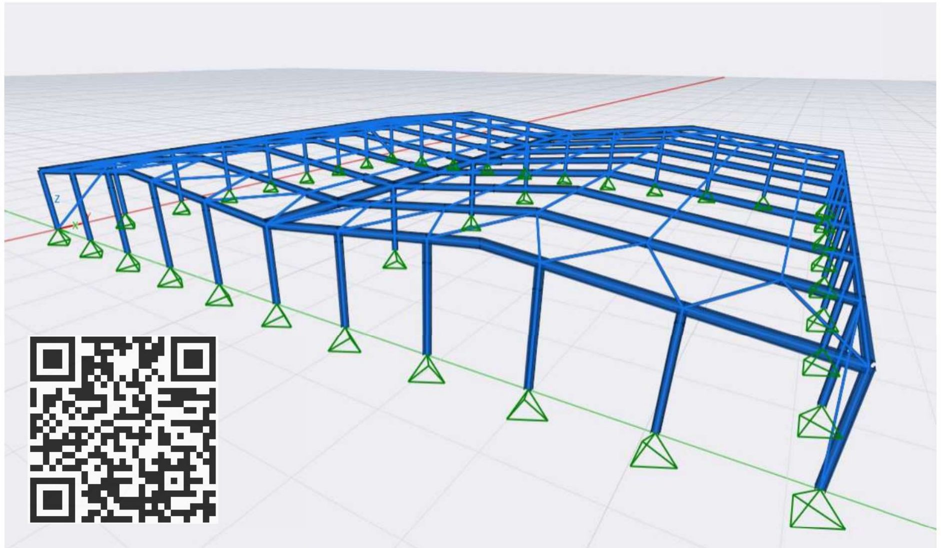
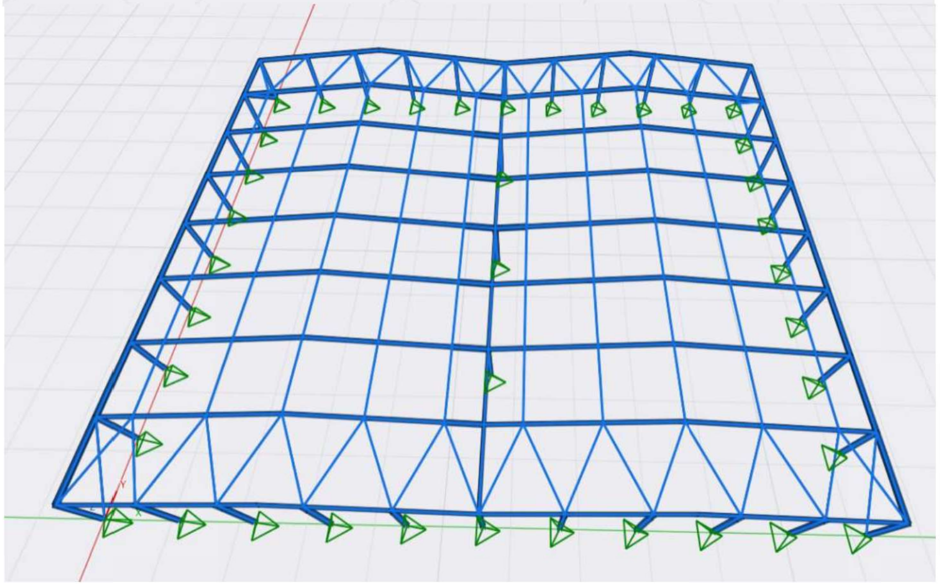
Sample Structure - to be analysed using FeaKALC 3D





INTRODUCTION

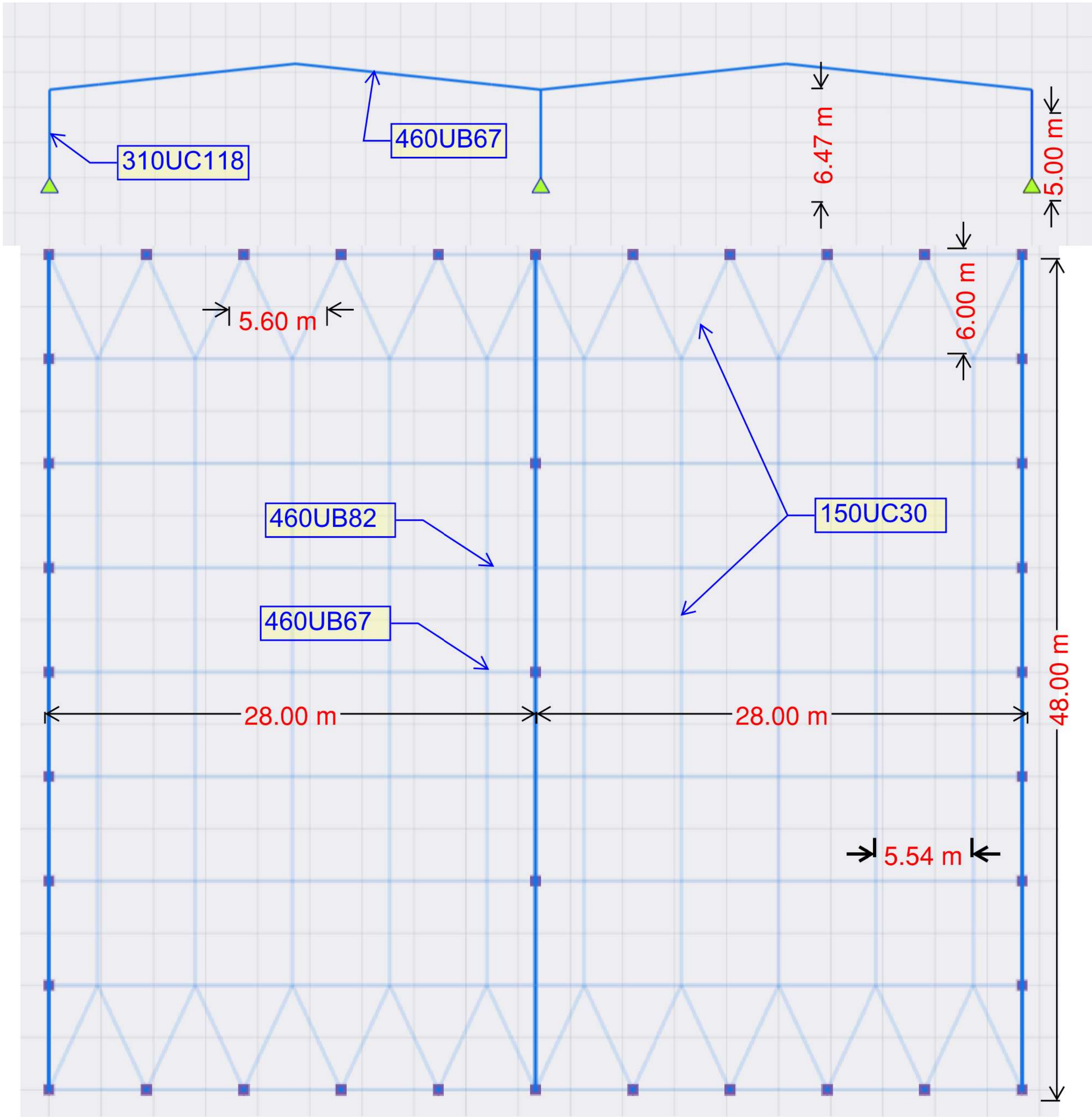
THIS TUTORIAL DEMONSTRATES THE MODELLING, LOADING, ANALYSIS AND DESIGN VERIFICATION OF A TYPICAL STEEL WAREHOUSE STRUCTURE USING FEAKALC 3D.
THE OBJECTIVE OF THE TUTORIAL IS NOT ONLY TO DEMONSTRATE THE SOFTWARE WORKFLOW, BUT ALSO TO ILLUSTRATE THE ENGINEERING CONSIDERATIONS INVOLVED IN DEVELOPING A STRUCTURAL ANALYSIS MODEL SUITABLE FOR DESIGN TO AUSTRALIAN STANDARDS.
THE EXAMPLE STRUCTURE CONSISTS OF A MULTI-SPAN STEEL PORTAL FRAME WAREHOUSE WITH COLD-FORMED STEEL PURLINS AND SIDE GIRTS SUPPORTING LIGHTWEIGHT ROOF AND WALL CLADDING. THE STRUCTURE IS SUBJECTED TO GRAVITY AND WIND ACTIONS IN ACCORDANCE WITH AS/NZS 1170.

THE TUTORIAL SERIES WILL COVER:

- DEVELOPMENT OF THE STRUCTURAL MODEL GEOMETRY
- DEFINITION OF MATERIAL AND SECTION PROPERTIES
- DETERMINATION OF GRAVITY LOADS
- DETERMINATION OF WIND LOADS IN ACCORDANCE WITH AS/NZS 1170.2
- APPLICATION OF LOAD CASES AND LOAD COMBINATIONS
- LINEAR ELASTIC ANALYSIS USING FEAKALC 3D
- INTERPRETATION OF REACTIONS, MEMBER FORCES AND DEFLECTIONS
- DESIGN VERIFICATION OF PRIMARY STEEL MEMBERS TO AS 4100

THE CALCULATIONS AND LOAD ASSUMPTIONS PRESENTED HEREIN ARE INTENDED FOR EDUCATIONAL PURPOSES AND TO DEMONSTRATE THE MODELLING PROCESS. ENGINEERS SHOULD ALWAYS EXERCISE PROFESSIONAL JUDGEMENT AND VERIFY ALL ASSUMPTIONS, LOADING CRITERIA AND DESIGN REQUIREMENTS APPLICABLE TO THEIR SPECIFIC PROJECT.
THIS TUTORIAL FORMS PART OF THE RKALC LEARNING CENTRE, WHICH PROVIDES PRACTICAL ENGINEERING EXAMPLES AND TRAINING RESOURCES FOR STRUCTURAL ENGINEERS USING THE RKALC ECOSYSTEM.

Geometry



310UC118
460UB67
6.47 m
5.00 m
5.60 m
6.00 m
460UB82
460UB67
150UC30
28.00 m
28.00 m
48.00 m
5.54 m

Gravity Loads

SEE AS1170.1

A - Dead Loads

1 - Roof Sheeting = 5 kg/m²

2 - Own Weight of Steel Beams

- UB's at 67kg/m', spaced at 6 meters

Weight = 67/6 = 11.17 kg/m² (this will be automatically included in FeaKALC)

3- Purlins

- say 150 Deep purlings at spacing = 1.2, weight of purlin = 3kg/m
- Loading becomes = 3/1.2 = 2.5kg/m²

4- Insulation

say 2 kg/m²

5- Services

say 30 kg/m²

5- False Ceiling

say 10 kg/m²

Total Dead load = 5 + 2.5 + 2 + 30 + 10 = 49.5 kg/m²

= 0.5 KN/m² (KPa) + own weight

B- Live Load

Area of roof = 48x56 = 2688m²

= 0.25 KPa (ref Table 3.2 below of AS1170.1 - 2002)

13 AS/NZS 1170.1:2002

TABLE 3.2

REFERENCE VALUES OF ROOF ACTIONS

Type of activity/occupancy for part of the building or structure	Specific uses	Uniformly distributed actions kPa	Concentrated actions kN
R1 Street awnings (including cladding)	Accessible from adjacent windows, roofs or balconies	1.5	1.8
	Accessible only from ground level	1.0	1.8
A2 **R2 Other roofs**	(i) Structural elements	$(1.8/A + 0.12)$ but not less than 0.25 (see Notes 1, 2 and 3)	1.4 (see Note 3)
	(ii) Cladding providing direct support	As for structural elements	1.1
	(iii) Surfaces over which boards or ladders are required to be laid	—	0.5

NOTES:

1 Structural elements supporting more than 200 m² of roof area shall be designed to support 0.25 kPa on the 200 m² of the supported area that gives the worst effect.

2 A = the plan projection of the surface area of roof supported by the member under analysis, in square metres.

A2 3 For structural elements in roofs of houses, the uniform distributed actions shall be 0.25 kPa and the concentrated actions shall be 1.1 kN.

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RKALC STRUCTURAL ENGINEERING

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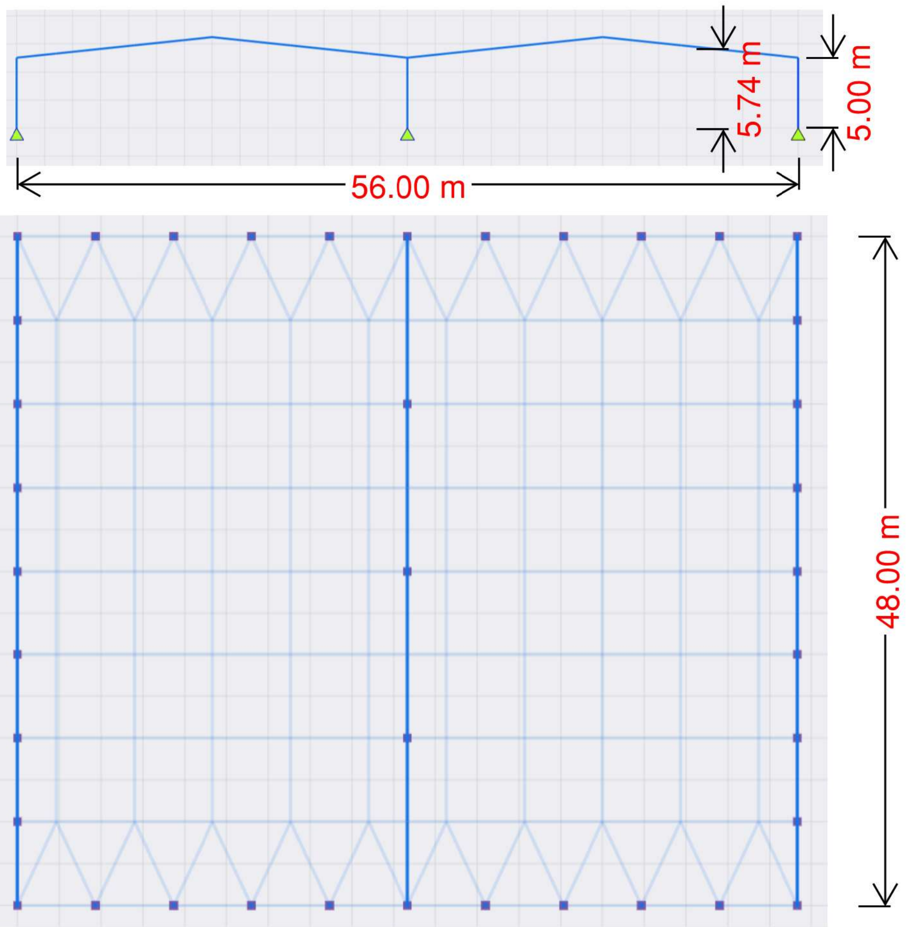
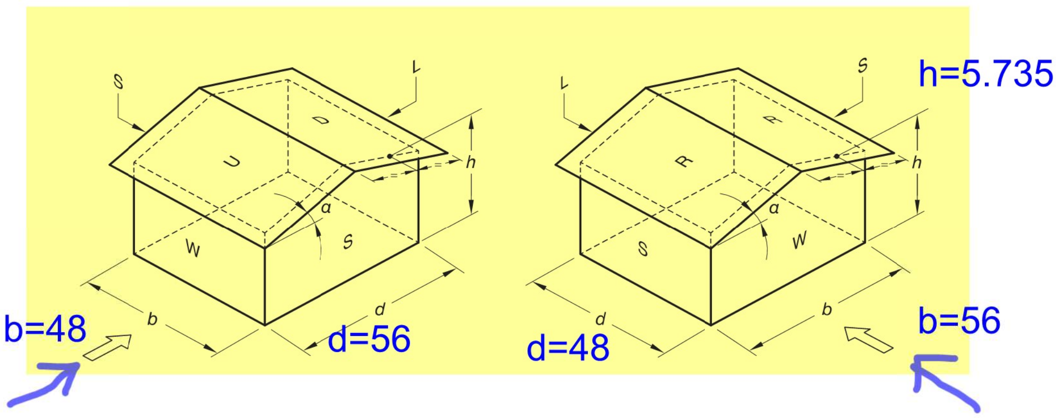
Wind Loads

Basic Wind Pressure = 0.6 x 45² x Cfig = 1.215*Cfig

SEE AS1170.2





Cross Wind Case

alfa = 6 degrees
h/d = 5.735/ 56 = 0.1 < 0.5
d/b = 56 / 48 = 1.16>~~ 1

Along Wind Case

alfa = 6 degrees
h/d = 5.735/ 48 = 0.12 < 0.5
d/b = 48/56 = 0.857

Wind Loads

Reference tables

Table 5.2(A) — Walls — External pressure coefficients ($C_{p,e}$) for rectangular enclosed buildings — Windward wall (W)

h	External pressure coefficients ($C_{p,e}$)
> 25.0 m	0.8 (wind speed varies with height)
≤ 25.0 m	For buildings on ground— 0.8, when wind speed varies with height; or 0.7, when wind speed is taken for $z = h$
	For elevated buildings— 0.8 (wind speed taken at h)

Table 5.2(B) — Walls — External pressure coefficients ($C_{p,e}$) for rectangular enclosed buildings — Leeward wall (L)

Wind direction θ degrees (see Figure 2.2)	Roof shape	Roof pitch (α), degrees	d/b	External pressure coefficients ($C_{p,e}$)
0	Hip or gable	< 10	≤ 1	−0.5
			2	−0.3
			≥ 4	−0.2
0	Hip or gable	10	All values	−0.3
0	Hip or gable	15		−0.3
0	Hip or gable	20		−0.4
0	Hip or gable	≥ 25	≤ 0.1	−0.75
			≥ 0.3	−0.5
90	Gable (see Note 3)	All values	≤ 1	−0.5
			2	−0.3
			≥ 4	−0.2

NOTE 1 For intermediate values of d/b and α, linear interpolation should be used.

NOTE 2 The design wind speed to be used with these pressure coefficients should be taken at the average roof height ($z = h$).

NOTE 3 For hip roofs use the same values as for $\theta = 0°$.

Table 5.2(C) — Walls — External pressure coefficients ($C_{p,e}$) for rectangular enclosed buildings — Side walls (S)

Horizontal distance from windward edge	External pressure coefficients ($C_{p,e}$)
0 to 1h	−0.65
1h to 2h	−0.5
2h to 3h	−0.3
> 3h	−0.2

NOTE The design wind speed to be used with these pressure coefficients should be taken at the average roof height ($z = h$).

A1 Table 5.3(A) — Roofs — External pressure coefficients ($C_{p,e}$) for rectangular enclosed buildings — For upwind slope (U), and downwind slope (D) and (R) for gable roofs with α < 10°, and monoslope roofs

Roof type and slope		Horizontal distance from windward edge of roof	External pressure coefficient ($C_{p,e}$)	
Crosswind slopes for gable roofs, and downwind slopes of monoslope roofs (R)	Upwind slope (U), downwind slope (D)		h/d ≤ 0.5	h/d ≥ 1.0
All α	α < 10°	0 to 0.5h	−0.9, −0.4	−1.3, −0.6
		0.5 to 1h	−0.9, −0.4	−0.7, −0.3
		1h to 2h	−0.5, 0	(−0.7), (−0.3) See NOTE
		2h to 3h	−0.3, 0.1	
		> 3h	−0.2, 0.2	

NOTE The values given in parentheses are provided for interpolation purposes. A1

A1 Table 5.1(B) — Internal pressure coefficients ($C_{p,i}$) for buildings with openings greater than 0.5 % of the area of the corresponding wall or roof

Ratio of area of openings on one surface to the total open area (including permeability) of other wall and roof surfaces	Largest opening on windward wall	Largest opening on leeward wall	Largest opening on side wall	Largest opening on roof
0.5 or less	−0.3, 0.0	−0.3, 0.0	−0.3, 0.0	−0.3, 0.0
1	−0.1, 0.2	−0.3, 0.0	−0.3, 0.0	−0.3, 0.0
2	0.7 $K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$
3	0.85 $K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$
6 or more	$K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$

NOTE 1 $C_{p,e}$ is the relevant external pressure coefficient at the location of the largest opening. For example, in Column 2, $C_{p,e}$ means the windward wall pressure coefficient obtained from Table 5.2(A); in Column 3, $C_{p,e}$ means the leeward wall pressure coefficient obtained from Table 5.2(B), in Column 5, $C_{p,e}$ means the roof pressure coefficient for that part of the roof containing the opening.

NOTE 2 K_a is the area reduction factor related to the total area of the opening(s), A, on the surface under consideration treating the "tributary area" as the area of the opening. See Clause 5.4.2.

NOTE 3 K_ℓ is the local pressure factor, based on the area and location of the opening on the surface under consideration, treating the "Area, A" as the area of the opening. See Clause 5.4.4. A1

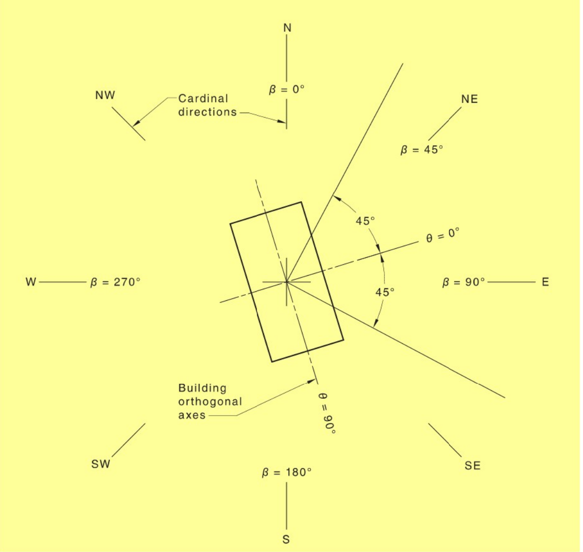


TABLE C1

EXTERNAL PRESSURE COEFFICIENTS ($C_{p,e}$) FOR MULTI-SPAN BUILDINGS—PITCHED ROOFS

Surface reference (see Figure C1)				
A	B	C	M	Y
0.7	Use Table 5.3(a), 5.3(b) or 5.3(c) for same (h/d_s) and α, as appropriate		−0.3 and 0.2 for α <10° −0.5 and 0.3 for α ≥10°	−0.2

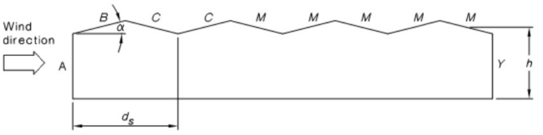
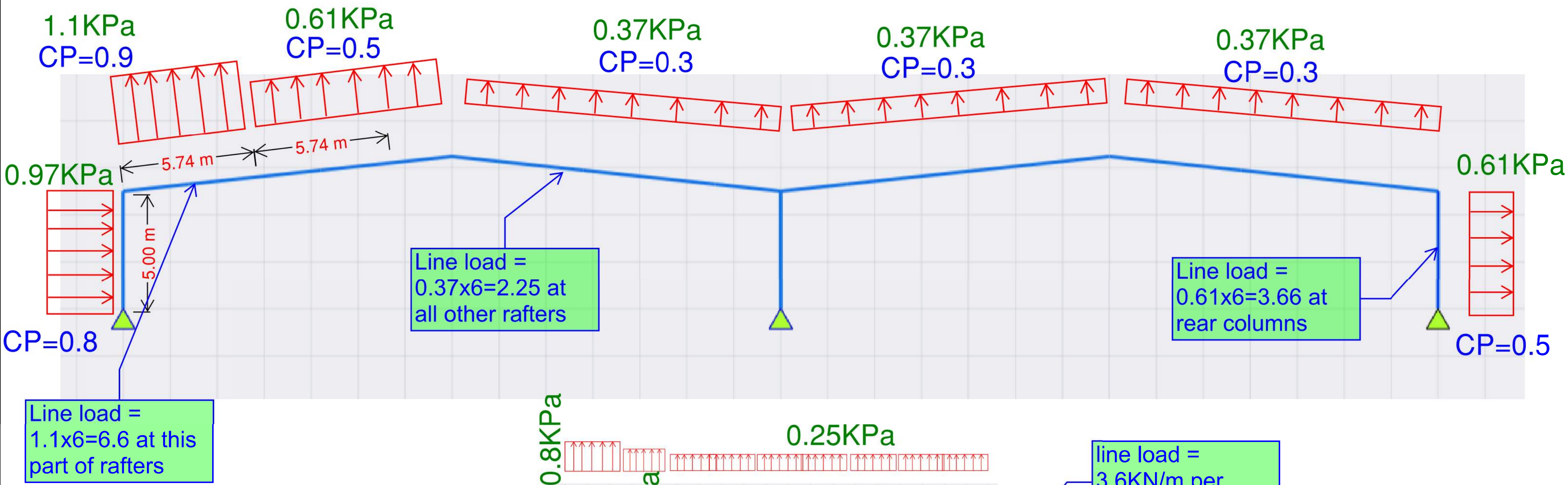


FIGURE C1 EXTERNAL PRESSURE COEFFICIENTS ($C_{p,e}$) FOR MULTI-SPAN BUILDINGS—PITCHED ROOFS

RKALC LEARNING CENTRE	FeaKALC 3D Tutorial # 1	By	RK
	Warehouse to AS4100	Sheet No. 6	Date 6/26

Wind Loads - CASE 1



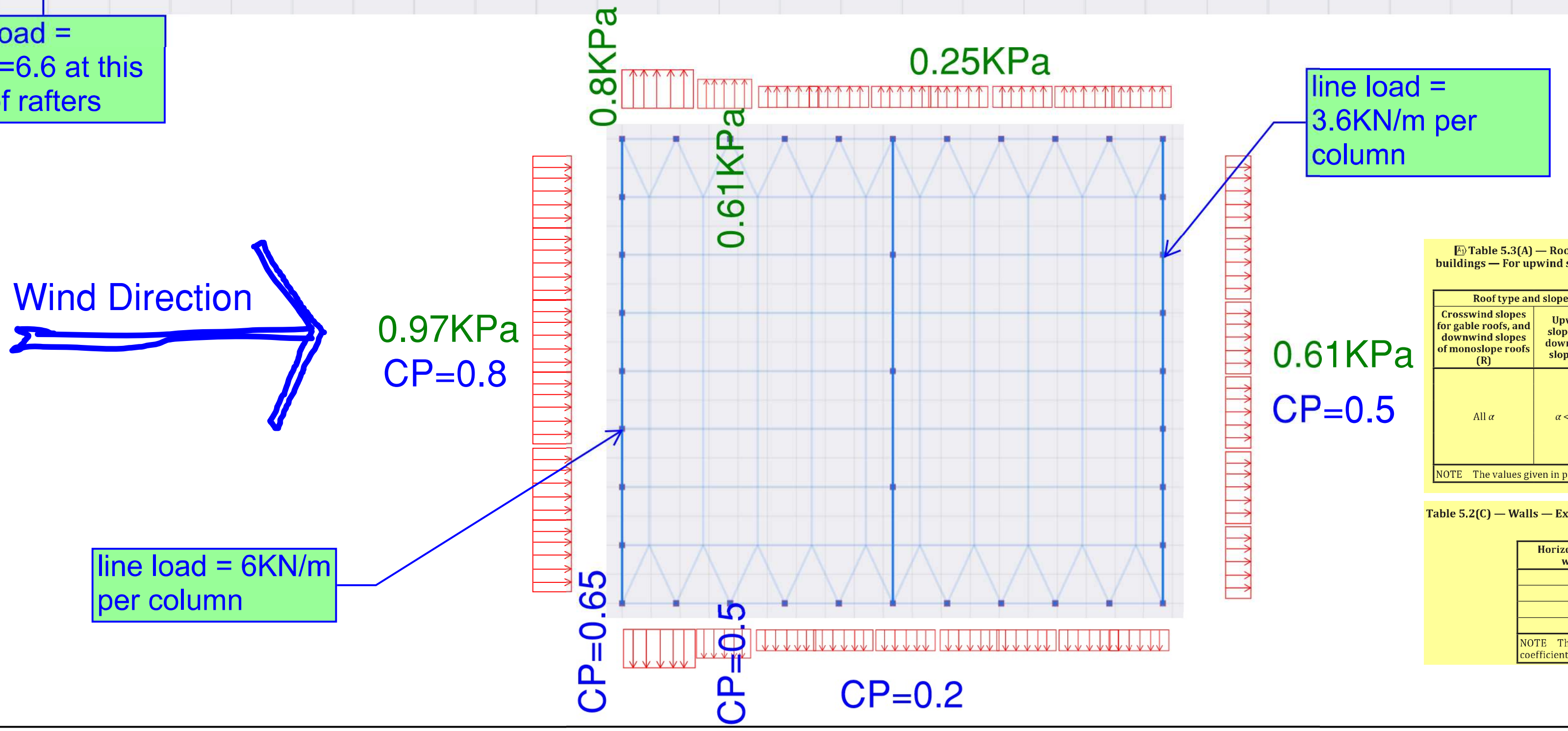


Table 5.3(A) — Roofs — External pressure coefficients ($C_{p,e}$) for rectangular enclosed buildings — For upwind slope (U), and downwind slope (D) and (R) for gable roofs with α < 10°, and monoslope roofs

Roof type and slope		Horizontal distance from windward edge of roof	External pressure coefficient ($C_{p,e}$)	
Crosswind slopes for gable roofs, and downwind slopes of monoslope roofs (R)	Upwind slope (U), downwind slope (D)		$h/d \leq 0.5$	$h/d \geq 1.0$
All α	$\alpha < 10°$	0 to 0.5h	−0.9, −0.4	−1.3, −0.6
		0.5 to 1h	−0.9, −0.4	−0.7, −0.3
		1h to 2h	−0.5, 0	(−0.7), (−0.3) See NOTE
		2h to 3h	−0.3, 0.1	
		> 3h	−0.2, 0.2	

NOTE The values given in parentheses are provided for interpolation purposes.

Table 5.2(C) — Walls — External pressure coefficients ($C_{p,e}$) for rectangular enclosed buildings — Side walls (S)

Horizontal distance from windward edge	External pressure coefficients ($C_{p,e}$)
0 to 1h	−0.65
1h to 2h	−0.5
2h to 3h	−0.3
> 3h	−0.2

NOTE The design wind speed to be used with these pressure coefficients should be taken at the average roof height ($z = h$).

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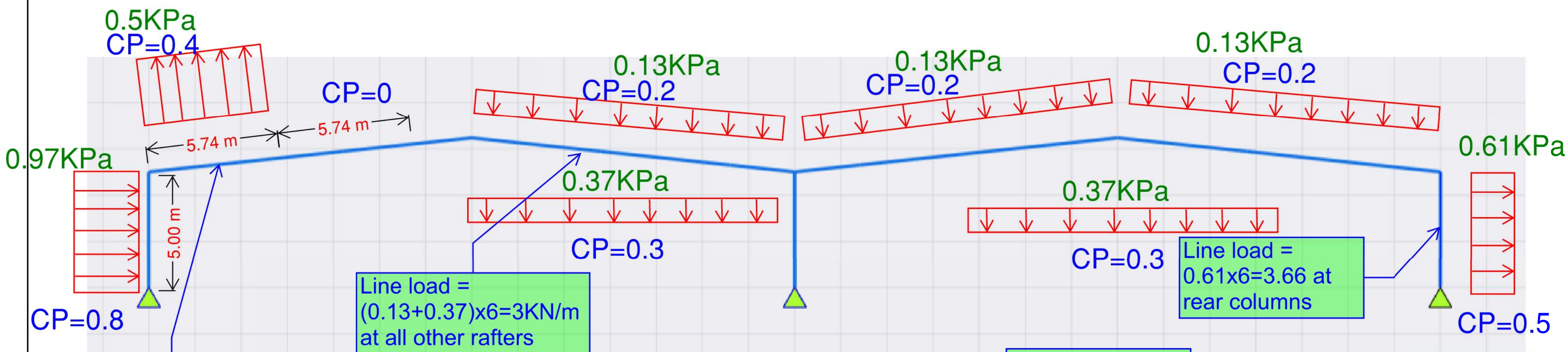
Wind Loads - CASE 2



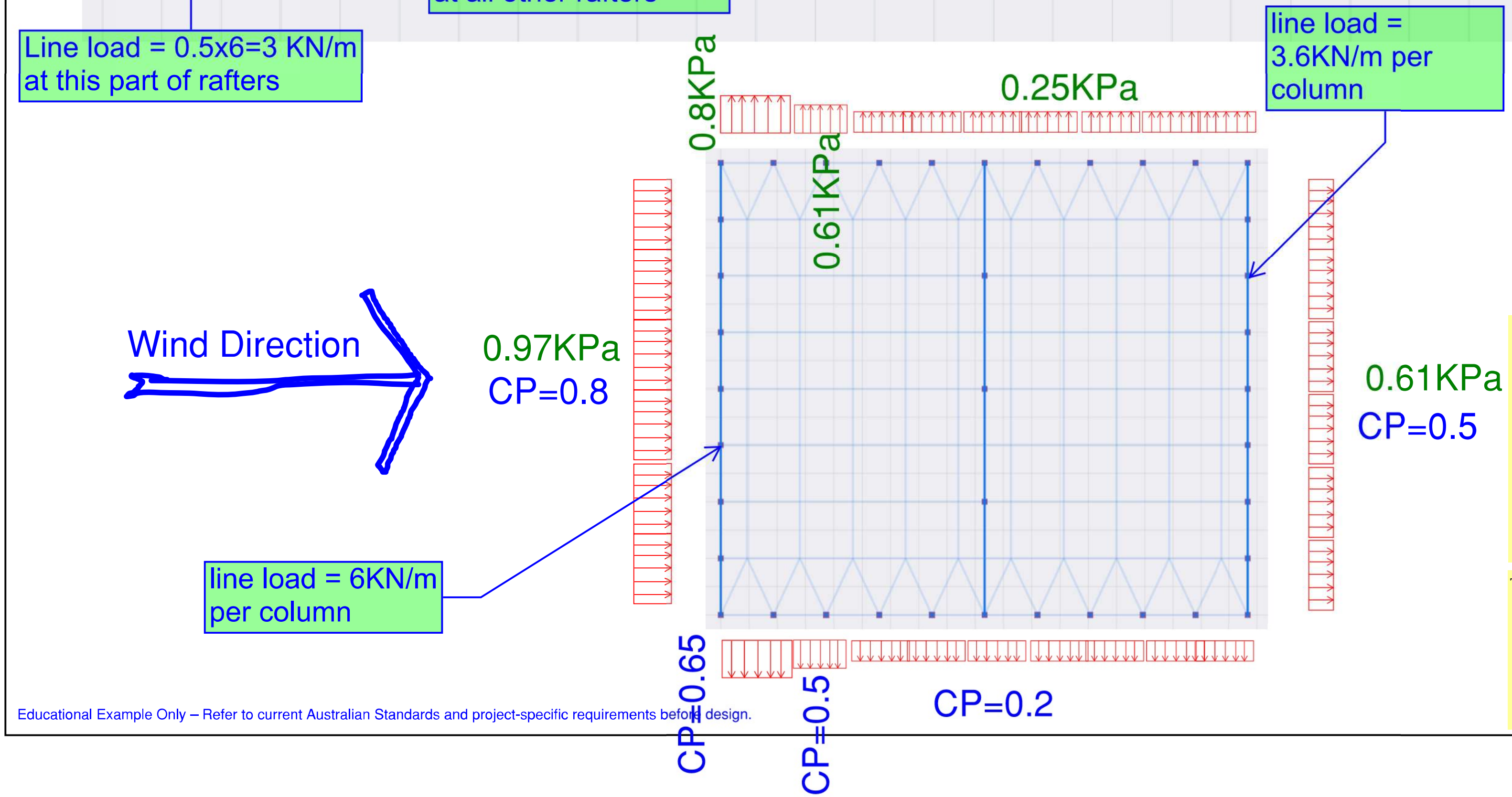


Table 5.1(B) — Internal pressure coefficients ($C_{p,i}$) for buildings with openings greater than 0.5 % of the area of the corresponding wall or roof

Ratio of area of openings on one surface to the sum of the total open area (including permeability) of other wall and roof surfaces	Largest opening on windward wall	Largest opening on leeward wall	Largest opening on side wall	Largest opening on roof
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1	−0.1, 0.2	−0.3, 0.0	−0.3, 0.0	−0.3, 0.0
2	0.7 $K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$
3	0.85 $K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$
6 or more	$K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$	$K_a K_\ell C_{p,e}$

NOTE 1 $C_{p,e}$ is the relevant external pressure coefficient at the location of the largest opening. For example, in Column 2, $C_{p,e}$ means the windward wall pressure coefficient obtained from Table 5.2(A); in Column 3, $C_{p,e}$ means the leeward wall pressure coefficient obtained from Table 5.2(B), in Column 5, $C_{p,e}$ means the roof pressure coefficient for that part of the roof containing the opening.

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Table 5.3(A) — Roofs — External pressure coefficients ($C_{p,e}$) for rectangular enclosed buildings — For upwind slope (U), and downwind slope (D) and (R) for gable roofs with $\alpha < 10°$, and monoslope roofs

Roof type and slope			External pressure coefficient ($C_{p,e}$)	
Crosswind slopes for gable roofs, and downwind slopes of monoslope roofs (R)	Upwind slope (U), downwind slope (D)	Horizontal distance from windward edge of roof	$h/d \leq 0.5$	$h/d \geq 1.0$
All α	$\alpha < 10°$	0 to 0.5h	−0.9, −0.4	−1.3, −0.6
		0.5 to 1h	−0.9, −0.4	−0.7, −0.3
		1h to 2h	−0.5, 0	(−0.7), (−0.3) See NOTE
		2h to 3h	−0.3, 0.1	
		> 3h	−0.2, 0.2	

NOTE The values given in parentheses are provided for interpolation purposes.

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Horizontal distance from windward edge	External pressure coefficients ($C_{p,e}$)
0 to 1h	−0.65
1h to 2h	−0.5
2h to 3h	−0.3
> 3h	−0.2

NOTE The design wind speed to be used with these pressure coefficients should be taken at the average roof height ($z = h$).

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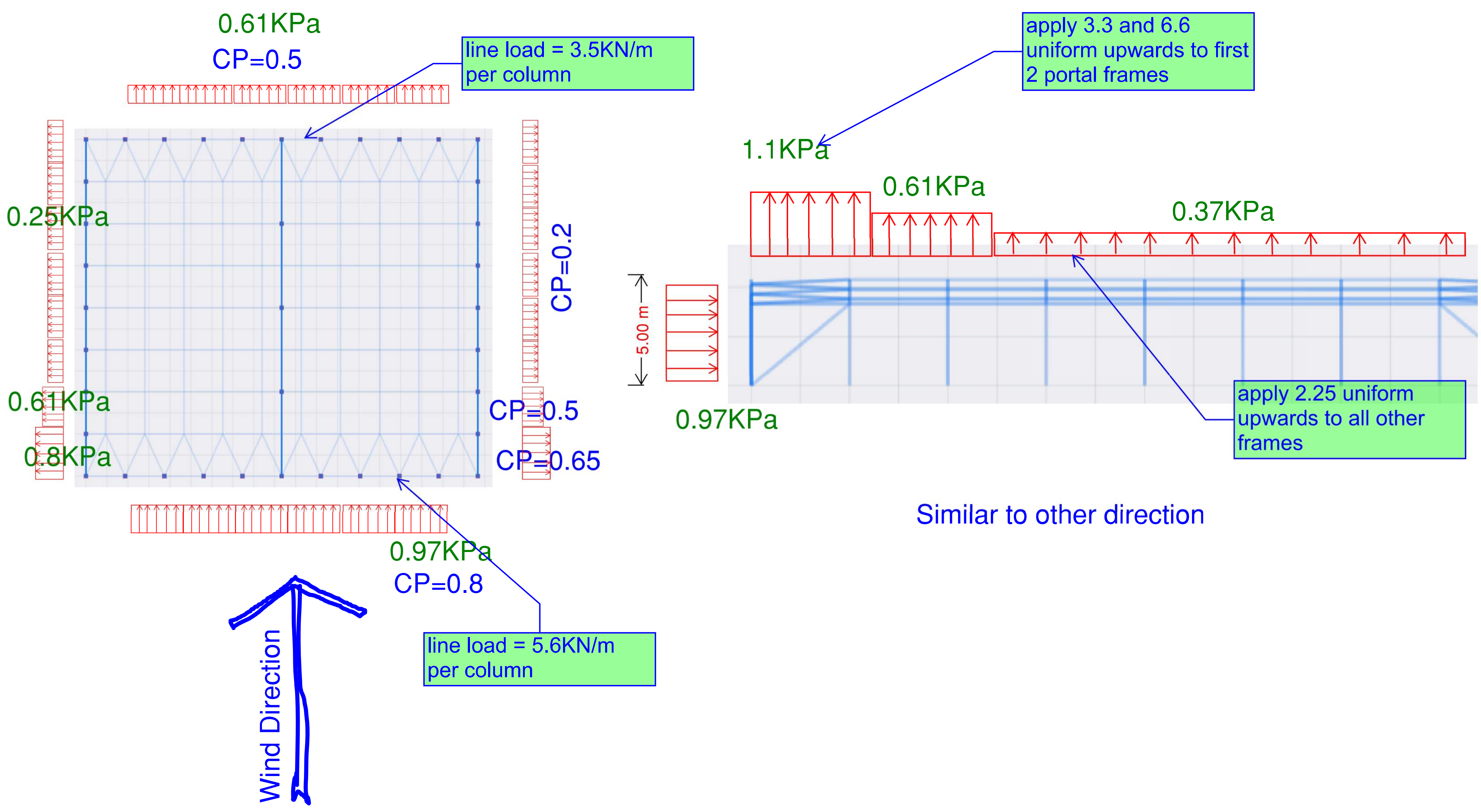
Wind Loads - CASE 3



Educational Example Only – Refer to current Australian Standards and project-specific requirements before design.

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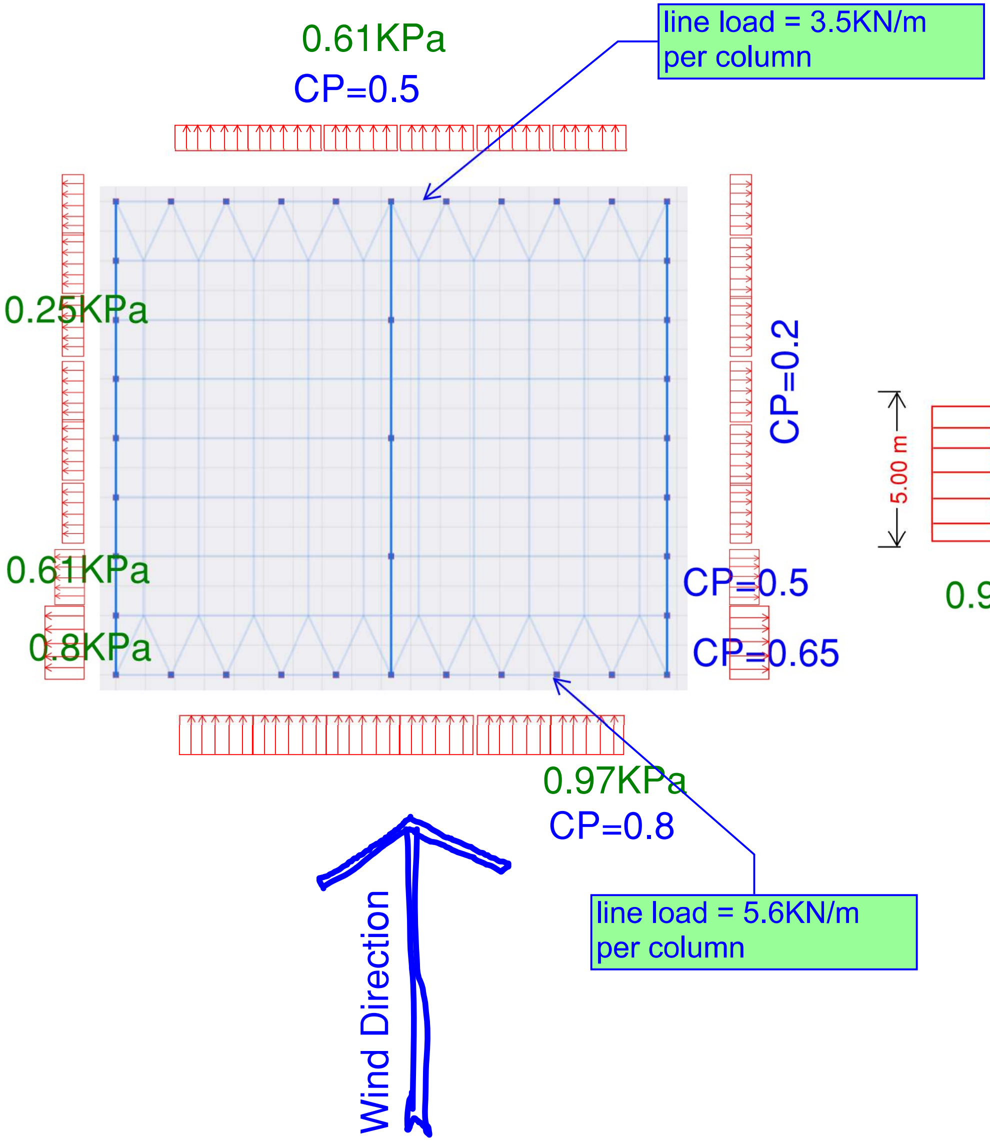
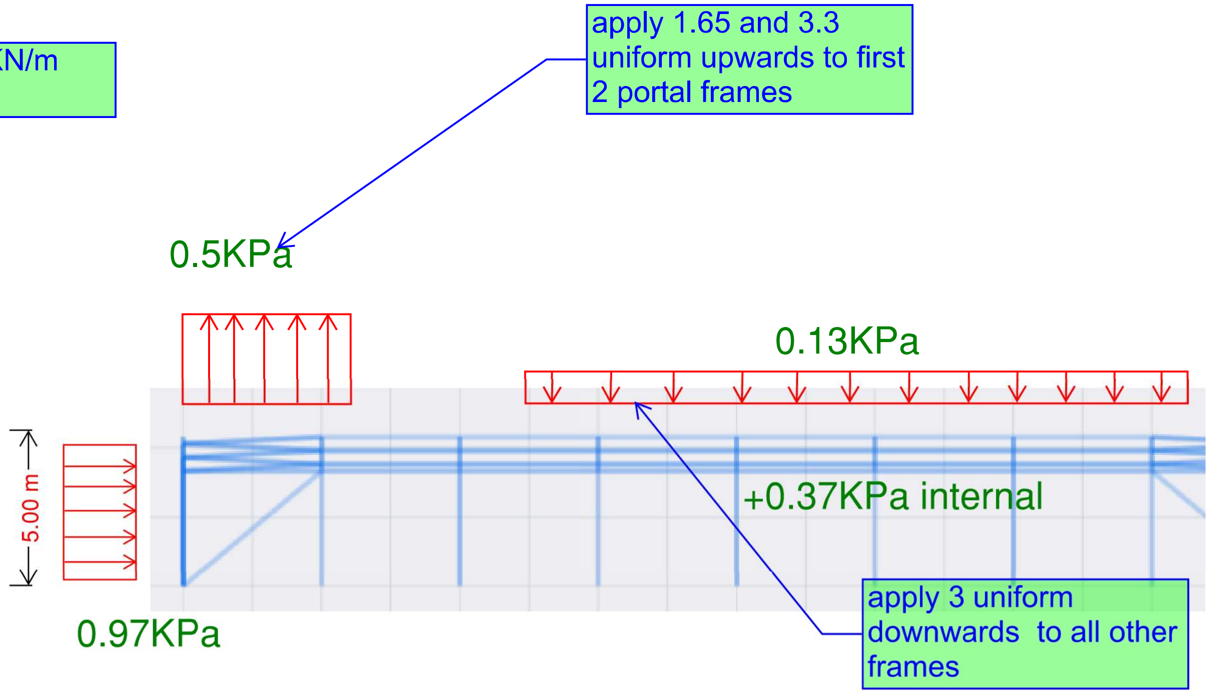
RKALC STRUCTURAL ENGINEERING	Warehouse to AS4100	Sheet No. 9	Date 6/26

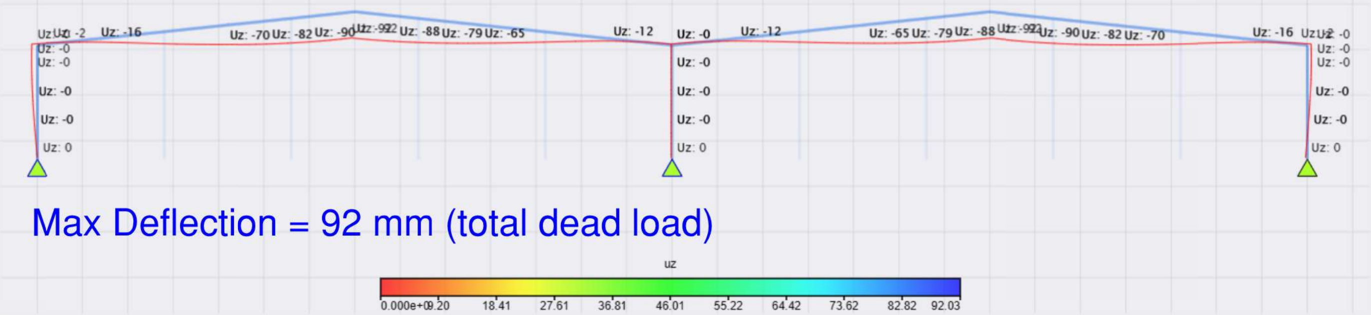
Wind Loads - CASE 4



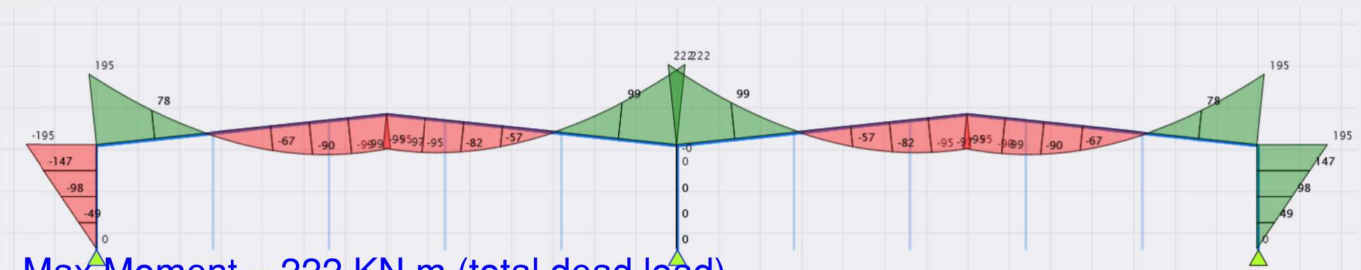


Educational Example Only – Refer to current Australian Standards and project-specific requirements before design.

Initial Results



Max Deflection = 92 mm (total dead load)



Max Moment = 222 KN.m (total dead load)

for dead load, per beam = 3.67KN/m

Approx eve moment = 3.67* 28^2 / 14 = 205 (not full fixity)

Deflection = 92 mm = 28000/305 (Span/305)

dead load deflection is broken as follows

1-beam's own weight deflection = 0.67 / 3.67 * 92 = 17 mm
2- SDL deflection = 92 - 17 = 75 mm

SDL deflection is broken down as follows

Roofing and insulation etc = 9.5kg / 49.5total = 19% = 14.25 mm
false ceiling and services = 81%

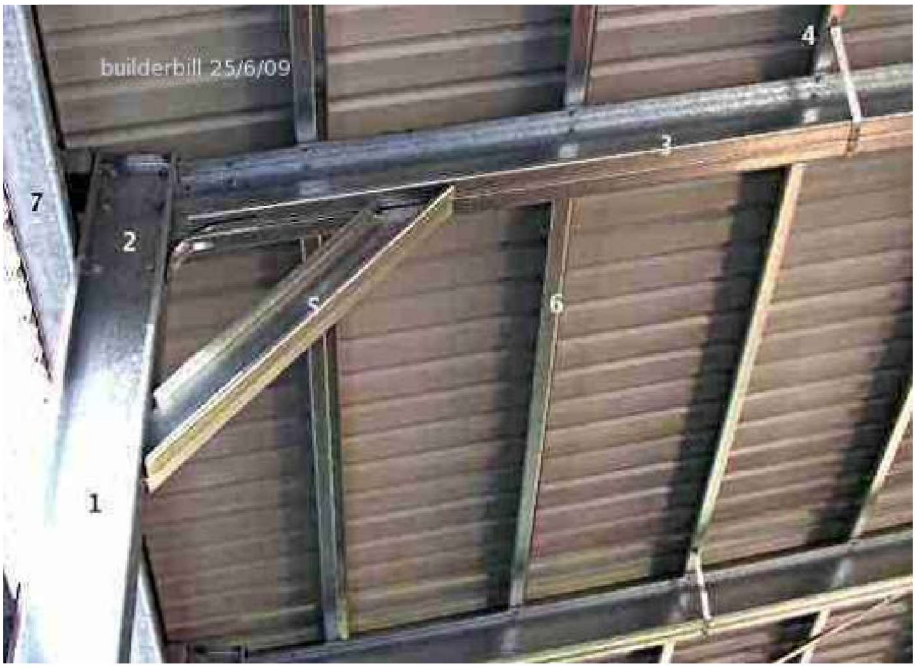
this means we can pre- camber by 14.25 + 17 = 32 mm = 34% of dead load def.

net deflection = 60 (from other sustained loads).

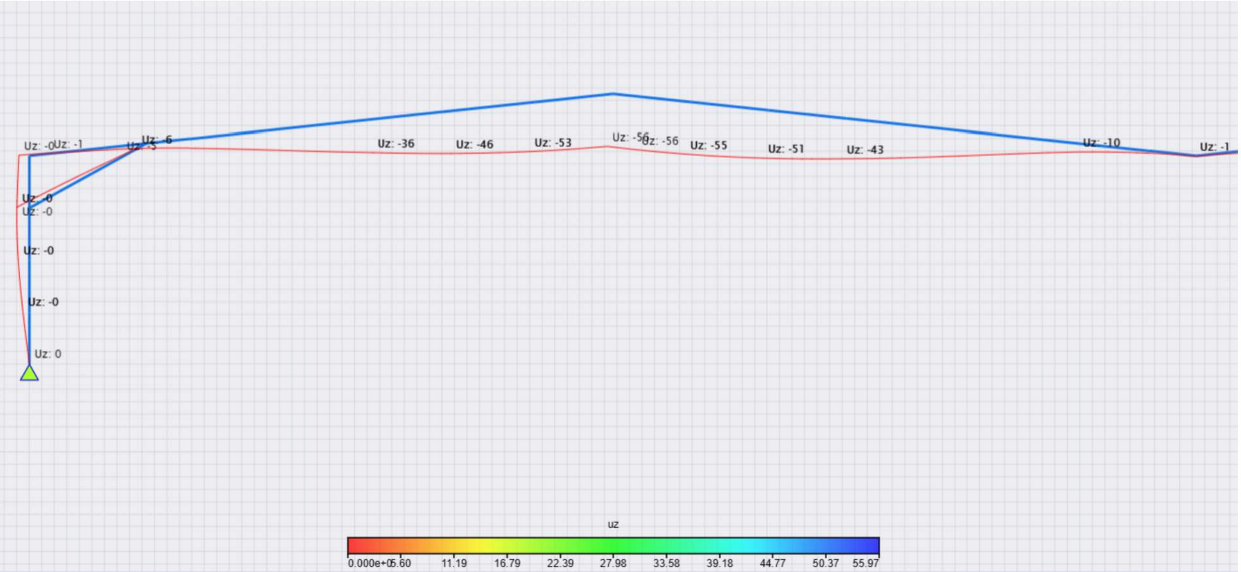
Potential Problems?

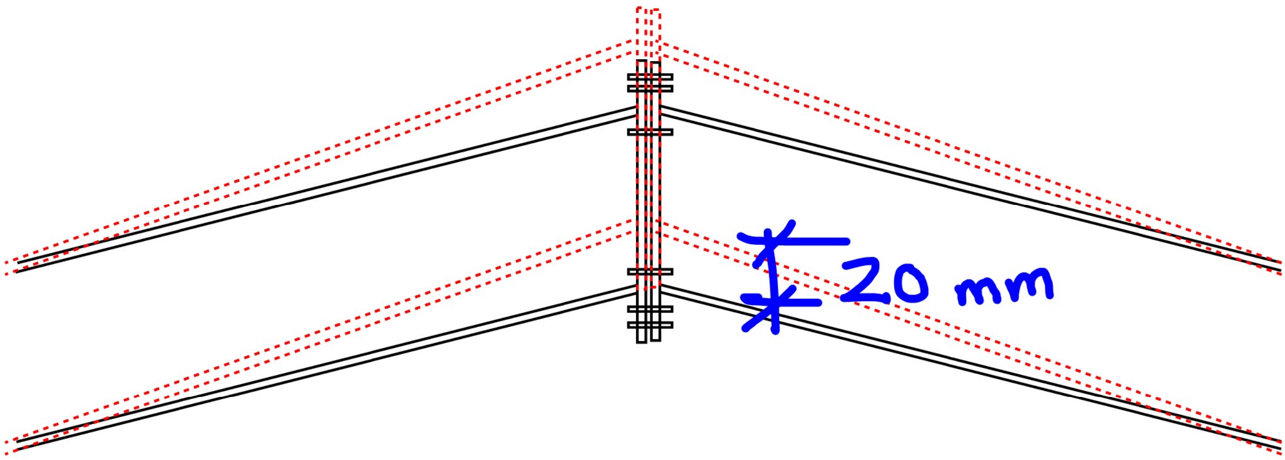
if false ceiling or services have no tolerance for 60 mm deflection (for example warehouse is going to be an office) then, we will need to add knee braces as follows:

rafters in frames sitting on valley beams will also be increased to 570UB82



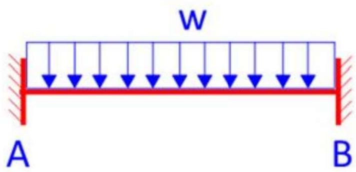
this will reduce dead load deflection to 53 mm, apply precamber = 30%
precamber = 16 mm, say 20 mm to be adopted





Precamber, this will essentially cancel deflection
caused by steel own weight, sheeting and purlins

How to Verify?



$$M_A = M_B = \frac{WL^2}{12}$$

$$M_{Midspan} = \frac{WL^2}{24}$$

$$\Delta = \frac{WL^4}{384EI}$$

$$R_A = R_b = \frac{WL}{2}$$

I Sections

Geometry

Steel Grade	300
Section Family	UB
Section	460UB67.1
Length - Axis X (mm)	2000
Length - Axis Y (mm)	2000

Key Properties

fy (N/mm²)	300	fu (N/mm²)	440
Class (X)	Compact	Class (Y)	Compact
Ze (X)	1480000	Ze (Y)	228947

Section Properties

Depth	454	Width	190
tw	8.5	tf	12.7
Weight (kg/m)	67.35	Area	8580
Ix	2.96E+08	Iy	1.45E+07
Zx	1303965	Zy	152631.6
Sx	1480000	Sy	238000
rx	185.7386	ry	41.10933
Iw	7.06E+11	J	378000

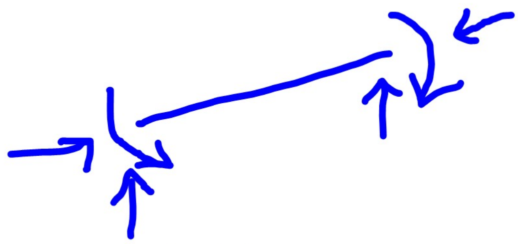
Support Moment (DL) =
WL^2 / 12 =3.67 * 28^2 / 12 = 240 KN.m

Midspan Moment (DL) = 120

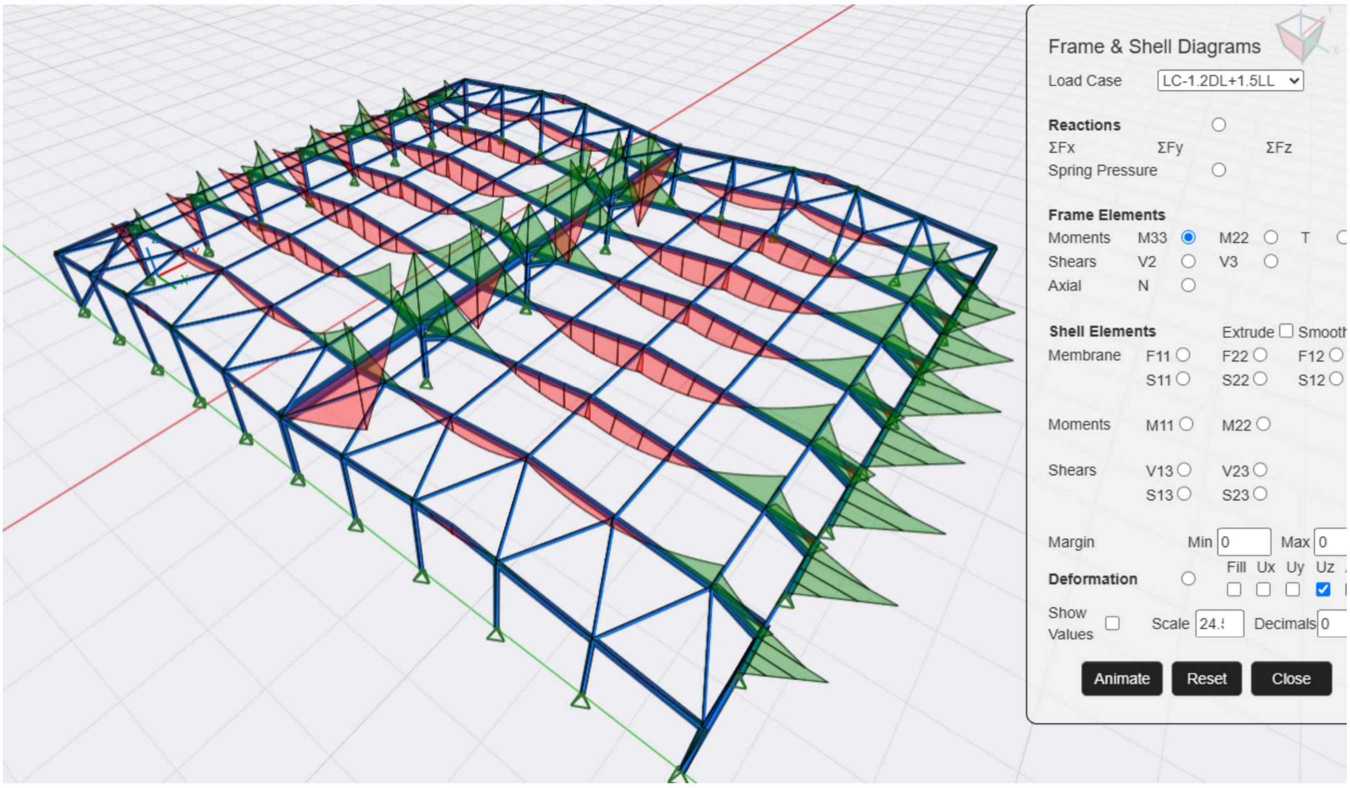
Deflection = WL^4/384 / E / I = 99 mm

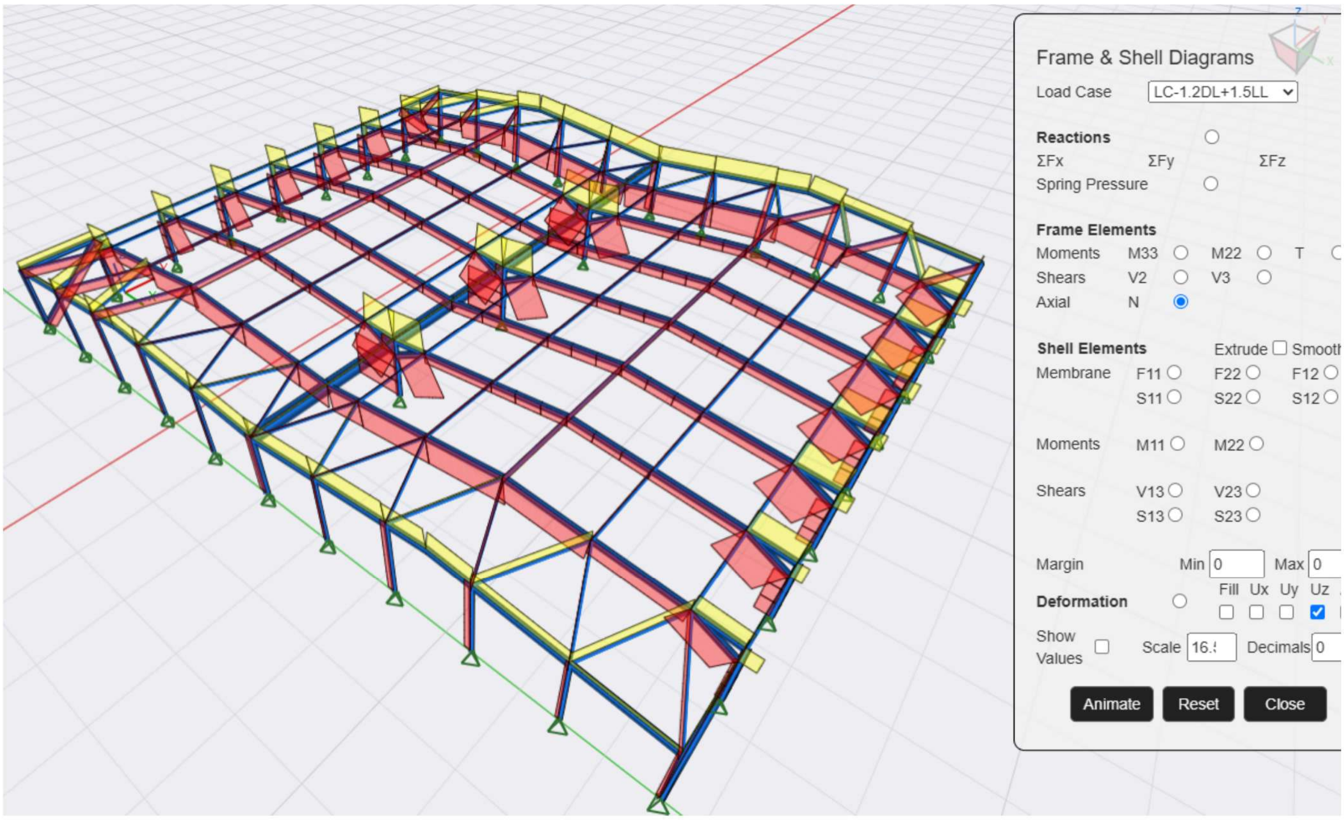
	Model	Simplified
End Moment	~ 200	240 (fully fixed)
Midspan	~ 99	~ 120 (fully fixed)
Deflection	~ 93	~ 99 (fully fixed)

NOTE: members not flat, therefore axial forces reduce deflections and mess up approx calc



OUTPUT RESULTS


Frame & Shell Diagrams
Load Case LC-1.2DL+1.5LL
Reactions
ΣFx ΣFy ΣFz
Spring Pressure
Frame Elements
Moments M33 M22 T
Shears V2 V3
Axial N
Shell Elements Extrude Smooth
Membrane F11 F22 F12
S11 S22 S12
Moments M11 M22
Shears V13 V23
S13 S23
Margin Min 0 Max 0
Deformation Fill Ux Uy Uz
Show Values Scale 24. Decimals 0
Animate
Reset
Close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S11 S22 S12
Moments M11 M22
Shears V13 V23
S13 S23
Margin Min 0 Max 0
Deformation Fill Ux Uy Uz
Show Values Scale 16. Decimals 0
Animate
Reset
Close

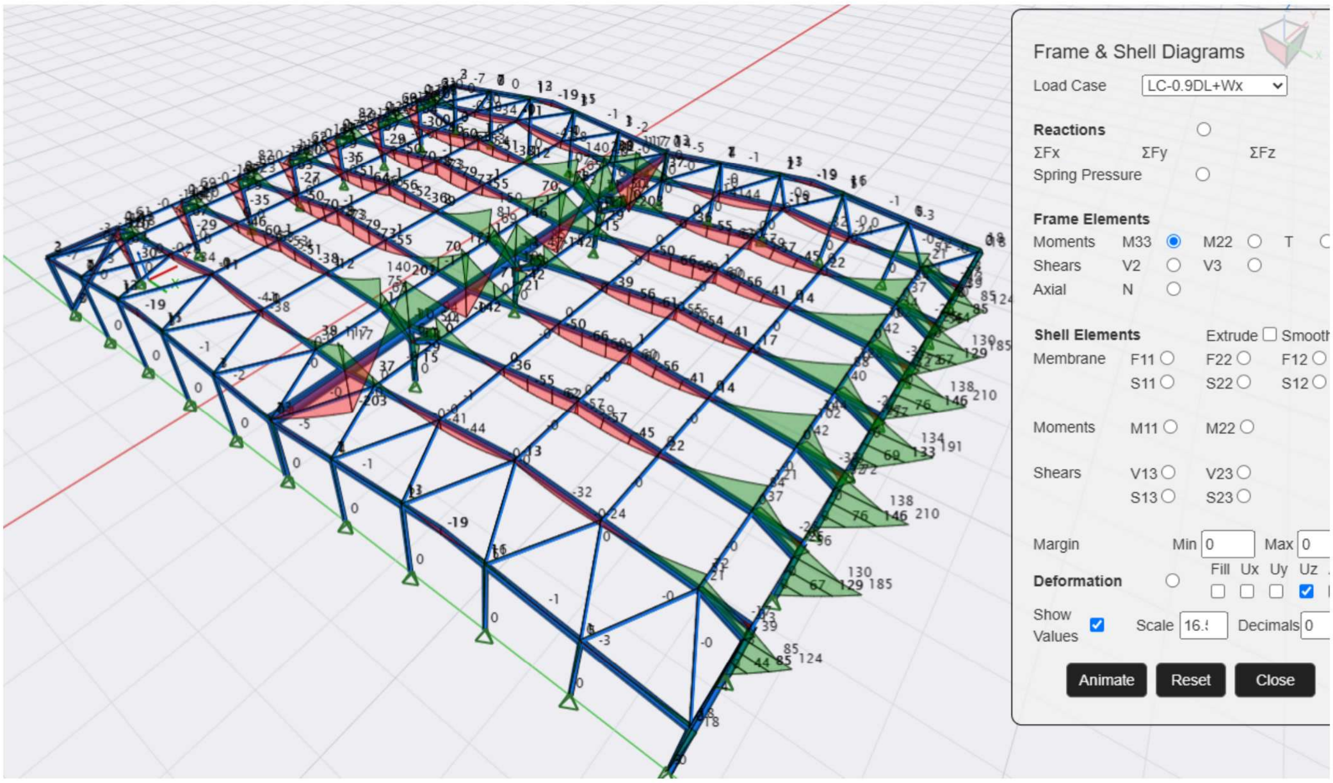
RKALC STRUCTURAL ENGINEERING

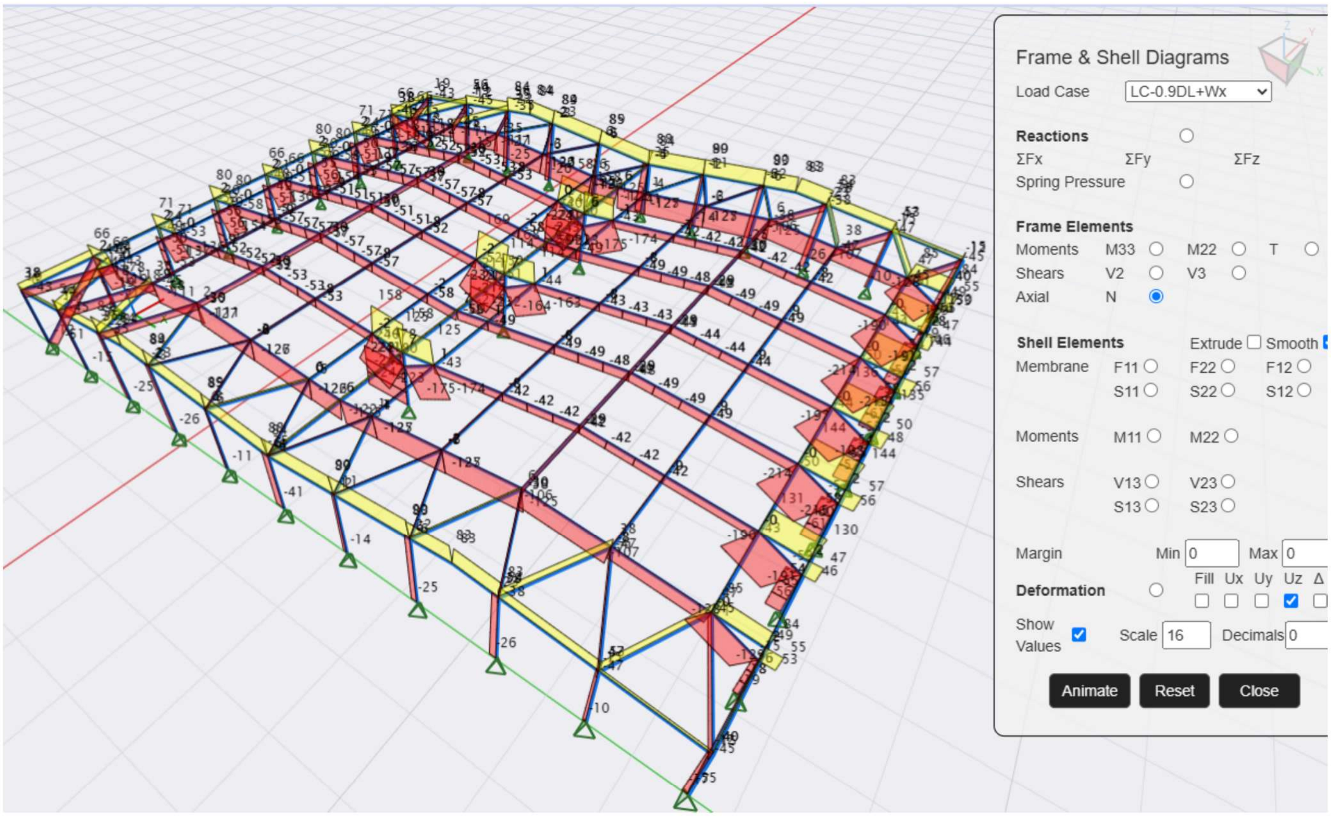
LEARNING CENTRE

FeaKALC 3D Tutorial # 1

Warehouse to AS4100

Sheet No.	Date



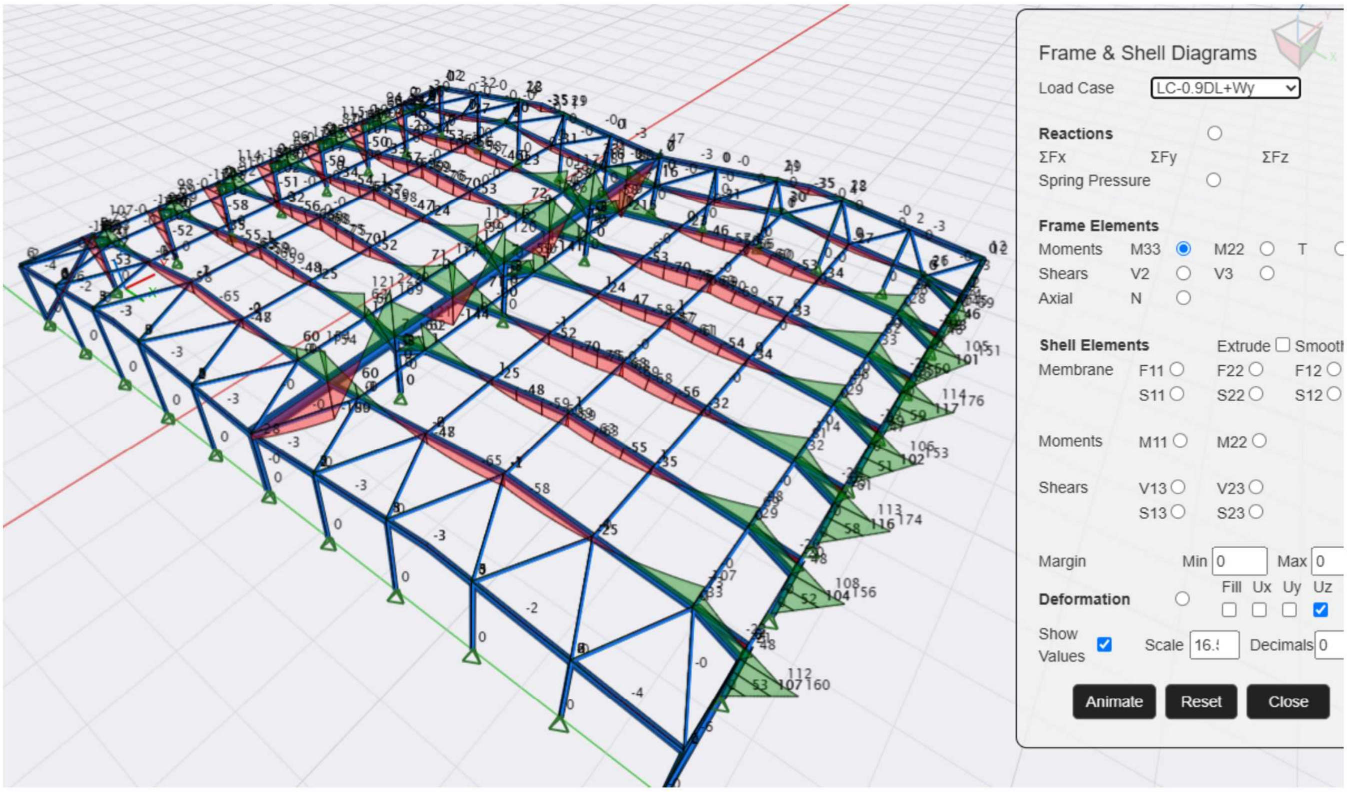


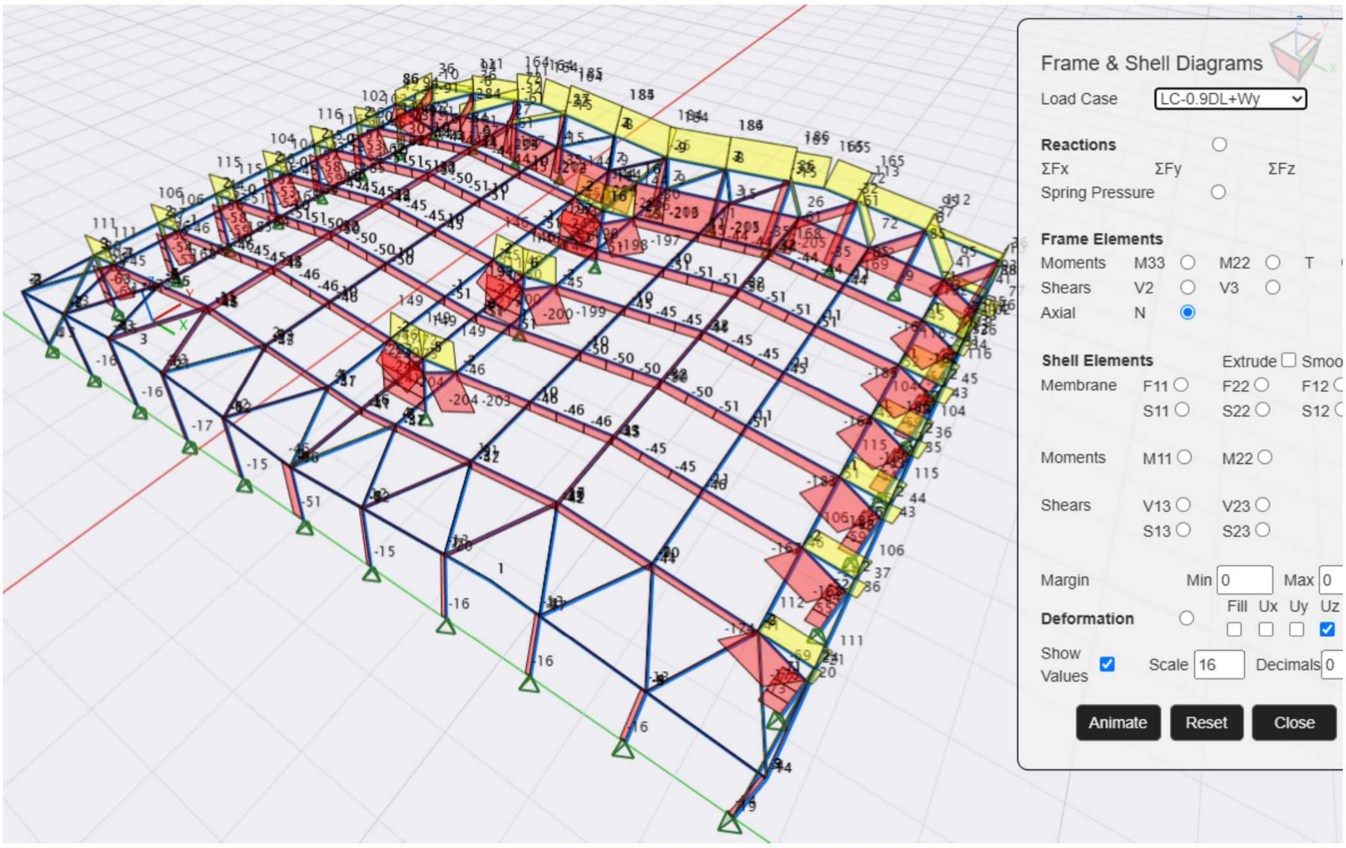
LEARNING CENTRE

FeaKALC 3D Tutorial # 1

Warehouse to AS4100

Sheet No.	Date



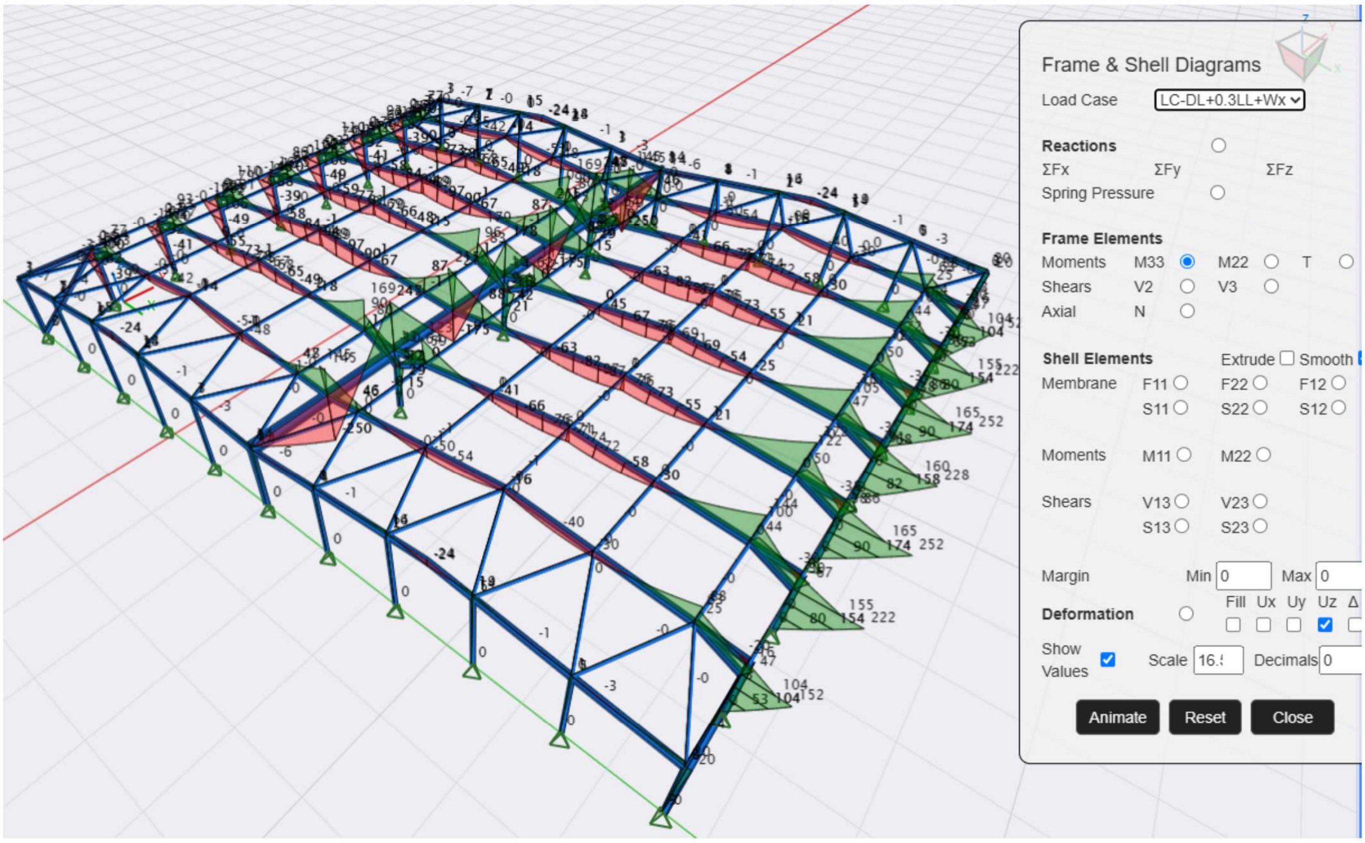


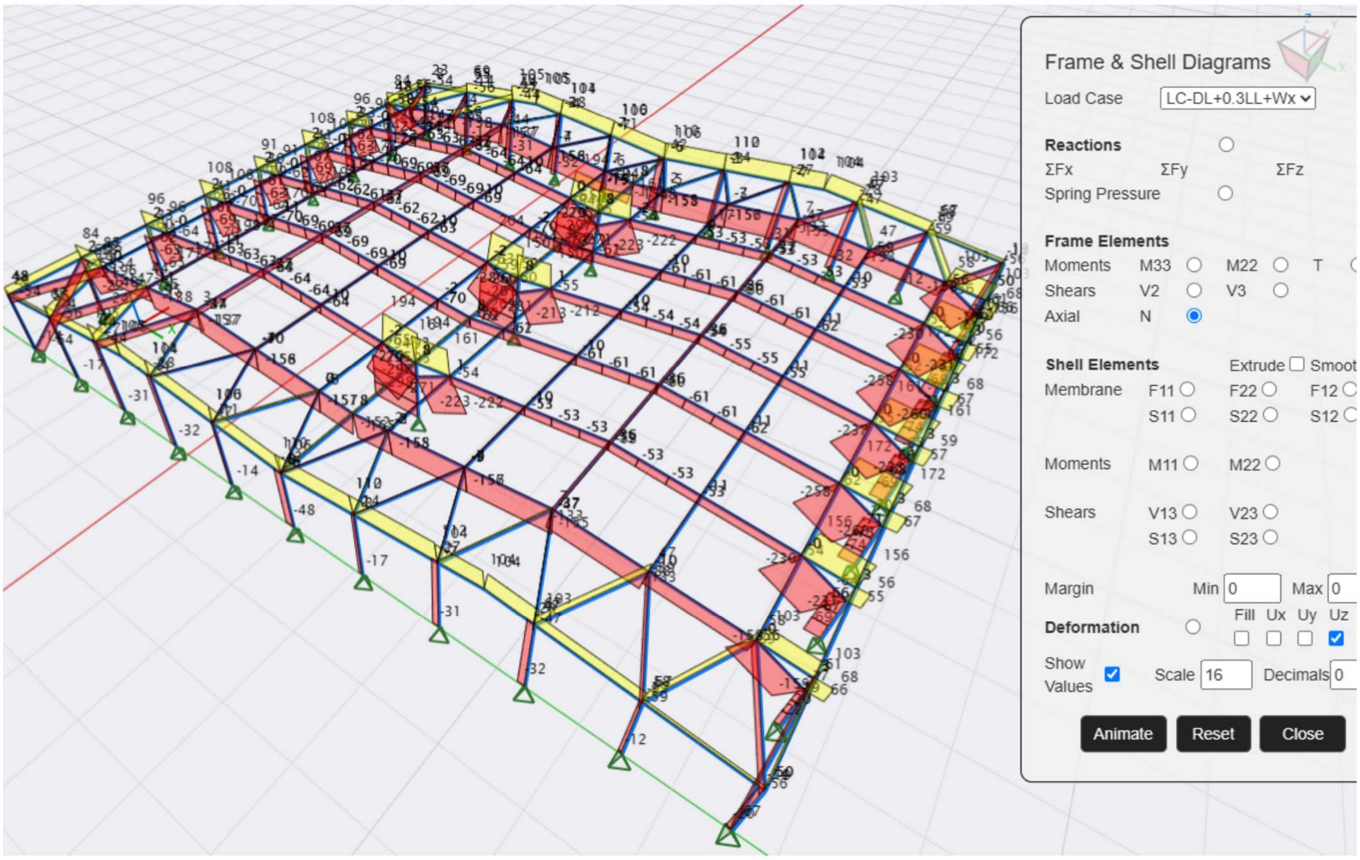
LEARNING CENTRE

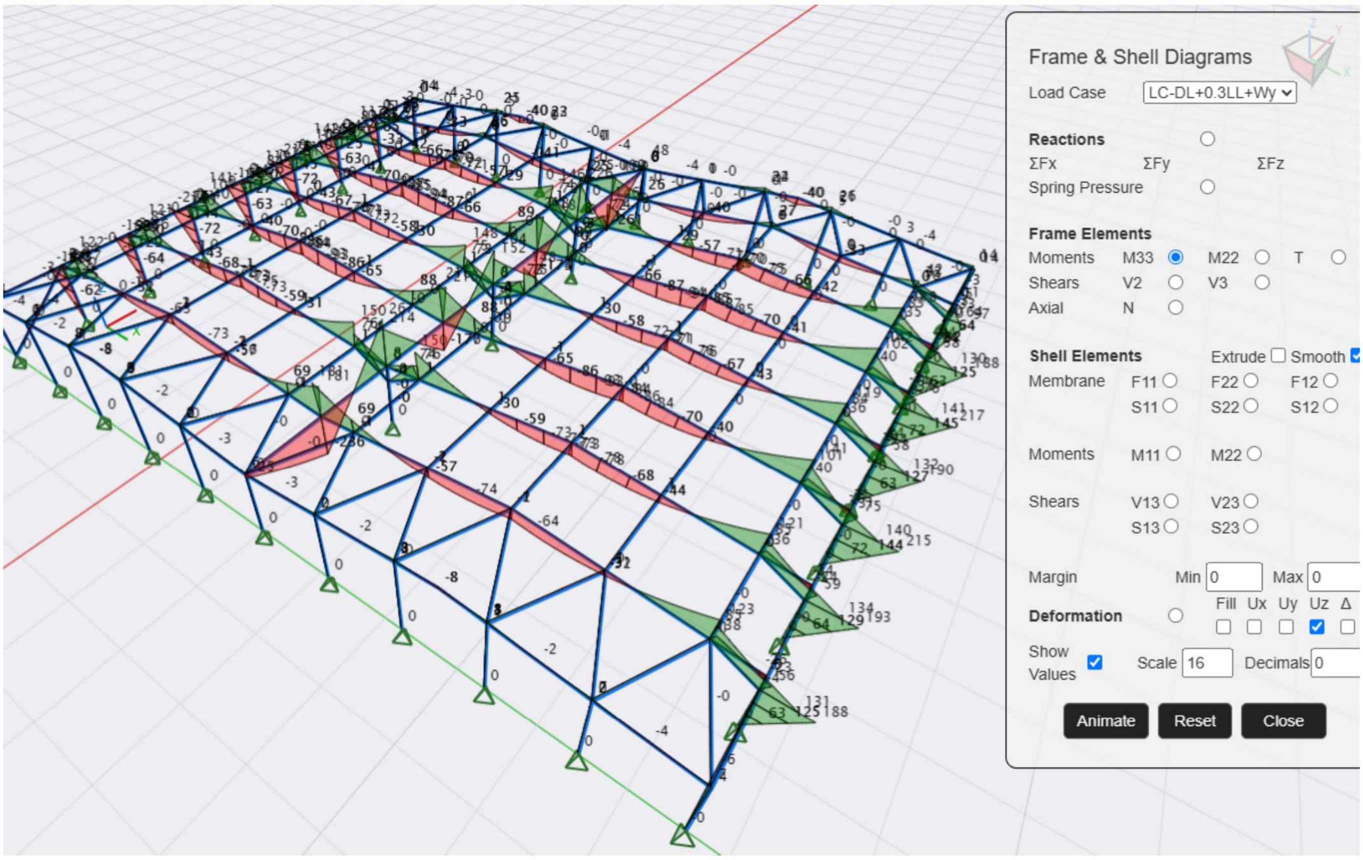
FeaKALC 3D Tutorial # 1

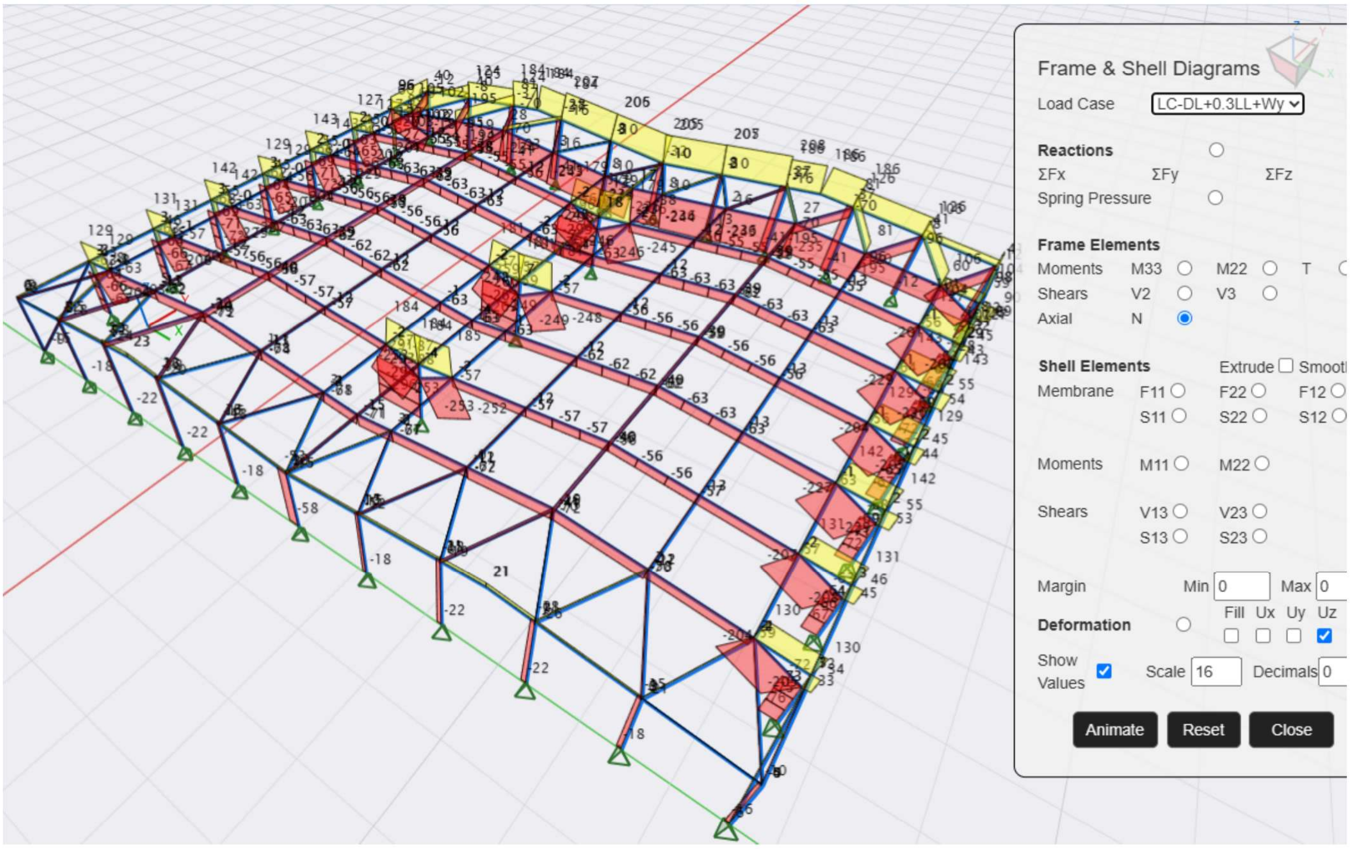
Warehouse to AS4100

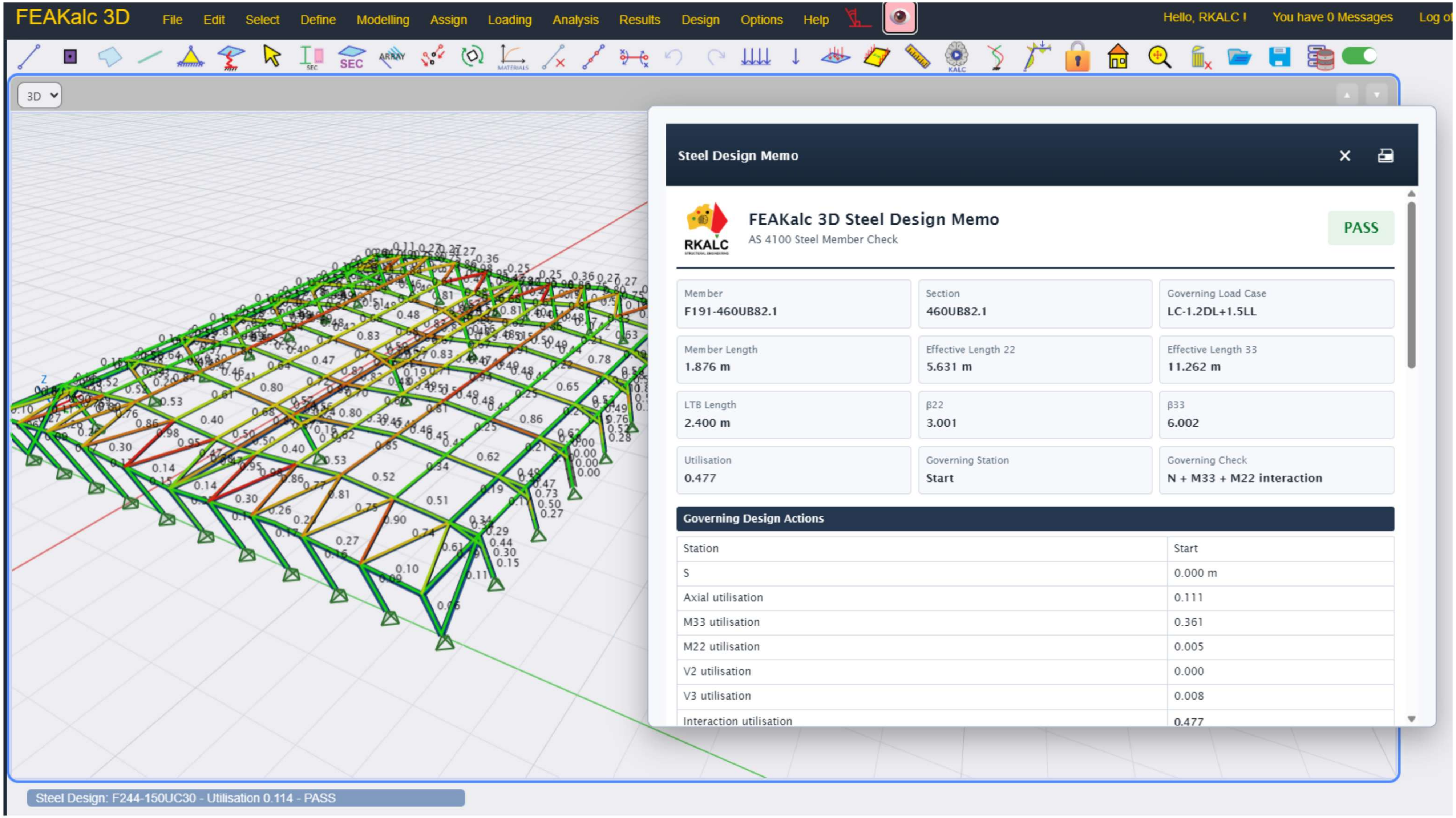
Sheet No.	Date






Frame & Shell Diagrams
Load Case LC-DL+0.3LL+Wy
Reactions
ΣFx ΣFy ΣFz
Spring Pressure
Frame Elements
Moments M33 M22 T
Shears V2 V3
Axial N
Shell Elements Extrude Smooth
Membrane F11 F22 F12
S11 S22 S12
Moments M11 M22
Shears V13 V23
S13 S23
Margin Min 0 Max 0
Deformation Fill Ux Uy Uz Δ
Show Values Scale 16 Decimals 0
Animate Reset Close


Frame & Shell Diagrams
Load Case LC-DL+0.3LL+Wy
Reactions
ΣFx ΣFy ΣFz
Spring Pressure
Frame Elements
Moments M33 M22 T
Shears V2 V3
Axial N
Shell Elements Extrude Smooth
Membrane F11 F22 F12
S11 S22 S12
Moments M11 M22
Shears V13 V23
S13 S23
Margin Min 0 Max 0
Deformation Fill Ux Uy Uz
Show Values Scale 16 Decimals 0
Animate Reset Close



FEAKalc 3D
File Edit Select Define Modelling Assign Loading Analysis Results Design Options Help
Hello, RKALC ! You have 0 Messages
3D
Steel Design Memo
FEAKalc 3D Steel Design Memo
AS 4100 Steel Member Check
PASS
Member F191-460UB82.1
Section 460UB82.1
Governing Load Case LC-1.2DL+1.5LL
Member Length 1.876 m
Effective Length 22 5.631 m
Effective Length 33 11.262 m
LTB Length 2.400 m
β22 3.001
β33 6.002
Utilisation 0.477
Governing Station Start
Governing Check N + M33 + M22 interaction
Governing Design Actions
Station Start
S 0.000 m
Axial utilisation 0.111
M33 utilisation 0.361
M22 utilisation 0.005
V2 utilisation 0.000
V3 utilisation 0.008
Interaction utilisation 0.477
Steel Design: F244-150UC30 - Utilisation 0.114 - PASS

LEARNING CENTRE

FeaKALC 3D Tutorial # 1

Warehouse to AS4100

Sheet No.	Date

Member Capacities

Navigate to steel calculator to compare rafter loads vs capacities (all pass)

Rafters Type 1

I Sections

Your Design Package is valid until 30/03/2030 10:44:38 PM

Geometry

Steel Grade	300
Section Family	UB
Section	460UB67.1
Length - Axis X (mm)	2000
Length - Axis Y (mm)	2000

Axis X

Key Values

αs	0.89	αm	1	Moa	1646
λ	11.254	ξ	32.476	αa	-2.353
αc	1	Kf	0.91	η	0
λn	11.254	αb	0	Mb/Ms	89 %

Capacities

ΦMsx (KN.m)	400	ΦNsx (KN)	2109
ΦMbx (KN.m)	356	ΦNcx (KN)	2109
ΦVweb (KN)	667		

Axis Y

Key Values

αs	1.014	αm	1	Moa	1646
λ	50.849	ξ	2.257	αa	20.332
αc	0.856	Kf	0.91	η	0.122
λn	50.849	αb	0	Mb/Ms	100 %

Capacities

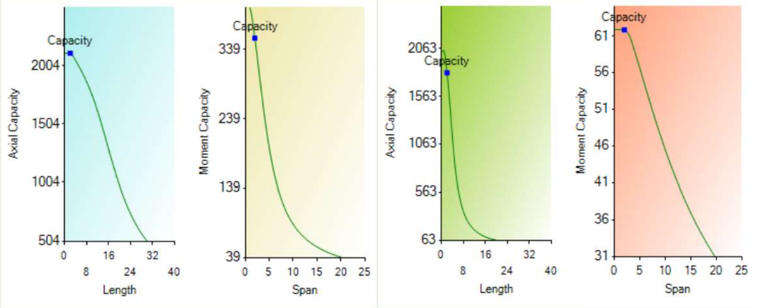
ΦMsy (KN.m)	62	ΦNsy (KN)	2109
ΦMby (KN.m)	62	ΦNcy (KN)	1806

Key Properties

fy (N/mm²)	300	fu (N/mm²)	440
Class (X)	Compact	Class (Y)	Compact
Ze (X)	1480000	Ze (Y)	228947

Section Properties

Depth	454	Width	190
tw	8.5	tf	12.7
Weight (kg/m)	67.35	Area	8580
Ix	2.96E+08	Iy	1.45E+07
Zx	1303965	Zy	152631.6
Sx	1480000	Sy	238000
rx	185.7386	ry	41.10933
Iw	7.06E+11	J	378000



Rafters Type 2

I Sections

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Geometry

Steel Grade	300
Section Family	UB
Section	460UB82.1
Length - Axis X (mm)	2000
Length - Axis Y (mm)	2000

Axis X

Key Values

αs	0.897	αm	1	Moa	2161
λ	11.45	ξ	31.39	αa	-2.146
αc	1	Kf	0.968	η	0
λn	11.45	αb	0	Mb/Ms	90 %

Capacities

ΦMsx (KN.m)	497	ΦNsx (KN)	2744
ΦMbx (KN.m)	446	ΦNcx (KN)	2744
ΦVweb (KN)	787		

Axis Y

Key Values

αs	1.015	αm	1	Moa	2161
λ	51.208	ξ	2.234	αa	20.363
αc	0.855	Kf	0.968	η	0.123
λn	51.208	αb	0	Mb/Ms	100 %

Capacities

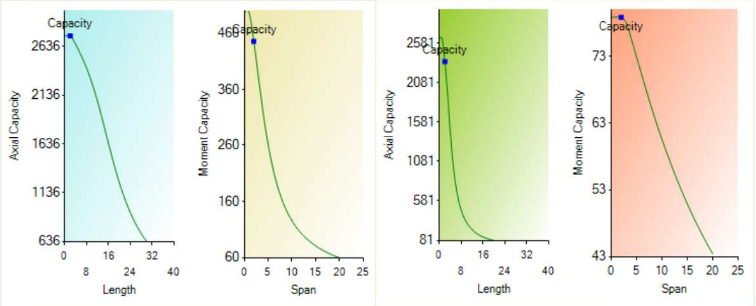
ΦMsy (KN.m)	79	ΦNsy (KN)	2744
ΦMby (KN.m)	79	ΦNcy (KN)	2345

Key Properties

fy (N/mm²)	300	fu (N/mm²)	440
Class (X)	Compact	Class (Y)	Compact
Ze (X)	1840000	Ze (Y)	292147

Section Properties

Depth	460	Width	191
tw	9.9	tf	16
Weight (kg/m)	82.43	Area	10500
Ix	3.72E+08	Iy	1.86E+07
Zx	1617391	Zy	194764.4
Sx	1840000	Sy	303000
rx	188.2248	ry	42.08834
Iw	9.17E+11	J	701000



purlins

Rafter

fly braces to limit LTB length

roofing (sheeting and insulation)

Columns

I Sections

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Geometry

Steel Grade	300
Section Family	UC
Section	310UC118
Length - Axis X (mm)	5000
Length - Axis Y (mm)	5000

Key Properties

fy (N/mm²)	280	fu (N/mm²)	440
Class (X)	Compact	Class (Y)	Compact
Ze (X)	1960000	Ze (Y)	881433

Section Properties

Depth	315	Width	307
tw	11.9	tf	18.7
Weight (kg/m)	117.75	Area	15000
Ix	2.77E+08	Iy	9.02E+07
Zx	1758730	Zy	587622.1
Sx	1960000	Sy	893000
rx	135.8921	ry	77.54568
Iw	1.98E+12	J	1630000

Axis X

Key Values

αs	0.834	αm	1	Moa	1429
λ	38.939	ξ	3.393	αa	17.984
αc	0.909	Kf	1	η	0.083
λn	38.939	αb	0	Mb/Ms	83 %

Capacities

ΦMsx (KN.m)	494	ΦNsx (KN)	3780
ΦMbx (KN.m)	412	ΦNcx (KN)	3437
ΦVweb (KN)	607		

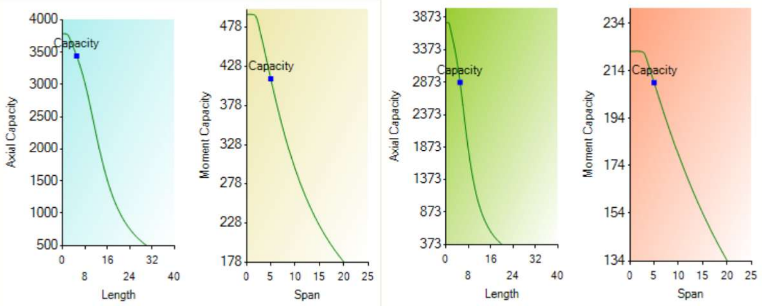
Axis Y

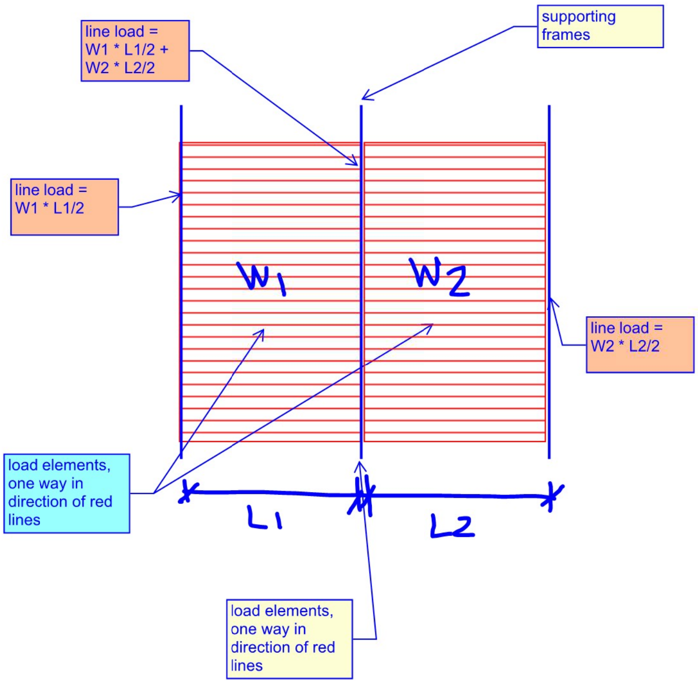
Key Values

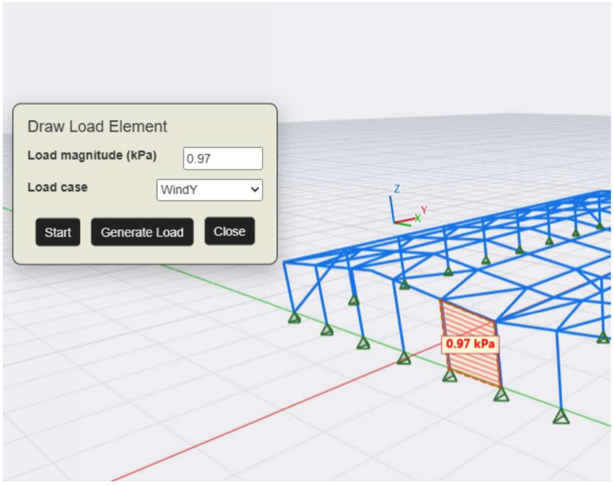
αs	0.941	αm	1	Moa	1429
λ	68.237	ξ	1.525	αa	20.301
αc	0.759	Kf	1	η	0.178
λn	68.237	αb	0	Mb/Ms	94 %

Capacities

ΦMsy (KN.m)	222	ΦNsy (KN)	3780
ΦMby (KN.m)	209	ΦNcy (KN)	2871




line load =
W1 * L1/2 +
W2 * L2/2
supporting
frames
line load =
W1 * L1/2
W1
W2
line load =
W2 * L2/2
load elements,
one way in
direction of red
lines
L1
L2
load elements,
one way in
direction of red
lines


Draw Load Element
Load magnitude (kPa)
0.97
Load case
WindY
Start
Generate Load
Close
0.97 kPa