + SDL + 0.4Q + Wsz +45 Degrees
- 240 C SLS300: 0.9SW + 0.9SDL + Ws-z 0 Degrees
- 241 C SLS301: 0.9SW + 0.9SDL + Ws-z +45 Degrees
- 242 C SLS302: 0.9SW + 0.9SDL + Wsx +90 Degrees
- 243 C SLS303: 0.9SW + 0.9SDL + Wsx -90 Degrees
- 244 C SLS304: 0.9SW + 0.9SDL + Wsz -45 Degrees
- 245 C SLS305: 0.9SW + 0.9SDL + Wsz 0 Degrees
- 246 C SLS306: 0.9SW + 0.9SDL + Ws-z -45 Degrees
- 247 C SLS307: 0.9SW + 0.9SDL + Wsz +45 Degrees

TOP OF DIGITAL SIGN

NODE DISPLACEMENTS - Node: 136 Restraint Code: 000000

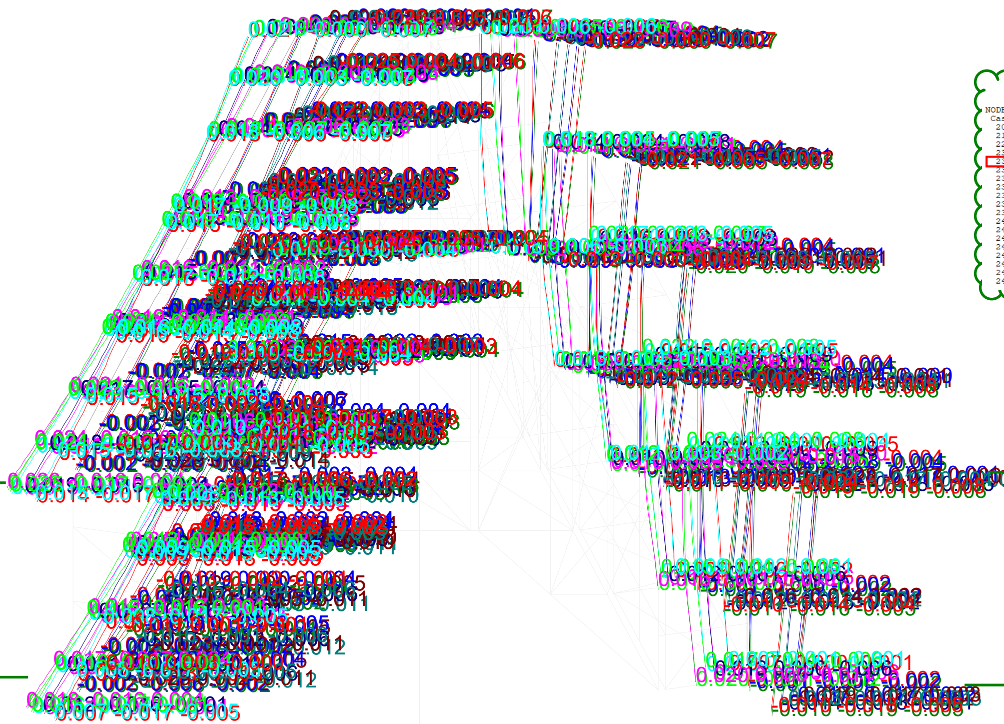
Case	trans-x	trans-y	trans-z	rot-x	rot-y	rot-z
200	-0.0011	-0.0053	-0.0041	-0.0000	0.0000	-0.0001
210	-0.0023	-0.0059	-0.0047	-0.0003	-0.0000	-0.0000
220	-0.0016	-0.0056	-0.0043	-0.0001	0.0000	-0.0001
230	-0.0274	0.0064	-0.0068	-0.0000	0.0007	0.0034
231	-0.0290	0.0014	-0.0151	-0.0009	0.0020	0.0025
232	-0.0216	0.0013	-0.0092	-0.0006	0.0002	0.0025
233	0.0185	-0.0167	-0.0044	-0.0006	-0.0007	-0.0030
234	0.0255	-0.0172	0.0004	-0.0006	-0.0023	-0.0032
235	0.0242	-0.0176	-0.0019	-0.0003	-0.0007	-0.0036
236	0.0143	-0.0174	-0.0090	-0.0006	0.0008	-0.0031
237	-0.0177	0.0027	-0.0043	-0.0004	-0.0012	0.0031
240	-0.0268	0.0071	-0.0062	0.0001	0.0007	0.0034
241	-0.0284	0.0022	-0.0144	-0.0008	0.0021	0.0025
242	-0.0210	0.0021	-0.0086	-0.0005	0.0003	0.0025
243	0.0191	-0.0159	-0.0038	-0.0005	-0.0007	-0.0030
244	0.0261	-0.0165	0.0011	-0.0005	-0.0023	-0.0032
245	0.0248	-0.0168	-0.0013	-0.0002	-0.0006	-0.0036
246	0.0148	-0.0166	-0.0084	-0.0005	0.0008	-0.0031
247	-0.0171	0.0034	-0.0037	-0.0003	-0.0012	0.0031

BOTTOM OF DIGITAL SIGN

NODE DISPLACEMENTS - Node: 150 Restraint Code: 000000

Case	trans-x	trans-y	trans-z	rot-x	rot-y	rot-z
200	-0.0016	-0.0053	-0.0019	0.0009	-0.0004	-0.0000
210	-0.0026	-0.0059	-0.0022	0.0016	-0.0006	0.0003
220	-0.0020	-0.0056	-0.0020	0.0012	-0.0005	0.0001
230	-0.0197	0.0063	-0.0048	0.0018	-0.0003	0.0037
231	-0.0234	0.0014	-0.0116	0.0019	0.0005	0.0029
232	-0.0160	0.0013	-0.0058	0.0013	-0.0009	0.0028
233	0.0114	-0.0167	-0.0010	0.0006	-0.0011	-0.0028
234	0.0179	-0.0172	0.0038	0.0006	-0.0026	-0.0030
235	0.0157	-0.0176	0.0008	0.0005	-0.0006	-0.0034
236	0.0067	-0.0174	-0.0054	0.0004	0.0005	-0.0029
237	-0.0108	0.0027	-0.0007	0.0008	-0.0019	0.0032
240	-0.0191	0.0071	-0.0045	0.0014	-0.0002	0.0035
241	-0.0228	0.0022	-0.0113	0.0015	0.0007	0.0028
242	-0.0155	0.0021	-0.0055	0.0010	-0.0008	0.0027
243	0.0119	-0.0159	-0.0007	0.0002	-0.0009	-0.0029
244	0.0185	-0.0164	0.0041	0.0002	-0.0025	-0.0031
245	0.0162	-0.0168	0.0010	0.0001	-0.0005	-0.0035
246	0.0073	-0.0166	-0.0052	0.0001	0.0006	-0.0031
247	-0.0102	0.0034	-0.0004	0.0004	-0.0017	0.0031

The maximum vertical deflection of signage is 17.6mm or L/475 where L is the total width of the signage.



The maximum absolute deflection of top of signage is 33mm or L/255 where L is the total width of the signage.

Considering the same load combination, the relative deflection of the bottom of sign is only 6mm which is minimal and implies that the whole sign box deflects altogether.

TOP OF STATIC SIGN

NODE DISPLACEMENTS - Node: 108 Restraint Code: 000000

Case	trans-x	trans-y	trans-z	rot-x	rot-y	rot-z
200	-0.0017	-0.0069	-0.0042	-0.0005	0.0001	0.0006
210	-0.0032	-0.0093	-0.0047	-0.0005	0.0001	0.0011
220	-0.0023	-0.0078	-0.0044	-0.0005	0.0001	0.0008
230	-0.0278	-0.0183	-0.0001	-0.0006	0.0012	0.0039
231	-0.0284	-0.0189	-0.0004	-0.0010	0.0024	0.0037
232	-0.0219	-0.0182	-0.0045	-0.0010	0.0009	0.0035
233	0.0178	-0.0012	-0.0099	-0.0007	-0.0008	-0.0014
234	0.0251	-0.0012	-0.0153	-0.0006	-0.0026	-0.0010
235	0.0232	0.0024	-0.0089	-0.0005	-0.0011	-0.0023
236	0.0132	-0.0002	-0.0050	-0.0009	0.0008	-0.0024
237	-0.0189	-0.0192	-0.0084	-0.0011	-0.0004	0.0037
240	-0.0270	-0.0166	0.0005	-0.0006	0.0012	0.0037
241	-0.0276	-0.0172	0.0003	-0.0010	0.0024	0.0035
242	-0.0211	-0.0166	-0.0039	-0.0010	0.0009	0.0033
243	0.0186	0.0004	-0.0093	-0.0007	-0.0008	-0.0017
244	0.0259	0.0004	-0.0146	-0.0006	-0.0026	-0.0012
245	0.0240	0.0040	-0.0083	-0.0004	-0.0011	-0.0026
246	0.0139	0.0015	-0.0043	-0.0009	0.0008	-0.0026
247	-0.0181	-0.0176	-0.0078	-0.0011	-0.0004	0.0035

The maximum absolute deflection of top of signage is 28mm or L/300 where L is the total width of the signage.

Considering the same load combination, the relative deflection of the bottom of sign is only 9mm which is minimal and implies that the whole sign box deflects altogether.

BOTTOM OF STATIC SIGN

NODE DISPLACEMENTS - Node: 109 Restraint Code: 000000

Case	trans-x	trans-y	trans-z	rot-x	rot-y	rot-z
200	-0.0006	-0.0069	-0.0019	-0.0006	0.0000	0.0005
210	-0.0011	-0.0093	-0.0022	-0.0006	0.0000	0.0009
220	-0.0008	-0.0078	-0.0021	-0.0006	0.0000	0.0007
230	-0.0177	-0.0183	0.0019	-0.0004	0.0011	0.0048
231	-0.0196	-0.0189	0.0030	-0.0011	0.0023	0.0039
232	-0.0136	-0.0182	-0.0012	-0.0010	0.0008	0.0037
233	0.0128	-0.0012	-0.0064	-0.0011	-0.0008	-0.0027
234	0.0202	-0.0012	-0.0118	-0.0012	-0.0025	-0.0031
235	0.0163	0.0024	-0.0062	-0.0008	-0.0011	-0.0034
236	0.0072	-0.0001	-0.0014	-0.0010	0.0009	-0.0026
237	-0.0099	-0.0192	-0.0049	-0.0011	-0.0004	0.0040
240	-0.0175	-0.0166	0.0022	-0.0004	0.0011	0.0046
241	-0.0194	-0.0172	0.0033	-0.0010	0.0023	0.0037
242	-0.0133	-0.0166	-0.0008	-0.0010	0.0008	0.0035
243	0.0131	0.0004	-0.0061	-0.0011	-0.0008	-0.0029
244	0.0204	0.0004	-0.0115	-0.0012	-0.0026	-0.0033
245	0.0166	0.0041	-0.0059	-0.0007	-0.0011	-0.0036
246	0.0075	0.0015	-0.0011	-0.0009	0.0009	-0.0028
247	-0.0096	-0.0175	-0.0046	-0.0010	-0.0004	0.0038

The maximum vertical deflection of signage is 19.2mm or L/435 where L is the total width of the signage.

Z
X

theta: 90 phi: 30

Deflection - Signbox

Displaced Shape

F.1 BASE PLATE MAXIMUM STRESSES

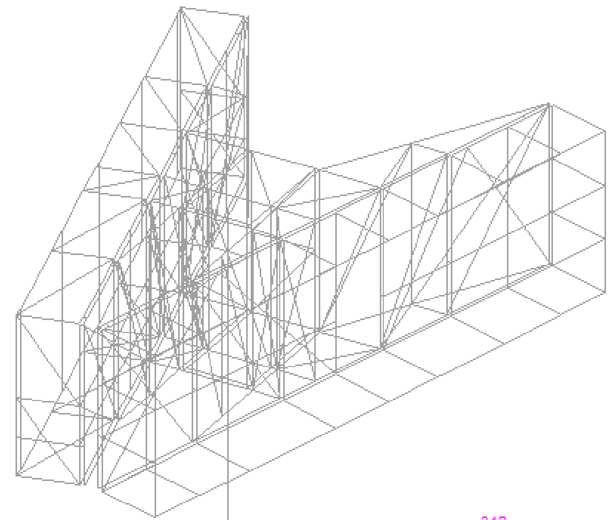
MAXIMUM ULS BASE REACTIONS

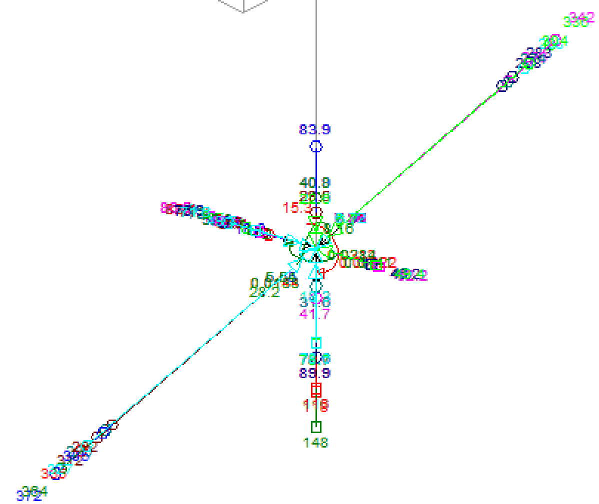
NODE REACTIONS - Node: 1 Restraint Code: 111111

	Case	Fx	Fy	Fz	Mx	My	Mz
	100	-0.009	117.830	-0.014	39.127	-0.031	-15.284
ULS1: MAX FY	110	-0.014	148.015	-0.013	41.377	-0.028	-28.185
ULS2: MAX MZ (MAX FY)	140	52.271	116.436	-5.546	18.622	-40.865	-372.112
	141	46.357	116.326	7.370	86.522	-83.945	-312.454
	142	44.436	116.324	6.744	82.323	-29.587	-299.436
	143	-44.953	116.415	6.910	83.596	31.634	267.648
	144	-46.169	116.432	7.357	86.870	89.929	275.845
	145	-52.170	116.411	5.852	57.017	41.704	335.851
	146	-49.405	116.421	6.695	81.916	-22.565	297.826
ULS3: MAX MY + MZ (MAX FY)	147	49.648	116.347	6.713	82.149	18.202	-334.717
ULS4: MAX MZ (MIN FY)	150	52.290	78.704	-5.542	8.163	-40.797	-364.104
	151	46.375	78.599	7.374	75.936	-83.886	-304.599
	152	44.453	78.597	6.751	71.742	-29.533	-291.587
	153	-44.959	78.699	6.917	72.989	31.600	274.377
	154	-46.175	78.715	7.364	76.254	89.892	282.563
	155	-52.179	78.691	5.859	46.467	41.660	342.440
	156	-49.412	78.707	6.703	71.315	-22.601	304.492
ULS5: MAX MY + MZ (MIN FY)	157	49.665	78.618	6.722	71.569	18.258	-326.795

Load Cases:

- 100 C ULS01: 1.35(SW + SDL)
- 110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
- 140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
- 141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
- 142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
- 143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
- 144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
- 145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
- 146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
- 147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
- 150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
- 151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
- 152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
- 153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
- 154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
- 155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
- 156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
- 157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees

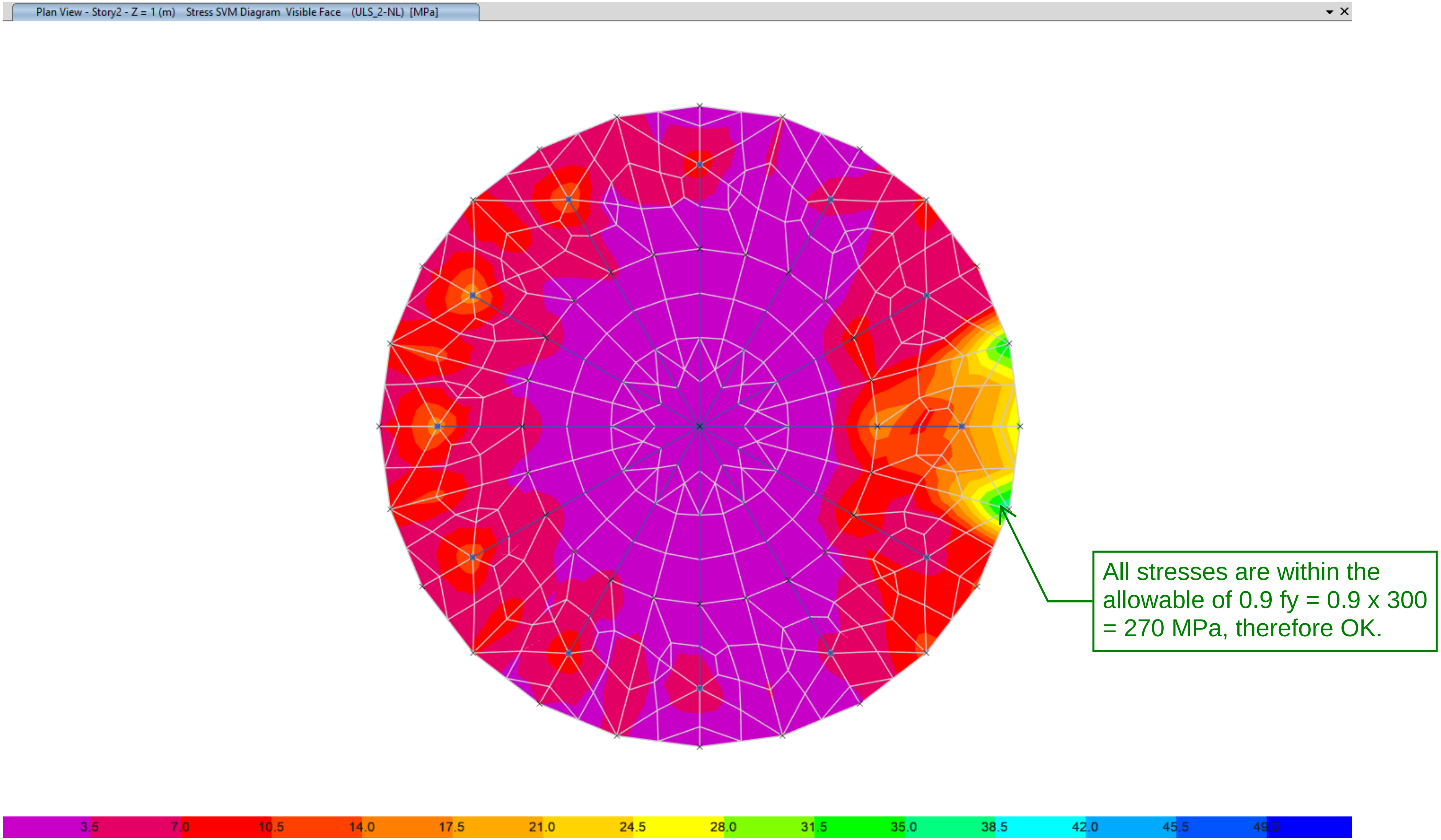




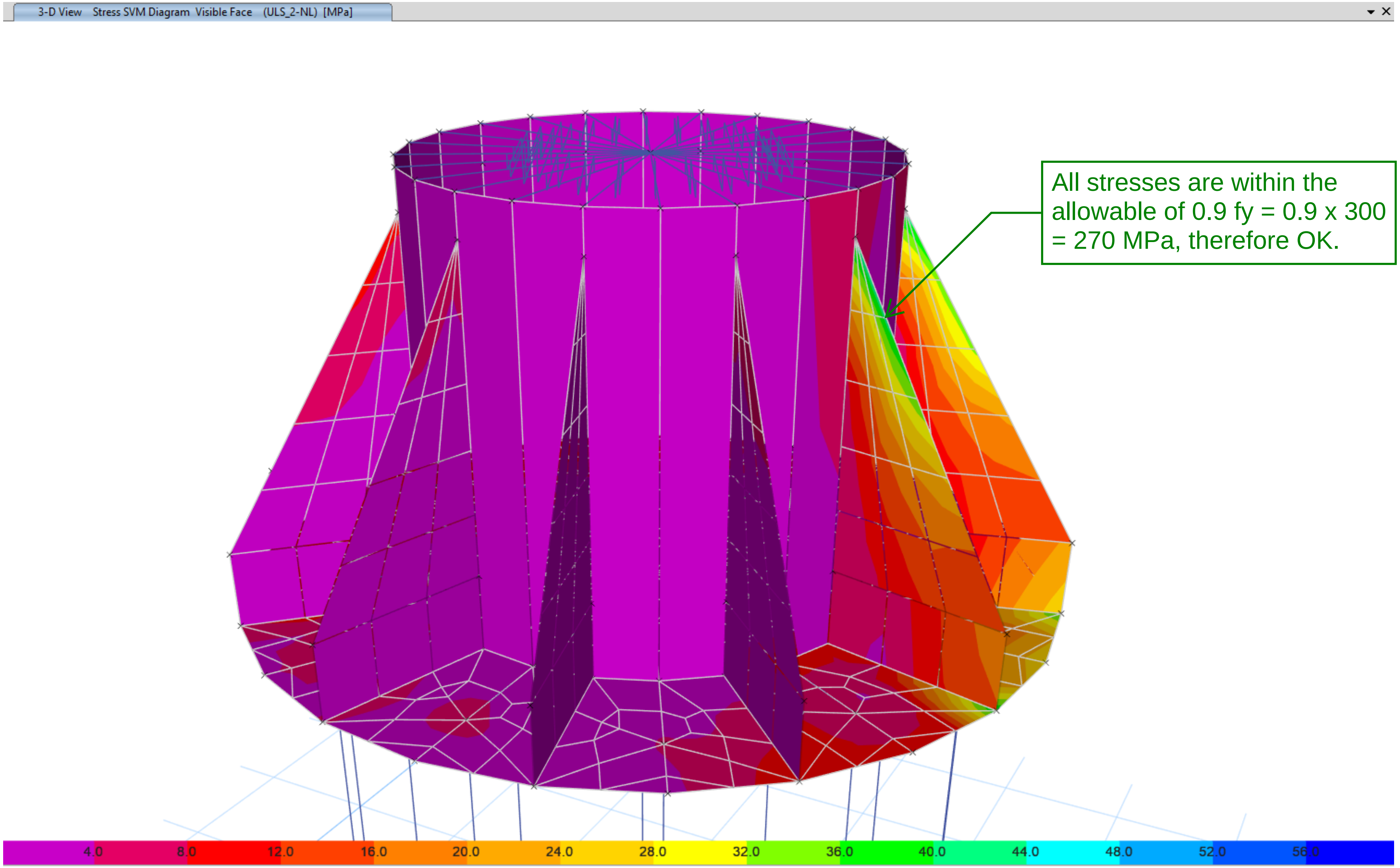
The above ULS base reactions were applied to the ETABS finite element model of the base plate connection, including the stiffeners, to check the maximum stresses in the steel elements.

Compression-only area spring was assigned to the baseplate to represent the concrete underneath, while tension-only members pinned at the base were used to represent the anchors.

25mm THICK BASE PLATE CHECK



10mm THICK STIFFENER CHECK



F.2 ANCHOR CHECK

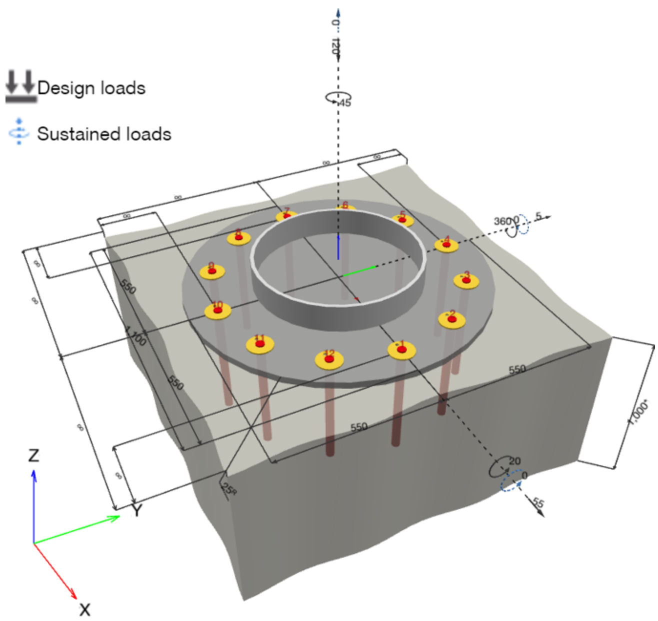
Specifier's comments:

1 Input data

Anchor type and size:	**HIT-RE 500 V3 100 years + HAS-U 5.8 M30**
Return period (service life in years):	100
Item number:	not available (insert) / 2123403 HIT-RE 500 V3 (mortar)
Hilti Filling Set or any suitable annular gap filling solution	
Effective embedment depth:	$h_{ef,act}$ = 400.0 mm ($h_{ef,limit}$ = - mm)
Material:	5.8
Approval No.:	ETA 16/0143
Issued I Valid:	14/5/2019 | -
Proof:	Engineering judgement SOFA BOND - based on ETAG BOND testing
Stand-off installation:	e_b = 0.0 mm (no stand-off); t = 25.0 mm
Baseplate[R] :	l_x x l_y x t = 1,100.0 mm x 1,100.0 mm x 25.0 mm; (Recommended plate thickness: not calculated)
Profile:	Circular hollow section, ; (L x W x T) = 610.0 mm x 610.0 mm x 12.7 mm
Base material:	cracked concrete, 50MPa, $f_{c,cube}$ = 60.00 N/mm^2; h = 1,000.0 mm, Temp. short/long: 0/0 °C
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	No reinforcement or Reinforcement spacing >= 150 mm (any Ø) or >= 100 mm (Ø <= 10 mm)
	with longitudinal edge reinforcement d >= 12.0 [mm] + close mesh (stirrups, hangers) s <= 100.0 [mm]
	Reinforcement to control splitting according to EOTA TR 029, 5.2.2.6 present.

[R] - The anchor calculation is based on a rigid baseplate assumption.

Geometry [mm] & Loading [kN, kNm]



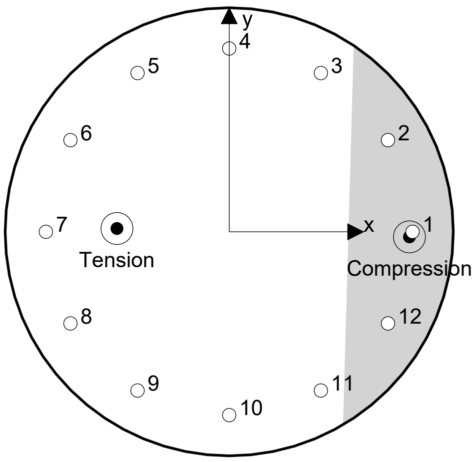
1.1 Load combination

Case	Description	Forces [kN] / Moments [kNm]	Seismic	Fire	Max. Util. Anchor [%]
1	Case 110	$N = -150.000$; $V_x = 0.000$; $V_y = 0.000$; $M_x = 45.000$; $M_y = 30.000$; $M_z = 0.000$; $N_{sus} = 0.000$; $M_{x,sus} = 0.000$; $M_{y,sus} = 0.000$;	no	no	2
2	Case 140	$N = -120.000$; $V_x = 55.000$; $V_y = 5.000$; $M_x = 20.000$; $M_y = 360.000$; $M_z = 45.000$; $N_{sus} = 0.000$; $M_{x,sus} = 0.000$; $M_{y,sus} = 0.000$;	no	no	71
3	Case 147	$N = -120.000$; $V_x = 50.000$; $V_y = 10.000$; $M_x = 85.000$; $M_y = 320.000$; $M_z = 20.000$; $N_{sus} = 0.000$; $M_{x,sus} = 0.000$; $M_{y,sus} = 0.000$;	no	no	63
4	Case 150	$N = -80.000$; $V_x = 55.000$; $V_y = 10.000$; $M_x = 10.000$; $M_y = 350.000$; $M_z = 45.000$; $N_{sus} = 0.000$; $M_{x,sus} = 0.000$; $M_{y,sus} = 0.000$;	no	no	71
5	Case 157	$N = -80.000$; $V_x = 50.000$; $V_y = 10.000$; $M_x = 75.000$; $M_y = 315.000$; $M_z = 20.000$; $N_{sus} = 0.000$; $M_{x,sus} = 0.000$; $M_{y,sus} = 0.000$;	no	no	64

Utilization = 0.71 < 1.0, therefore OK.

2 Load case/Resulting anchor forces

Controlling load case: 2 Case 140



Anchor reactions [kN]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	0.000	10.249	4.583	9.167
2	0.000	8.061	0.417	8.050
3	9.221	5.651	-2.634	5.000
4	34.741	3.842	-3.750	0.833
5	59.878	4.248	-2.634	-3.333
6	77.897	6.397	0.417	-6.384
7	83.970	8.790	4.583	-7.500
8	76.469	10.831	8.750	-6.384
9	57.404	12.262	11.800	-3.333
10	31.884	12.944	12.917	0.833
11	6.747	12.816	11.800	5.000
12	0.000	11.890	8.750	8.050

max. concrete compressive strain: 0.25 [‰]
max. concrete compressive stress: 7.65 [N/mm^2]
resulting tension force in (x/y)=(-275.5/8.1): 438.211 [kN]
resulting compression force in (x/y)=(442.4/-12.5): 518.211 [kN]

Anchor forces are calculated based on the assumption of a rigid baseplate.

Company:		Page:	3
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Port of Newcastle Signage - 01 Apr 2022	Date:	3/4/2022
Fastening Point:			

3 Tension load (EOTA TR 029, Section 5.2.2)

	Load [kN]	Capacity [kN]	Utilization β_N [%]	Status
Steel failure*	83.970	187.000	45	OK
Combined pullout-concrete cone failure**	438.211	674.000	66	OK
Concrete Breakout failure**	438.211	621.422	71	OK
Splitting failure**	N/A	N/A	N/A	N/A

* highest loaded anchor **anchor group (anchors in tension)

3.1 Steel failure

$N_{Rk,s}$ [kN]	$\gamma_{M,s}$	$N_{Rd,s}$ [kN]	N_{Sd} [kN]
280.500	1.500	187.000	83.970

3.2 Combined pullout-concrete cone failure

$A_{p,N}$ [mm^2]	$A^0_{p,N}$ [mm^2]	$\tau_{Rk,ucr,25}$ [N/mm^2]	$s_{cr,Np}$ [mm]	$c_{cr,Np}$ [mm]	c_{min} [mm]
2,387,974	672,000	14.00	819.8	409.9	∞

ψ_c	$\tau_{Rk,cr}$ [N/mm^2]	k	$\psi^0_{g,Np}$	$\psi_{g,Np}$
1.091	6.00	2.300	2.281	1.716

$e_{c1,N}$ [mm]	$\psi_{ec1,Np}$	$e_{c2,N}$ [mm]	$\psi_{ec2,Np}$	$\psi_{s,Np}$	$\psi_{re,Np}$
138.9	0.747	8.1	0.981	1.000	1.000

$N^0_{Rk,p}$ [kN]	$N_{Rk,p}$ [kN]	$\gamma_{M,p}$	$N_{Rd,p}$ [kN]	N_{Sd} [kN]
226.316	1,011.000	1.500	674.000	438.211

Group anchor ID
3-11

3.3 Concrete Breakout failure

$A_{c,N}$ [mm^2]	$A^0_{c,N}$ [mm^2]	$c_{cr,N}$ [mm]	$s_{cr,N}$ [mm]
3,754,859	1,440,000	600.0	1,200.0

$e_{c1,N}$ [mm]	$\psi_{ec1,N}$	$e_{c2,N}$ [mm]	$\psi_{ec2,N}$	$\psi_{s,N}$	$\psi_{re,N}$
138.9	0.812	8.1	0.987	1.000	1.000

k_1	$N^0_{Rk,c}$ [kN]	$\gamma_{M,c}$	$N_{Rd,c}$ [kN]	N_{Sd} [kN]
7.200	446.168	1.500	621.422	438.211

Group anchor ID
3-11

Company:		Page:	4
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Port of Newcastle Signage - 01 Apr 2022	Date:	3/4/2022
Fastening Point:			

4 Shear load (EOTA TR 029, Section 5.2.3)

	Load [kN]	Capacity [kN]	Utilization β_V [%]	Status
Steel failure (without lever arm)*	12.944	112.240	12	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout failure*	12.816	97.970	14	OK
Concrete edge failure in direction **	N/A	N/A	N/A	N/A

* highest loaded anchor **anchor group (relevant anchors)

4.1 Steel failure (without lever arm)

$V_{Rk,s}$ [kN]	$\gamma_{M,s}$	$V_{Rd,s}$ [kN]	V_{Sd} [kN]
140.300	1.250	112.240	12.944

4.2 Pryout failure (bond relevant)

$A_{p,N}$ [mm^2]	$A^0_{p,N}$ [mm^2]	$\tau_{Rk,ucr,25}$ [N/mm^2]	$c_{cr,Np}$ [mm]	$s_{cr,Np}$ [mm]	c_{min} [mm]
218,177	672,000	14.00	409.9	819.8	∞

ψ_c	$\tau_{Rk,cr}$ [N/mm^2]	k_4	k-factor	$\psi^0_{g,Np}$	$\psi_{g,Np}$
1.091	6.00	2.300	2.000	0.000	1.000

$e_{c1,V}$ [mm]	$\psi_{ec1,Np}$	$e_{c2,V}$ [mm]	$\psi_{ec2,Np}$	$\psi_{s,Np}$	$\psi_{re,Np}$
0.0	1.000	0.0	1.000	1.000	1.000

$N^0_{Rk,p}$ [kN]	$N_{Rk,p}$ [kN]	$\gamma_{M,c,p}$	$V_{Rd,cp}$ [kN]	V_{Sd} [kN]
226.316	73.477	1.500	97.970	12.816

Group anchor ID
11

5 Combined tension and shear loads (EOTA TR 029, Section 5.2.4)

Steel failure

β_N	β_V	α	Utilization $\beta_{N,V}$ [%]	Status
0.705	0.131	1.500	64	OK

$\beta_N^\alpha + \beta_V^\alpha \leq 1.0$

6 Displacements (highest loaded anchor)

Short term loading:

N_{Sk} = 56.644 [kN] δ_N = 0.2705 [mm]

V_{Sk} = 8.023 [kN] δ_V = 0.2407 [mm]

δ_{NV} = 0.3620 [mm]

Long term loading:

N_{Sk} = 56.644 [kN] δ_N = 0.3606 [mm]

V_{Sk} = 8.023 [kN] δ_V = 0.4012 [mm]

δ_{NV} = 0.5394 [mm]

Comments: Tension displacements are valid with half of the required installation torque moment for uncracked concrete! Shear displacements are valid without friction between the concrete and the baseplate! The gap due to the drilled hole and clearance hole tolerances are not included in this calculation!

The acceptable anchor displacements depend on the fastened construction and must be defined by the designer!

7 Warnings

- The anchor design methods in PROFIS Engineering require rigid baseplates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the baseplate are not considered - the baseplate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required baseplate thickness with CBFEM to limit the stress of the baseplate based on the assumptions explained above. The proof if the rigid baseplate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Checking the transfer of loads into the base material is required in accordance with EOTA TR 029, Section 7!
- The design is only valid if the clearance hole in the fixture is not larger than the value given in Table 4.1 of EOTA TR029! For larger diameters of the clearance hole see Chapter 1.1. of EOTA TR029!
- Your design has selected filled holes. Please ensure that there is a proper method to fill the annular gap between the fixture and HIT-RE 500 V3 100 years + HAS-U 5.8 M30and contact Hilti in case of any questions.
- The accessory list in this report is for the information of the user only. In any case, the instructions for use provided with the product have to be followed to ensure a proper installation.
- Characteristic bond resistances depend on short- and long-term temperatures.
- The design method SOFA assumes that no hole clearance between the anchors and the fixture is present. This can be achieved by filling the gap with mortar of sufficient compressive strength (e.g. by using the HILTI Filling set) or by other suitable means
- The compliance with current standards (e.g. EN 1993, AS 4100:1998, etc.) is the responsibility of the user
- An SLS-check is not performed for SOFA and has to be provided by the user!
- The characteristic bond resistances depend on the return period (service life in years): 100

Fastening meets the design criteria!

8 Installation data

Baseplate, steel: Custom baseplate material; E = 200,000.00 N/mm^2; f_{yk} = 235.00 N/mm^2

Profile: Circular hollow section, ; (L x W x T) = 610.0 mm x 610.0 mm x 12.7 mm

Hole diameter in the fixture: d_f = 33.0 mm

Plate thickness (input): 25.0 mm

Recommended plate thickness: not calculated

Drilling method: Hammer drilled

Cleaning: Compressed air cleaning of the drilled hole according to instructions for use is required

Anchor type and size: HIT-RE 500 V3 100 years + HAS-U 5.8 M30

Item number: not available (insert) / 2123403 HIT-RE 500 V3 (mortar)

Maximum installation torque: 300 Nm

Hole diameter in the base material: 35.0 mm

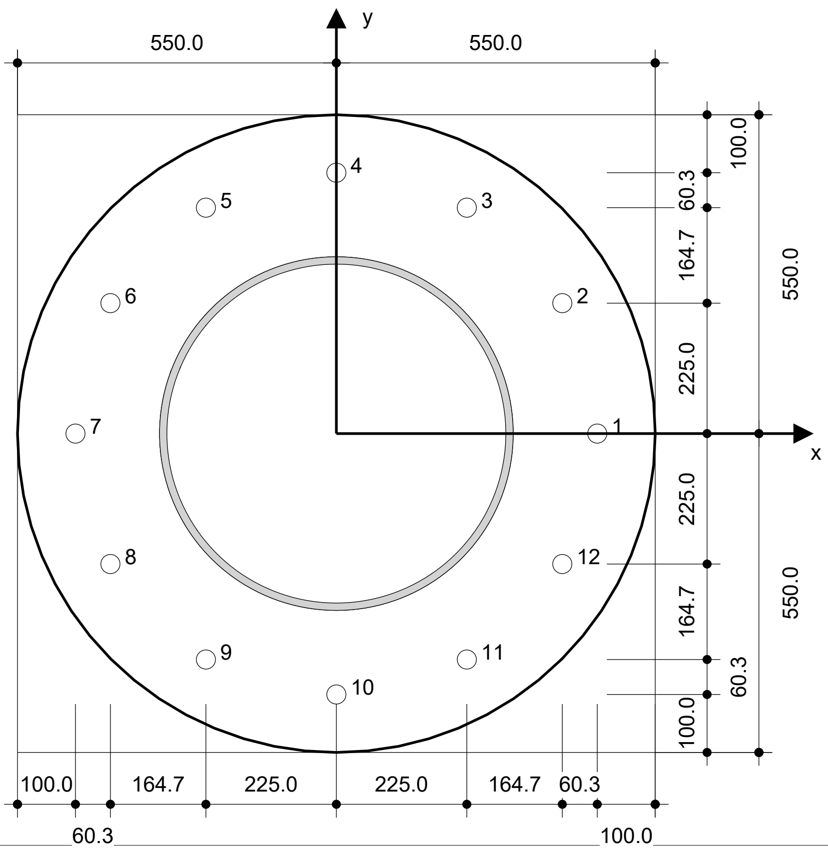
Hole depth in the base material: 400.0 mm

Minimum thickness of the base material: 470.0 mm

Hilti HAS-U threaded rod with HIT-RE 500 V3 injection mortar with 400 mm embedment h_ef, M30, Steel galvanized, Hammer drilling installation per ETA 16/0143, with annular gaps filled with Hilti Filling Set or any suitable gap solutions

8.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Compressed air with required accessories to blow from the bottom of the hole • Proper diameter wire brush	• Dispenser including cassette and mixer • Hilti Filling Set • Torque wrench



Company:		Page:	8
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Port of Newcastle Signage - 01 Apr 2022	Date:	3/4/2022
Fastening Point:			

Coordinates Anchor [mm]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}	Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	450.0	-0.0	-	-	-	-	7	-450.0	-0.0	-	-	-	-
2	389.7	225.0	-	-	-	-	8	-389.7	-225.0	-	-	-	-
3	225.0	389.7	-	-	-	-	9	-225.0	-389.7	-	-	-	-
4	-0.0	450.0	-	-	-	-	10	-0.0	-450.0	-	-	-	-
5	-225.0	389.7	-	-	-	-	11	225.0	-389.7	-	-	-	-
6	-389.7	225.0	-	-	-	-	12	389.7	-225.0	-	-	-	-

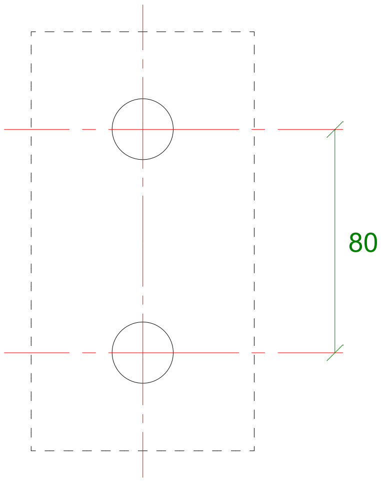
9 Remarks; Your Cooperation Duties

- Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.
- You must take all necessary and reasonable steps to prevent or limit damage caused by the Software. In particular, you must arrange for the regular backup of programs and data and, if applicable, carry out the updates of the Software offered by Hilti on a regular basis. If you do not use the AutoUpdate function of the Software, you must ensure that you are using the current and thus up-to-date version of the Software in each case by carrying out manual updates via the Hilti Website. Hilti will not be liable for consequences, such as the recovery of lost or damaged data or programs, arising from a culpable breach of duty by you.

Limcon V3.6

ballonc3616
Job: Connections Checks -- Connection: Saddle-2bolts

CONNECTION: Saddle-2bolts - Bolt Group
Gusset plate (min.): 80x12x150 Gr.300+
Bolts: 2 x M20 8.8/TB/N in 1 col.

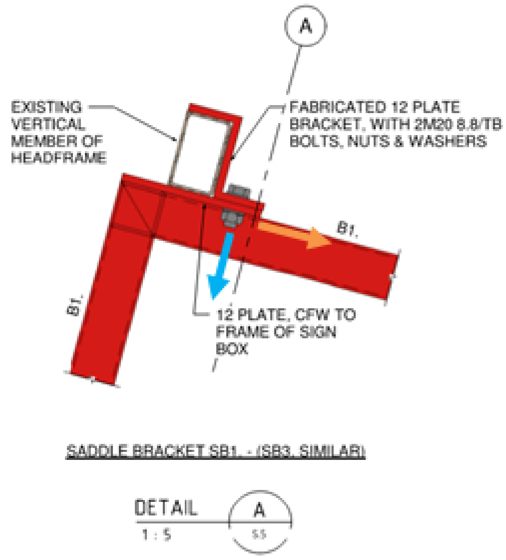


LIMCON V3.63.2.6 {0} 04-APR-22 13:43:31

Connection: Saddle-2bolts
Type: Bolt Group
Country: Australia
Units: SI metric
Design code: AS 4100

Plate (min.):
150x80x12 Gr./fy/fu=300+/30/440MPa

Bolts:
2 x M20 8.8/TB/N in 1 column at 80 pitch.
Min. X direction edge distance . 40 mm
Min. Y direction edge distance . 35 mm
No. shear planes 1



Design actions:
Horiz. force, F*x . . . . 40.0 kN
Vert. force, F*y . . . . 0.0 kN
Force, F*z . . . . 10.0 kN
Moment, M*x . . . . 0.00 kN.m
Moment, M*y . . . . 0.00 kN.m
Moment, M*z . . . . 0.00 kN.m

Angle of load from vert. . . . . 90.00°
Eccentricity . . . . 0.0 mm

GEOMETRY CHECK
|Edge distance dia. multiple . . 1.500
|Min. spacing dia. multiple . . 2.500

Horizontal edge distance	40	≥	30	Yes
Vertical edge distance	35	≥	30	Yes
Horizontal bolt spacing	160	≥	50	Yes
Vertical bolt spacing	80	≥	50	Yes

ANALYSIS RESULT
|ø 0.80

```
   |Bolt fuf  . . . . . . . . . . .     830 MPa
   |fy  . . . . . . . . . . . . . .     300 MPa
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt bearing capacity  .   304.1 kN                                      AS4100 9.3.2.4
 Using elastic method for in-plane checks...
  No. bolts . . . . . . . . . . .         2
  Bolt centroid measured from bottom left bolt:
   Centroid x coordinate, xc  . . .       0 mm
   Centroid y coordinate, yc  . . .      40 mm
  Moment of inertia about XX  . . .    3200 mm2
  Moment of inertia about YY  . . .       0 mm2
  Polar moment of inertia . . . . .    3200 mm2

 WARNING: Block shear is not checked.

 DESIGN CAPACITY CHECKS
                                                  Capacity ratio ─────────┐
                                                  Design action ────┐     |
                                                ┌─Design capacity   |     |          Reference
                                                |                   |     |          ═════════════
  BEARING/TEARING IN PART 1...
   |fy  . . . . . . . . . . . . . .     300 MPa
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt bearing capacity  .   304.1 kN                                      AS4100 9.3.2.4
   |Horiz. force on part 1 fx (1,1)    20.0 kN
   |Vert.  force on part 1 fy (1,1)     0.0 kN
   |»Res.  force on part 1 fr (1,1)    20.0 kN
   |Horiz. force on part 1 fx (2,1)    20.0 kN
   |Vert.  force on part 1 fy (2,1)     0.0 kN
   |»Res.  force on part 1 fr (2,1)    20.0 kN
  Resultants in cartesian axis directions:
  (These are statically equivalent to bolt group actions.)
   Horiz. resultant . . . . . . . .    40.0 kN
   Vert. resultant  . . . . . . . .     0.0 kN
   Moment resultant . . . . . . . .    0.00 kN.m
  Bolt shear (critical bolt row, column)...
                 (1,1) is top left    (Row,Col.)
   Bolt shear . . . . . . . . . . . . . (1,1)    92.6  ≥  V*res =   20.0  4.63  Pass
  Bolt bearing/tearing (critical bolt row, column)...
   Bolt bearing . . . . . . . . . . . . (1,1)   304.1  ≥  V*res =   20.0  15.2  Pass
   |Dh  . . . . . . . . . . . . . .    22.0 mm
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt tearing capacity  .   185.3 kN                                      AS4100 9.3.2.4
   Bolt group ext. tearing (right)  . . (1,1)   185.3  ≥  V*h   =   20.0  9.27  Pass  AS4100 9.3.2.4

  Out-of-plane checks
   |ø . . . . . . . . . . . . . . .    0.80
   |Bolt fuf  . . . . . . . . . . .     830 MPa
   Prying factor  . . . . . . . . . . . . . .    0.00
   Single bolt tension capacity . . . . . . .   162.7 kN
   |xm  . . . . . . . . . . . . . .       0 mm
   |ym  . . . . . . . . . . . . . .      80 mm
   |Bolt (1,1)
   |Shear utilization ratio . . . .      22%
   |Tension utilization ratio . . .       3%
   |Bolt (2,1)
   |Shear utilization ratio . . . .      22%
   |Tension utilization ratio . . .       3%
   Bolt shear+tension interaction:
    Shear in critical bolt  . . . . . . (1,1)    20.0 kN
    Tension in critical bolt  . . . . . (1,1)     5.0 kN
    Bolt shear+tension interaction  . . . . .    1.00  ≥             0.22  4.63  Pass  AS4100 9.3.2.3

  BEARING/TEARING IN PART 2...
   |fy  . . . . . . . . . . . . . .     300 MPa
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt bearing capacity  .   304.1 kN                                      AS4100 9.3.2.4
   |Horiz. force on part 2 fx (1,1)   -20.0 kN
   |Vert.  force on part 2 fy (1,1)     0.0 kN
   |»Res.  force on part 2 fr (1,1)    20.0 kN
   |Horiz. force on part 2 fx (2,1)   -20.0 kN
   |Vert.  force on part 2 fy (2,1)     0.0 kN
   |»Res.  force on part 2 fr (2,1)    20.0 kN
  Resultants in cartesian axis directions:
```

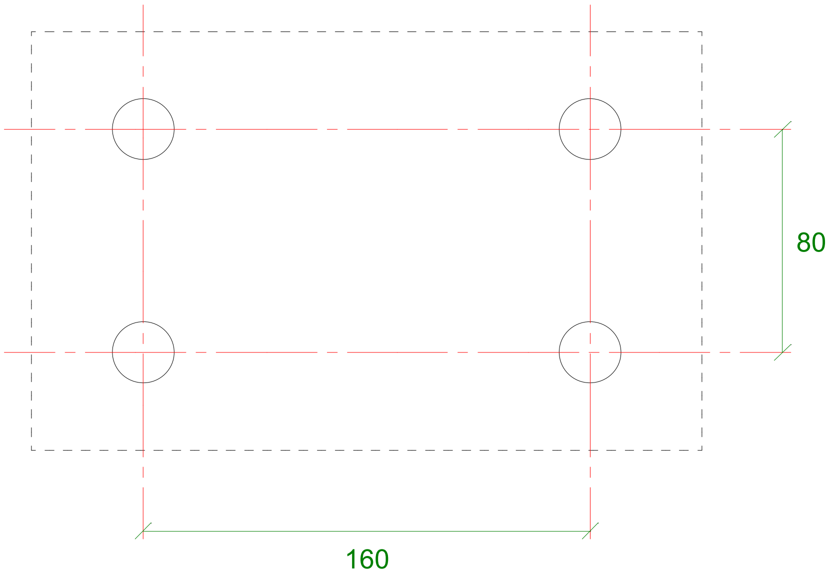
```
 (These equilibrate bolt group actions.)
  Horiz. resultant . . . . . . . .   -40.0 kN
  Vert. resultant  . . . . . . . .     0.0 kN
  Moment resultant . . . . . . . .    0.00 kN.m
 Bolt shear (critical bolt row, column)...
                (1,1) is top left   (Row,Col.)
  Bolt shear . . . . . . . . . . . . . (1,1)    92.6  ≥  V*res =   20.0  4.63  Pass
 Bolt bearing/tearing (critical bolt row, column)...
  Bolt bearing . . . . . . . . . . . . (1,1)   304.1  ≥  V*res =   20.0  15.2  Pass
  |Dh  . . . . . . . . . . . . . . .    22.0 mm
  |fu  . . . . . . . . . . . . . . .     440 MPa
  |ø . . . . . . . . . . . . . . . .    0.90
  |Single bolt tearing capacity  .   185.3 kN                                        AS4100 9.3.2.4
  Bolt group ext. tearing (left) . . . (1,1)   185.3  ≥  V*h   =   20.0  9.27  Pass  AS4100 9.3.2.4

 Out-of-plane checks
  |ø . . . . . . . . . . . . . . . .    0.80
  |Bolt fuf  . . . . . . . . . . . .     830 MPa
  Prying factor  . . . . . . . . . . . . . . .    0.00
  Single bolt tension capacity . . . . . . .   162.7 kN
  |xm  . . . . . . . . . . . . . . .       0 mm
  |ym  . . . . . . . . . . . . . . .      80 mm
  |Bolt (1,1)
  |Shear utilization ratio . . . .      22%
  |Tension utilization ratio . . .       3%
  |Bolt (2,1)
  |Shear utilization ratio . . . .      22%
  |Tension utilization ratio . . .       3%
  Bolt shear+tension interaction:
   Shear in critical bolt  . . . . . . (1,1)    20.0 kN
   Tension in critical bolt  . . . . . (1,1)     5.0 kN
   Bolt shear+tension interaction  . . . . .    1.00  ≥            0.22  4.63  Pass  AS4100 9.3.2.3

CRITICAL LIMIT STATE . . .   Bolt shear
UTILIZATION RATIO  . . . .     22%
CAPACITY RATIO, ø.Ru/S* .    4.631   Pass
```

ballonc3616
Job: Connections Checks -- Connection: Saddle-4bolts

CONNECTION: Saddle-4bolts - Bolt Group
Gusset plate (min.): 240x12x150 Gr.300+
Bolts: 4 x M20 8.8/TB/N in 2 cols.

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LIMCON V3.63.2.6 {0}                                          04-APR-22
                                                               13:43:21

 Connection: Saddle-4bolts
       Type: Bolt Group
    Country: Australia
      Units: SI metric
Design code: AS 4100

Plate (min.):
 150x240x12  Gr./fy/fu=300+/30/440MPa

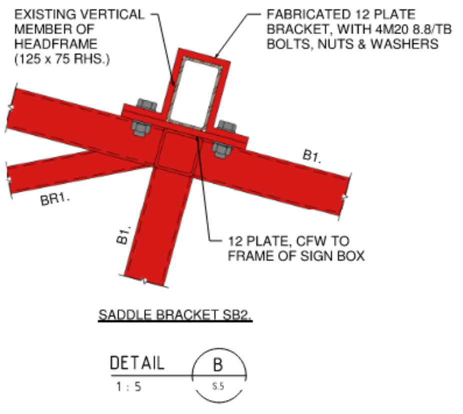
Bolts:
 4 x M20 8.8/TB/N in 2 cols. and 2 rows at 160 gauge and 80 pitch.
 Min. X direction edge distance  .      40 mm
 Min. Y direction edge distance  .      35 mm
 No. shear planes  . . . . . . . .       1

Design actions:
 Horiz. force, F*x . . . . . . . .    40.0 kN
 Vert.  force, F*y . . . . . . . .     0.0 kN
 Force,  F*z . . . . . . . . . . .    10.0 kN
 Moment, M*x . . . . . . . . . . .    0.00 kN.m
 Moment, M*y . . . . . . . . . . .    0.00 kN.m
 Moment, M*z . . . . . . . . . . .    0.00 kN.m

 Angle of load from vert.  . . . .   90.00°
 Eccentricity  . . . . . . . . . .     0.0 mm

GEOMETRY CHECK
  |Edge distance dia. multiple . .   1.500
  |Min. spacing dia. multiple  . .   2.500
 Horizontal edge distance  . . . .       40           ≥      30                 Yes
 Vertical edge distance  . . . . .       35           ≥      30                 Yes
 Horizontal bolt spacing . . . . .      160           ≥      50                 Yes
 Vertical bolt spacing . . . . . .       80           ≥      50                 Yes

ANALYSIS RESULT
  |ø . . . . . . . . . . . . . . .    0.80
```



```
   |Bolt fuf  . . . . . . . . . . .     830 MPa
   |fy  . . . . . . . . . . . . . .     300 MPa
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt bearing capacity  .   304.1 kN                                     AS4100 9.3.2.4
 Using elastic method for in-plane checks...
  No. bolts . . . . . . . . . . . .       4
  Bolt centroid measured from bottom left bolt:
   Centroid x coordinate, xc  . . .      80 mm
   Centroid y coordinate, yc  . . .      40 mm
  Moment of inertia about XX  . . .    6400 mm2
  Moment of inertia about YY  . . . 2.5600E+04 mm2
  Polar moment of inertia . . . . . 3.2000E+04 mm2

 WARNING: Block shear is not checked.

 DESIGN CAPACITY CHECKS
                                                  Capacity ratio ─────────┐
                                                  Design action ────┐     │
                                                 ┌Design capacity   │     │          Reference
                                                 │                  │     │        ══════════════
  BEARING/TEARING IN PART 1...
   |fy  . . . . . . . . . . . . . .     300 MPa
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt bearing capacity  .   304.1 kN                                     AS4100 9.3.2.4
   |Horiz. force on part 1 fx (1,1)    10.0 kN
   |Vert.  force on part 1 fy (1,1)     0.0 kN
   |»Res.  force on part 1 fr (1,1)    10.0 kN
   |Horiz. force on part 1 fx (1,2)    10.0 kN
   |Vert.  force on part 1 fy (1,2)     0.0 kN
   |»Res.  force on part 1 fr (1,2)    10.0 kN
   |Horiz. force on part 1 fx (2,1)    10.0 kN
   |Vert.  force on part 1 fy (2,1)     0.0 kN
   |»Res.  force on part 1 fr (2,1)    10.0 kN
   |Horiz. force on part 1 fx (2,2)    10.0 kN
   |Vert.  force on part 1 fy (2,2)     0.0 kN
   |»Res.  force on part 1 fr (2,2)    10.0 kN
  Resultants in cartesian axis directions:
  (These are statically equivalent to bolt group actions.)
   Horiz. resultant . . . . . . . .    40.0 kN
   Vert. resultant  . . . . . . . .     0.0 kN
   Moment resultant . . . . . . . .    0.00 kN.m
  Bolt shear (critical bolt row, column)...
                (1,1) is top left    (Row,Col.)
   Bolt shear . . . . . . . . . . . . . (1,1)    92.6  ≥  V*res =   10.0  9.26  Pass
  Bolt bearing/tearing (critical bolt row, column)...
   Bolt bearing . . . . . . . . . . . . (1,1)   304.1  ≥  V*res =   10.0  30.4  Pass
   |Dh  . . . . . . . . . . . . . .    22.0 mm
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt tearing capacity  .   185.3 kN                                     AS4100 9.3.2.4
   Bolt group ext. tearing (right)  . . (1,2)   185.3  ≥  V*h   =   10.0  18.5  Pass  AS4100 9.3.2.4
   |Dh  . . . . . . . . . . . . . .    22.0 mm
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt tearing capacity  .   703.3 kN                                     AS4100 9.3.2.4
   Bolt group int. tearing (horiz.) . . (1,1)   703.3  ≥  V*h   =   10.0  70.3  Pass  AS4100 9.3.2.4

  Out-of-plane checks
   |ø . . . . . . . . . . . . . . .    0.80
   |Bolt fuf  . . . . . . . . . . .     830 MPa
   Prying factor  . . . . . . . . . . . . . .    0.00
   Single bolt tension capacity . . . . . . .   162.7 kN
   |xm  . . . . . . . . . . . . . .     160 mm
   |ym  . . . . . . . . . . . . . .      80 mm
   |Bolt (1,1)
   |Shear utilization ratio . . . .      11%
   |Tension utilization ratio . . .       2%
   |Bolt (1,2)
   |Shear utilization ratio . . . .      11%
   |Tension utilization ratio . . .       2%
   |Bolt (2,1)
   |Shear utilization ratio . . . .      11%
   |Tension utilization ratio . . .       2%
   |Bolt (2,2)
   |Shear utilization ratio . . . .      11%
   |Tension utilization ratio . . .       2%
```

```
   Bolt shear+tension interaction:
    Shear in critical bolt  . . . . . . (1,1)    10.0 kN
    Tension in critical bolt  . . . . . (1,1)     2.5 kN
    Bolt shear+tension interaction  . . . . .    1.00  ≥            0.11   9.26   Pass   AS4100 9.3.2.3

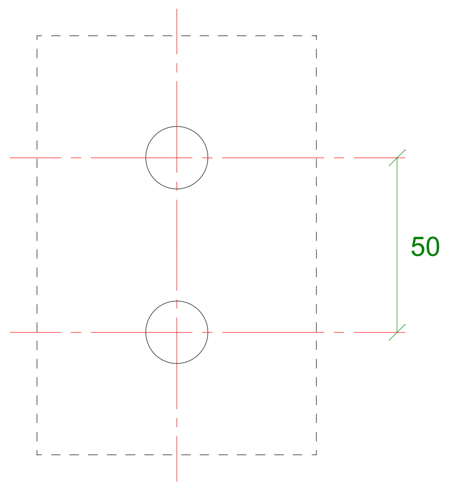
  BEARING/TEARING IN PART 2...
   |fy  . . . . . . . . . . . . . .     300 MPa
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt bearing capacity  .   304.1 kN                                           AS4100 9.3.2.4
   |Horiz. force on part 2 fx (1,1)   -10.0 kN
   |Vert.  force on part 2 fy (1,1)     0.0 kN
   |»Res.  force on part 2 fr (1,1)    10.0 kN
   |Horiz. force on part 2 fx (1,2)   -10.0 kN
   |Vert.  force on part 2 fy (1,2)     0.0 kN
   |»Res.  force on part 2 fr (1,2)    10.0 kN
   |Horiz. force on part 2 fx (2,1)   -10.0 kN
   |Vert.  force on part 2 fy (2,1)     0.0 kN
   |»Res.  force on part 2 fr (2,1)    10.0 kN
   |Horiz. force on part 2 fx (2,2)   -10.0 kN
   |Vert.  force on part 2 fy (2,2)     0.0 kN
   |»Res.  force on part 2 fr (2,2)    10.0 kN
  Resultants in cartesian axis directions:
  (These equilibrate bolt group actions.)
   Horiz. resultant . . . . . . . .   -40.0 kN
   Vert. resultant  . . . . . . . .     0.0 kN
   Moment resultant . . . . . . . .    0.00 kN.m
  Bolt shear (critical bolt row, column)...
                (1,1) is top left   (Row,Col.)
   Bolt shear . . . . . . . . . . . . . . (1,1)    92.6  ≥  V*res =   10.0   9.26   Pass
  Bolt bearing/tearing (critical bolt row, column)...
   Bolt bearing . . . . . . . . . . . . . (1,1)   304.1  ≥  V*res =   10.0   30.4   Pass
   |Dh  . . . . . . . . . . . . . .    22.0 mm
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt tearing capacity  .   185.3 kN                                           AS4100 9.3.2.4
   Bolt group ext. tearing (left) . . . (1,1)   185.3  ≥  V*h    =   10.0   18.5   Pass   AS4100 9.3.2.4
   |Dh  . . . . . . . . . . . . . .    22.0 mm
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt tearing capacity  .   703.3 kN                                           AS4100 9.3.2.4
   Bolt group int. tearing (horiz.) . . (1,2)   703.3  ≥  V*h    =   10.0   70.3   Pass   AS4100 9.3.2.4

  Out-of-plane checks
   |ø . . . . . . . . . . . . . . .    0.80
   |Bolt fuf  . . . . . . . . . . .     830 MPa
   Prying factor  . . . . . . . . . . . . . .    0.00
   Single bolt tension capacity . . . . . . .   162.7 kN
   |xm  . . . . . . . . . . . . . .     160 mm
   |ym  . . . . . . . . . . . . . .      80 mm
   |Bolt (1,1)
   |Shear utilization ratio . . . .      11%
   |Tension utilization ratio . . .       2%
   |Bolt (1,2)
   |Shear utilization ratio . . . .      11%
   |Tension utilization ratio . . .       2%
   |Bolt (2,1)
   |Shear utilization ratio . . . .      11%
   |Tension utilization ratio . . .       2%
   |Bolt (2,2)
   |Shear utilization ratio . . . .      11%
   |Tension utilization ratio . . .       2%
   Bolt shear+tension interaction:
    Shear in critical bolt  . . . . . . (1,1)    10.0 kN
    Tension in critical bolt  . . . . . (1,1)     2.5 kN
    Bolt shear+tension interaction  . . . . .    1.00  ≥            0.11   9.26   Pass   AS4100 9.3.2.3

 CRITICAL LIMIT STATE . . .   Bolt shear
 UTILIZATION RATIO  . . . .     11%
 CAPACITY RATIO, ø.Ru/S* .    9.263   Pass
```

ballonc3616
Job: Connections Checks -- Connection: Z-bracket

CONNECTION: Z-bracket - Bolt Group
Gusset plate (min.): 80x8x120 Gr.300+
Bolts: 2 x M16 8.8/S/N in 1 col.



LIMCON V3.63.2.6 {0}   05-APR-22
13:42:50

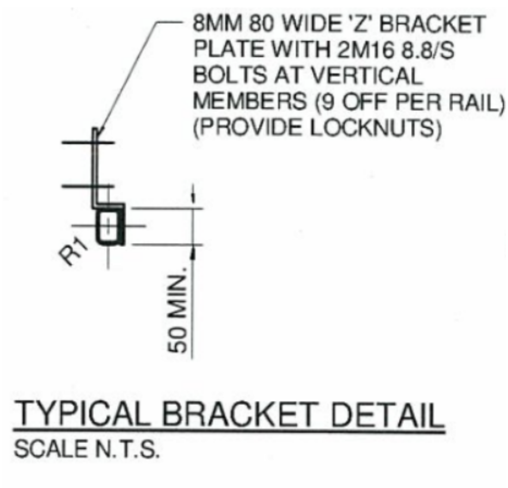
Connection: Z-bracket
Type: Bolt Group
Country: Australia
Units: SI metric
Design code: AS 4100

Plate (min.):
120x80x8 Gr./fy/fu=300+/32/440MPa

Bolts:
2 x M16 8.8/S/N in 1 column at 50 pitch.
Min. X direction edge distance . 40 mm
Min. Y direction edge distance . 35 mm
No. shear planes 1

Design actions:
Horiz. force, F*x . . . . 5.0 kN
Vert. force, F*y . . . . 40.0 kN
Force, F*z . . . . 5.0 kN
Moment, M*x . . . . 0.00 kN.m
Moment, M*y . . . . 0.00 kN.m
Moment, M*z . . . . 0.00 kN.m

Angle of load from vert. . . . . 7.13°
Eccentricity . . . . 0.0 mm



GEOMETRY CHECK

|Edge distance dia. multiple . .	1.500			
|Min. spacing dia. multiple . .	2.500			
Horizontal edge distance	40	≥	24	Yes
Vertical edge distance	35	≥	24	Yes
Horizontal bolt spacing	160	≥	40	Yes
Vertical bolt spacing	50	≥	40	Yes

ANALYSIS RESULT
|ø 0.80

```
   |Bolt fuf  . . . . . . . . . . .     830 MPa
   |fy  . . . . . . . . . . . . . .     320 MPa
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt bearing capacity  .   162.2 kN                                              AS4100 9.3.2.4
 Using elastic method for in-plane checks...
  No. bolts . . . . . . . . . . . .       2
  Bolt centroid measured from bottom left bolt:
   Centroid x coordinate, xc  . . .       0 mm
   Centroid y coordinate, yc  . . .      25 mm
  Moment of inertia about XX  . . .    1250 mm2
  Moment of inertia about YY  . . .       0 mm2
  Polar moment of inertia . . . . .    1250 mm2

 WARNING: Block shear is not checked.

 DESIGN CAPACITY CHECKS
                                                         Capacity ratio ─────────┐
                                                         Design action ────┐     │
                                                       ┌─Design capacity   │     │          Reference
                                                       │                   │     │          ══════════════
  BEARING/TEARING IN PART 1...
   |fy  . . . . . . . . . . . . . .     320 MPa
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt bearing capacity  .   162.2 kN                                              AS4100 9.3.2.4
   |Horiz. force on part 1 fx (1,1)     2.5 kN
   |Vert.  force on part 1 fy (1,1)    20.0 kN
   |»Res.  force on part 1 fr (1,1)    20.2 kN
   |Horiz. force on part 1 fx (2,1)     2.5 kN
   |Vert.  force on part 1 fy (2,1)    20.0 kN
   |»Res.  force on part 1 fr (2,1)    20.2 kN
  Resultants in cartesian axis directions:
  (These are statically equivalent to bolt group actions.)
   Horiz. resultant . . . . . . . .     5.0 kN
   Vert. resultant  . . . . . . . .    40.0 kN
   Moment resultant . . . . . . . .    0.00 kN.m
  Bolt shear (critical bolt row, column)...
                  (1,1) is top left   (Row,Col.)
   Bolt shear . . . . . . . . . . . . . (1,1)    59.3  ≥  V*res =   20.2  2.94  Pass
  Bolt bearing/tearing (critical bolt row, column)...
   Bolt bearing . . . . . . . . . . . . (1,1)   162.2  ≥  V*res =   20.2  8.05  Pass
   |Dh  . . . . . . . . . . . . . .    18.0 mm
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt tearing capacity  .   107.7 kN                                              AS4100 9.3.2.4
   Bolt group ext. tearing (top)  . . . (1,1)   107.7  ≥  V*v   =   20.0  5.39  Pass  AS4100 9.3.2.4
   |Dh  . . . . . . . . . . . . . .    18.0 mm
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt tearing capacity  .   123.6 kN                                              AS4100 9.3.2.4
   Bolt group ext. tearing (right)  . . (1,1)   123.6  ≥  V*h   =    2.5  49.4  Pass  AS4100 9.3.2.4
   |Dh  . . . . . . . . . . . . . .    18.0 mm
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt tearing capacity  .   126.7 kN                                              AS4100 9.3.2.4
   Bolt group int. tearing (vert.)  . . (2,1)   126.7  ≥  V*v   =   20.0  6.34  Pass  AS4100 9.3.2.4

  Out-of-plane checks
   |ø . . . . . . . . . . . . . . .    0.80
   |Bolt fuf  . . . . . . . . . . .     830 MPa
   Prying factor  . . . . . . . . . . . . . .    0.00
   Single bolt tension capacity . . . . . . .   104.2 kN
   |xm  . . . . . . . . . . . . . .       0 mm
   |ym  . . . . . . . . . . . . . .      50 mm
   |Bolt (1,1)
   |Shear utilization ratio . . . .      34%
   |Tension utilization ratio . . .       2%
   |Bolt (2,1)
   |Shear utilization ratio . . . .      34%
   |Tension utilization ratio . . .       2%
   Bolt shear+tension interaction:
    Shear in critical bolt  . . . . . . (1,1)    20.2 kN
    Tension in critical bolt  . . . . . (1,1)     2.5 kN
    Bolt shear+tension interaction  . . . . .    1.00  ≥            0.34  2.94  Pass  AS4100 9.3.2.3

  BEARING/TEARING IN PART 2...
   |fy  . . . . . . . . . . . . . .     320 MPa
```

```
   |fu  . . . . . . . . . . . . . .    440 MPa
   |ø . . . . . . . . . . . . . . .   0.90
   |Single bolt bearing capacity  .   162.2 kN                                         AS4100 9.3.2.4
   |Horiz. force on part 2 fx (1,1)    -2.5 kN
   |Vert.  force on part 2 fy (1,1)   -20.0 kN
   |»Res.  force on part 2 fr (1,1)    20.2 kN
   |Horiz. force on part 2 fx (2,1)    -2.5 kN
   |Vert.  force on part 2 fy (2,1)   -20.0 kN
   |»Res.  force on part 2 fr (2,1)    20.2 kN
  Resultants in cartesian axis directions:
  (These equilibrate bolt group actions.)
   Horiz. resultant . . . . . . . .    -5.0 kN
   Vert. resultant  . . . . . . . .   -40.0 kN
   Moment resultant . . . . . . . .    0.00 kN.m
  Bolt shear (critical bolt row, column)...
                 (1,1) is top left   (Row,Col.)
   Bolt shear . . . . . . . . . . . . . (1,1)    59.3  ≥  V*res =   20.2  2.94  Pass
  Bolt bearing/tearing (critical bolt row, column)...
   Bolt bearing . . . . . . . . . . . . (1,1)   162.2  ≥  V*res =   20.2  8.05  Pass
   |Dh  . . . . . . . . . . . . . .    18.0 mm
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt tearing capacity  .   107.7 kN                                         AS4100 9.3.2.4
   Bolt group ext. tearing (btm.) . . . (2,1)   107.7  ≥  V*v   =   20.0  5.39  Pass   AS4100 9.3.2.4
   |Dh  . . . . . . . . . . . . . .    18.0 mm
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt tearing capacity  .   123.6 kN                                         AS4100 9.3.2.4
   Bolt group ext. tearing (left) . . . (1,1)   123.6  ≥  V*h   =    2.5  49.4  Pass   AS4100 9.3.2.4
   |Dh  . . . . . . . . . . . . . .    18.0 mm
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt tearing capacity  .   126.7 kN                                         AS4100 9.3.2.4
   Bolt group int. tearing (vert.)  . . (1,1)   126.7  ≥  V*v   =   20.0  6.34  Pass   AS4100 9.3.2.4

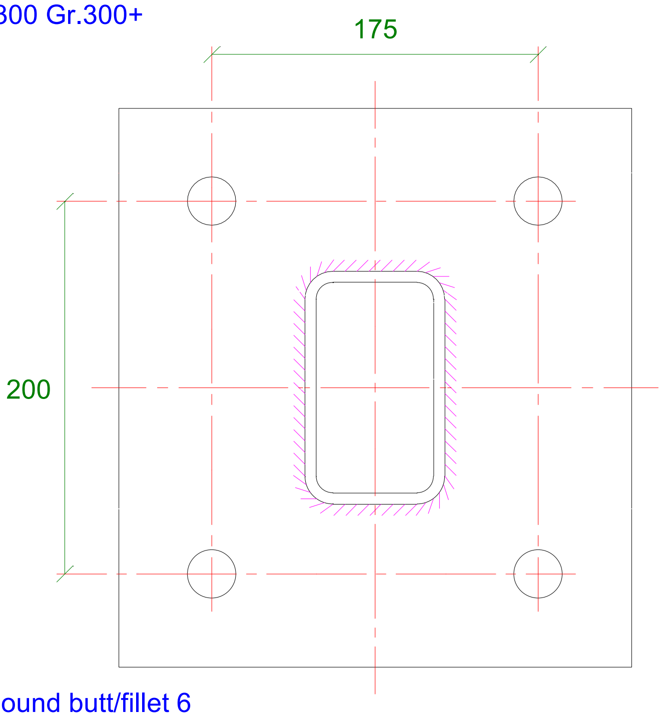
  Out-of-plane checks
   |ø . . . . . . . . . . . . . . .    0.80
   |Bolt fuf  . . . . . . . . . . .     830 MPa
   Prying factor  . . . . . . . . . . . . . .    0.00
   Single bolt tension capacity . . . . . . .   104.2 kN
   |xm  . . . . . . . . . . . . . .       0 mm
   |ym  . . . . . . . . . . . . . .      50 mm
   |Bolt (1,1)
   |Shear utilization ratio . . . .      34%
   |Tension utilization ratio . . .       2%
   |Bolt (2,1)
   |Shear utilization ratio . . . .      34%
   |Tension utilization ratio . . .       2%
   Bolt shear+tension interaction:
    Shear in critical bolt  . . . . . . (1,1)    20.2 kN
    Tension in critical bolt  . . . . . (1,1)     2.5 kN
    Bolt shear+tension interaction  . . . . .    1.00  ≥            0.34  2.94  Pass   AS4100 9.3.2.3

 CRITICAL CONDITION . . . .    Bolt shear+tension interaction
 RATIO  . . . . . . . . . .   2.941   Pass
```

Limcon V3.6

ballonc3616
Job: Connections Checks -- Connection: SplicePlate2

CONNECTION: SplicePlate2 - RHS Bolted Moment End Plate
H1/H2 125X75X6.0RHS Gr.250
End plate 75x16x300 Gr.300+



Weld: 410/SP compound butt/fillet 6
Bolts: 4 x M24 8.8/TB/N

```
LIMCON V3.63.2.6 {0}                                                                    05-APR-22
                                                                                          12:14:56
 Connection: SplicePlate2
       Type: RHS Bolted Moment End Plate
    Country: Australia
      Units: SI metric
Design code: AS 4100

Member:  Mark=H1/H2  Section=125X75X6.0RHS   Grade=250
     D =     125 mm        Area =     2130       fy =     250 MPa
     B =      75 mm          Zx =    66600       fu =     320 MPa
     T =     6.0 mm          Sx =    84200
 .EC3 section class  . . . . . . .         1
  |d . . . . . . . . . . . . . . . .     113 mm
  |b . . . . . . . . . . . . . . . .      63 mm
  |t . . . . . . . . . . . . . . . .     6.0 mm
  |Flange b/t  . . . . . . . . . . .   10.50
  |Flange slenderness  . . . . . . .   10.50
  |Flange yield slenderness ratio      0.26
  |Web d/t . . . . . . . . . . . . .   18.83
  |Web slenderness . . . . . . . . .   18.83
  |Web yield slenderness ratio . .      0.16
  |Critical slenderness  . . . . .     10.50
  |Aw  . . . . . . . . . . . . . . .    1305 mm2
  |fy  . . . . . . . . . . . . . . .     250 MPa
  |ø . . . . . . . . . . . . . . . .    0.90
  |A . . . . . . . . . . . . . . . .    2130 mm2
  |Ae  . . . . . . . . . . . . . . .    2130 mm2                                 AS4100 6.2.1
  |kf  . . . . . . . . . . . . . . .   1.000
 .Section moment capacity  . . . .      18.9 kN.m                                Note 1
 .Section shear capacity . . . . .     176.1 kN                                  Cl.5.11.3
 .Section tension capacity . . . .     479.3 kN                                  AS4100 7.2
 .Section compression capacity . .     479.3 kN                                  AS4100 6.2.1

End plate:
 300x275x16  Gr./fy/fu=300+/30/440MPa

End plate weld:
```

```
 6 CBF/410MPa/SP all around section.

Bolts:
 4 x M20 8.8/TB/N edge distance 50 gauge 10 .

INPUT DESIGN ACTIONS
 Moment, M* . . . . . . . . . . . .    4.40 kN.m
 Shear, V* . . . . . . . . . . . . .   13.4 kN
 Axial, N* . . . . . . . . . . . . .   22.4 kN  (tens.)
  |A . . . . . . . . . . . . . . . .   2130 mm2
  |Ae  . . . . . . . . . . . . . . .   2130 mm2                                       AS4100 6.2.1
  |kf  . . . . . . . . . . . . . . .  1.000
  |d . . . . . . . . . . . . . . . .    113 mm
  |b . . . . . . . . . . . . . . . .     63 mm
  |t . . . . . . . . . . . . . . . .    6.0 mm
  |Flange b/t  . . . . . . . . . . .  10.50
  |Flange slenderness  . . . . . . .  10.50
  |Flange yield slenderness ratio      0.26
  |Web d/t . . . . . . . . . . . . .  18.83
  |Web slenderness . . . . . . . . .  18.83
  |Web yield slenderness ratio . .     0.16
  |Critical slenderness  . . . . . .  10.50
  |Aw  . . . . . . . . . . . . . . .   1305 mm2
  |fy  . . . . . . . . . . . . . . .    250 MPa
  |ø . . . . . . . . . . . . . . . .   0.90

Specified minimum design actions:
 Bending       50% of øMs  (   18.9)  =   9.47 kN.m
 Shear          0% of øVs  (  176.1)  =    0.0 kN
                                          40.0 kN
 Tension       30% of øNs  (  479.3)  =  143.8 kN
 Compression   15% of øNs  (  479.3)  =   71.9 kN

Using USyd. R745 1997 model...
(ASI 2013)

  |Bolt fuf  . . . . . . . . . . . .    830 MPa
Final design actions:
 Moment, M*  . . . . . . . . . . . .   9.47 kN.m
 Shear, V* . . . . . . . . . . . . .   40.0 kN
 Tension, N*t  . . . . . . . . . . .  143.8 kN
 Flange force (axial)  . . . . . . .   57.5 kN
 Moment (axial)  . . . . . . . . . .   6.84 kN.m
 Flange force increment  . . . . . .   57.5 kN
 End plate design moment, M*eq . .     16.3 kN.m

GEOMETRY CHECKS
Tested parameter ranges:
 Depth of beam section . . . . . .      125           ≤     400                Yes
  |d . . . . . . . . . . . . . . . .    113 mm
  |b . . . . . . . . . . . . . . . .     63 mm
  |t . . . . . . . . . . . . . . . .    6.0 mm
  |Flange b/t  . . . . . . . . . . .  10.50
  |Flange slenderness  . . . . . . .  10.50
  |Flange yield slenderness ratio      0.26
  |Web d/t . . . . . . . . . . . . .  18.83
  |Web slenderness . . . . . . . . .  18.83
  |Web yield slenderness ratio . .     0.16
  |Critical slenderness  . . . . . .  10.50
 Slenderness plasticity limit  . .     30.0
 Slenderness yield limit . . . . .     40.0
 Section slenderness . . . . . . .     10.5
 » Compactness = C
 Horiz. distance to bolt, c  . . .       50 mm
 Vert. distance to bolt, so  . . .       38 mm

Yield line analysis:
 Mode 1 failure moment . . . . . .     48.2 kN.m
 Mode 2 failure moment . . . . . .     61.3 kN.m
 Mode 3 failure moment . . . . . .     48.6 kN.m
 Plate equivalent width  . . . . .      275 mm

DESIGN CAPACITY CHECKS
                                     Capacity ratio ──────────┐
                                     Design action ────┐      │
                                    ┌Design capacity   │      │          Reference
                                    │                  │      │       ══════════════
CHECK 3 - Bolts in Tension:                                              TDG24 p.4-19
```

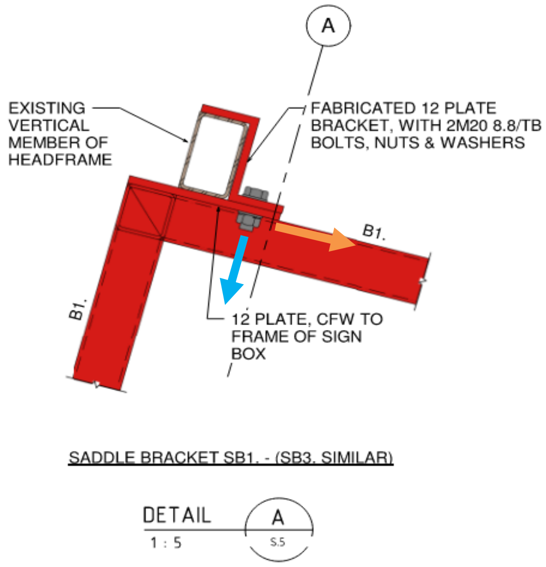
```
   |ø . . . . . . . . . . . . . . .    0.80
   |Bolt fuf  . . . . . . . . . . .     830 MPa
  Single bolt tension capacity  . .   162.7 kN                                              AS4100 9.3.2.2
  Bolt tension failure capacity . . . . . . .    40.8  ≥  M*    =   16.3  2.50  Pass  Ref.27 (28)

 CHECK 5 - Plate Bending:                                                                   TDG24 p.4-24
  End plate failure capacity  . . . . . . . .    55.9  ≥  M*    =   16.3  3.42  Pass  Ref.27 (31)

 CHECK 7 - Bolts in Shear:                                                                  TDG24 p.4-32
   |ø . . . . . . . . . . . . . . .    0.80
   |Bolt fuf  . . . . . . . . . . .     830 MPa
  Shear capacity of compression bolts . . . .   185.3  ≥  V*    =   40.0  4.63  Pass
   |fy  . . . . . . . . . . . . . .     300 MPa
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt bearing capacity  .   405.5 kN                                              AS4100 9.3.2.4
  End plate bearing capacity  . . . . . . . .   811.0  ≥  V*    =   40.0  20.3  Pass

 CHECK 8 - Bolt Tearout in End Plate:                                                       TDG24 p.4-33
  No. bolts effective in shear  . .       2
   |Dh  . . . . . . . . . . . . . .    22.0 mm
   |fu  . . . . . . . . . . . . . .     440 MPa
   |ø . . . . . . . . . . . . . . .    0.90
   |Single bolt tearing capacity  .   310.5 kN                                              AS4100 9.3.2.4
  End plate tearing capacity (ext.) . . . . .   620.9  ≥  V*    =   40.0  15.5  Pass  AS4100 9.3.2.4

 Serviceability limit states:
  Bolt yielding serviceability capacity . . .    30.1  ≥  M     =   10.9  2.77  Pass  Ref.27 (33)
  Plate yielding serviceability capacity  . .    31.1  ≥  M     =   10.9  2.86  Pass  Ref.27 (34)
```



M* = 0.298 kN-m

Shear, Fx	2.32	kN
Axial, Fz	7.00	kN
Moment Arm	42.5	mm

Plate width, b = 150 mm

Effective thickness, t = 12 mm

fy = 300 MPa

Grade 300

AS 4100-1998 Sec 5.2

λ_e = b/t $\sqrt{(f_y/250)}$

= 13.69

λ_{ep} = 9 AS 4100-1998, Table 5.2

λ_{ey} = 16 AS 4100-1998, Table 5.2

λ_{ep} < λ_e ≤ λey

Z_e = Z + {[(λey - λe) / (λey - λep)] (Zc - Z)}

S = 5400 mm^3

Z = 3600 mm^3

Z_c = 5400 mm^3

Z_e = 4193.21 mm^3

Capacity:

ϕM_s = 0.9 $f_y Z_e$

= (0.9) (300) (4193.21) Demand:

= 1.1 kN-m > 0.298 kN-m **OKAY!**

26%

Stress in Plate

σ_b = M*/ Z_e

σ_b = 70948 kPa

σ_b = **70.948** MPa

Tensile Stress

σ_n = P/A

σ_n = 1288.89 kPa

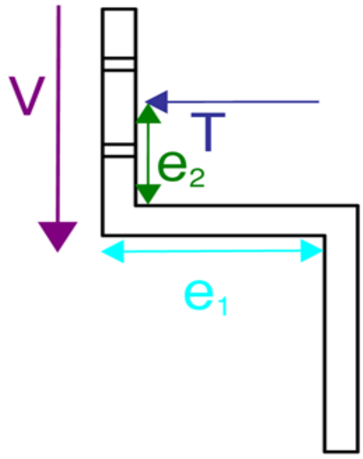
σ_n = **1.29** MPa

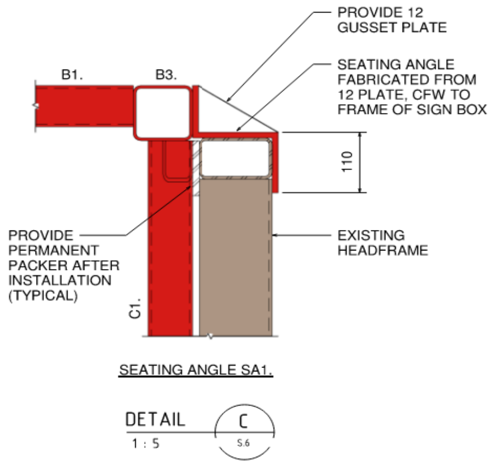
Total Stress

σ_t = 72.24 MPa < 270.000 MPa

OKAY!

ARCADIS	DOCUMENT No **Port of Newcastle Signages**	SHEET
SUBJECT	**LOCAL CHECKS**	
	CALCULATIONS	





Forces:

V =	**22.70 kN**
e_1 =	**0.140 m**
T =	**13.40 kN**
e_2 =	**0.050 m**

Plate width, b = 200 mm
Effective thickness, t = 12 mm

fy = 300 MPa
Grade 300

M* = 3.848 kN-m

AS 4100-1998
Sec 5.2

λ_e = b/t $\sqrt{(f_y/250)}$
= 18.26

λ_{ep} = **9** AS 4100-1998, Table 5.2
λ_{ey} = **25** AS 4100-1998, Table 5.2

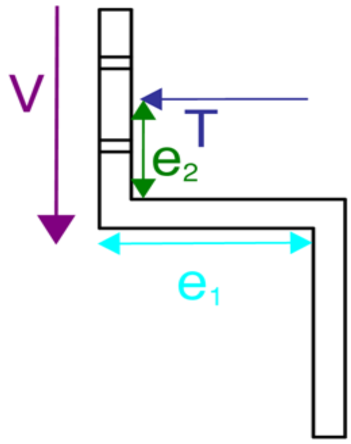
λ_{ep} < λ_e ≤ **λey**

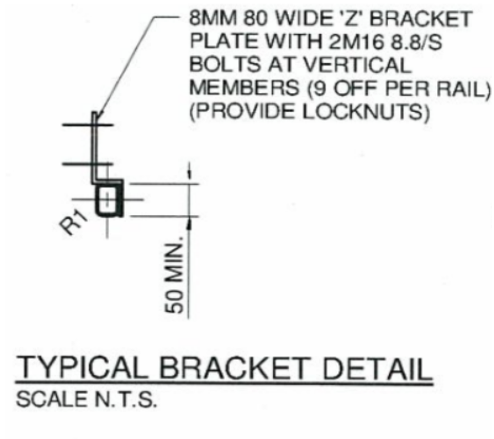
Z_e = Z + {[(λey - λe) / (λey - λep)] (Zc - Z)}
S = 119500 mm^3
Z = 58600 mm^3
Z_c = 119500 mm^3

Z_e = 84263.95 mm^3

Capacity:
ϕM_s = **0.9 $f_y Z_e$**
= (0.9) (300) (84263.95) Demand:
= 22.8 kN-m > 3.848 kN-m **OKAY!**

Stress in Plate **17%**
σ_b = M*/ Z_e
σ_b = 45666 kPa
σ_b = **45.666** MPa
Tensile Stress
σ_n = P/A
σ_n = 5583.33 kPa
σ_n = **5.58** MPa
Total Stress
σ_t = 51.25 MPa < 270.000 MPa
OKAY!





Forces:

V =	**3.49 kN**
e_1 =	**0.038 m**
T =	**3.35 kN**
e_2 =	**0.055 m**

Plate width, b = 80 mm
Effective thickness, t = 8 mm

fy = 300 MPa
Grade 300

M* = 0.315 kN-m

AS 4100-1998 Sec 5.2

λ_e = b/t $\sqrt{(f_y/250)}$
= 10.95

λ_{ep} = 9 AS 4100-1998, Table 5.2
λ_{ey} = 25 AS 4100-1998, Table 5.2

λ_{ep} < λ_e ≤ λey

Z_e = Z + {[(λey - λe) / (λey - λep)] (Zc - Z)}
S = 1280 mm^3
Z = 853.333333 mm^3
Z_c = 1280 mm^3

Z_e = 1227.88 mm^3

Capacity:
ϕM_s = 0.9 $f_y Z_e$
= (0.9) (300) (1227.88) Demand:
= 0.3 kN-m > 0.315 kN-m **OKAY!**

95%

Stress in Plate
σ_b = M*/ Z_e
σ_b = 256641 kPa
σ_b = **256.641** MPa

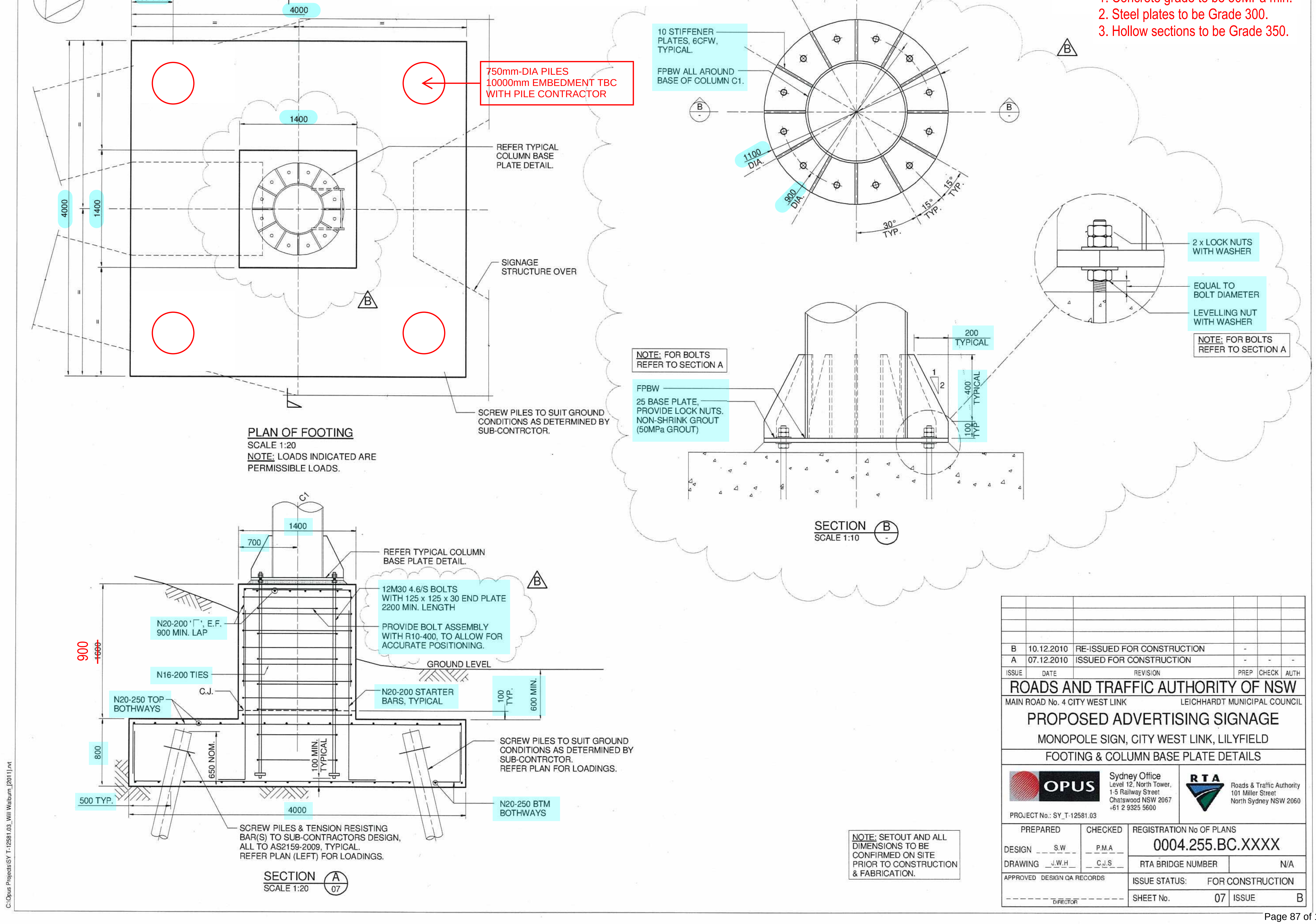
Tensile Stress
σ_n = P/A
σ_n = 5234.38 kPa
σ_n = **5.23** MPa

Total Stress
σ_t = 261.88 MPa < 270.000 MPa
OKAY!

G. FOUNDATION DESIGN

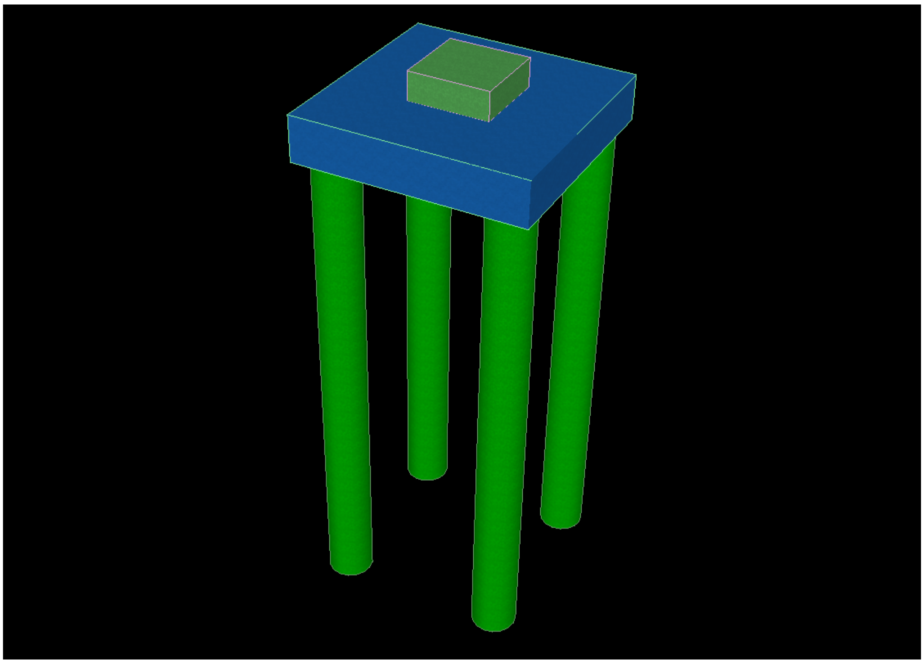
Pedestal and pile cap design as shown in the drawing below are adequate for the proposed Port of Newcastle signages. Modifications are in red mark-up.

Notes:
1. Concrete grade to be 50MPa min.
2. Steel plates to be Grade 300.
3. Hollow sections to be Grade 350.



G.1 PILE CAP DESIGN

To determine the design bending moment and shear in the pile cap, the structure was modelled and analyzed in RAM Concept.



Loadings

Loads that were applied at the base of the column include gravity and wind loads based on the reactions obtained from the Microstran analysis.

Load Combinations

Load combinations are automatically generated by RAM Concept based on AS3600:2018.

Service LC: D + ΨL
Max Service LC: D + L
Service Wind LC: D + ΨL + W
Service Wind LC: D + ΨL - W
Service Wind LC: D + W
Service Wind LC: D - W

Ultimate LC: 1.35D
Ultimate LC: 0.9D
Ultimate LC: 1.2D + 1.5L
Ultimate LC: 0.9D + 1.5L
Ultimate Wind LC: 1.2D + ΨL + W
Ultimate Wind LC: 1.2D + ΨL - W
Ultimate Wind LC: 0.9D + W
Ultimate Wind LC: 0.9D - W

ARCADIS		Job No.	Sheet No.	Revision.
				2
Client	Roads and Maritime Services of NSW	Member/Location	Pile Cap	
Project	Advertising Signage Digital Conversion, City West Link, Lilyfield	Made By	CB	Filename
		Date	04/04/2022	Check by

1. DESIGN PARAMETERS

Section Geometry

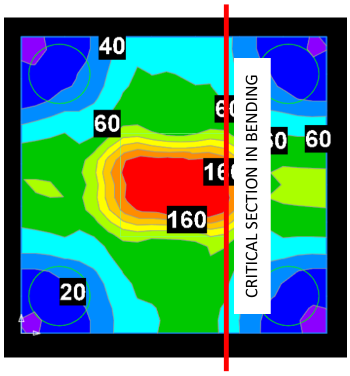
Panel Width, b =	4000	mm
Panel Thickness, t or h =	800	mm
Top cover, c =	75	mm
Bottom cover, c =	75	mm
Side cover, c =	75	mm
Durable cover (depth to check crack width) , c_{dur} =	75	mm

Material Properties

Concrete grade, f'_c =	50	N/mm^2
Steel grade, f_{sy} =	500	N/mm^2
Modulus of elasticity of steel, E_s =	200	kN/mm^2
Modulus of elasticity of concrete, E_c =	34.8	kN/mm^2
Exposure classification =	B2	
Maximum crack width allowable =	0.3	mm

Design Loads

M_{sls} =	201	kNm
M^*_{uls} =	369	kNm
V^*_{uls} =	282	kN
T^*_{uls} =	0	kNm
N^*_{uls} =	0	kN
Average intensity of effective prestress, σ_{cp} =	0	MPa



ULS ENVELOPE
DIAGRAM FOR BENDING MOMENT
(from RAM Concept)

Note: Tension is positive. Compression is negative

2. REINFORCEMENT PROVISION

Tension Reinforcement

1st Row

Rebar Dia, φ_1=	20	mm
Bundled =	no	
No. of bar =	17	
Spacing, c/c =	237	mm
Clear spacing =	217.38	mm
Area of steel, As =	5340.71	mm^2
Depth to rebar from top =	699.00	mm

2nd Row

Rebar Dia, φ_1=		mm
Bundled =	no	
No. of bar =		
Spacing, c/c =	237	
Clear spacing =	237.38	mm
Area of steel, As =	0.00	mm^2
Spacer Bar Dia, φ_1=	32	mm
Depth to rebar from top =	657.00	mm

3rd Row

Rebar Dia, φ_1=		mm
Bundled =	no	
No. of bar =		
Spacing, c/c =	237	
Clear spacing =	237.38	mm
Area of steel, As =	0.00	mm^2
Depth to rebar from top =	625.00	mm

Compression Reinforcement

1st Row

Rebar Dia, φ_1=	20	mm
Bundled =	no	
No. of bar =	17	
Spacing, c/c =	237	mm
Clear spacing =	217.38	mm
Area of steel, As =	5340.71	mm^2
Depth to rebar from top =	101.00	mm

2nd Row

Rebar Dia, φ_1=		mm
Bundled =	no	
No. of bar =		
Spacing, c/c =	237	
Clear spacing =	237.38	mm
Area of steel, As =	0.00	mm^2
Depth to rebar from top =	131.00	mm

RESULTS

SLS Stress & Crack control

OK < 0.3 mm

SLS Steel stress < Maxm. Allowable .: OK

Shear

Transverse Shear Reo to be provided

OK Asv.prov>Asv.min

OK φVu>V*eq

Tension reinforcement

OK Ast.min<Ast.prov

OK φMuo>M*uls

OK As > As req

OK Spacing adequate

Compression Summary

Total $A_{sc.prov}$ =	5340.71	mm^2	
d_{sc} =	101.00	mm	
A_{sc} / $b_w d$ =	0.0019		

Tension Summary

Total $A_{st.prov}$ =	5340.71	mm^2	
Effective Depth, d =	699.00	mm	
A_{st} / $b_w d$ =	0.0019		
	Ast/bwd < 0.2 (D/d)2 f'ct.f / fsy .: Muo should be ≥ (Muo)_min		Cl 8.1.6.1 AS5100.5-2017

Ligatures

Diameter of ligs =	16	mm	
Number of legs =	6		
Lig spacing, s =	250	mm	

3 (a). SLS REINFORCEMENT STRESS (AS5100.5-2017)

Modular Ratio, n =	5.75		
k =	0.14		
Cracked Neutral Axis, kd =	96.46	mm	
Cracked Moment of Inertia, I_{cr} =	1.234E+10	mm^4	
Stress in Concrete, σ_c =	1.57	MPa	
Stress in Steel, σ_{st} =	56.3	MPa	
Maximum Allowable Stress, σ_{all} =	130.1	MPa	T 8.6.1(B) Cl 8.6.1 AS5100.5-2017
	SLS Steel stress < Maxm. Allowable .: OK		

3 (b). SLS FLEXURAL CRACK WIDTH (CRACK CONTROL CHECK TO BS-EN 1992-1-1:2004)

Calculate Modulus of Elasticity for Concrete and Modular Ratio

Age of Concrete at time of loading, τ =	28	days	
No. of days for Long Term crack, t =	36500	days	
Hypothetical Thickness, th =	800	mm	
a_2 =	0.82		
k_2 =	0.80		
k_3 =	1.10		
k_4 =	0.50		
k_5 =	1.00		
Basic Creep Factor, $\varphi_{cc.b}$ =	2.8		
Final Creep Factor after 30yrs, φ^*_{cc} =	1.234		Cl 3.1.8.3 AS5100.5:2017
Effective Modulus of Elasticity for Concrete, $E_{c,eff}$ =	15.58	kN/mm^2	Eq 7.20 BS EN 1992-1-1:2004
Modular Ratio, α_e =	12.84		

Calculate Maximum Crack Spacing

k_1 =	0.8	High bond bars	Refer to notes under Eq 11 BS EN 1992-1-1:2004
k_2 =	0.5	For bending	
k_3 =	3.4	Recommended	
k_4 =	0.425	Recommended	
Cracked neutral axis, x_c =	138.62	mm	
$h_{c,ef}$ [min of 2.5(h-d), (h-x)/3, h/2] =	220.46	mm	
Effective area of concrete in tension, $A_{c,eff}$ =	881843.92	mm^2	Cl 7.3.2 (3) BS EN 1992-1-1:2004
$\rho_{p,eff}$ =	0.006		
Maximum crack spacing, $s_{r,max}$ =	816.40	mm	Cl 7.3.4 (3) BS EN 1992-1-1:2004
	5(cover+0.5*db) = 425>S .: OK		

Calculate $\varepsilon_{sm} - \varepsilon_{cm}$

Long term loading factor, k_t =	0.4		
Mean concrete tensile strength, $f_{ct,eff}$ =	3.564	MPa	Cl 3.1.1.3 AS5100.5:2017
2nd Moment of intertia within cracked section, I_{cr} =	2.5086E+10	mm^4	
Max stress in concrete under SLS, σ_c =	1.11	MPa	
Stress of steel (average of all rows), $\sigma_{s,avg}$ =	57.51	MPa	
Stress of steel (first row), $\sigma_{s,max}$ =	57.51	MPa	
$\varepsilon_{sm} - \varepsilon_{cm}$ =	-930.31	µstrain	Eq 7.9 Cl 7.3.4 (2) BS EN 1992-1-1:2004
$0.6\sigma_s/E_s$ =	172.53	µstrain	
Therefore apply =	172.53	µstrain	

Calculate Crack Width W_K

w_k =	0.141	mm	Eq 7.8 Cl 7.3.4 (1) BS EN 1992-1-1:2004
	OK < 0.3 mm		

4. TENSION REINFORCEMENT DESIGN (ULTIMATE LIMIT DESIGN CHECK) (AS5100.5:2017) - NO AXIAL LOAD CONSIDERED

Max strain in comp fibre =	0.003		Cl 8.1.3 (a)
Yield strain of passive steel =	0.0025		
α_2 =	0.85	$0.67 \leq \alpha_2 \geq 0.85$	Eq 8.1.3(1)
γ =	0.7	$0.67 \leq \gamma \geq 0.85$	Eq 8.1.3(2)

Calculate Bending Strength Requirements

Section modulus of uncracked section, Z =	4.27E+08	mm^3	
$(M_{uo})_{min}$ =	2172.23	kNm	Cl 8.1.6.1
α_b =	0.2	Rectangular	
$A_{st.min}$ ≥	5220.82	mm^2	Eq 8.1.6.1(2)
	OK Ast.min<Ast.prov		
Neutral axis parameter, k_u =	0.064		
k_{uo} =	0.40		ensure ductile failure Cl.8.1.5
Capacity reduction factor, ϕ =	0.7567		Table 2.3.2 (b)
Neutral axis depth, d_n =	44.88	mm	
Depth of compression block, $\gamma k_u d$ =	31.42	mm	
M_{uo} =	2172.23	kNm	
Bending Moment Capacity, ϕM_{uo} =	1643.66	kNm	**Utilisation = 0.22**
	OK φMuo>M*uls		

5. CONSIDERATION OF TORSION (AS5100.5:2017)

Total enclosed area, A_{cp} =	3200000	mm^2	
Perimeter, u_c =	9600	mm	
Torsional cracking moment, T_{cr} =	2489	kNm	Eq 8.2.1.2(2)
	Ignore Torsion, T*<0.25φTcr		
Perimeter of closed transverse torsion reo, u_h =	8936	mm	
Area enclosed by centreline of exterior transverse torsion reo A_{0h} =	2430756	mm^2	
Area enclosed by shear flow path, A_0 = $0.85A_{oh}$ =	2066142.6	mm^2	Cl 8.2.5.6
Equivalent Shear, V^*_{eq} =	282	kN	Eq 8.2.1.2(4)

6. SHEAR & TORSION REINFORCEMENT DESIGN (AS5100.5:2017 & Amendment 2018)

Reuirements for transverse shear reinforcement

Check if $V^* > 0.5\varphi(V_{uc}+P_v)$	No		Cl 8.2.1.6(a)
Check if $T^* > 0.25\varphi Tcr$	No		Cl 8.2.1.6(b)
	Transverse Shear Reo to be provided		

Calculate Minimum transverse shear reinforcement

Yield strength of rebar used as fitments, $f_{sy.f}$ =	500	MPa	
$A_{sv.min}$ =	1131.37	mm^2	Eq 8.2.1.7
$A_{sv.prov}$ =	1206.37	mm^2	
	OK Asv.prov>Asv.min		

Calculate Ultimate Shear Strength (Vuc)

√f'c =	7.07	MPa	Cl 8.2.4.1
d_v =	683.29	mm	Cl 8.2.1.9
Aggregate size, d_g =	20	mm	
k_{dg} =	0.89		Eq 8.2.4.2(2)
Limit for, M^*_{uls} =	369.00	kNm	Eq 8.2.4.3 & Eq 8.2.4.4
ε_x =	3.85E-04		Eq 8.2.4.3(1) & Eq 8.2.4.4(1)
k_v =	0.25		Eq 8.2.4.2(1)
Ultimate shear strength, V_{uc} =	4902.34	kN	Cl 8.2.4.1
	Shear reinforcement not required		

Calculate Shear Strength limited by web crushing (Vu.max)

Ultimate shear strength limited by web crushibng failure, $V_{u.max}$ =	33599	kN	Cl 8.2.3.3
$\phi V_{u.max}$ =	23519	kN	

Calculate Shear Reinforcement (Vus)

θ_v =	31.69	deg	Cl 8.2.4.2
$\cot(\theta_v)$ =	1.620		
Shear reinforcement, V_{us} =	2670.13	kN	Cl 8.2.5.2

Check Web Crushing due to combined shear & torsion

For box section, applied stress =	0.10	MPa	Eq 8.2.4.5
Maxm. allowable stress, $\varphi V_{u.max} / b_v d_v$ =	8.61	MPa	
	Adequate wall thickness: OK		

Calculate Torsional Reinforcement (Tus)

A_{sw}/s available for torsion additional to Shear A_{sv}/s =	201.06	mm^2/m	
Ultimate torsional strength, T_{us} =	2691319.34	kNm	Cl 8.2.5.6
	Minimum torsional reo OK		Cl 8.2.5.5
	Adequate torsional reinforcement		Cl 8.2.5.4

Calculate Combined Shear & Torsion Design Strength

V_u =	7572.47	kN		
Capacity reduction factor, ϕ =	0.7		Table 2.3.2 (e)	
ϕV_u =	5300.73	kN	**Utilisation =**	**0.05**
	OK φVu>V*eq			

7. Proportioning longitudinal reinforcement on the flexural tension side (AS5100.5:2017 & Amendment 2018)

Calculate additional tension due to shear

ΔF_{td} =	0.00	kN	Cl 8.2.7	
Additional steel required, $\Delta A_s f_{sy}$ =	0.00	kN	Cl 8.2.7 (3)	
Capacity reduction factor, φ =	0.7		Table 2.3.2 (c)	
Longitudinal steel not required for flexure, A_s =	4141.72	mm^2		
Longitudinal steel can be used from flexure, φ As fsy =	1449.60	kN	Utilisation =	0.00
	OK φAs fsy > ΔFtd/φ			
Additional steel required =	0.00	mm^2		

Combined utilisation with flexural reinforcement = 0.22

OK As > As req

ARCADIS

		Job No.	Sheet No.	Revision.
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Client	Roads and Maritime Services of NSW	Member/Location	Pile Cap	
Project	Advertising Signage Digital Conversion, City West Link, Lilyfield	Made By	CB	Filename
		Date	04/04/2022	Check by

1. DESIGN PARAMETERS

Section Geometry

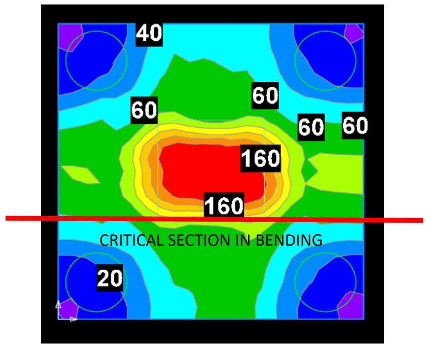
Panel Width, b =	4000	mm
Panel Thickness, t or h =	800	mm
Top cover, c =	95	mm
Bottom cover, c =	95	mm
Side cover, c =	95	mm
Durable cover (depth to check crack width) , c_{dur} =	95	mm

Material Properties

Concrete grade, f'_c =	50	N/mm^2
Steel grade, f_{sy} =	500	N/mm^2
Modulus of elasticity of steel, E_s =	200	kN/mm^2
Modulus of elasticity of concrete, E_c =	34.8	kN/mm^2
Exposure classification =	B2	
Maximum crack width allowable =	0.3	mm

Design Loads

M_{sls} =	150	kNm
M^*_{uls} =	230	kNm
V^*_{uls} =	200	kN
T^*_{uls} =	0	kNm
N^*_{uls} =	0	kN
Average intensity of effective prestress, σ_{cp} =	0	MPa



ULS ENVELOPE
DIAGRAM FOR BENDING MOMENT
(from RAM Concept)

Note: Tension is positive. Compression is negative

2. REINFORCEMENT PROVISION

Tension Reinforcement

1st Row

Rebar Dia, φ_1=	20	mm
Bundled =	no	
No. of bar =	17	
Spacing, c/c =	235	mm
Clear spacing =	214.88	mm
Area of steel, As =	5340.71	mm^2
Depth to rebar from top =	679.00	mm

2nd Row

Rebar Dia, φ_1=		mm
Bundled =	no	
No. of bar =		
Spacing, c/c =	235	
Clear spacing =	234.88	mm
Area of steel, As =	0.00	mm^2
Spacer Bar Dia, φ_1=	32	mm
Depth to rebar from top =	637.00	mm

3rd Row

Rebar Dia, φ_1=		mm
Bundled =	no	
No. of bar =		
Spacing, c/c =	235	
Clear spacing =	234.88	mm
Area of steel, As =	0.00	mm^2
Depth to rebar from top =	605.00	mm

Compression Reinforcement

1st Row

Rebar Dia, φ_1=	20	mm
Bundled =	no	
No. of bar =	17	
Spacing, c/c =	235	mm
Clear spacing =	214.88	mm
Area of steel, As =	5340.71	mm^2
Depth to rebar from top =	121.00	mm

2nd Row

Rebar Dia, φ_1=		mm
Bundled =	no	
No. of bar =		
Spacing, c/c =	235	
Clear spacing =	234.88	mm
Area of steel, As =	0.00	mm^2
Depth to rebar from top =	151.00	mm

RESULTS

SLS Stress & Crack control

OK < 0.3 mm

SLS Steel stress < Maxm. Allowable .: OK

Shear

Transverse Shear Reo to be provided

OK Asv.prov>Asv.min

OK φVu>V*eq

Tension reinforcement

NOT OK Ast. min>Ast.prov - Provide more rebar

OK φMuo>M*uls

OK As > As req

OK Spacing adequate

Compression Summary

Total $A_{sc.prov}$ =	5340.71	mm^2	
d_{sc} =	121.00	mm	
A_{sc} / $b_w d$ =	0.0020		

Tension Summary

Total $A_{st.prov}$ =	5340.71	mm^2	
Effective Depth, d =	679.00	mm	
A_{st} / $b_w d$ =	0.0020		
	Ast/bwd < 0.2 (D/d)2 f'ct.f / fsy .: Muo should be ≥ (Muo)_min		Cl 8.1.6.1 AS5100.5-2017

Ligatures

Diameter of ligs =	16	mm	
Number of legs =	6		
Lig spacing, s =	250	mm	

3 (a). SLS REINFORCEMENT STRESS (AS5100.5-2017)

Modular Ratio, n =	5.75		
k =	0.14		
Cracked Neutral Axis, kd =	96.22	mm	
Cracked Moment of Inertia, I_{cr} =	1.163E+10	mm^4	
Stress in Concrete, σ_c =	1.24	MPa	
Stress in Steel, σ_{st} =	43.1	MPa	
Maximum Allowable Stress, σ_{all} =	132.1	MPa	T 8.6.1(B) Cl 8.6.1 AS5100.5-2017
	SLS Steel stress < Maxm. Allowable .: OK		

3 (b). SLS FLEXURAL CRACK WIDTH (CRACK CONTROL CHECK TO BS-EN 1992-1-1:2004)

Calculate Modulus of Elasticity for Concrete and Modular Ratio

Age of Concrete at time of loading, τ =	28	days	
No. of days for Long Term crack, t =	36500	days	
Hypothetical Thickness, th =	800	mm	
a_2 =	0.82		
k_2 =	0.80		
k_3 =	1.10		
k_4 =	0.50		
k_5 =	1.00		
Basic Creep Factor, $\varphi_{cc.b}$ =	2.8		
Final Creep Factor after 30yrs, φ^*_{cc} =	1.234		Cl 3.1.8.3 AS5100.5:2017
Effective Modulus of Elasticity for Concrete, $E_{c,eff}$ =	15.58	kN/mm^2	Eq 7.20 BS EN 1992-1-1:2004
Modular Ratio, α_e =	12.84		

Calculate Maximum Crack Spacing

k_1 =	0.8	High bond bars	Refer to notes under Eq 11 BS EN 1992-1-1:2004
k_2 =	0.5	For bending	
k_3 =	3.4	Recommended	
k_4 =	0.425	Recommended	
Cracked neutral axis, x_c =	136.40	mm	
$h_{c,ef}$ [min of 2.5(h-d), (h-x)/3, h/2] =	221.20	mm	
Effective area of concrete in tension, $A_{c,eff}$ =	884800.09	mm^2	Cl 7.3.2 (3) BS EN 1992-1-1:2004
$\rho_{p,eff}$ =	0.006		
Maximum crack spacing, $s_{r,max}$ =	886.28	mm	Cl 7.3.4 (3) BS EN 1992-1-1:2004
	5(cover+0.5*db) = 525>S .: OK		

Calculate $\varepsilon_{sm} - \varepsilon_{cm}$

Long term loading factor, k_t =	0.4		
Mean concrete tensile strength, $f_{ct,eff}$ =	3.564	MPa	Cl 3.1.1.3 AS5100.5:2017
2nd Moment of intertia within cracked section, I_{cr} =	2.3574E+10	mm^4	
Max stress in concrete under SLS, σ_c =	0.87	MPa	
Stress of steel (average of all rows), $\sigma_{s,avg}$ =	44.18	MPa	
Stress of steel (first row), $\sigma_{s,max}$ =	44.18	MPa	
$\varepsilon_{sm} - \varepsilon_{cm}$ =	-1000.88	μstrain	Eq 7.9 Cl 7.3.4 (2) BS EN 1992-1-1:2004
$0.6\sigma_s/E_s$ =	132.55	μstrain	
Therefore apply =	132.55	μstrain	

Calculate Crack Width W_K

w_k =	0.117	mm	Eq 7.8 Cl 7.3.4 (1) BS EN 1992-1-1:2004
	OK < 0.3 mm		

4. TENSION REINFORCEMENT DESIGN (ULTIMATE LIMIT DESIGN CHECK) (AS5100.5:2017) - NO AXIAL LOAD CONSIDERED

Max strain in comp fibre =	0.003		Cl 8.1.3 (a)
Yield strain of passive steel =	0.0025		
α_2 =	0.85	$0.67 \leq \alpha_2 \geq 0.85$	Eq 8.1.3(1)
γ =	0.7	$0.67 \leq \gamma \geq 0.85$	Eq 8.1.3(2)

Calculate Bending Strength Requirements

Section modulus of uncracked section, Z =	4.27E+08	mm^3	
$(M_{uo})_{min}$ =	2172.23	kNm	Cl 8.1.6.1
α_b =	0.2	Rectangular	
$A_{st.min}$ ≥	5374.59	mm^2	Eq 8.1.6.1(2)
	NOT OK Ast. min>Ast.prov - Provide more rebar	However, 34mm2 deficiency in As can be considered acceptable	
Neutral axis parameter, k_u =	0.066		
k_{uo} =	0.40		ensure ductile failure Cl.8.1.5
Capacity reduction factor, ϕ =	0.7567		Table 2.3.2 (b)
Neutral axis depth, d_n =	44.88	mm	
Depth of compression block, $\gamma k_u d$ =	31.42	mm	
M_{uo} =	2052.39	kNm	
Bending Moment Capacity, ϕM_{uo} =	1552.98	kNm	**Utilisation = 0.15**
	OK φMuo>M*uls		

5. CONSIDERATION OF TORSION (AS5100.5:2017)

Total enclosed area, A_{cp} =	3200000	mm^2	
Perimeter, u_c =	9600	mm	
Torsional cracking moment, T_{cr} =	2489	kNm	Eq 8.2.1.2(2)
	Ignore Torsion, T*<0.25φTcr		
Perimeter of closed transverse torsion reo, u_h =	8776	mm	
Area enclosed by centreline of exterior transverse torsion reo A_{0h} =	2253636	mm^2	
Area enclosed by shear flow path, $A_0 = 0.85A_{oh}$ =	1915590.6	mm^2	Cl 8.2.5.6
Equivalent Shear, V^*_{eq} =	200	kN	Eq 8.2.1.2(4)

6. SHEAR & TORSION REINFORCEMENT DESIGN (AS5100.5:2017 & Amendment 2018)

Reuirements for transverse shear reinforcement

Check if $V^* > 0.5\varphi(V_{uc}+P_v)$	No		Cl 8.2.1.6(a)
Check if $T^* > 0.25\varphi Tcr$	No		Cl 8.2.1.6(b)
	Transverse Shear Reo to be provided		

Calculate Minimum transverse shear reinforcement

Yield strength of rebar used as fitments, $f_{sy.f}$ =	500	MPa	
$A_{sv.min}$ =	1131.37	mm^2	Eq 8.2.1.7
$A_{sv.prov}$ =	1206.37	mm^2	
	OK Asv.prov>Asv.min		

Calculate Ultimate Shear Strength (Vuc)

$\sqrt{f'c}$ =	7.07	MPa	Cl 8.2.4.1
d_v =	663.29	mm	Cl 8.2.1.9
Aggregate size, d_g =	20	mm	
k_{dg} =	0.89		Eq 8.2.4.2(2)
Limit for, M^*_{uls} =	229.90	kNm	Eq 8.2.4.3 & Eq 8.2.4.4
ε_x =	2.56E-04		Eq 8.2.4.3(1) & Eq 8.2.4.4(1)
k_v =	0.29		Eq 8.2.4.2(1)
Ultimate shear strength, V_{uc} =	5422.96	kN	Cl 8.2.4.1
	Shear reinforcement not required		

Calculate Shear Strength limited by web crushing (Vu.max)

Ultimate shear strength limited by web crushibng failure, $V_{u.max}$ =	32085	kN	Cl 8.2.3.3
$\phi V_{u.max}$ =	22460	kN	

Calculate Shear Reinforcement (Vus)

θ_v =	30.79	deg	Cl 8.2.4.2
$\cot(\theta_v)$ =	1.678		
Shear reinforcement, V_{us} =	2685.57	kN	Cl 8.2.5.2

Check Web Crushing due to combined shear & torsion

For box section, applied stress =	0.08	MPa	Eq 8.2.4.5
Maxm. allowable stress, $\varphi V_{u.max} / b_v d_v$ =	8.47	MPa	
	Adequate wall thickness: OK		

Calculate Torsional Reinforcement (Tus)

A_{sw}/s available for torsion additional to Shear A_{sv}/s =	201.06	mm^2/m	
Ultimate torsional strength, T_{us} =	2585312.37	kNm	Cl 8.2.5.6
	Minimum torsional reo OK		Cl 8.2.5.5
	Adequate torsional reinforcement		Cl 8.2.5.4

Calculate Combined Shear & Torsion Design Strength

V_u =	8108.53	kN		
Capacity reduction factor, ϕ =	0.7		Table 2.3.2 (e)	
ϕV_u =	5675.97	kN	**Utilisation =**	**0.04**
	OK φVu>V*eq			

7. Proportioning longitudinal reinforcement on the flexural tension side (AS5100.5:2017 & Amendment 2018)

Calculate additional tension due to shear

ΔF_{td} =	0.00	kN	Cl 8.2.7	
Additional steel required, $\Delta A_s f_{sy}$ =	0.00	kN	Cl 8.2.7 (3)	
Capacity reduction factor, φ =	0.7		Table 2.3.2 (c)	
Longitudinal steel not required for flexure, A_s =	4550.08	mm^2		
Longitudinal steel can be used from flexure, φ As fsy =	1592.53	kN	Utilisation =	0.00
	OK φAs fsy > ΔFtd/φ			
Additional steel required =	0.00	mm^2		

Combined utilisation with flexural reinforcement = 0.15

OK As > As req

G.2 PILE CHECKS

MAXIMUM ULS BASE REACTIONS

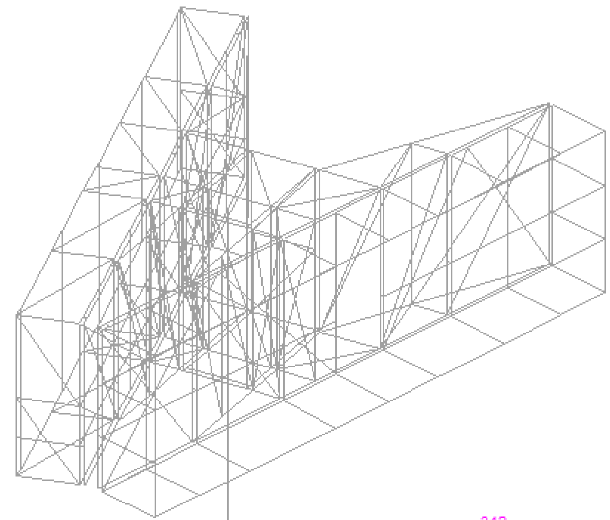
NODE REACTIONS - Node: 1 Restraint Code: 111111

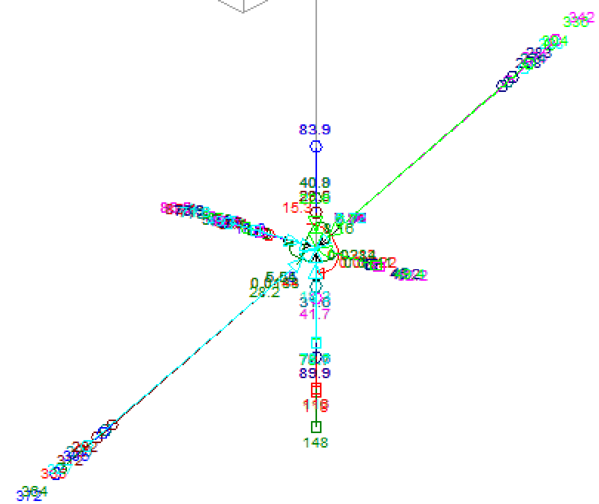
	Case	Fx	Fy	Fz	Mx	My	Mz
	100	-0.009	117.830	-0.014	39.127	-0.031	-15.284
ULS1: MAX FY	110	-0.014	148.015	-0.013	41.377	-0.028	-28.185
ULS2: MAX MZ (MAX FY)	140	52.271	116.436	-5.546	18.622	-40.865	-372.112
	141	46.357	116.326	7.370	86.522	-83.945	-312.454
	142	44.436	116.324	6.744	82.323	-29.587	-299.436
	143	-44.953	116.415	6.910	83.596	31.634	267.648
	144	-46.169	116.432	7.357	86.870	89.929	275.845
	145	-52.170	116.411	5.852	57.017	41.704	335.851
	146	-49.405	116.421	6.695	81.916	-22.565	297.826
ULS3: MAX MY + MZ (MAX FY)	147	49.648	116.347	6.713	82.149	18.202	-334.717
ULS4: MAX MZ (MIN FY)	150	52.290	78.704	-5.542	8.163	-40.797	-364.104
	151	46.375	78.599	7.374	75.936	-83.886	-304.599
	152	44.453	78.597	6.751	71.742	-29.533	-291.587
	153	-44.959	78.699	6.917	72.989	31.600	274.377
	154	-46.175	78.715	7.364	76.254	89.892	282.563
	155	-52.179	78.691	5.859	46.467	41.660	342.440
	156	-49.412	78.707	6.703	71.315	-22.601	304.492
ULS5: MAX MY + MZ (MIN FY)	157	49.665	78.618	6.722	71.569	18.258	-326.795

Load Cases:

100 C ULS01: 1.35(SW + SDL)
110 C ULS02: 1.2SW + 1.5Q + 1.2SDL
140 C ULS30: 1.2SW + 0.4Q + 1.2SDL + Wu-z 0 Degrees
141 C ULS31: 1.2SW + 0.4Q + 1.2SDL + Wu-z +45 Degrees
142 C ULS32: 1.2SW + 0.4Q + 1.2SDL + Wux +90 Degrees
143 C ULS33: 1.2SW + 0.4Q + 1.2SDL + Wux -90 Degrees
144 C ULS34: 1.2SW + 0.4Q + 1.2SDL + Wuz -45 Degrees
145 C ULS35: 1.2SW + 0.4Q + 1.2SDL + Wuz 0 Degrees
146 C ULS36: 1.2SW + 0.4Q + 1.2SDL + Wu-z -45 Degrees
147 C ULS37: 1.2SW + 0.4Q + 1.2SDL + Wuz +45 Degrees
150 C ULS20: 0.9SW + 0.9SDL + Wu-z 0 Degrees
151 C ULS21: 0.9SW + 0.9SDL + Wu-z +45 Degrees
152 C ULS22: 0.9SW + 0.9SDL + Wux +90 Degrees
153 C ULS23: 0.9SW + 0.9SDL + Wux -90 Degrees
154 C ULS24: 0.9SW + 0.9SDL + Wuz -45 Degrees
155 C ULS25: 0.9SW + 0.9SDL + Wuz 0 Degrees
156 C ULS26: 0.9SW + 0.9SDL + Wu-z -45 Degrees
157 C ULS27: 0.9SW + 0.9SDL + Wuz +45 Degrees

The above ULS base reactions were applied to the ETABS model of the pile group to determine the design forces to be used for pile design. Load application is on top of the 900mm pedestal to account for the additional bending moments from lateral loads.





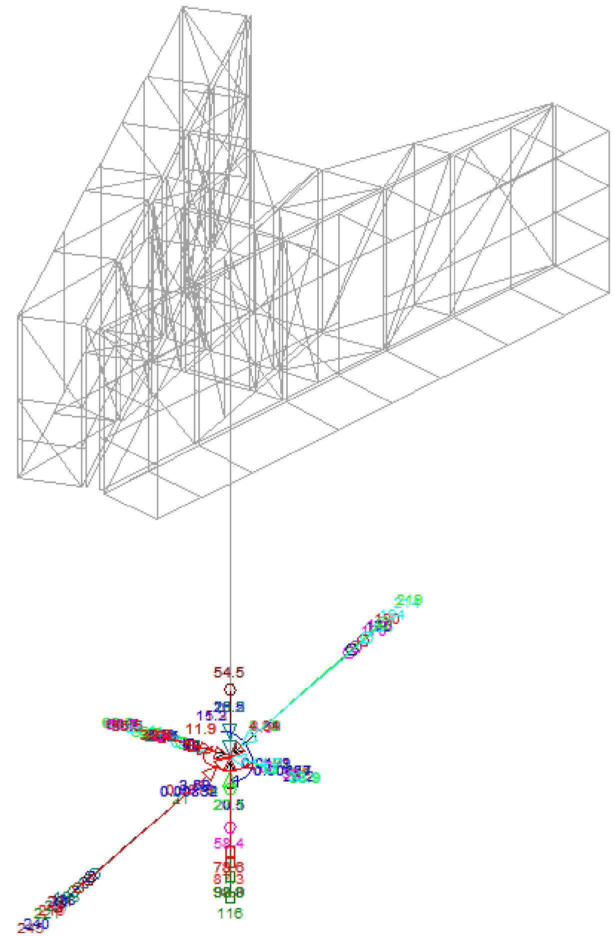
MAXIMUM SLS BASE REACTIONS

NODE REACTIONS - Node: 1 Restraint Code: 111111

	Case	Fx	Fy	Fz	Mx	My	Mz
	200	-0.005	87.281	-0.008	28.914	-0.017	-11.297
SLS1: MAX FY	210	-0.009	116.133	-0.009	33.312	-0.019	-21.005
	220	-0.007	98.822	-0.008	30.670	-0.018	-15.174
SLS2: MAX MZ (MAX FY)	230	33.983	98.891	-3.588	19.135	-26.538	-245.434
	231	30.131	98.843	4.824	63.370	-54.548	-206.655
	232	28.887	98.842	4.390	60.452	-19.213	-198.243
	233	-29.223	98.877	4.504	61.300	20.547	169.975
	234	-30.008	98.884	4.820	63.542	58.438	175.277
	235	-33.916	98.876	3.822	44.065	27.093	214.318
	236	-32.121	98.879	4.341	60.097	-14.684	189.599
SLS3: MAX MY + MZ (MAX FY)	237	32.281	98.852	4.342	60.145	11.864	-221.202
SLS4: MAX MZ (MIN FY)	240	33.989	78.618	-3.587	14.484	-26.518	-240.171
	241	30.136	78.573	4.825	58.675	-54.531	-201.445
	242	28.892	78.572	4.392	55.759	-19.198	-193.033
	243	-29.222	78.612	4.506	56.598	20.536	174.791
	244	-30.008	78.620	4.822	58.837	58.426	180.089
	245	-33.917	78.610	3.824	39.384	27.080	219.081
	246	-32.121	78.615	4.343	55.398	-14.695	194.392
SLS5: MAX MY + MZ (MIN FY)	247	32.286	78.582	4.345	55.451	11.879	-215.965

Load Cases:

200 C SLS10: SW + SDL
210 C SLS11: SW + SDL + Q
220 C SLS12: SW + SDL + 0.4Q
230 C SLS200: SW + SDL + 0.4Q + Ws-z 0 Degrees
231 C SLS201: SW + SDL + 0.4Q + Ws-z +45 Degrees
232 C SLS202: SW + SDL + 0.4Q + Wsx +90 Degrees
233 C SLS203: SW + SDL + 0.4Q + Wsx -90 Degrees
234 C SLS204: SW + SDL + 0.4Q + Wsz -45 Degrees
235 C SLS205: SW + SDL + 0.4Q + Wsz 0 Degrees
236 C SLS206: SW + SDL + 0.4Q + Ws-z -45 Degrees
237 C SLS207: SW + SDL + 0.4Q + Wsz +45 Degrees
240 C SLS300: 0.9SW + 0.9SDL + Ws-z 0 Degrees
241 C SLS301: 0.9SW + 0.9SDL + Ws-z +45 Degrees
242 C SLS302: 0.9SW + 0.9SDL + Wsx +90 Degrees
243 C SLS303: 0.9SW + 0.9SDL + Wsx -90 Degrees
244 C SLS304: 0.9SW + 0.9SDL + Wsz -45 Degrees
245 C SLS305: 0.9SW + 0.9SDL + Wsz 0 Degrees
246 C SLS306: 0.9SW + 0.9SDL + Ws-z -45 Degrees
247 C SLS307: 0.9SW + 0.9SDL + Wsz +45 Degrees



The above SLS base reactions were applied to the ETABS model of the pile group to determine the design forces to be used for pile design. Load application is on top of the 900mm pedestal to account for the additional bending moments from lateral loads.

SOIL LOADS APPLIED TO THE PILE CAP

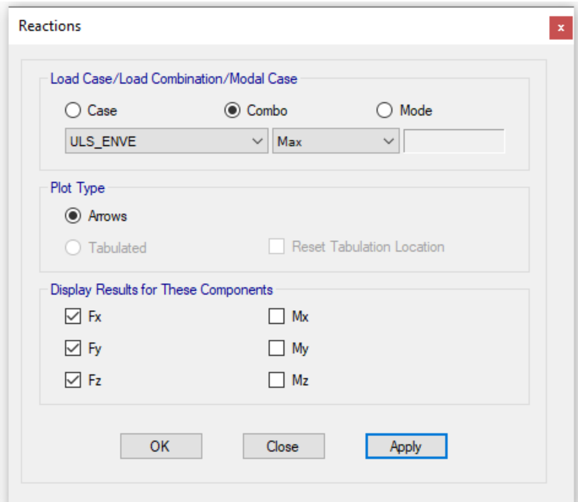
Two cases were considered:

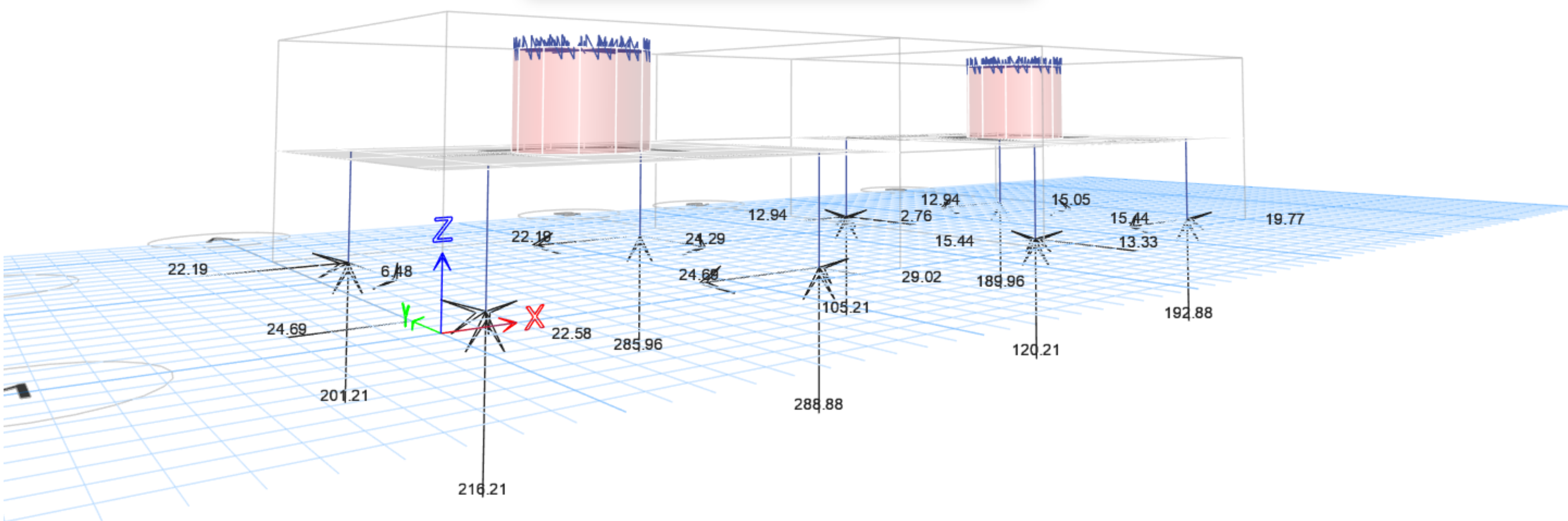
Full soil weight case
Full weight of soil above the pile cap from the 750mm layer of fill with 20kN/m^3 unit weight. The applied soil weight as per calculation below is 15kPa.

Uplift case
Buoyant force due to the displaced groundwater volume will produce a net upward pressure acting on the pile cap, with a magnitude of 3.68kPa as per calculation below.

Soil Layer	Thickness (m)	Eff. Weight (kN/m^3)	Overburden Weight (kPa)
Unsaturated fill	0.75	20	15
Vol of concrete foundation	30.47	m^3	
Uplift pressure	18.68	kPa	

MAXIMUM PILE REACTIONS (ULTIMATE)

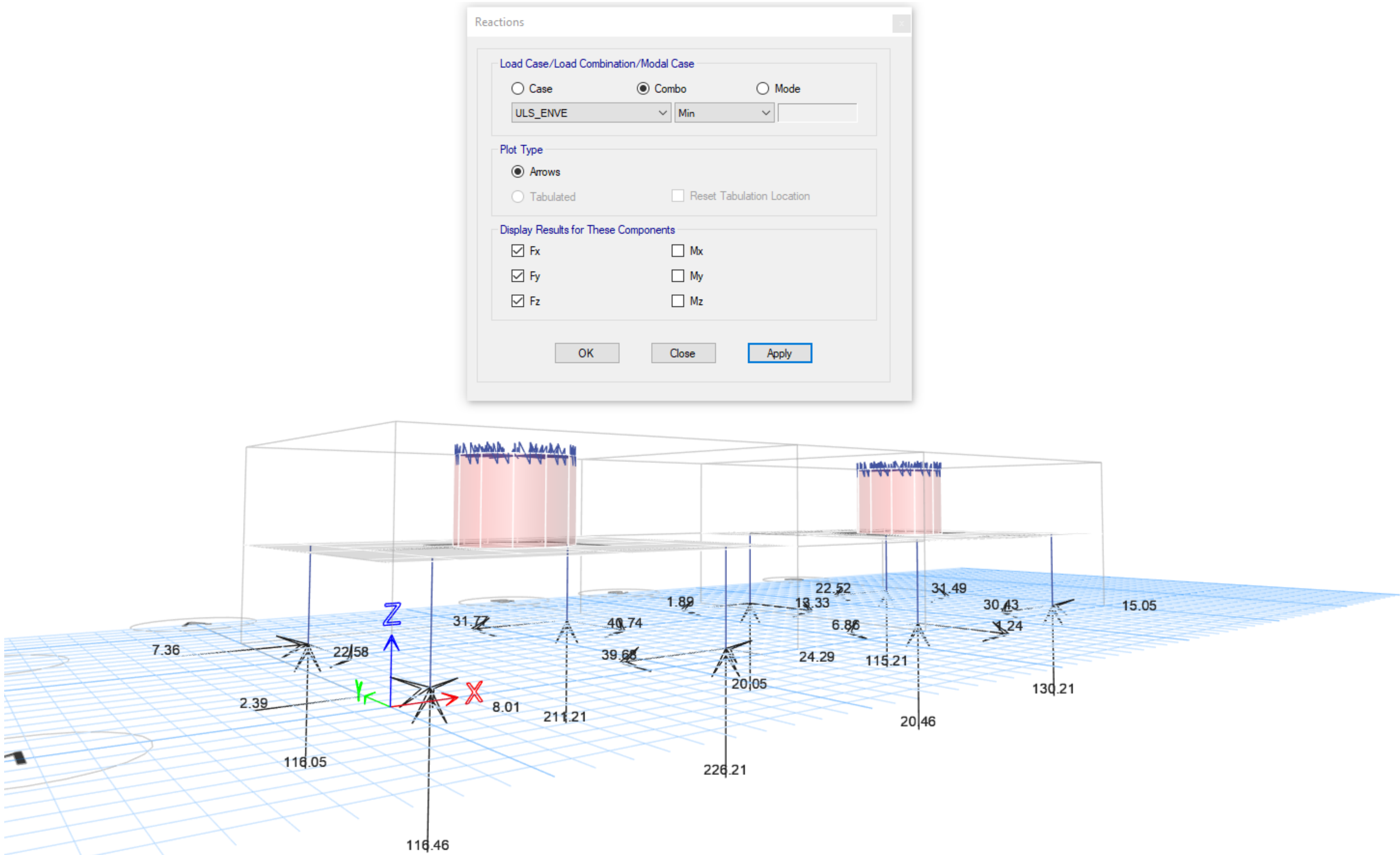




FULL SOIL WEIGHT CASE

WITH UPLIFT CASE

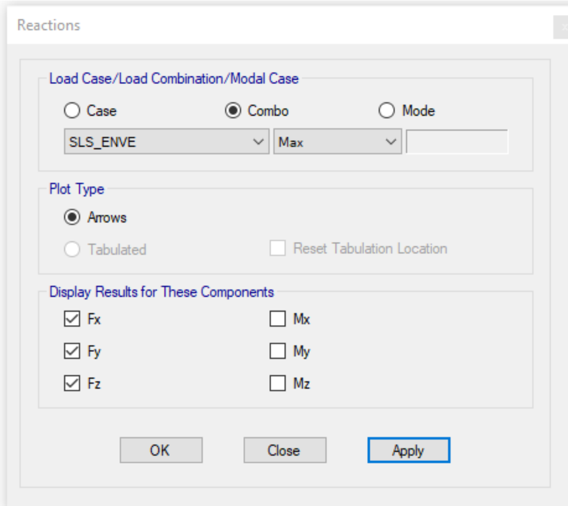
MINIMUM PILE REACTIONS (ULTIMATE)

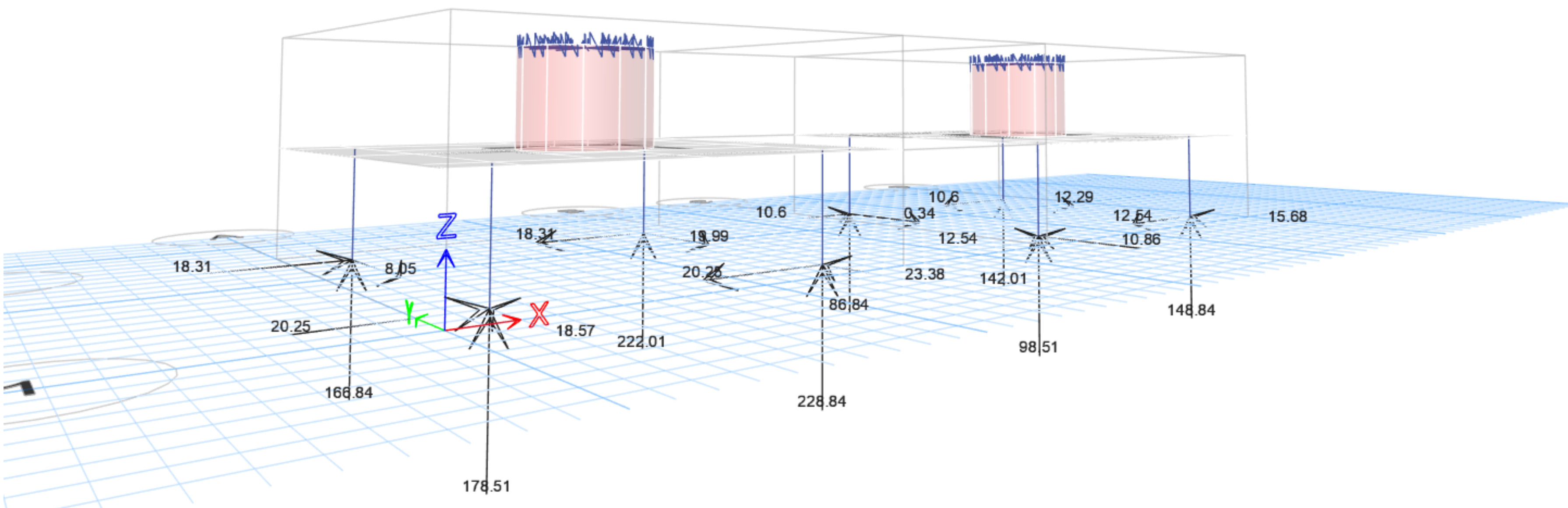


FULL SOIL WEIGHT CASE

WITH UPLIFT CASE

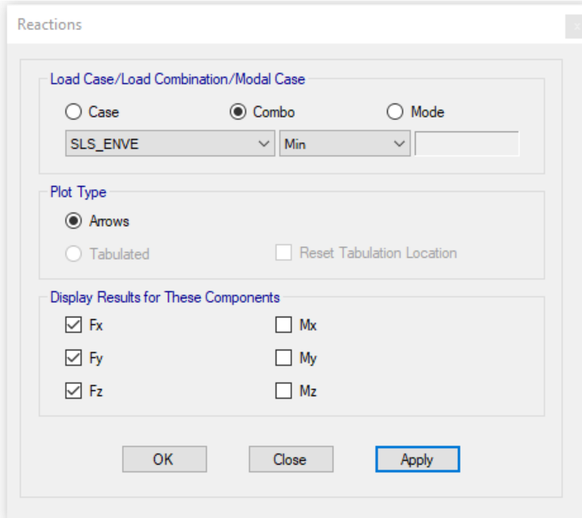
MAXIMUM PILE REACTIONS (SERVICE)

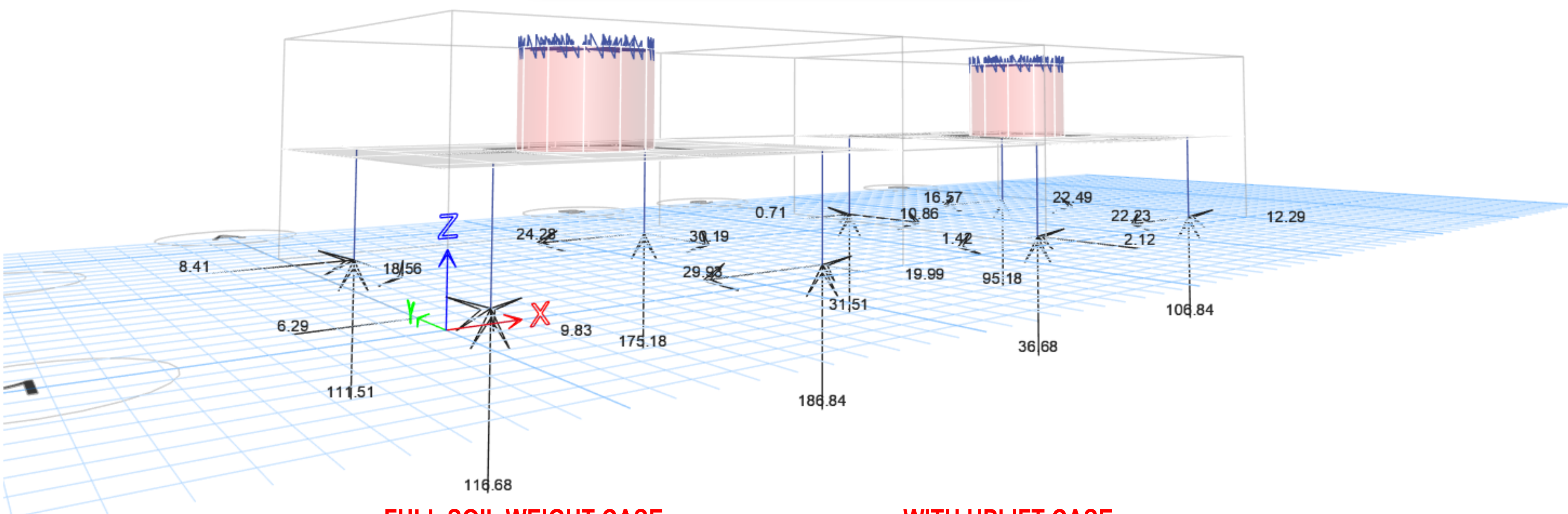




FULL SOIL WEIGHT CASE **WITH UPLIFT CASE**

MINIMUM PILE REACTIONS (SERVICE)

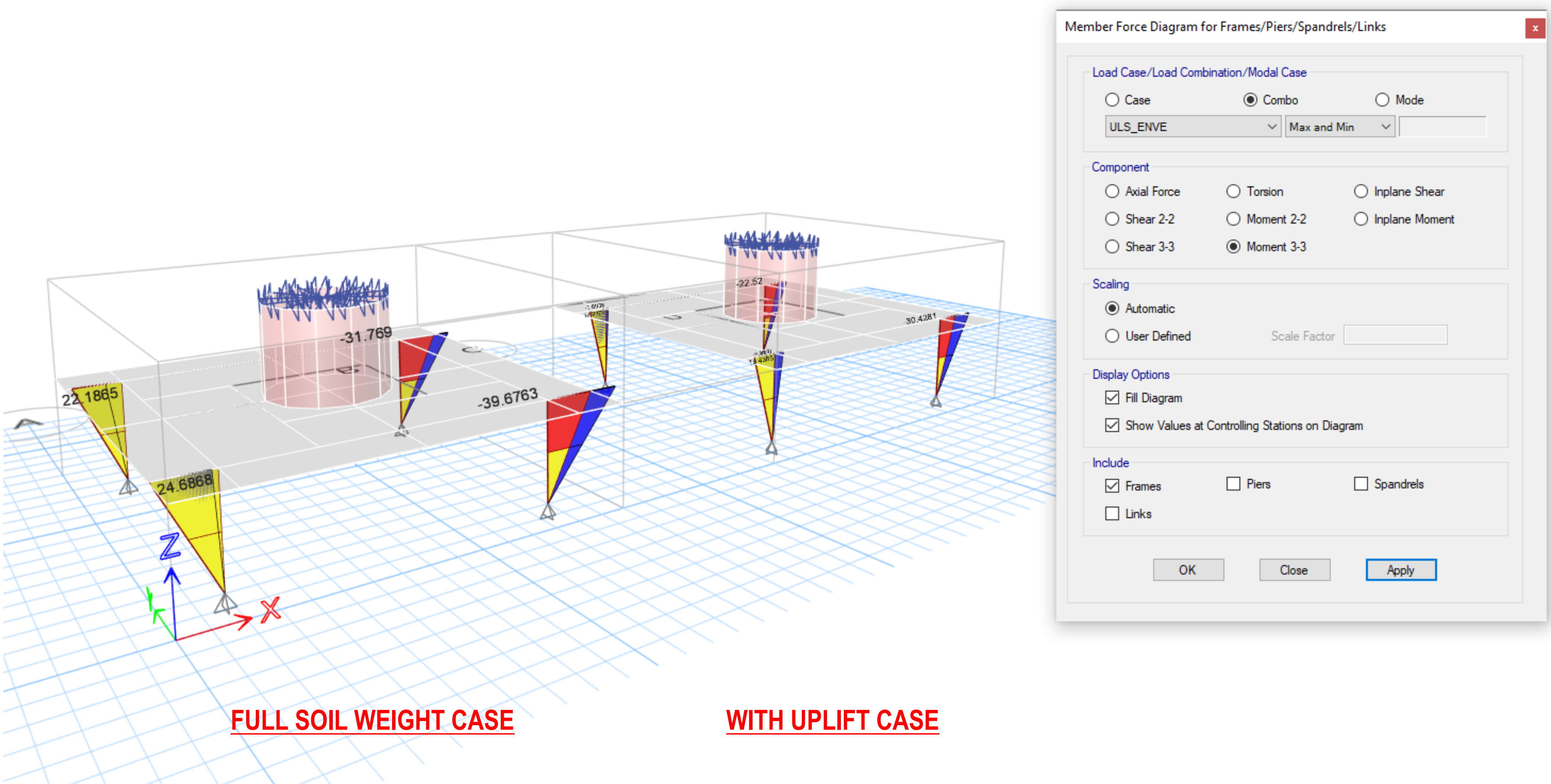




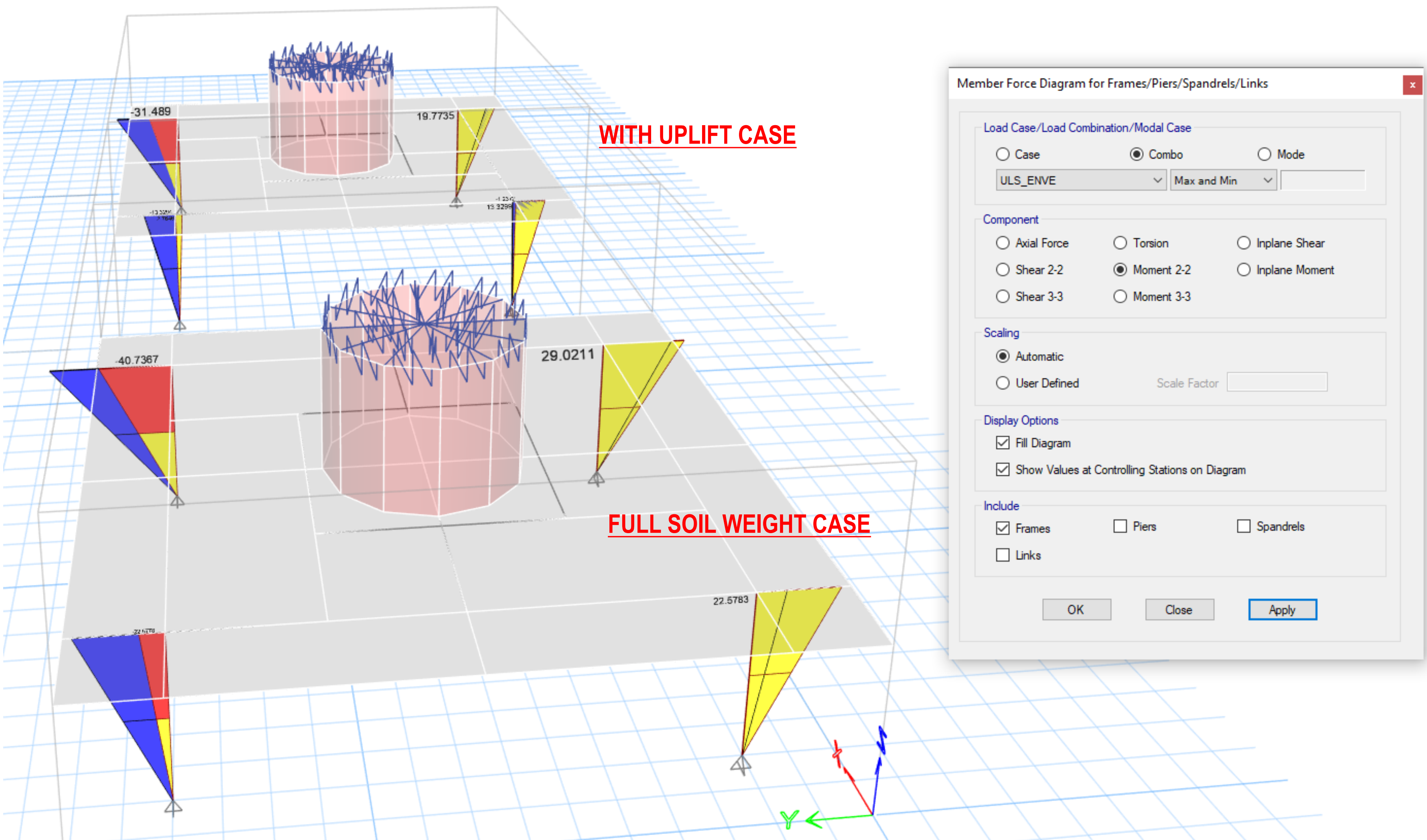
FULL SOIL WEIGHT CASE

WITH UPLIFT CASE

DESIGN BENDING MOMENT IN PILE (ULTIMATE) - X-DIRECTION



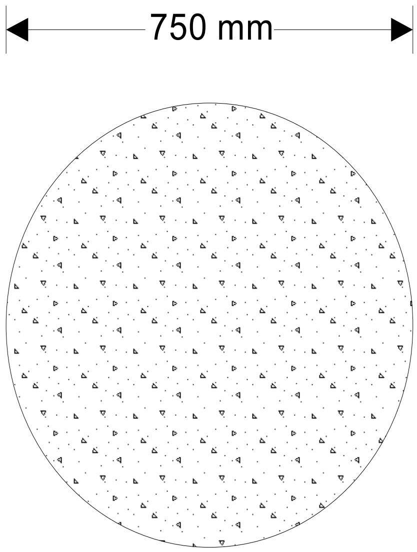
DESIGN BENDING MOMENT IN PILE (ULTIMATE) - Y-DIRECTION



PILE DESIGN

In accordance with Australian Standard: Piling-Design and installation per AS 2159-2009

Tedds calculation version 1.0.02



Pile details

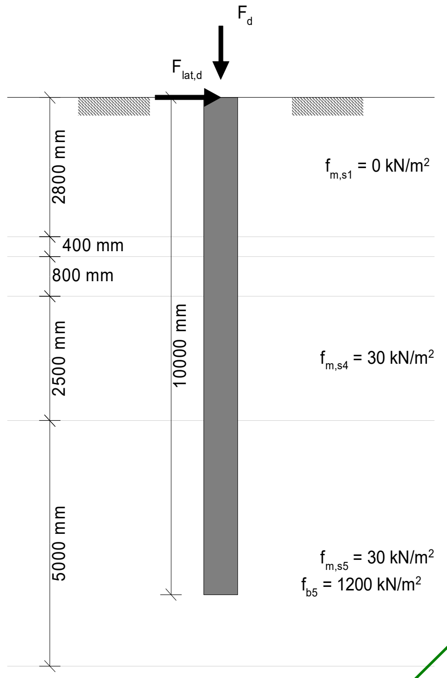
Installation method	Driven
Shape	750 mm diameter
Length	L = **10000** mm

Material details

Material	Concrete
Concrete strength	f'_c = **50** MPa
Concrete in situ strength	f_{cmi} = **53** MPa
Concrete density	ρ = **2550** kg/m^3
Modulus of elasticity	$E = (\rho / 1\ kg/m^3)^{1.5} \times (0.024 \times \sqrt{(f_{cmi} \times 1\ MPa)} + 0.12\ MPa)$ = **37951** MPa

Geometric properties

Assume top 1.5 x h ineffective (Cl. 4.4.1)	Yes
Pile section depth	h = **750** mm
Bearing area	$A_{bearing} = \pi \times h^2 / 4$ = **4418** cm^2
Pile perimeter	$Perim_{pile} = \pi \times h$ = **2356** mm
Moment of inertia	$I = \pi \times h^4 / 64$ = **1553156** cm^4
Section modulus	$S = \pi \times h^3 / 32$ = **41417** cm^3



$f_{m,si}$ = Average unit skin friction, compression, f_{bi} = Ultimate unit end bearing

Average skin friction and end bearing pressure are assumed values only since no values are indicated in the geotechnical report. Pile design should be checked by the pile contractor based on correct soil strength parameters.

Stratum details

Stratum	Geomaterial	Thickness, $t_{stratai}$ (mm)	Ultimate unit bearing, f_{bi} (kN/m²)	Average skin friction, compression, $f_{m,si}$ (kN/m²)	Average skin friction, tension, $f_{m,sti}$ (kN/m²)	Strength reduction factor, comp. $\phi_{c,g}$	Strength reduction factor, tension $\phi_{t,g}$
1	Cohesionless	2800	-	0	-	0.45	-
2	Cohesionless	400	-	30	-	0.45	-
3	Cohesive	800	-	30	-	0.45	-
4	Cohesionless	2500	-	30	-	0.45	-
5	Cohesionless	5000	1200	30	-	0.45	-

Design action details

Design action, compression $F_{c,d}$ = **290** kN

Design action, tension $F_{t,d}$ = **0** kN

Design action, lateral $F_{lat,d}$ = **30** kN

Service level design action, lateral $F_{lat,ds'}$ = **25** kN

Axial compression resistance

Design ultimate axial bearing resistance $R_b = A_b \times f_b$ = **530.1** kN

Design ultimate axial friction resistance per stratum

Stratum 1 $R_{s1} = f_{m,s1} \times Perim_{pile} \times (t_{strata1} - (1.5 \times h - D_{strata1}))$ = **0** kN

Stratum 2 $R_{s2} = f_{m,s2} \times Perim_{pile} \times t_{strata2}$ = **28.3** kN

Stratum 3 $R_{s3} = f_{m,s3} \times Perim_{pile} \times t_{strata3}$ = **56.5** kN

Stratum 4 $R_{s4} = f_{m,s4} \times Perim_{pile} \times t_{strata4}$ = **176.7** kN

Stratum 5 $R_{s5} = f_{m,s5} \times Perim_{pile} \times (L - D_{strata5})$ = **247.4** kN

Design ultimate axial friction resistance, total $R_s = R_{s1} + R_{s2} + R_{s3} + R_{s4} + R_{s5}$ = **508.9** kN

Design ultimate axial geotechnical strength, comp $R_{d,ug} = R_b + R_s$ = **1039.1** kN

Geotechnical strength reduction factor	$\phi_{c,g}$ = **0.45**
Design geotechnical strength in compression	$R_{d,g} = \phi_{c,g} \times R_{d,ug}$ = **467.6** kN
	$F_{c,d} / R_{d,g}$ = **0.62**

PASS - Design ultimate axial resistance exceeds factored axial load

Lateral analysis properties (Broms' Method, FHWA HI 97-013)

Soil type	Cohesionless soil
Pile head fixity	Free
Eccentricity of applied action	e_{actual} = **0** mm

WARNING – Lateral soil definition does not match defined general soil properties.

Cyclic loads applied	Yes
Average effective unit soil weight	γ' = **8.19** kN/m^3
Soil density	Medium
Angle of internal friction	ϕ = **30**
Critical depth of pile	Below groundwater

A 800mm clay layer is present as per the geotechnical report, but the general soil properties for this calculation is defined as cohesionless soil as the soil profile primarily consist of sand layers.

Lateral analysis

Critical depth	$D_{critical}$ = min(L,4.5 × h) = **3375** mm
Coeff of horiz. subgrade reaction(Table 9-11)	K_{hTable} = **5429** kN/m^3
Adjusted for cyclic loading	$K_h = 0.5 \times K_{hTable}$ = **2715** kN/m^3
Resisting moment of pile	$M_y = f'_c \times S$ = **2070.9** kNm
η factor	$\eta = (K_h / (E \times I))^{1/5}$ = **0.3409** m^{-1}
Length category value	$\eta L = \eta \times L$ = **3.41**
Pile length category	2.0 < ηL < 4.0 Intermediate pile
Rankine passive pressure coeff.	$K_p = (\tan(45 \text{ deg} + \phi / 2))^2$ = **3**
Find ultimate lateral load from Graph 9.29:	
Graph x axis value	GX = L / h = **13.33**
Plot line value	e_{actual} / L = **0**
Graph y axis value	GY= **88.33**
Ultimate lateral action	$R_{d,ug,lat} = 88.33 \times K_p \times h^3 \times \gamma'$ = **915.6** kN
Find ultimate lateral load from Graph 9.30:	
Graph x axis value	$GX = M_y / (h^4 \times \gamma' \times K_p)$ = **266.38**
Plot line value	e_{actual} / h = **0**
Graph y axis value	GY= **63.8**
Ultimate lateral action	$R_{d,ug,lat} = 63.8 \times K_p \times h^3 \times \gamma'$ = **661.3** kN
Min. ultimate lateral action	$R_{d,ug,lat}$ = **661.3** kN
Lateral geotechnical strength reduction factor	$\phi_{lat,g}$ = **0.45**
Ultimate lateral action capacity	$R_{d,g,lat} = \phi_{lat,g} \times R_{d,ug,lat}$ = **297.6** kN
	$F_{lat,d} / R_{d,g,lat}$ = **0.101**

PASS - Ultimate lateral action capacity exceeds factored lateral action

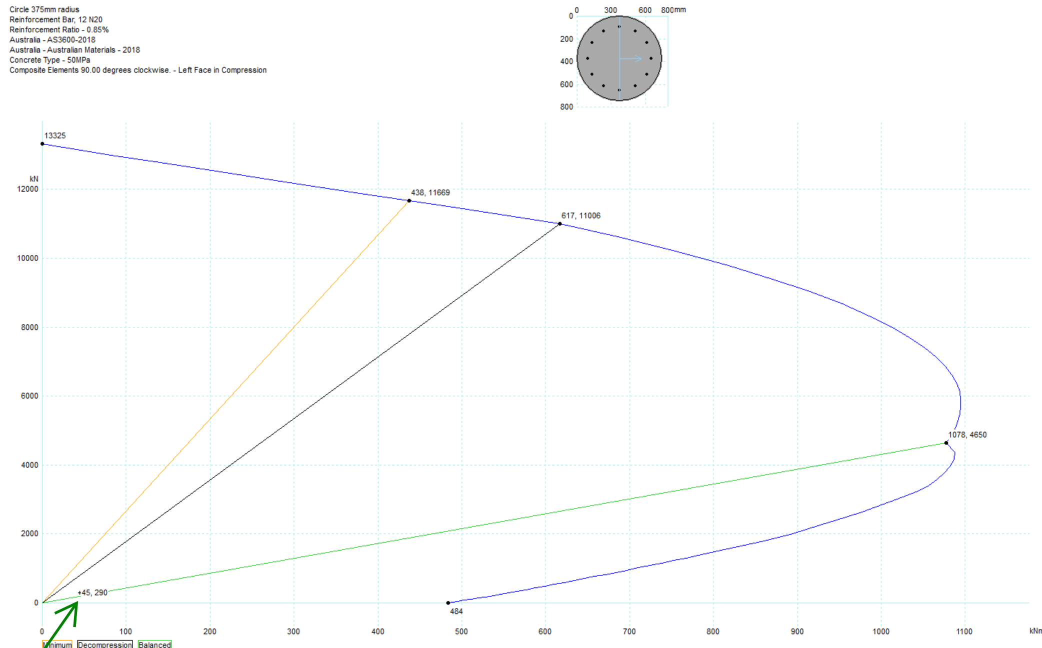
Find lateral deflection from Graph 9.33:	
Graph x axis value	$GX = \eta \times L$ = **3.41**
Plot line value	e_{actual} / L = **0**
Graph y axis value	GY = **0.78**
Lateral deflection	$\Delta_{LAT} = 0.78 \times F_{lat,ds'} \times L / ((E \times I)^{3/5} \times K_h^{2/5})$ = **2.8** mm

Allowable lateral deflection $\Delta_{LatAllow}$ = **25** mm

Δ_{LAT} / $\Delta_{LatAllow}$ = **0.114**

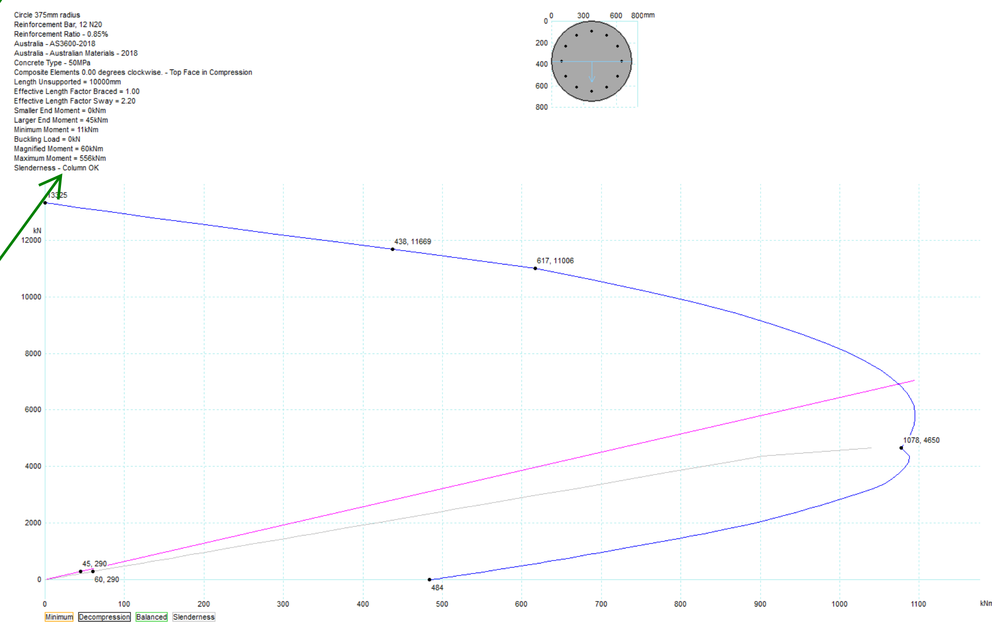
PASS - Allowable lateral deflection exceeds lateral deflection

RAPT CHECKS FOR PILE DESIGN FORCES



Based on the maximum pile reactions and forces from ETABS pile group analysis, refer to pages 97-102.

The design forces fall inside the interaction diagram, therefore OK.

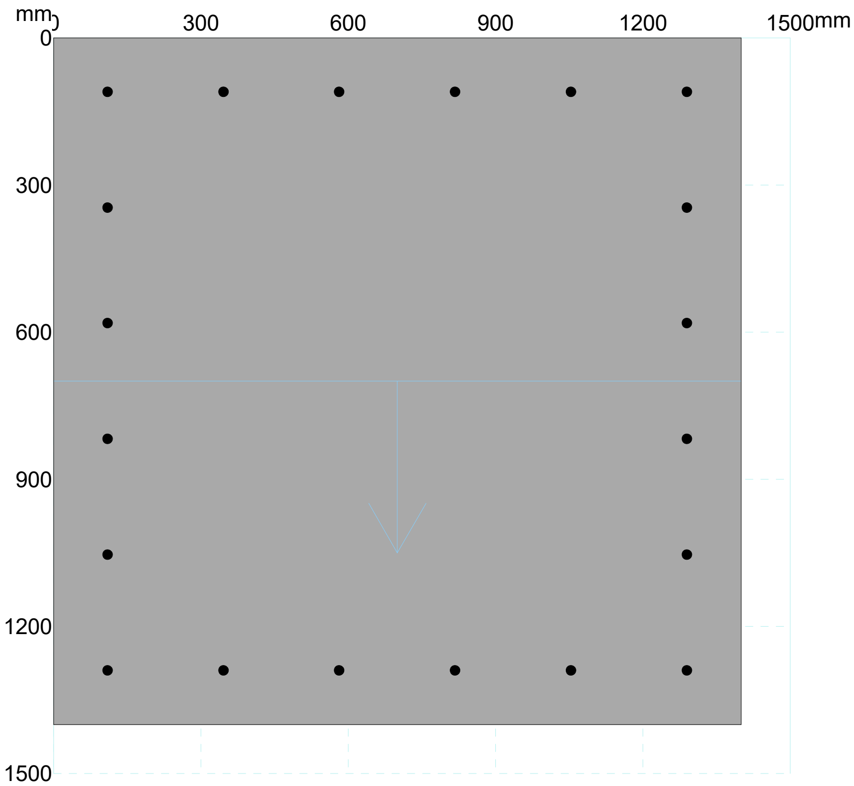


Slenderness is OK.

H.1 PEDESTAL CHECK

RAPT - Version: 6.6.4.0
Reinforced And Post-Tensioned Concrete Analysis & Design Package

Licensee
Hyder Consulting Middle East
9th Floor Tower 2 The Enterprise Centre
6766 Ayala Avenue cor. Paseo de Rozas
1200 Makati City
10631063161113WPN8



Input

General

Designer	A	
Project Name	A	
Project Number	A	
Description	A	
Design Code	List	Australia - AS3600-2018*SAVED*
Material	List	Australia - Australian Materials - 2018*SAVED*
Concrete Type	List	Standard Concrete
Concrete Strength	List	50MPa
Tension Curve	Y/N	N

Rectangle

	Solid/Void	X	Y	Width	Depth
#	List	mm	mm	mm	mm
1	Solid	0	0	1400	1400

Reinforcement Bar

	Reinforcement Bar Type	Reinforcement Bar Size	Number of bundled bars	X	Y	Distance	Tendon Force
#	List	List	List	mm	mm	mm	kN
1	N, Deformed, 500MPa	20, 20mm, 314mm2	1	110	110	1000	0
2				346	110	1000	0
3				582	110	1000	0
4				818	110	1000	0
5				1054	110	1000	0
6				346	1290	1000	0
7				582	1290	1000	0

#	Reinforcement Bar Type	Reinforcement Bar Size	Number of bundled bars	X	Y	Distance	Tendon Force
	List	List	List	mm	mm	mm	kN
8				818	1290	1000	0
9				1054	1290	1000	0
10				1290	1290	1000	0
11				110	346	1000	0
12				110	582	1000	0
13				110	818	1000	0
14				110	1054	1000	0
15				110	1290	1000	0
16				1290	110	1000	0
17				1290	346	1000	0
18				1290	582	1000	0
19				1290	818	1000	0
20				1290	1054	1000	0

Design Data

Capacity Reduction Factor in Flexure - Tension	#.#	0.85
Capacity Reduction Factor in Flexure - Compression	#.#	0.65
Capacity Reduction Factor in Shear	#.#	0.7
Concrete Material Factor Flexure	#.#	1
Concrete Material Factor Shear	#.#	1
Reinforcement Material Factor	#.#	1
Maximum Depth of Neutral Axis for Ductility	#.#	0.4
Shear Enhancement near Support	Y/N	N
Time of Loading in Days	#.#	28
Concrete Strength at Time of Loading	MPa	50
Design Period in Years	#.#	50
Relative Humidity	%	50
Average Temperature	C.	20
Long Term Calculation Basis	List	Code Default
Concrete Strength Gain Rate	List	N

Rotation

	Rotation
	#.#
1	0
2	90

Design Rotations and Actions : Rotation 0

	Moment	Axial Force	Description
0	kNm	kN	A
1	94	150	M = Mx + Fy * L = 85 + 10 * 0.9 = 94

Design Rotations and Actions : Rotation 90

	Moment	Axial Force	Description
0	kNm	kN	A
1	425	150	M = My + Fx * L = 375 + 55 * 0.9 = 425

Slenderness

Length Unsupported	mm	3000
Column Framing	List	Sway
Effective Length Factor Sway	#.#	2.2
Moment Ratio for Creep	#.#	0.75
Smaller End Moment M1	kNm	0
Larger End Moment M2	kNm	425
User Defined N*/Nc	#.#	0.28
Applied Axial Load	kN	150

Material Properties

Concrete : Standard Concrete : Concrete Strength Basis - Cylinder

Description	A	50MPa
Characteristic Compressive Strength	MPa	50
Mean Compressive Strength	MPa	59.7
Lower Characteristic Tensile Strength	MPa	4.24
Upper Characteristic Tensile Strength	MPa	7.64
Concrete Density	kg/m3	2447
Design Concrete Modulus	MPa	34013.6
Mean Concrete Modulus	MPa	35820.8
Basic Shrinkage Strain	mm/mm	800
Shrinkage Multiplier	#.#	1
Basic Creep Factor	#.#	2.4
Creep Multiplier	#.#	1
Concrete Strain at Peak Stress	#.#	0.002
Squash Load Factor	#.#	0.9
Concrete Strain Limit	#.#	0.004
Strength Gain Rate	List	Normal
Maximum Aggregate Size	mm	20

Reinforcement Bar

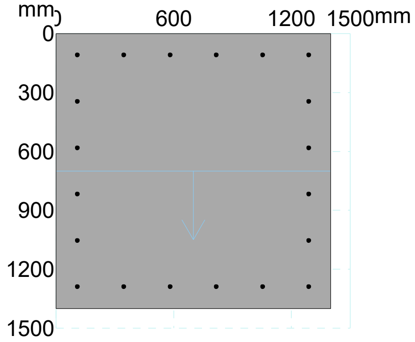
Designation	Type	Yield Stress	Elastic Modulus	Ductility	Peak Strain	Peak Stress	Design Strain Limit	Material Factor Flexure	Material Factor Shear	Material Capacity Reduction Factor - Flexure	Material Capacity Reduction Factor - Shear	Include as Flexural Reinforcement for Shear
N	Deformed	500	2e5	N	0.05	540	90	-1	-1	-1	-1	Y

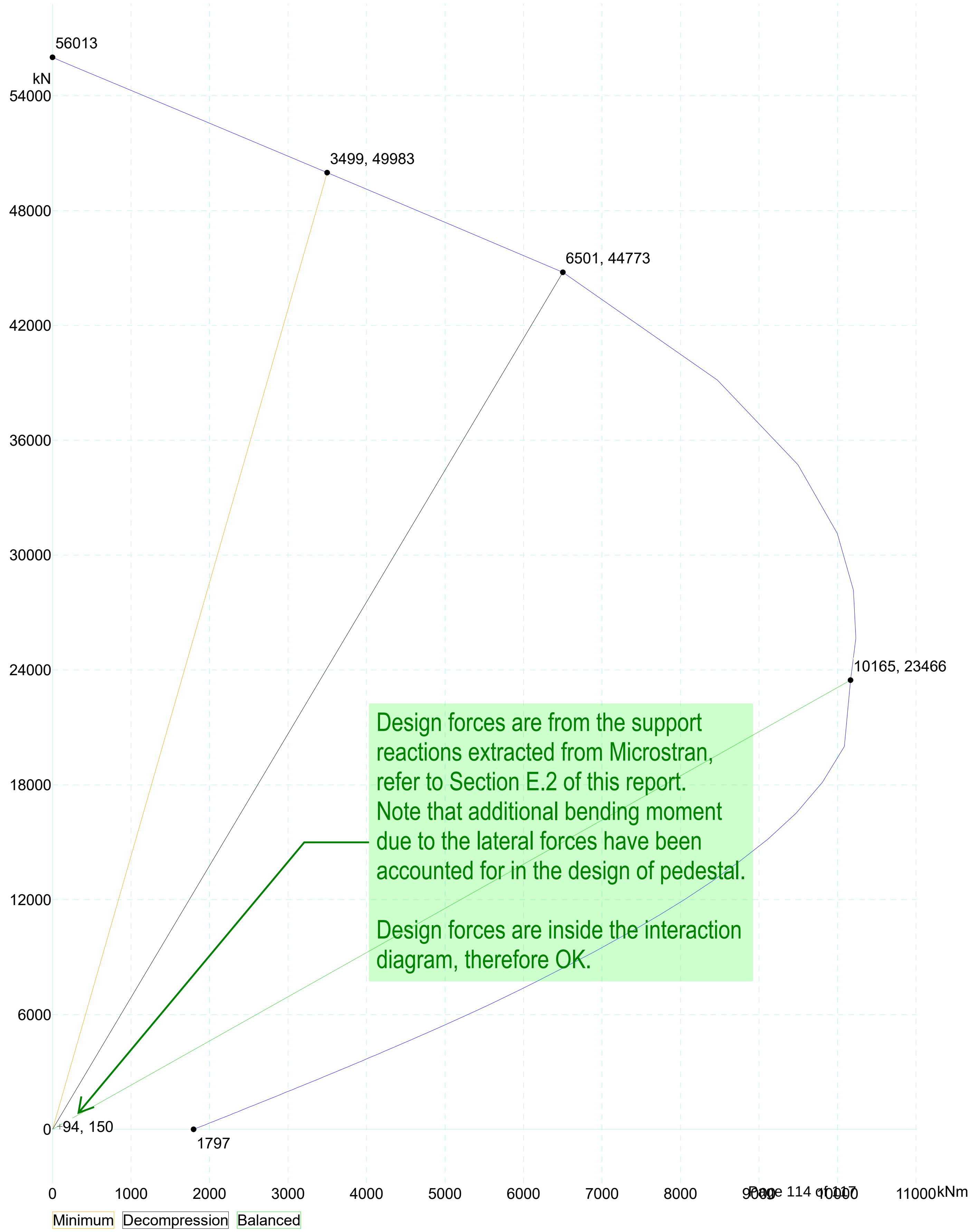
Description

Nominal Bar Size	Bar Diameter	Bar Area	Bar Inertia	Bar Weight	Stock Length
A	mm	mm2	mm4	kg/m	mm
10	10	78.5	491.07	0.62	12000
12	12	113	1018.29	0.89	12000
16	16	201	3218.29	1.58	12000
20	20	314	7857.14	2.47	12000
24	24	452	16292.6	3.55	12000
28	28	616	30184	4.83	12000
32	32	804	51492.6	6.31	12000
36	36	1020	82481.1	7.99	12000
40	40	1260	1.257e5	9.86	12000

General Interaction Diagram

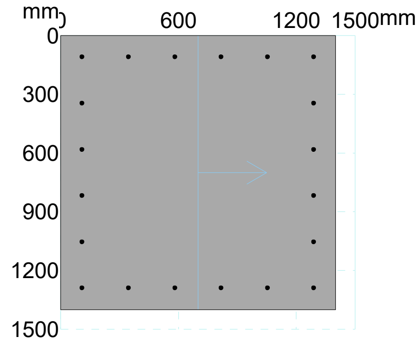
Square 1400mm
Reinforcement Bar, 20 N20
Reinforcement Ratio - 0.32%
Australia - AS3600-2018
Australia - Australian Materials - 2018
Concrete Type - 50MPa
Composite Elements 0.00 degrees clockwise. - Top Face in Compression

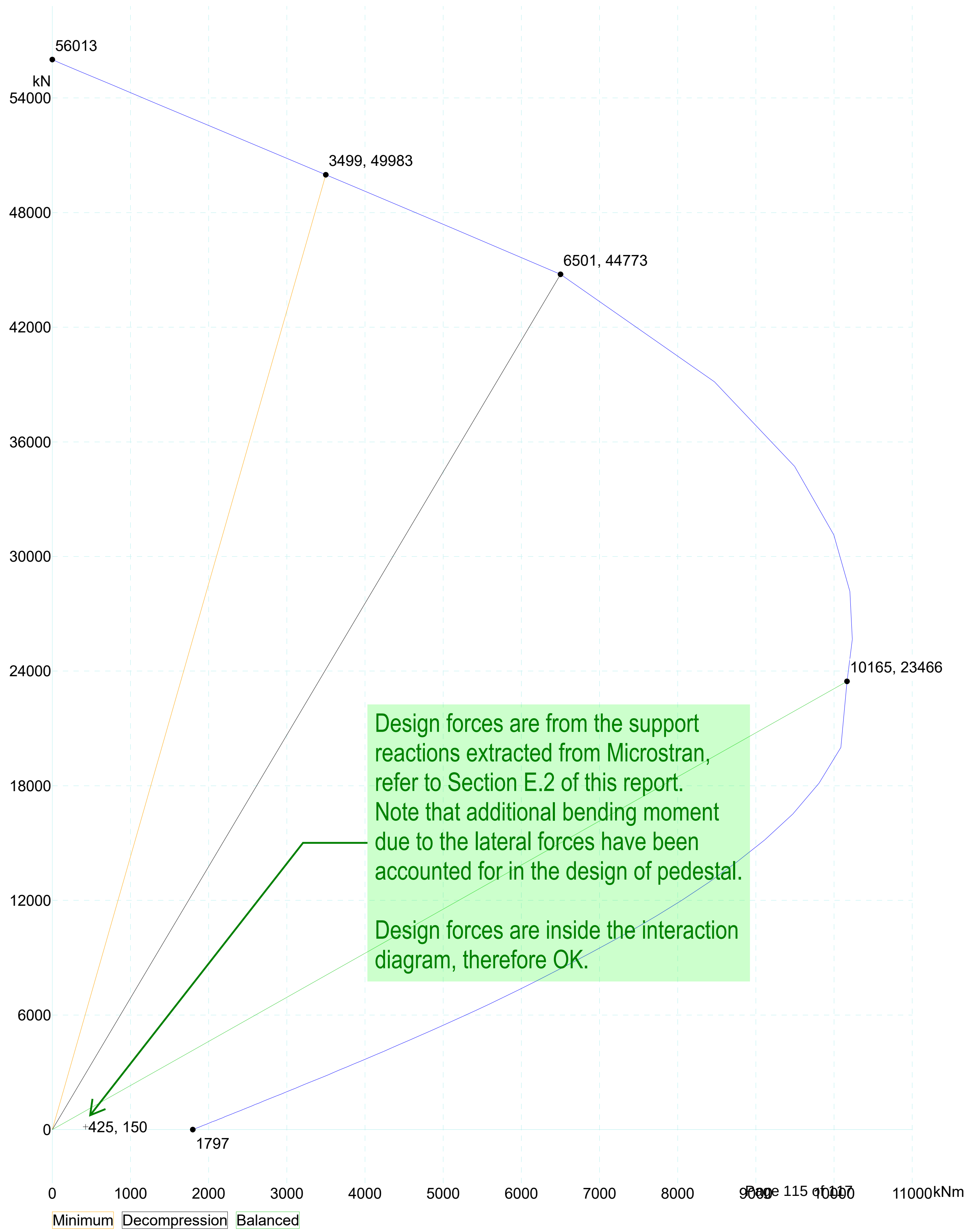




General Interaction Diagram

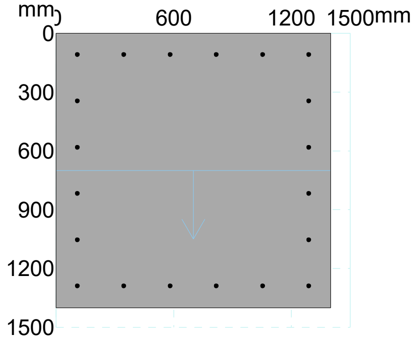
Square 1400mm
Reinforcement Bar, 20 N20
Reinforcement Ratio - 0.32%
Australia - AS3600-2018
Australia - Australian Materials - 2018
Concrete Type - 50MPa
Composite Elements 90.00 degrees clockwise. - Left Face in Compression

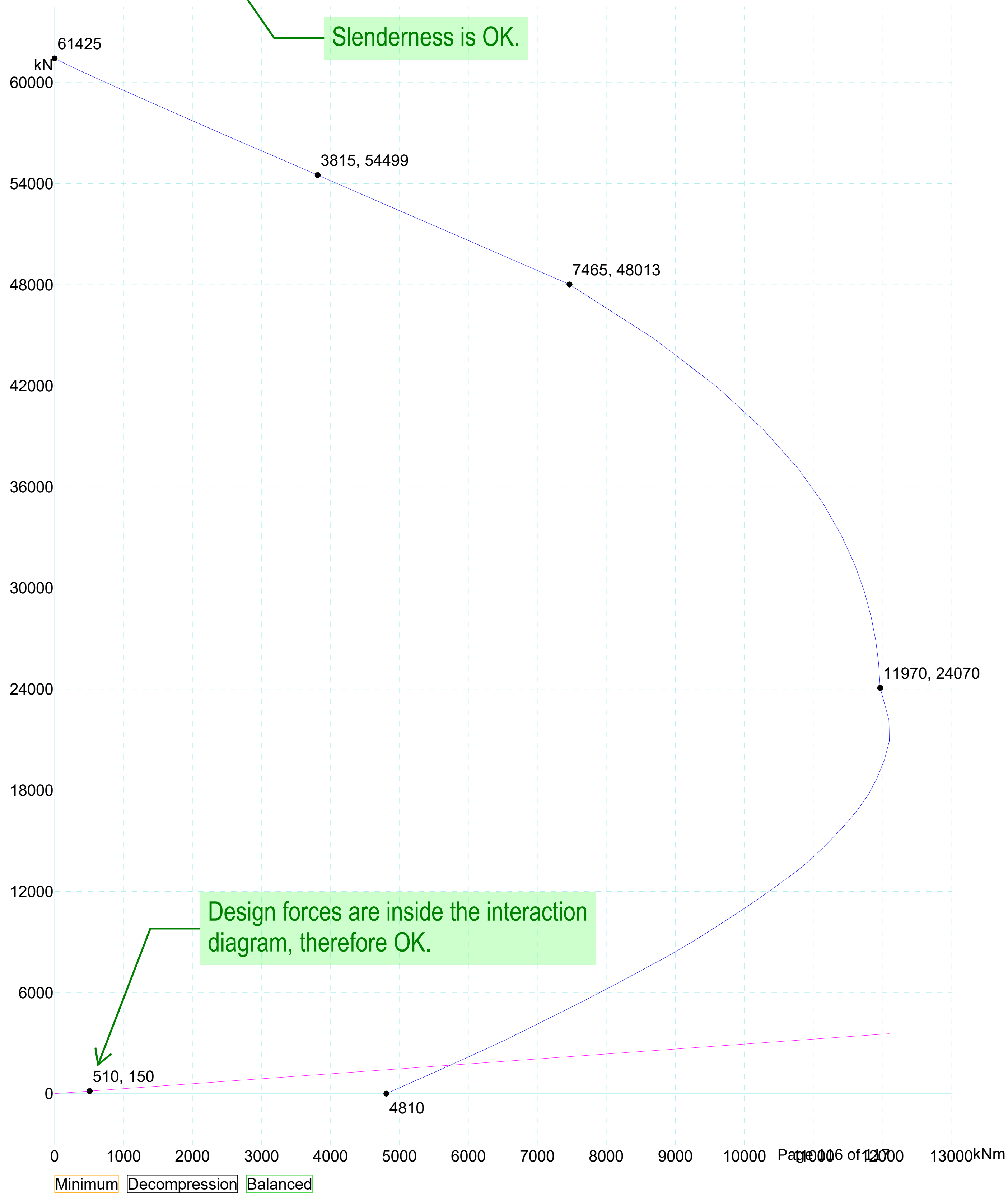




Slenderness Interaction Diagram

Square 1400mm
Reinforcement Bar, 20 N20
Reinforcement Ratio - 1.25%
Australia - AS3600-2018
Australia - Australian Materials - 2018
Concrete Type - 50MPa
Composite Elements 0.00 degrees clockwise. - Top Face in Compression
Length Unsupported = 3000mm
Effective Length Factor Braced = 1.00
Effective Length Factor Sway = 2.20
Smaller End Moment = 0kNm
Larger End Moment = 425kNm
Minimum Moment = 11kNm
Slenderness - Column is STOCKY according to Code limits. No moment magnification required.
Maximum Moment = 4892kNm





Errors and Warnings

Input

No errors or warnings were found.

Output

No errors or warnings were found.