

STRUCTURAL CALCULATIONS FOR
EXISTING PORTAL FRAME BUILDINGS AT
LADYGREEN FARM
DENFORD
LEEK
STAFFORDSHIRE
ST13 7JX

PREPARED IN ACCORDANCE WITH THE RELEVANT PARTS OF
THE FOLLOWING CODES OF PRACTICE:-

BS 6399 LOADINGS FOR BUILDINGS

BS 5950 STRUCTURAL USE OF STEELWORK

BS 8110 STRUCTURAL USE OF CONCRETE

REV A - OCTOBER 2023

DATE: SEPTEMBER 2021

REF: A5896

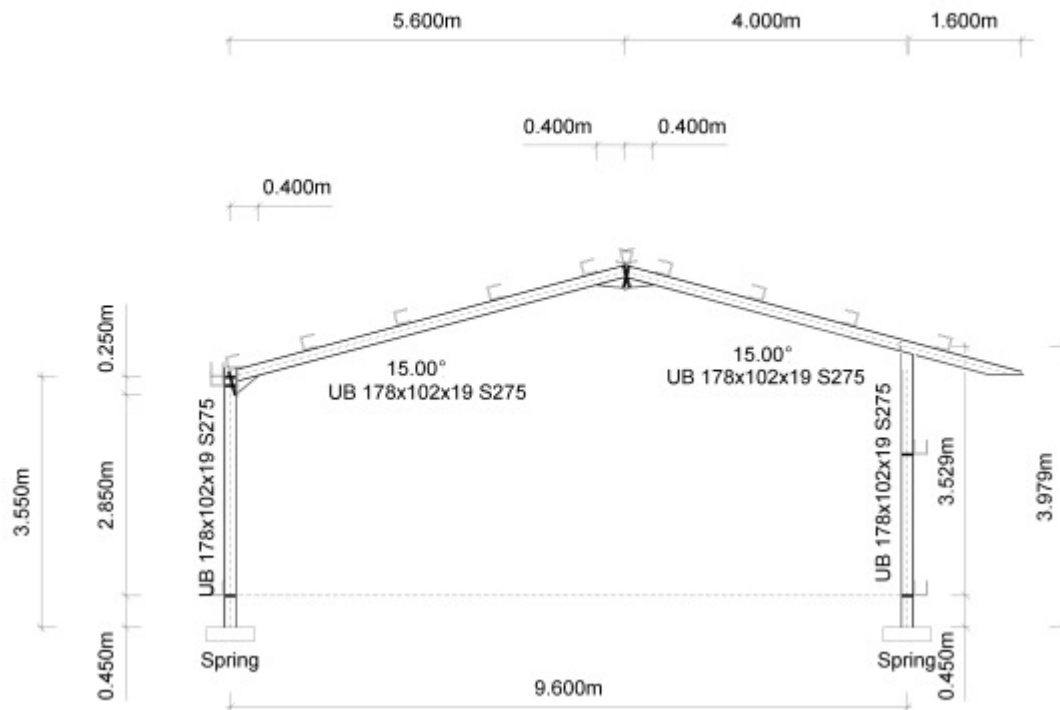
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Title of Scheme: **LADYGREEN FARM**

PORTAL FRAME

NOTE – PORTAL FRAMED BUILDINGS ARE IDENTICAL IN SPECIFICATION BUT HANDED.
ALL CALCULATIONS ARE EQUALLY APPLICABLE TO BOTH BUILDINGS.

Frame Diagram



Frame Details

No. Spans	1
Effective Frame Centres	4.572 m

Span Geometry

Span	Type	Axis	Lh Eaves [m]	Lh Apex [m]	Apex [m]	Rh Apex [m]	Rh Eaves [m]
Span 1	Asymmetric	X	0.0	-	5.600	-	9.600
		Z	3.100	-	4.601	-	3.529

Wind Options

Wind Method	Standard
Basic Wind Speed (Vb)	21.5 m/s
Ground Roughness	Country
Upwind distance from sea to site	100.0 km
Altitude factor (Sa)	1.1430
Seasonal factor (Ss)	1.0000
Probability factor (Sp)	1.0000

Snow Options

Basic Snow Load (Sb)	0.550 kN/m²
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Base Fixities

Base	Type	Level [m]	Vertical [kN/m]	Horizontal [kN/m]	Rotational [kNm/rad]	Capacity [%]	Capacity [kNm]
Span 1 Lh	Spring	-0.450 ULS	Restr.	Restr.	Free	1.00	
		-0.450 SLS	Restr.	Restr.	626.422	N/A	N/A
		-0.450 Stab	Restr.	Restr.	313.211	1.00	
Span 1 Rh	Spring	-0.450 ULS	Restr.	Restr.	Free	1.00	
		-0.450 SLS	Restr.	Restr.	567.440	N/A	N/A
		-0.450 Stab	Restr.	Restr.	283.720	1.00	

Haunches

Haunch	Section	Length [m]	Depth [m]	Beta [°]	Gamma [°]	Offset X1 [mm]	Offset X2 [mm]	Filler Plate
Span 1 Lh Eaves	UB 178x102x19	0.400	0.250	39.3328	24.3328	101.8	274.6	
Span 1 Apex Lh	UB 178x102x19	0.400	0.250	6.1150	21.1132	15.2	367.0	
Span 1 Apex Rh	UB 178x102x19	0.400	0.250	6.1150	21.1132	15.2	367.0	

Member Restraints

Span 1 Lh Column

Position [m]	Type
0.0	Torsional
0.450	Torsional
3.425	Torsional
3.550	Torsional

Span 1 Rh Column

Position [m]	Type
0.0	Torsional
0.450	Torsional
2.450	Torsional
3.775	Torsional
3.919	Torsional

Span 1 Lh Rafter

Position [m]	Type
0.0	Torsional
1.100	O/S Flange
2.470	O/S Flange
3.840	O/S Flange
5.210	O/S Flange
5.798	Torsional

Span 1 Rh Rafter

Position [m]	Type
0.0	Torsional
0.777	O/S Flange
2.147	O/S Flange
3.517	O/S Flange
4.105	Torsional

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Loadcases

Frame Dead Load (Dead)

Area Loads

Load Type	Span Member	Direction	Load ₁ [kN/m ²]	a [m]	Load ₂ [kN/m ²]	b [m]	Centres [m]
Sheeting	Span 1	Vert.	0.200	-	-	-	4.572

Point Loads

Load Type	Span Member	Direction	F [kN]	M [kNm]	a [m]
Force	Span 1 Rh Column	Vert.	1.5	-	3.979
Moment	Span 1 Rh Column	-	-	1.2	3.979

Frame Service Load (Dead)

Area Loads

Load Type	Span Member	Direction	Load ₁ [kN/m ²]	a [m]	Load ₂ [kN/m ²]	b [m]	Centres [m]
Span Area	Span 1	Vert.	0.150	-	-	-	4.572

Point Loads

Load Type	Span Member	Direction	F [kN]	M [kNm]	a [m]
Force	Span 1 Rh Column	Vert.	1.1	-	3.979
Moment	Span 1 Rh Column	-	-	0.9	3.979

Frame Imposed Load (Imposed)

Area Loads

Load Type	Span Member	Direction	Load ₁ [kN/m ²]	a [m]	Load ₂ [kN/m ²]	b [m]	Centres [m]
Span Area	Span 1	Vert.	0.600	-	-	-	4.572

Point Loads

Load Type	Span Member	Direction	F [kN]	M [kNm]	a [m]
Force	Span 1 Rh Column	Vert.	4.4	-	3.979
Moment	Span 1 Rh Column	-	-	3.5	3.979

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Wind L

Member	qs [kN/m ²]	Cpi	Cpe	L [m]	a [m]	Cae	Cai	%
Span 1 Lh Column	0.738	-0.3000	0.7080	3.550	5.788	0.9904	1.0000	100.00
Span 1 Lh Rafter	0.738	-0.3000	-0.8000	0.910	7.383	0.9721	1.0000	100.00
Span 1 Lh Rafter			-0.4000	4.888				
Span 1 Rh Rafter	0.738	-0.3000	-0.5000	3.231	6.169	0.9856	1.0000	100.00
Span 1 Rh Rafter			-0.8998	0.910				
Span 1 Rh Column	0.738	-0.3000	-0.5000	3.979	6.061	0.9870	1.0000	100.00

Wind R

Member	qs [kN/m ²]	Cpi	Cpe	L [m]	a [m]	Cae	Cai	%
Span 1 Lh Column	0.738	-0.3000	-0.5000	3.550	5.788	0.9904	1.0000	100.00
Span 1 Lh Rafter	0.738	-0.3000	-0.5000	4.888	7.383	0.9721	1.0000	100.00
Span 1 Lh Rafter			-0.9000	0.910				
Span 1 Rh Rafter	0.738	-0.3000	-0.8002	0.910	6.169	0.9856	1.0000	100.00
Span 1 Rh Rafter			-0.4001	3.231				
Span 1 Rh Column	0.738	-0.3000	0.7323	3.979	6.061	0.9870	1.0000	100.00

Wind G

Member	qs [kN/m ²]	Cpi	Cpe	L [m]	a [m]	Cae	Cai	%
Span 1 Lh Column	0.738	-0.3000	-0.8000	3.550	5.788	0.9904	1.0000	100.00
Span 1 Lh Rafter	0.738	-0.3000	-0.6000	5.798	7.383	0.9721	1.0000	100.00
Span 1 Rh Rafter	0.738	-0.3000	-0.6000	4.141	6.169	0.9856	1.0000	100.00
Span 1 Rh Column	0.738	-0.3000	-0.8030	3.979	6.061	0.9870	1.0000	100.00

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Combinations

Sw + Dead + Serv. + Imp.

Loadcase	Type	Ultimate	Service
Self weight	Dead	1.4000	1.0000
Frame Dead Load	Dead	1.4000	1.0000
Frame Service Load	Dead	1.4000	1.0000
Frame Imposed Load	Imposed	1.6000	1.0000

D+WL

Loadcase	Type	Ultimate	Service
Self weight	Dead	1.0000	1.0000
Frame Dead Load	Dead	1.0000	1.0000
Frame Service Load	Dead	1.0000	1.0000
Wind L	Wind	1.4000	1.0000

D+WR

Loadcase	Type	Ultimate	Service
Self weight	Dead	1.0000	1.0000
Frame Dead Load	Dead	1.0000	1.0000
Frame Service Load	Dead	1.0000	1.0000
Wind R	Wind	1.4000	1.0000

D+WG

Loadcase	Type	Ultimate	Service
Self weight	Dead	1.0000	1.0000
Frame Dead Load	Dead	1.0000	1.0000
Frame Service Load	Dead	1.0000	1.0000
Wind G	Wind	1.4000	1.0000

Design Wizard Options

Design Criteria

BS5950 Part1 : 2000

Maximum Hinge Rotation	6.0000	°
Percent Mp for Plasticity	99.00	%
Axial Load Factor	1.2500	

Design Limits

Eaves Deflection	Relative Limit	h/100.0
Apex Deflection	Relative Limit	s/200.0

Design Code: BS5950

Design Summary

Design Combination	Lambda p	Lambda r	Status
Sw + Dead + Serv. + Imp.	1.194	1.000	Pass
D+WL	2.214	1.000	Pass
D+WR	2.216	1.000	Pass
D+WG	8.188	1.000	Pass
Member Stability Status: Pass			

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Design Cases

Sw + Dead + Serv. + Imp.

Sections

Member	Section	Grade	Length	Mass	Weight	Mp	Mpr	UR
Span 1 Lh Column	UB 178x102x19	S275	3.550	19.05	67.61	47.1	46.9	0.671
Span 1 Lh Rafter	UB 178x102x19	S275	5.798	19.05	110.42	47.1	47.1	0.648
Span 1 Rh Rafter	UB 178x102x19	S275	4.141	19.05	78.87	47.1	47.0	0.988
Span 1 Rh Column	UB 178x102x19	S275	3.979	19.05	75.78	47.1	46.7	0.995
Total Rafter					189.28			
Total Column					143.39			
Total Haunch					10.08			
Total					342.75			

Strength

Rafters

Member	U.R.	Status
Span 1 Lh Rafter	0.647	Pass
Span 1 Rh Rafter	0.987	Pass

Columns

Member	U.R.	Status
Span 1 Lh Column	0.668	Pass
Span 1 Rh Column	0.987	Pass

Haunches

Member	U.R.	Status
Span 1 Lh Rafter Lh Eaves	0.404	Pass
Span 1 Lh Rafter Lh Apex	0.424	Pass
Span 1 Rh Rafter Rh Apex	0.361	Pass

Serviceability

Span	Status	Lh Eaves(H)	Lh Apex(V)	Apex(V)	Rh Apex(V)	Rh Eaves(H)
Span 1	Pass	5.0/35.5	na	39.2/48.0	na	25.7/39.8

Base Loads

Span	M [kNm]	F [kN]	N [kN]
Span 1 Lh Column	0.0	9.5	33.4
Span 1 Rh Column	0.0	-9.5	45.9

Connection Forces

Span	Mf [kNm]	Ff [kN]	Nf [kN]	Mh [kNm]	Fh [kN]	Nh [kN]
Span 1 Lh Eaves	31.2	31.8	9.5	23.1	26.3	16.9
Span 1 Lh Apex	-24.7	6.4	9.6	-27.8	-5.9	8.3
Span 1 Rh Apex	-24.7	-6.4	9.5	-22.4	6.6	11.6
Span 1 Rh Eaves	43.7	33.6	9.5	-	-	-

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Member Stability

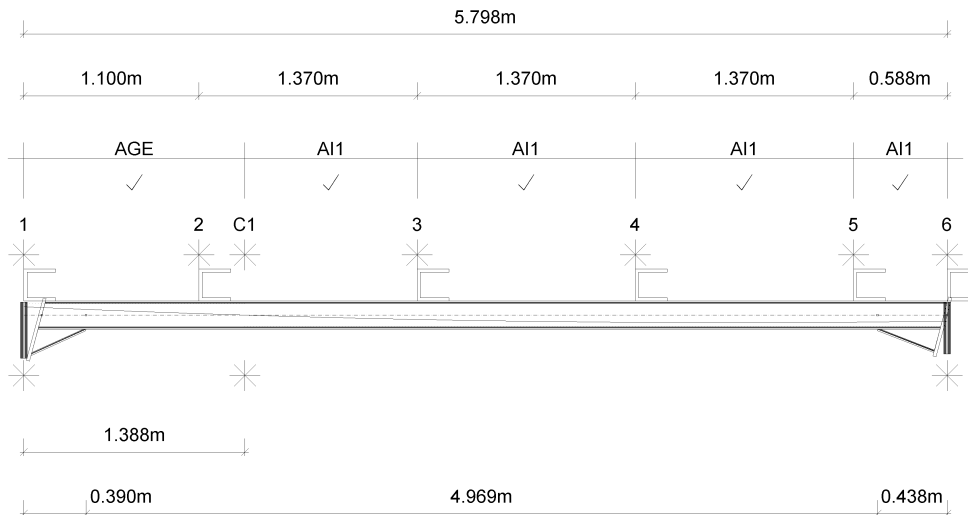
Rafters

Member	Status
Span 1 Lh Rafter	Pass
Span 1 Rh Rafter	Pass

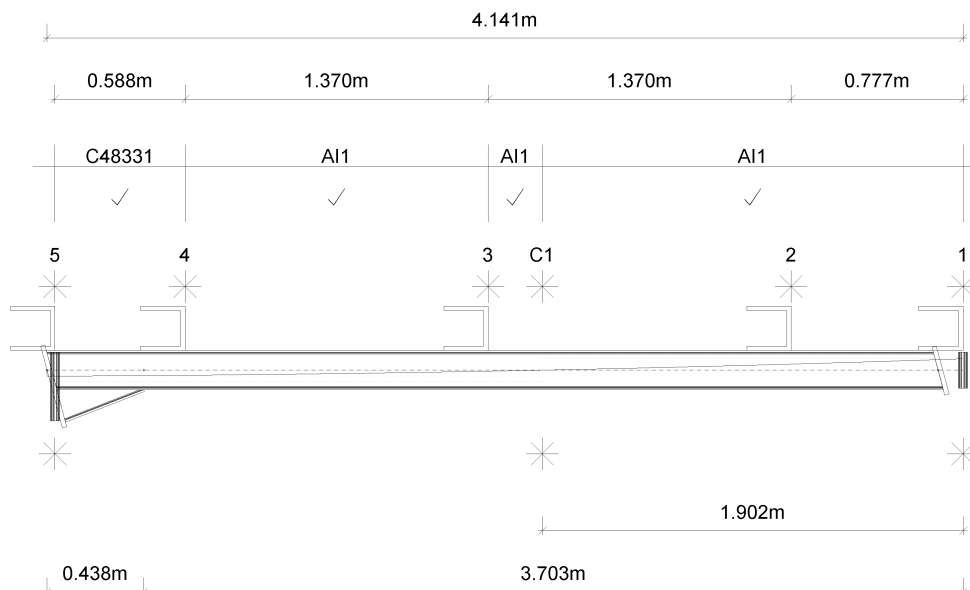
Columns

Member	Status
Span 1 Lh Column	Pass
Span 1 Rh Column	Pass

Span 1 Lh Rafter



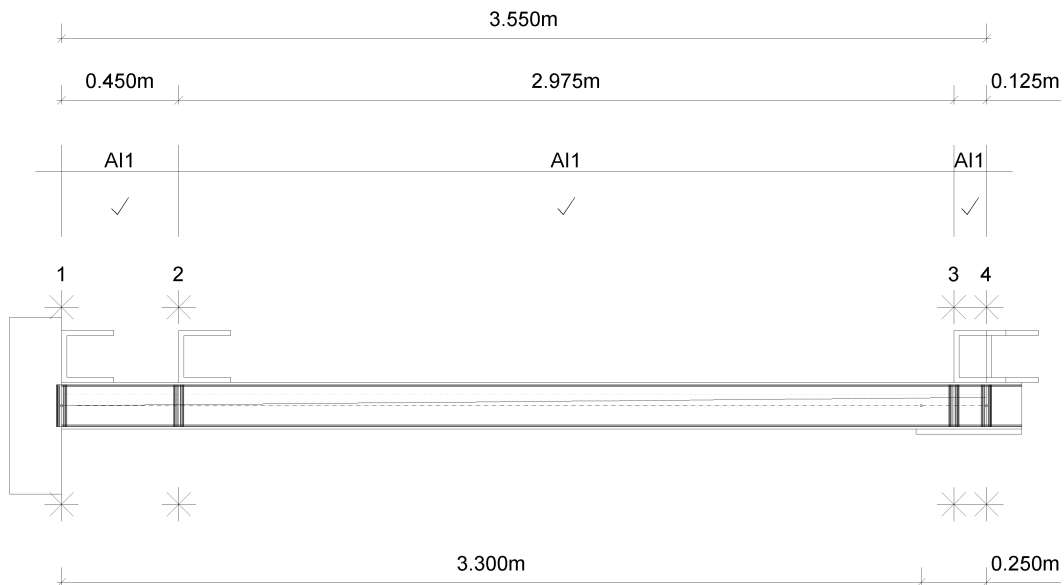
Span 1 Rh Rafter



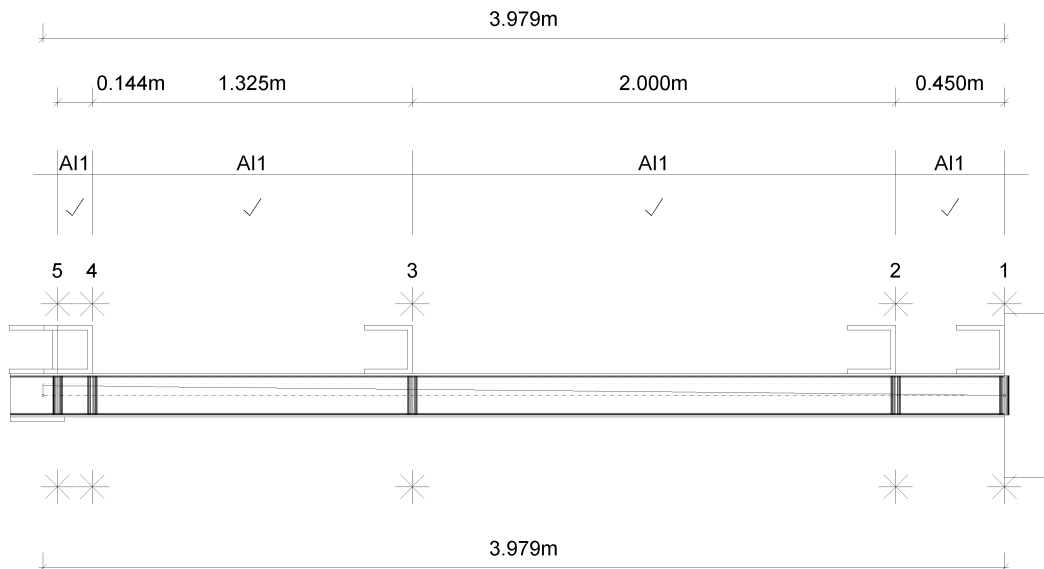
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Span 1 Lh Column



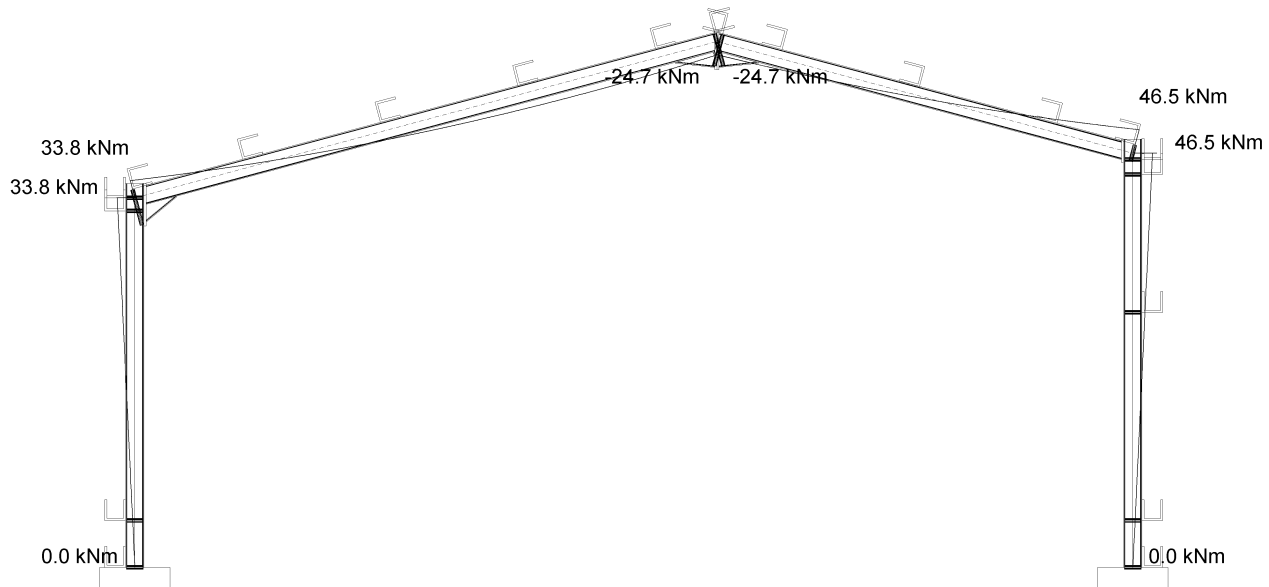
Span 1 Rh Column



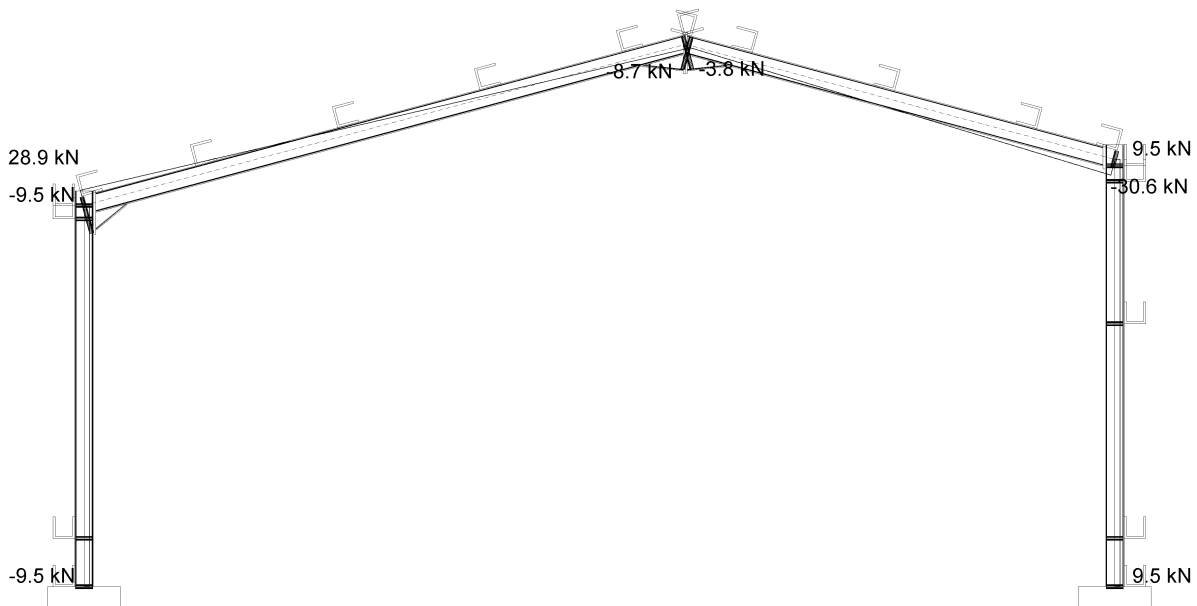
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Bending Moment Diagram



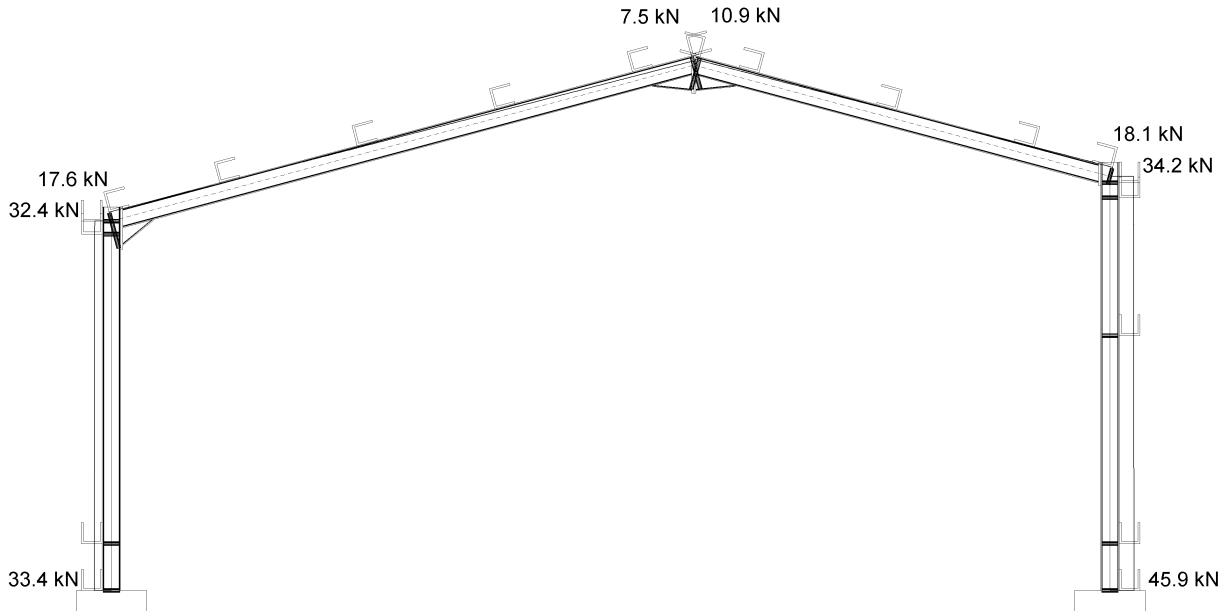
Shear Force Diagram



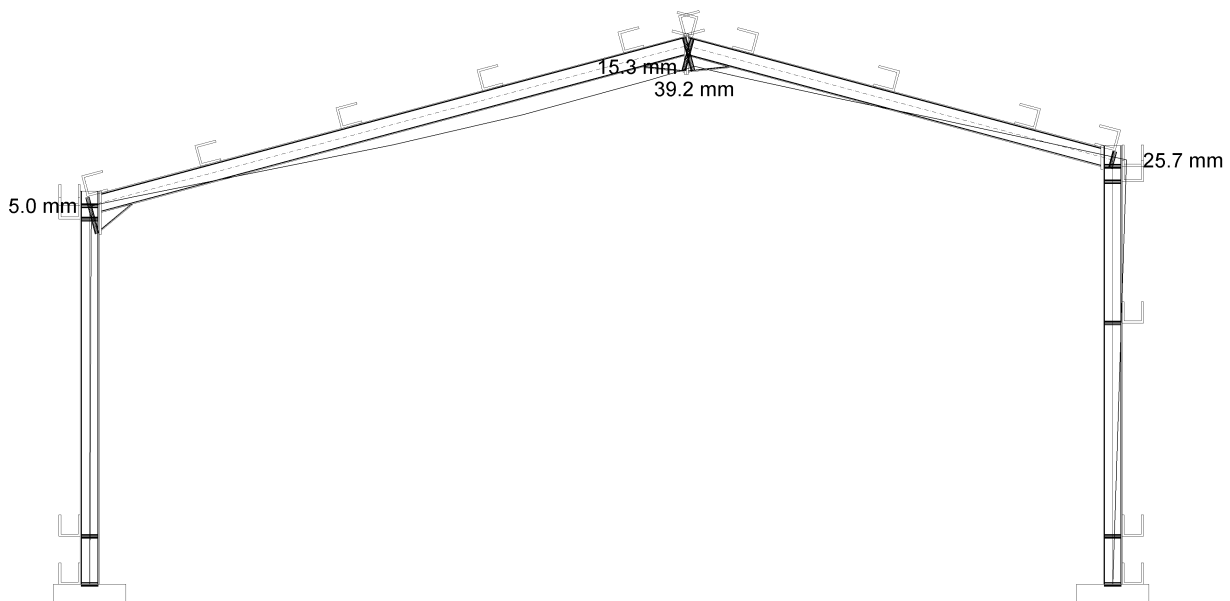
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Axial Load Diagram



Deflected Shape Diagram



D+WL Sections

Member	Section	Grade	Length	Mass	Weight	Mp	Mpr	UR
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Member	Section	Grade	Length	Mass	Weight	Mp	Mpr	UR
Span 1 Lh Column	UB 178x102x19	S275	3.550	19.05	67.61	47.1	47.1	0.384
Span 1 Lh Rafter	UB 178x102x19	S275	5.798	19.05	110.42	47.1	47.1	0.360
Span 1 Rh Rafter	UB 178x102x19	S275	4.141	19.05	78.87	47.1	47.1	0.525
Span 1 Rh Column	UB 178x102x19	S275	3.979	19.05	75.78	47.1	47.1	0.525
Total Rafter					189.28			
Total Column					143.39			
Total Haunch					10.08			
Total					342.75			

Strength Rafters

Member	U.R.	Status
Span 1 Lh Rafter	0.360	Pass
Span 1 Rh Rafter	0.525	Pass

Columns

Member	U.R.	Status
Span 1 Lh Column	0.395	Pass
Span 1 Rh Column	0.525	Pass

Haunches

Member	U.R.	Status
Span 1 Lh Rafter Lh Eaves	0.269	Pass
Span 1 Lh Rafter Lh Apex	0.036	Pass
Span 1 Rh Rafter Rh Apex	0.052	Pass

Serviceability

Span	Status	Lh Eaves(H)	Lh Apex(V)	Apex(V)	Rh Apex(V)	Rh Eaves(H)
Span 1	Pass	34.6/35.5	na	8.3/48.0	na	38.9/39.8

Base Loads

Span	M [kNm]	F [kN]	N [kN]
Span 1 Lh Column	0.0	-13.3	0.5
Span 1 Rh Column	0.0	-7.5	11.7

Connection Forces

Span	Mf [kNm]	Ff [kN]	Nf [kN]	Mh [kNm]	Fh [kN]	Nh [kN]
Span 1 Lh Eaves	-17.2	-0.1	3.5	-17.0	-0.8	3.2
Span 1 Lh Apex	1.3	6.4	2.5	-1.6	-6.2	0.9
Span 1 Rh Apex	1.3	-6.4	2.5	3.6	5.1	4.2
Span 1 Rh Eaves	24.1	8.3	3.8	-	-	-

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Member Stability

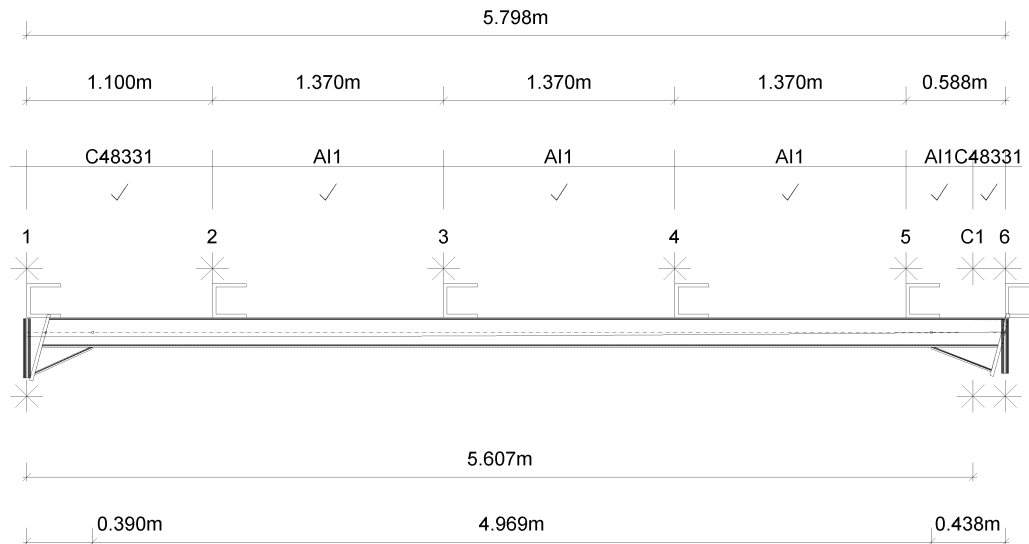
Rafters

Member	Status
Span 1 Lh Rafter	Pass
Span 1 Rh Rafter	Pass

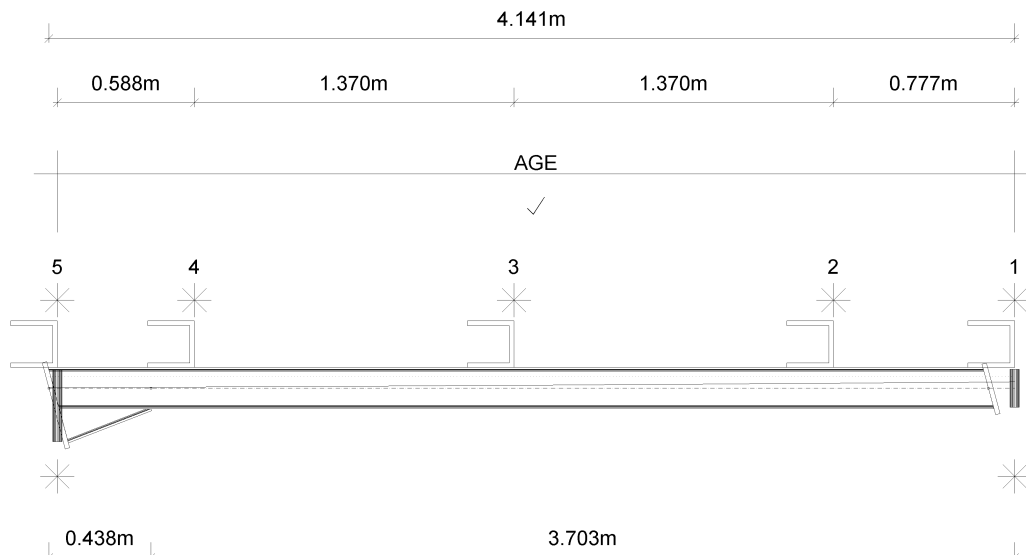
Columns

Member	Status
Span 1 Lh Column	Pass
Span 1 Rh Column	Pass

Span 1 Lh Rafter



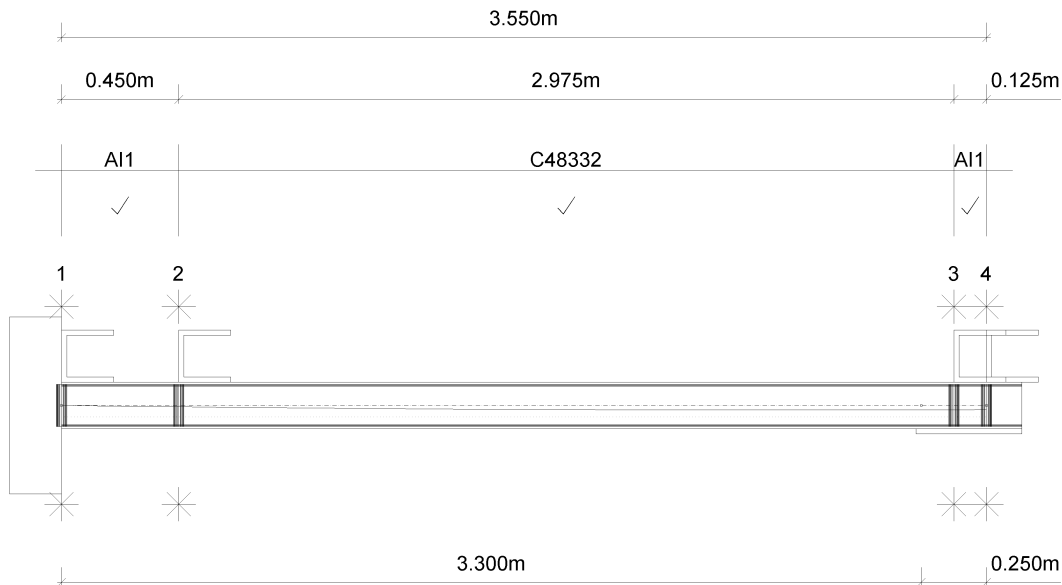
Span 1 Rh Rafter



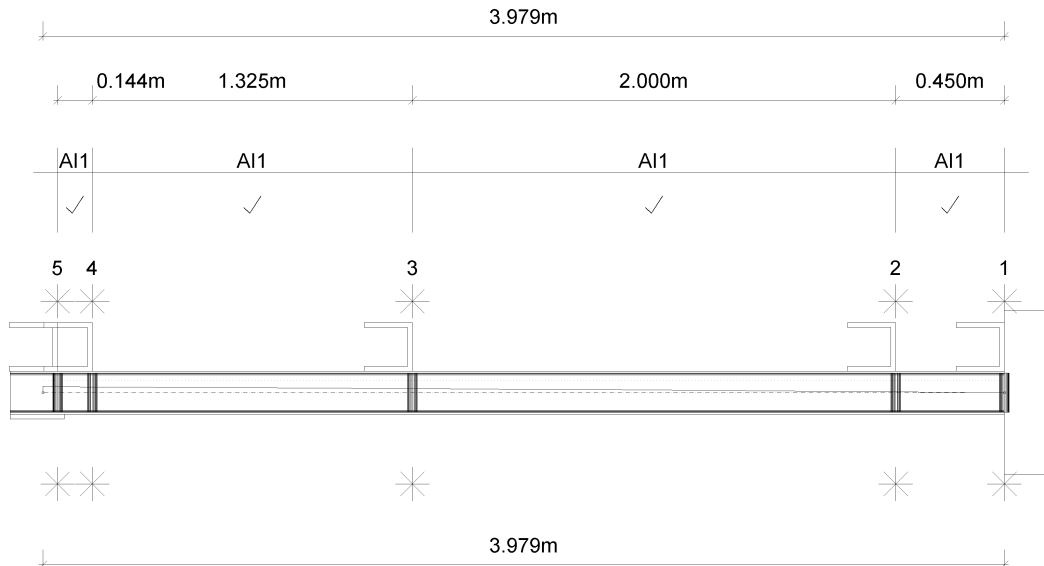
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Span 1 Lh Column



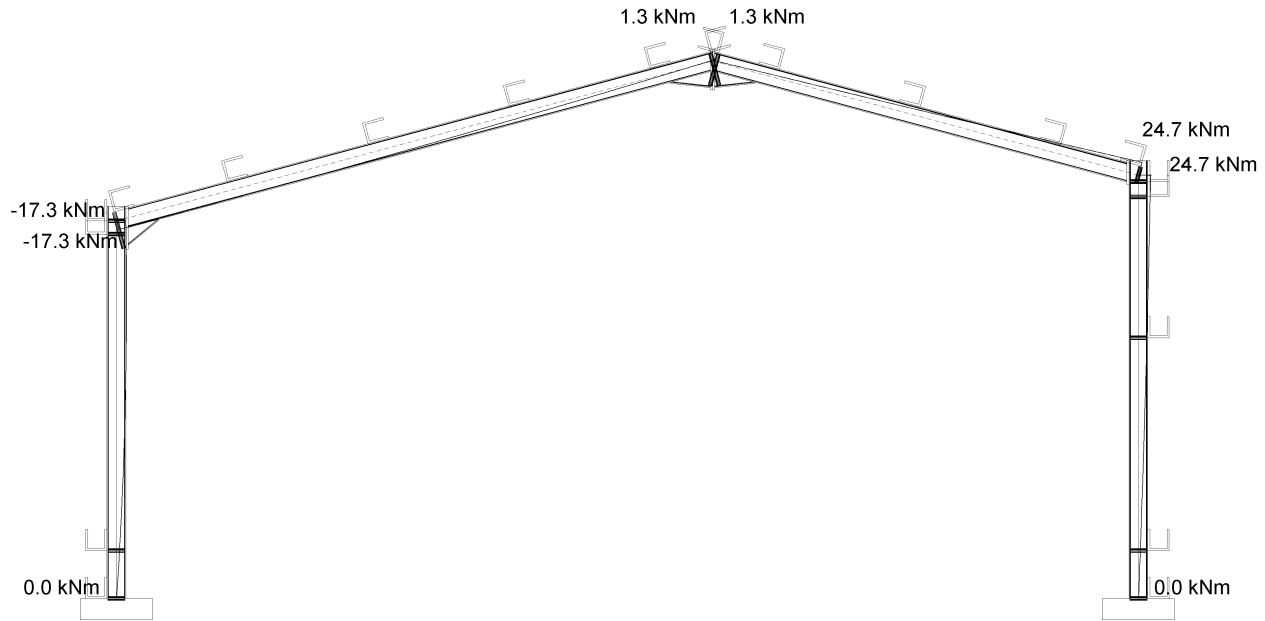
Span 1 Rh Column



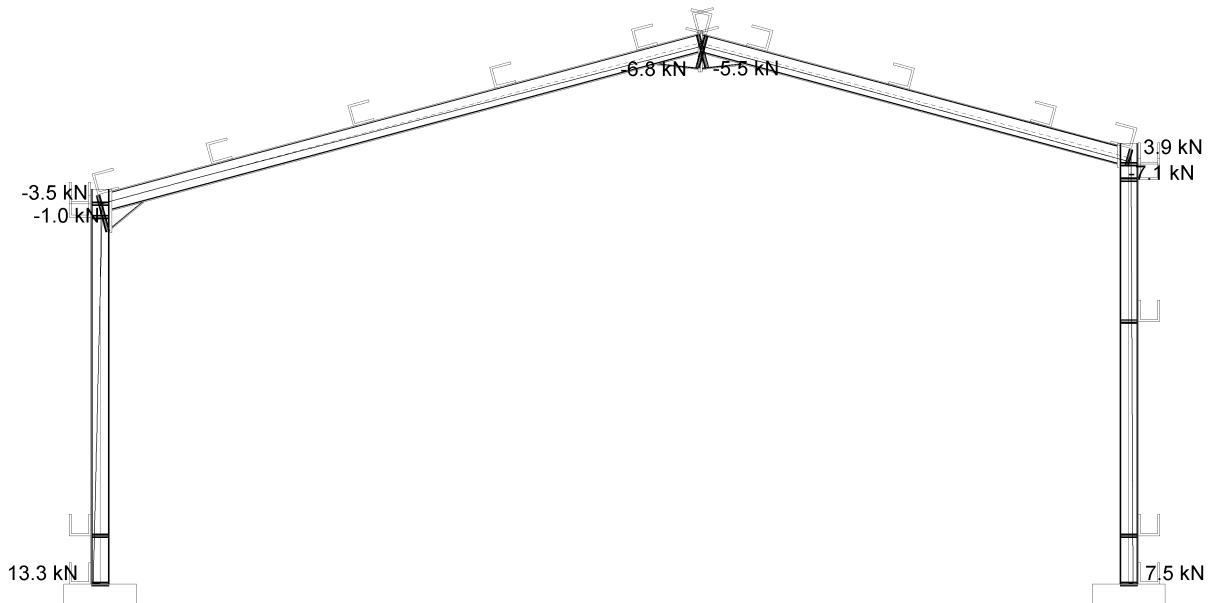
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Bending Moment Diagram



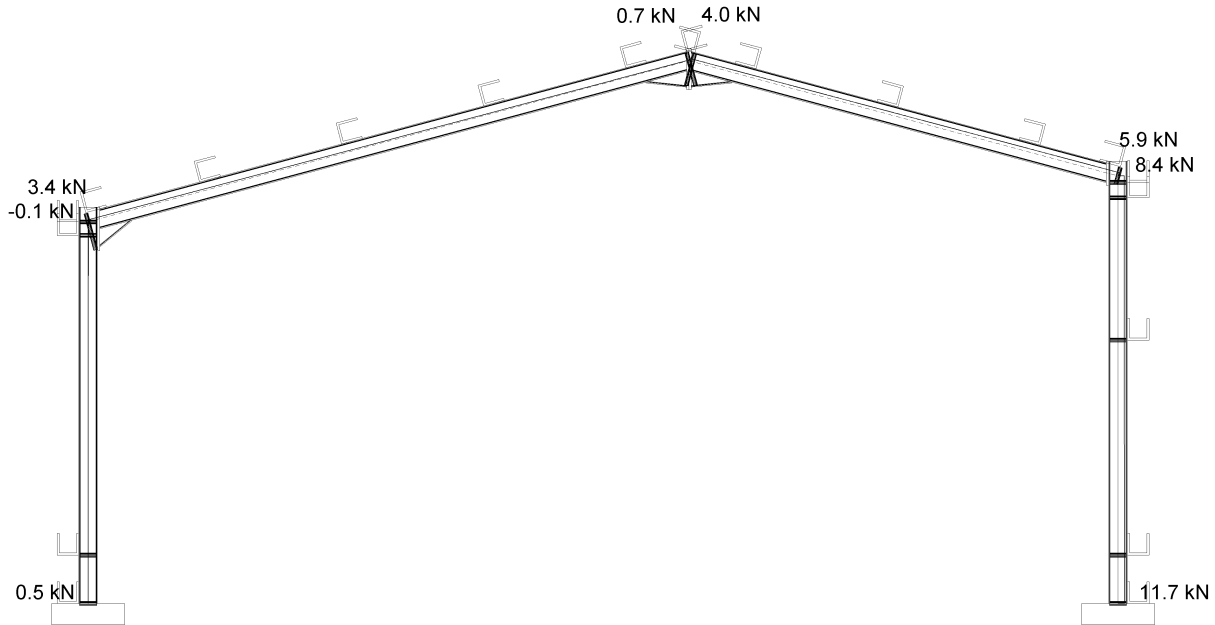
Shear Force Diagram



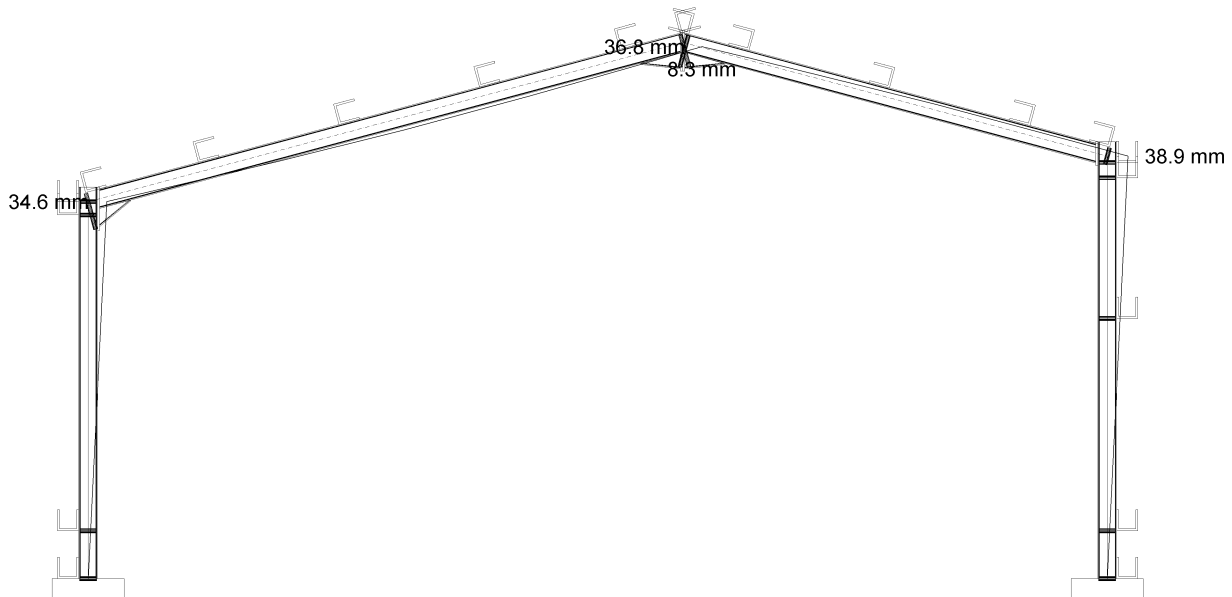
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Axial Load Diagram



Deflected Shape Diagram



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D+WR

Sections

Member	Section	Grade	Length	Mass	Weight	Mp	Mpr	UR
Span 1 Lh Column	UB 178x102x19	S275	3.550	19.05	67.61	47.1	47.1	0.533
Span 1 Lh Rafter	UB 178x102x19	S275	5.798	19.05	110.42	47.1	47.1	0.507
Span 1 Rh Rafter	UB 178x102x19	S275	4.141	19.05	78.87	47.1	47.1	0.343
Span 1 Rh Column	UB 178x102x19	S275	3.979	19.05	75.78	47.1	47.1	0.443
Total Rafter					189.28			
Total Column					143.39			
Total Haunch					10.08			
Total					342.75			

Strength

Rafters

Member	U.R.	Status
Span 1 Lh Rafter	0.507	Pass
Span 1 Rh Rafter	0.343	Pass

Columns

Member	U.R.	Status
Span 1 Lh Column	0.533	Pass
Span 1 Rh Column	0.443	Pass

Haunches

Member	U.R.	Status
Span 1 Lh Rafter Lh Eaves	0.388	Pass
Span 1 Lh Rafter Lh Apex	0.021	Pass
Span 1 Rh Rafter Rh Apex	0.051	Pass

Serviceability

Span	Status	Lh Eaves(H)	Lh Apex(V)	Apex(V)	Rh Apex(V)	Rh Eaves(H)
Span 1	Pass	-33.8/35.5	na	3.8/48.0	na	-31.9/39.8

Base Loads

Span	M [kNm]	F [kN]	N [kN]
Span 1 Lh Column	0.0	9.1	9.5
Span 1 Rh Column	0.0	14.2	2.1

Connection Forces

Span	Mf [kNm]	Ff [kN]	Nf [kN]	Mh [kNm]	Fh [kN]	Nh [kN]
Span 1 Lh Eaves	25.9	8.8	5.8	23.9	6.7	7.8
Span 1 Lh Apex	-1.1	-5.2	4.1	0.5	3.5	5.5
Span 1 Rh Apex	-1.1	5.2	4.1	-3.7	-5.5	2.8
Span 1 Rh Eaves	-15.9	-1.2	5.0	-	-	-

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Member Stability

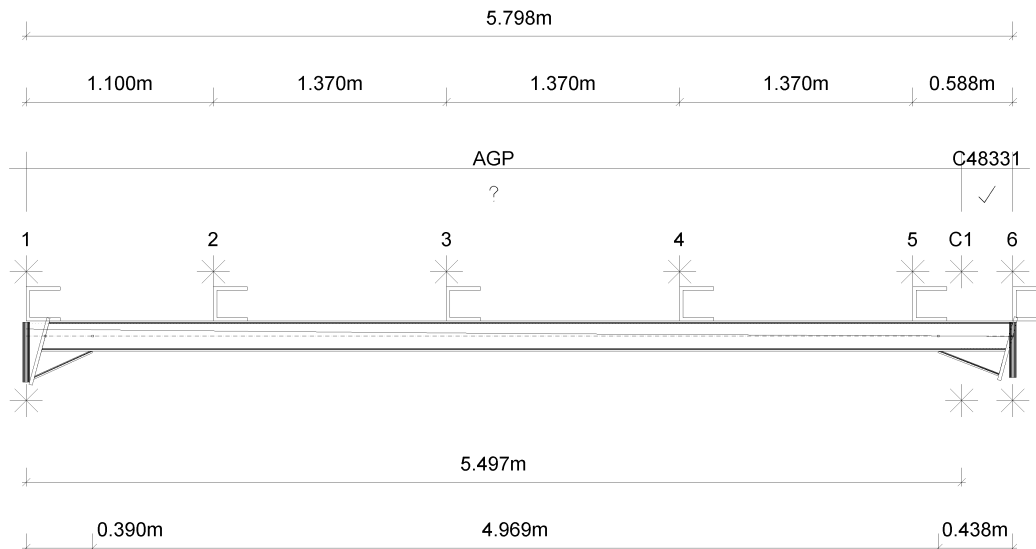
Rafters

Member	Status
Span 1 Lh Rafter	Pass
Span 1 Rh Rafter	Pass

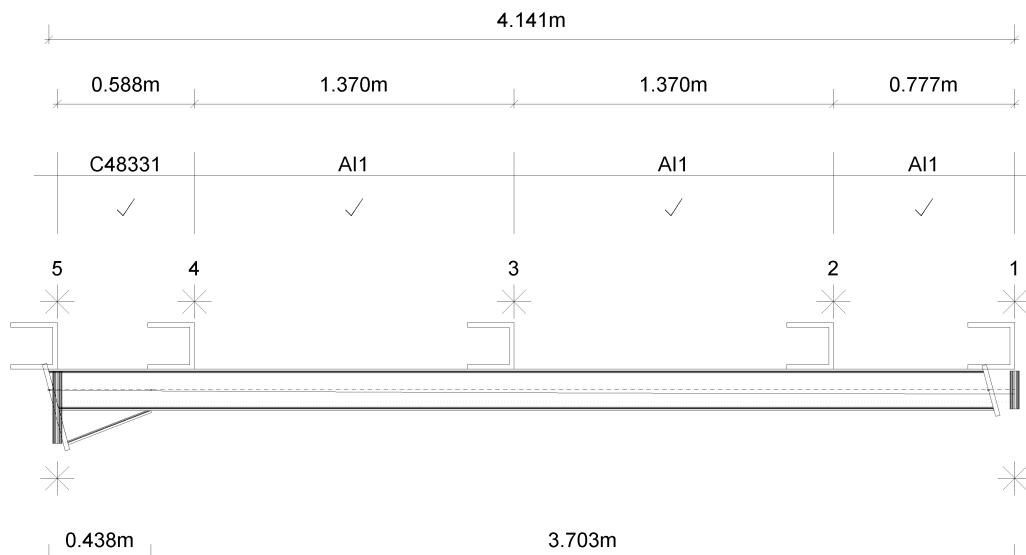
Columns

Member	Status
Span 1 Lh Column	Pass
Span 1 Rh Column	Pass

Span 1 Lh Rafter



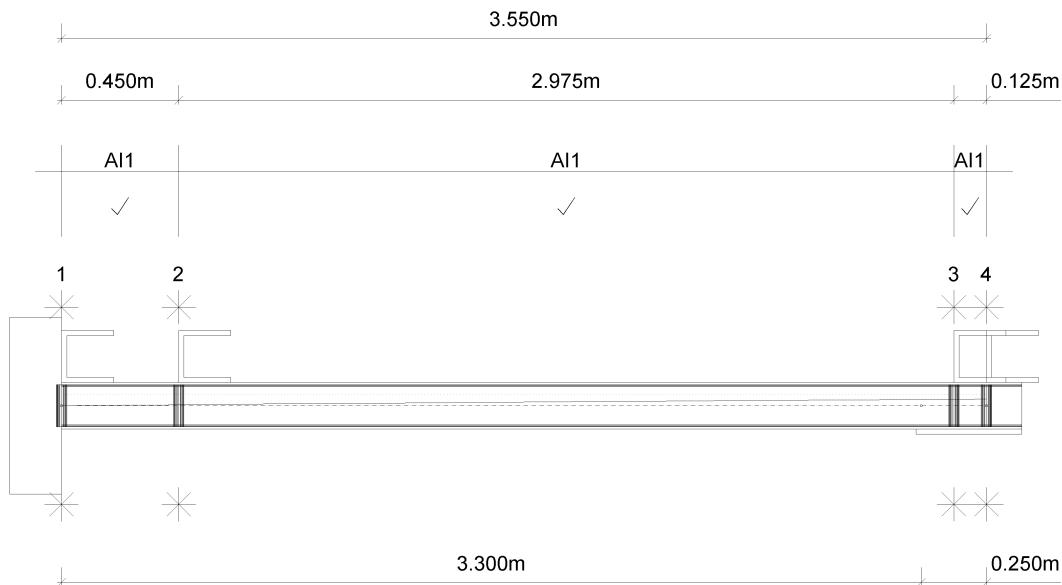
Span 1 Rh Rafter



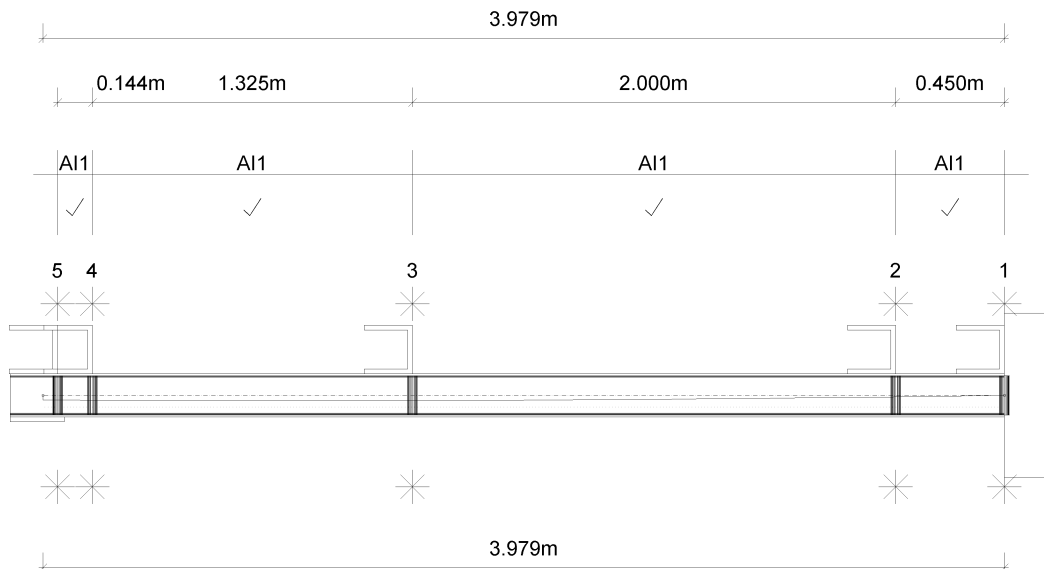
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Span 1 Lh Column



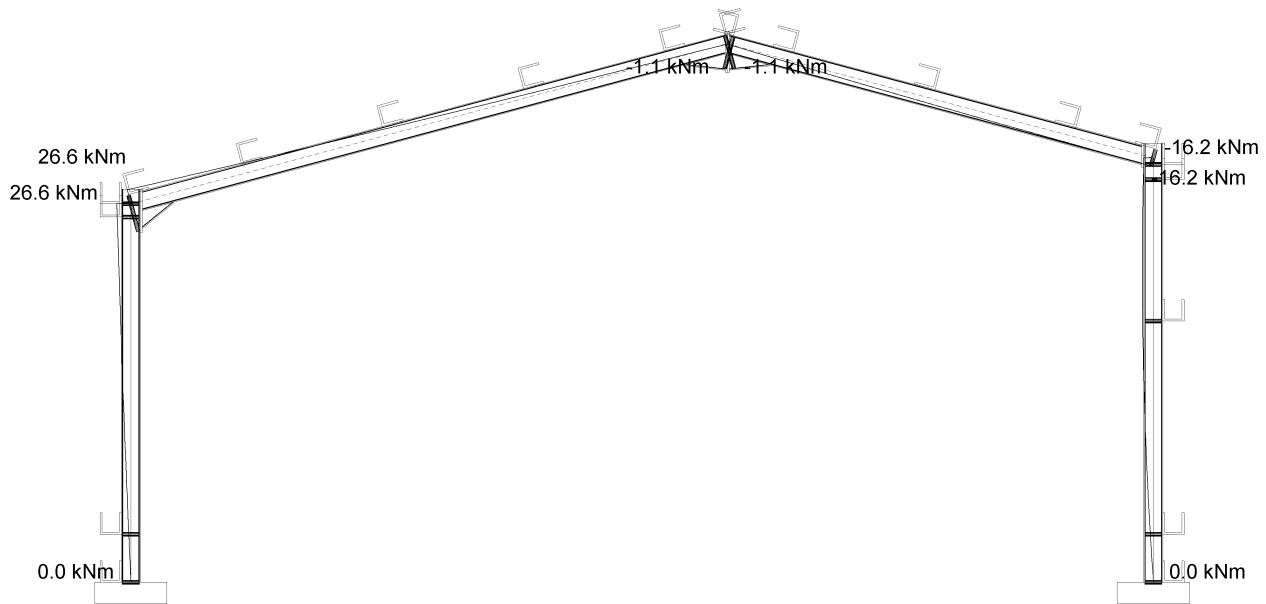
Span 1 Rh Column



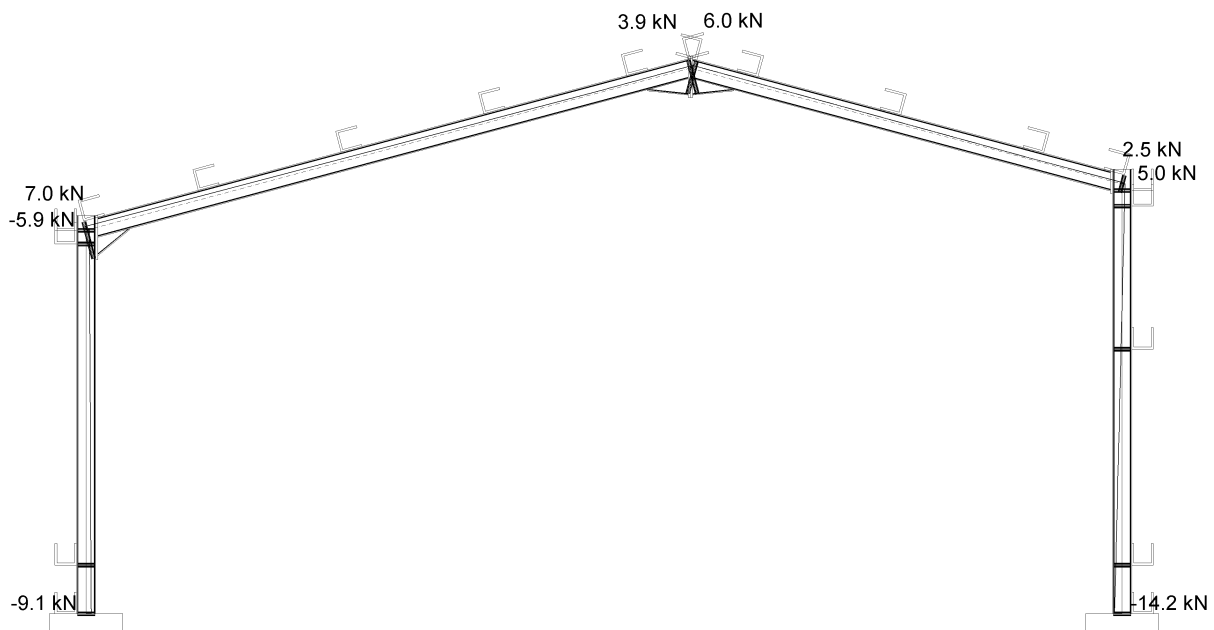
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Checked by:	BD	Date: SEP 21
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Title of Scheme: **LADYGREEN FARM**

Bending Moment Diagram



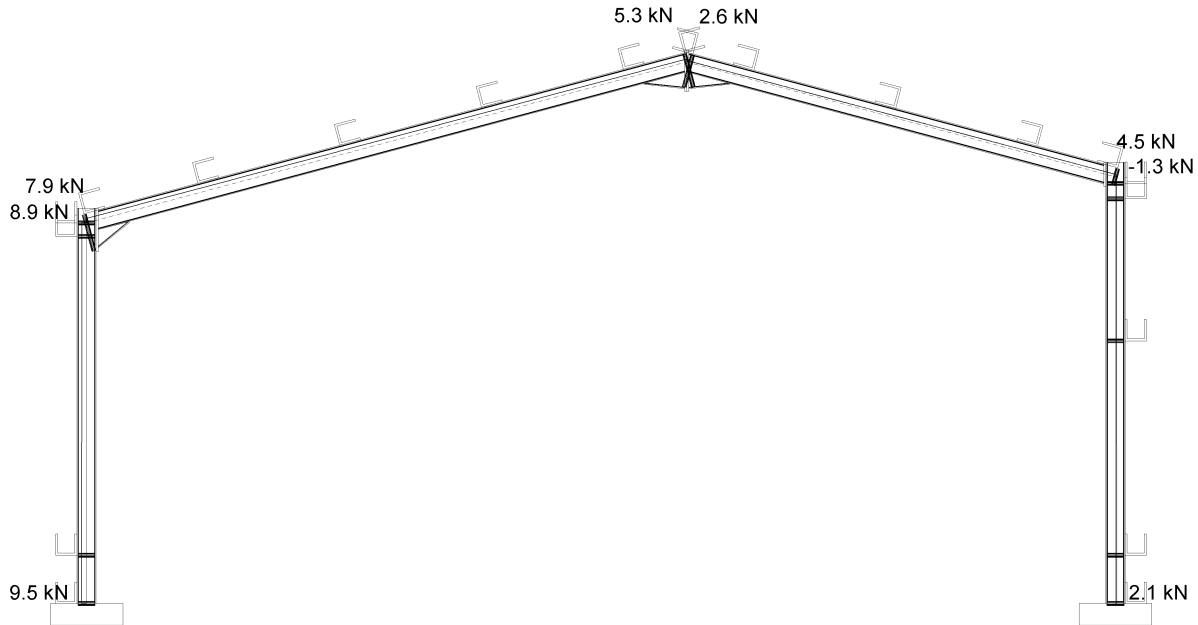
Shear Force Diagram



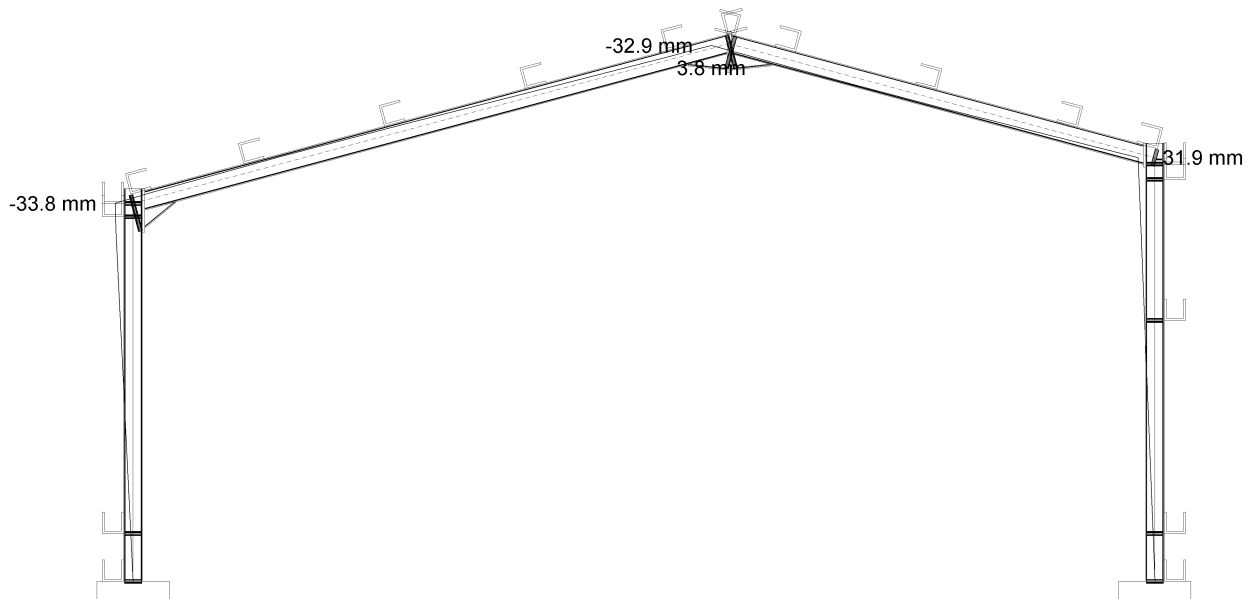
Sheet no.	21	Rev. A
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Title of Scheme: **LADYGREEN FARM**

Axial Load Diagram



Deflected Shape Diagram



D+WG Sections

Member	Section	Grade	Length	Mass	Weight	Mp	Mpr	UR
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Title of Scheme: **LADYGREEN FARM**

Member	Section	Grade	Length	Mass	Weight	Mp	Mpr	UR
Span 1 Lh Column	UB 178x102x19	S275	3.550	19.05	67.61	47.1	47.1	0.086
Span 1 Lh Rafter	UB 178x102x19	S275	5.798	19.05	110.42	47.1	47.1	0.122
Span 1 Rh Rafter	UB 178x102x19	S275	4.141	19.05	78.87	47.1	47.1	0.121
Span 1 Rh Column	UB 178x102x19	S275	3.979	19.05	75.78	47.1	47.1	0.136
Total Rafter					189.28			
Total Column					143.39			
Total Haunch					10.08			
Total					342.75			

Strength Rafters

Member	U.R.	Status
Span 1 Lh Rafter	0.122	Pass
Span 1 Rh Rafter	0.121	Pass

Columns

Member	U.R.	Status
Span 1 Lh Column	0.117	Pass
Span 1 Rh Column	0.136	Pass

Haunches

Member	U.R.	Status
Span 1 Lh Rafter Lh Eaves	0.041	Pass
Span 1 Lh Rafter Lh Apex	0.094	Pass
Span 1 Rh Rafter Rh Apex	0.085	Pass

Serviceability

Span	Status	Lh Eaves(H)	Lh Apex(V)	Apex(V)	Rh Apex(V)	Rh Eaves(H)
Span 1	Pass	0.7/35.5	na	12.1/48.0	na	7.2/39.8

Base Loads

Span	M [kNm]	F [kN]	N [kN]
Span 1 Lh Column	0.0	5.1	2.6
Span 1 Rh Column	0.0	-5.5	6.0

Connection Forces

Span	Mf [kNm]	Ff [kN]	Nf [kN]	Mh [kNm]	Fh [kN]	Nh [kN]
Span 1 Lh Eaves	3.1	1.9	-3.2	2.3	2.5	-2.8
Span 1 Lh Apex	-6.0	0.8	-5.2	-5.7	0.7	-5.0
Span 1 Rh Apex	-6.0	-0.8	-5.2	-5.0	2.3	-4.6
Span 1 Rh Eaves	5.4	2.6	-3.8	-	-	-

Member Stability

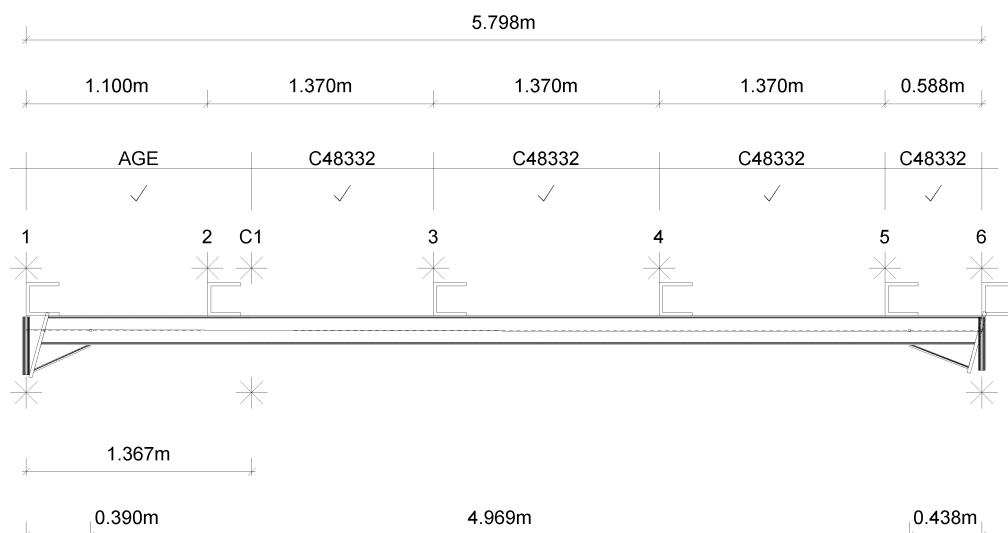
Rafters

Member	Status
Span 1 Lh Rafter	Pass
Span 1 Rh Rafter	Pass

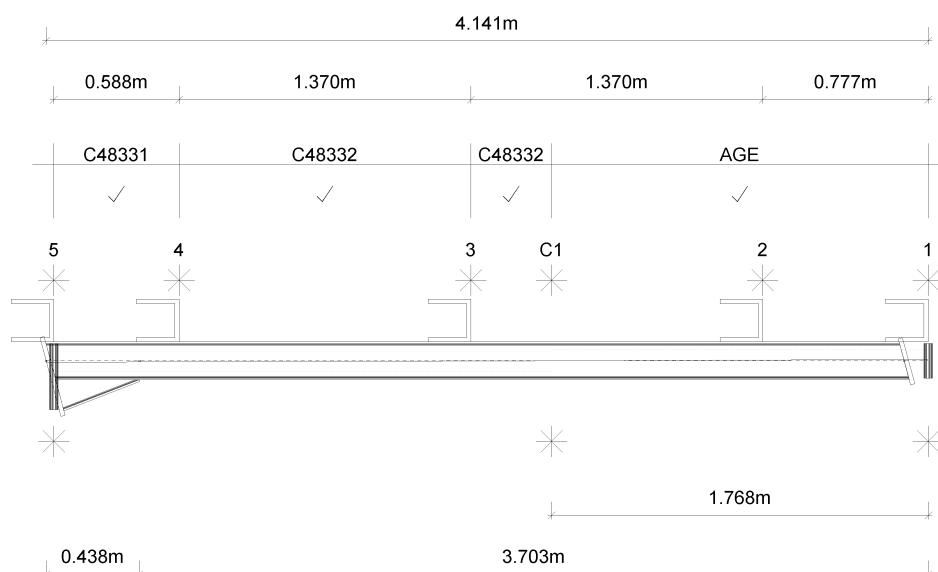
Columns

Member	Status
Span 1 Lh Column	Pass
Span 1 Rh Column	Pass

Span 1 Lh Rafter



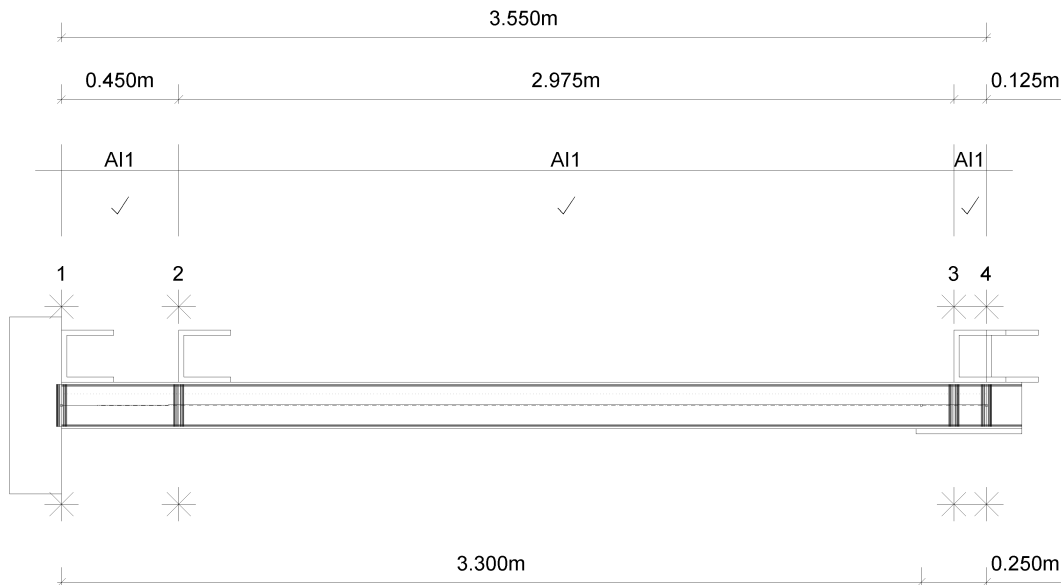
Span 1 Rh Rafter



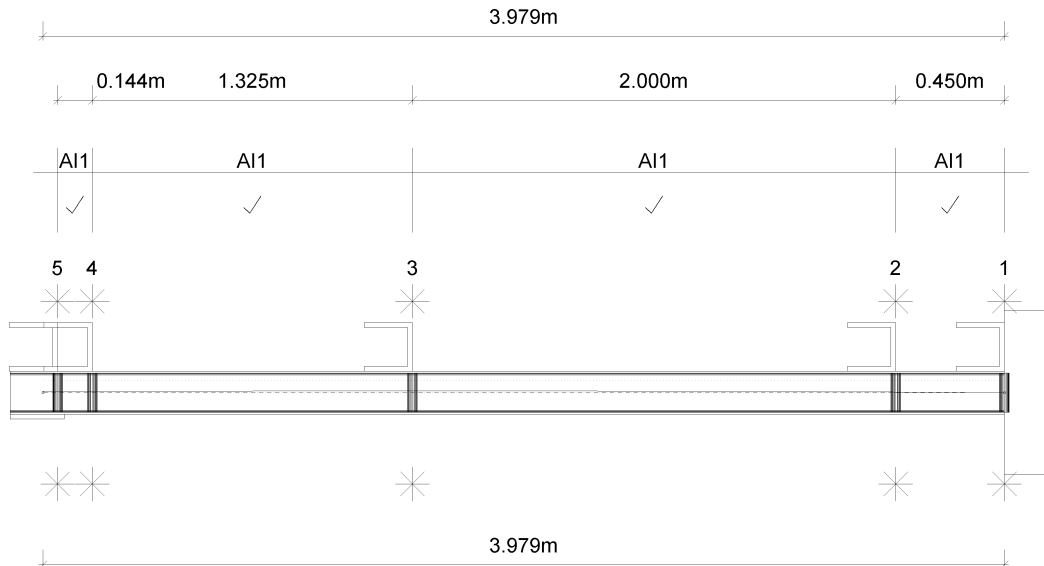
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Title of Scheme: **LADYGREEN FARM**

Span 1 Lh Column



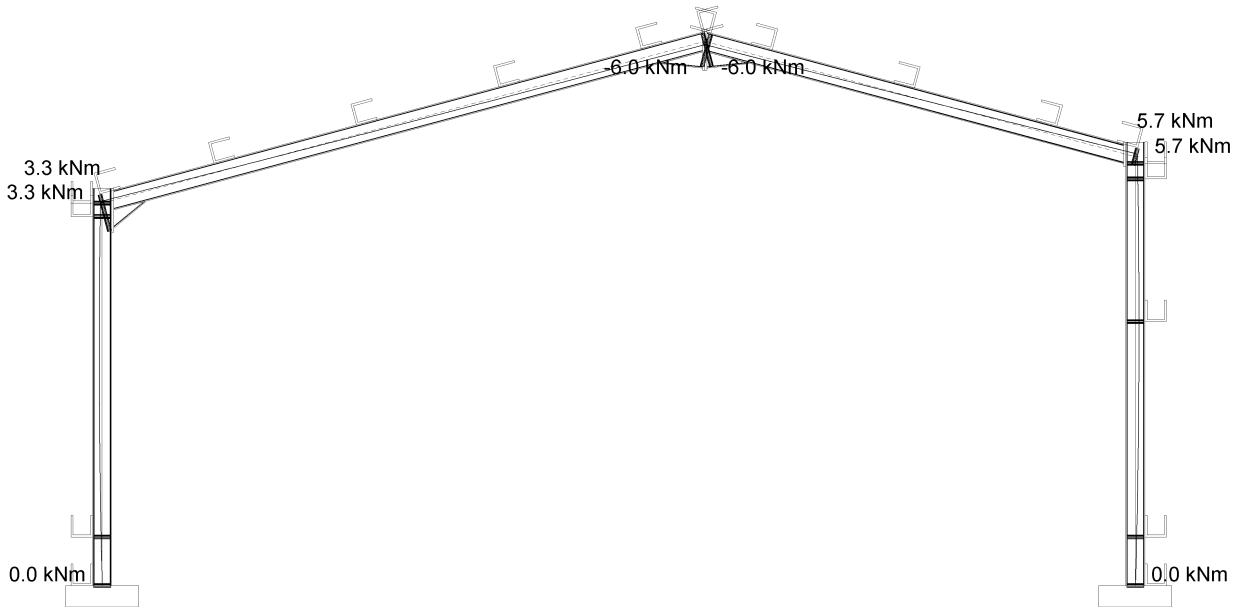
Span 1 Rh Column



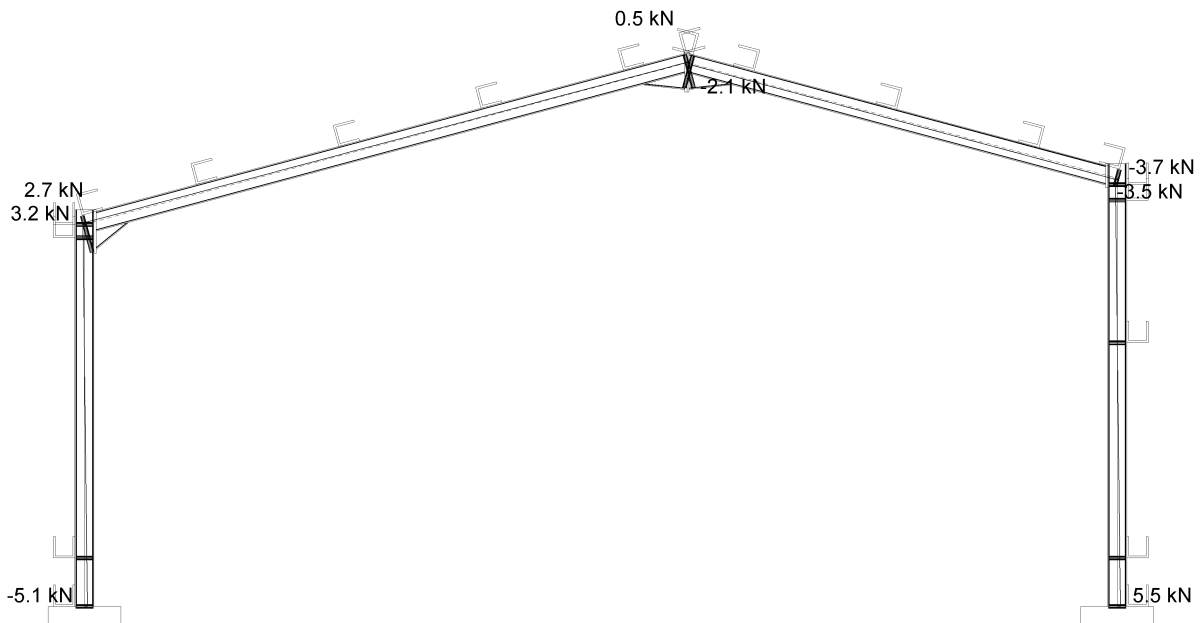
Sheet no.	25	Rev. A
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Title of Scheme: **LADYGREEN FARM**

Bending Moment Diagram



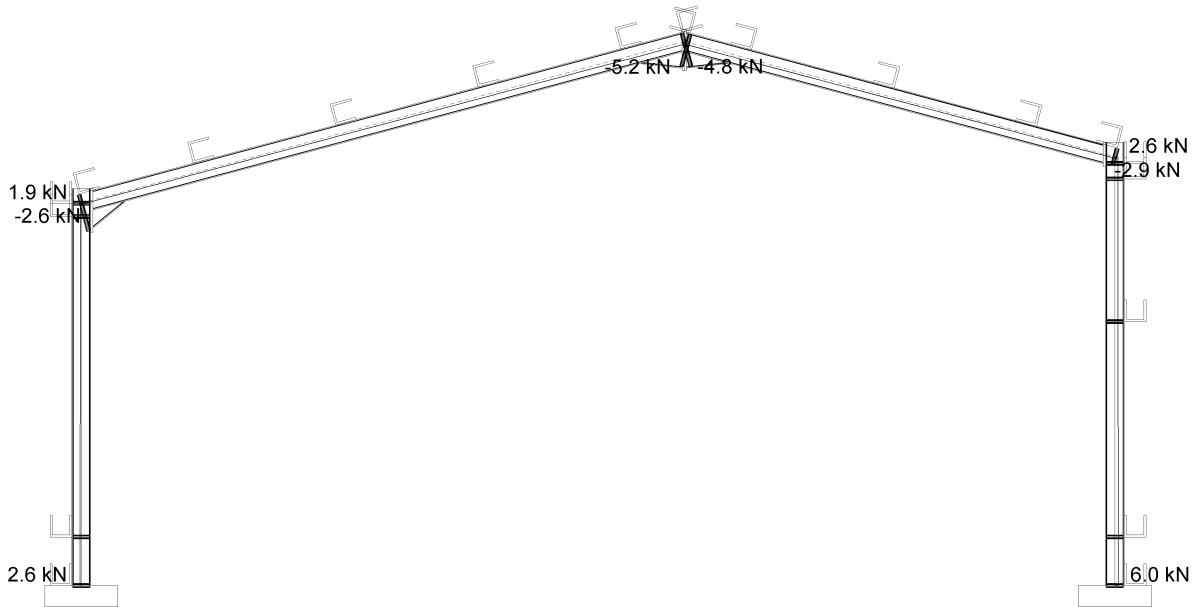
Shear Force Diagram



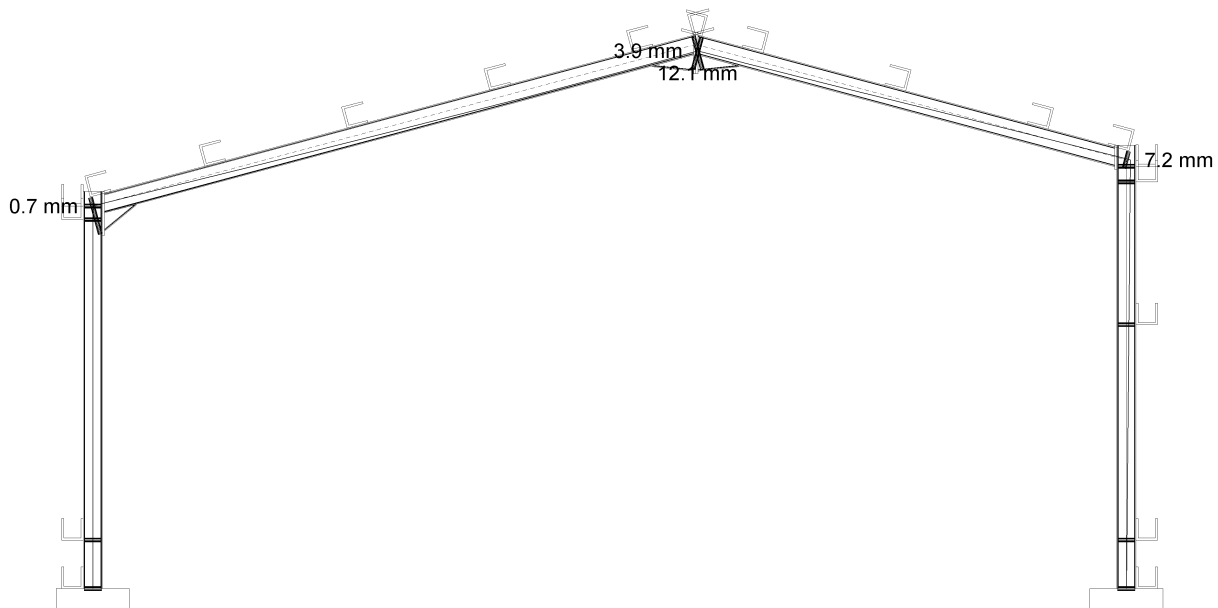
Sheet no.	26	Rev. A
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Axial Load Diagram



Deflected Shape Diagram



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Title of Scheme: **LADYGREEN FARM**

Foundation Loads

Self weight

Span	M [kNm]	F [kN]	N [kN]
Span 1 Lh Column	0.0	0.3	1.6
Span 1 Rh Column	0.0	-0.3	1.7

Frame Dead Load

Span	M [kNm]	F [kN]	N [kN]
Span 1 Lh Column	0.0	1.3	4.4
Span 1 Rh Column	0.0	-1.3	6.2

Frame Service Load

Span	M [kNm]	F [kN]	N [kN]
Span 1 Lh Column	0.0	0.9	3.2
Span 1 Rh Column	0.0	-0.9	4.5

Frame Imposed Load

Span	M [kNm]	F [kN]	N [kN]
Span 1 Lh Column	0.0	3.8	12.8
Span 1 Rh Column	0.0	-3.8	17.9

Wind L

Span	M [kNm]	F [kN]	N [kN]
Span 1 Lh Column	0.0	-11.3	-6.2
Span 1 Rh Column	0.0	-3.5	-0.4

Wind R

Span	M [kNm]	F [kN]	N [kN]
Span 1 Lh Column	0.0	4.7	0.2
Span 1 Rh Column	0.0	12.0	-7.3

Wind G

Span	M [kNm]	F [kN]	N [kN]
Span 1 Lh Column	0.0	1.8	-4.7
Span 1 Rh Column	0.0	-2.1	-4.5

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BRACING

PLAN BRACING

Total wind load to gable $\sim 10\text{m} \times 4.5\text{m} \times 0.74\text{kN/m}^2 \times 1.15 = 38.3\text{kN}$

Factored wind load to eaves $= 1.4 \times \frac{1}{4} \times 38.3\text{kN} = 13.4\text{kN}$

Length of bracing member $= (2.8^2 + 4.57^2)^{1/2} = 5.36\text{m}$

Axial force in member $= 5.36 / 4.57 \times 13.4\text{kN} = 15.7\text{kN}$

Effective buckling length of member $= 0.85 \times 5.36\text{m} = 4.55\text{m}$

USE MIN HOT-FINISHED CHS76.1x3.2 OR COLD-FORMED CHS76.1x4.0
PLAN BRACING IN 1no BAY

TIMBER EAVES STRUTS

Unfactored wind load to eaves $= \frac{1}{4} \times 38.3\text{kN} = 9.6\text{kN}$

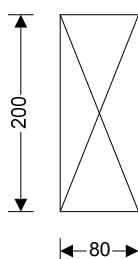
Length of eaves struts $= 4.57\text{m}$

TIMBER MEMBER DESIGN TO BS5268-2:2002

Analysis results

Design axial compression

$P = 9.600 \text{ kN}$



Timber section details

Breadth of sections

$b = 80 \text{ mm}$

Depth of sections

$h = 200 \text{ mm}$

Number of sections in member

$N = 1$

Overall breadth of member

$b_o = N \times b = 80 \text{ mm}$

Timber strength class

C16

Member details

Service class of timber

1

Load duration

Short term

Effective length - cl.2.11.3

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Unbraced length in x-axis	$L_x = 4572 \text{ mm}$
Effective length factor in x-axis - Table 21	$K_x = 1$
Effective length in x-axis	$L_{ex} = L_x \times K_x = 4572 \text{ mm}$
Unbraced length in y-axis	$L_y = 4572 \text{ mm}$
Effective length factor in y-axis - Table 21	$K_y = 1$
Effective length in y-axis	$L_{ey} = L_y \times K_y = 4572 \text{ mm}$

Section properties

Cross sectional area of member	$A = N \times b \times h = 16000 \text{ mm}^2$
Section modulus	$Z_x = N \times b \times h^2 / 6 = 533333 \text{ mm}^3$ $Z_y = h \times (N \times b)^2 / 6 = 213333 \text{ mm}^3$
Second moment of area	$I_x = N \times b \times h^3 / 12 = 53333333 \text{ mm}^4$ $I_y = h \times (N \times b)^3 / 12 = 8533333 \text{ mm}^4$
Radius of gyration	$i_x = \sqrt{I_x / A} = 57.7 \text{ mm}$ $i_y = \sqrt{I_y / A} = 23.1 \text{ mm}$

Modification factors

Duration of loading - Table 17	$K_3 = 1.50$
Total depth of member - cl.2.10.6	$K_7 = (300 \text{ mm} / h)^{0.11} = 1.05$
Load sharing - cl.2.9	$K_8 = 1.00$
Members subject to axial compression - Table 22	$K_{12} = 0.09$

Slenderness ratio - cl.2.11.4

Permissible slenderness ratio	$\lambda_{max} = 250$
Slenderness ratio	$\lambda = \max(L_{ex} / i_x, L_{ey} / i_y) = 197.973$

PASS - Slenderness ratio is less than permissible slenderness ratio

Compression parallel to grain

Permissible compressive stress	$\sigma_{c_adm} = \sigma_c \times K_3 \times K_8 \times K_{12} = 0.882 \text{ N/mm}^2$
Applied compressive stress	$\sigma_{c_a} = P / A = 0.600 \text{ N/mm}^2$
	$\sigma_{c_a} / \sigma_{c_adm} = 0.680$

PASS - Applied compressive stress is less than permissible compressive stress

EXISTING 200mm x 80mm TIMBER EAVES STRUTS ARE ADEQUATE

ELEVATION BRACING

Factored wind load to eaves = $1.4 \times 1/4 \times 38.3\text{kN} = 13.4\text{kN}$

Length of bracing member = $(4.57^2 + 4^2)^{1/2} = 6.07\text{m}$

Axial force in member = $6.07 / 4.57 \times 13.4\text{kN} = 17.8\text{kN}$

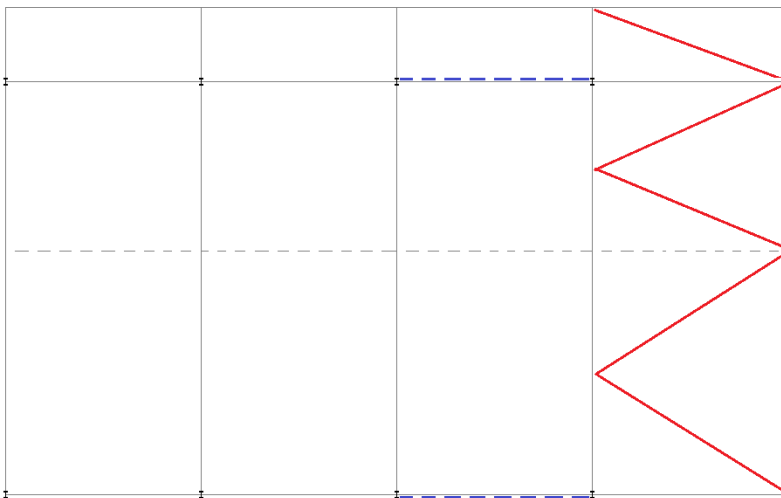
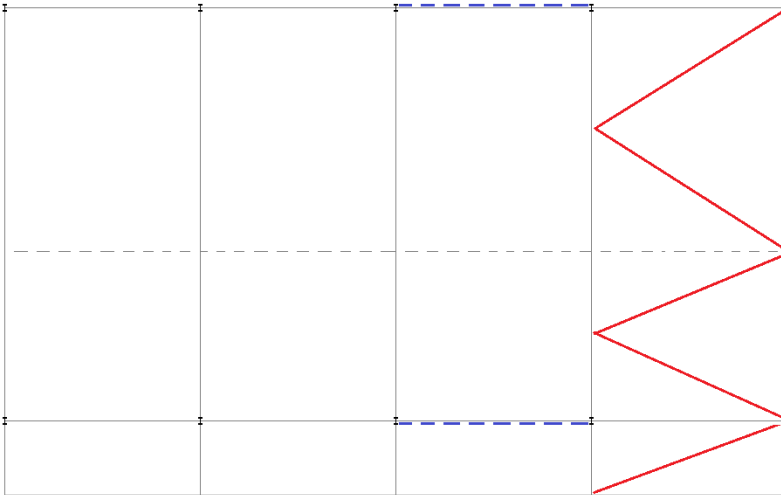
EXISTING 80mm x 8.0 S275 CROSS-FLAT BRACING IN 1no BAY IS ADEQUATE

Unfactored bracing load to foundation = $9.6 \times 3.9/4.57 = \pm 8.2\text{kN}$

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BRACING PLAN (NOT TO SCALE)



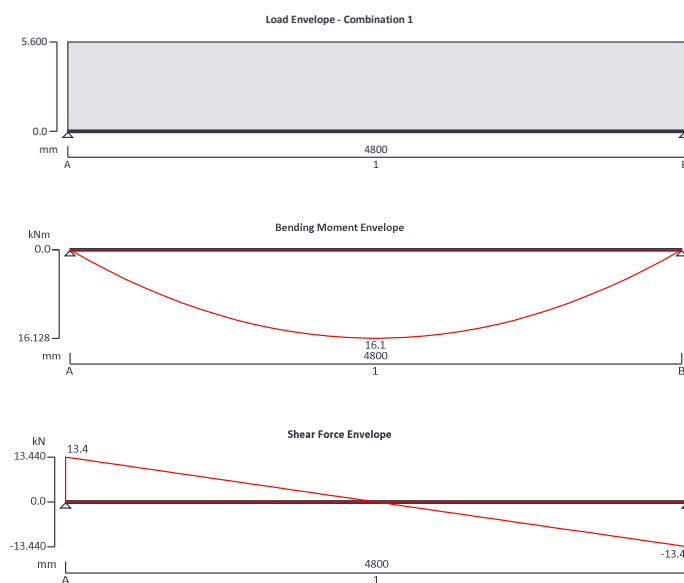
GABLE POSTS

Maximum height of gable posts ~ 4.8m

Wind force on gable post = $4.75\text{m} \times 0.74\text{kN/m}^2 \times 1.15 = 4.04\text{kN/m}$

STEEL BEAM ANALYSIS & DESIGN (BS5950)

In accordance with BS5950-1:2000 incorporating Corrigendum No.1



Support conditions

Support A

Vertically restrained

Rotationally free

Support B

Vertically restrained

Rotationally free

Applied loading

Beam loads

Wind full UDL 4.04 kN/m

Load combinations

Load combination 1

Wind $\times$ 1.40

Analysis results

Maximum moment

$M_{\max} = 16.1 \text{ kNm}$

$M_{\min} = 0 \text{ kNm}$

Maximum shear

$V_{\max} = 13.4 \text{ kN}$

$V_{\min} = -13.4 \text{ kN}$

Deflection

$\delta_{\max} = 9.9 \text{ mm}$

$\delta_{\min} = 0 \text{ mm}$

Maximum reaction at support A

$R_{A_{\max}} = 13.4 \text{ kN}$

$R_{A_{\min}} = 13.4 \text{ kN}$

Unfactored wind load reaction at support A

$R_{A_{\text{Wind}}} = 9.6 \text{ kN}$

Maximum reaction at support B

$R_{B_{\max}} = 13.4 \text{ kN}$

$R_{B_{\min}} = 13.4 \text{ kN}$

Unfactored wind load reaction at support B

$R_{B_{\text{Wind}}} = 9.6 \text{ kN}$

Section details

Section type

UB 178x102x19 (BS4-1)

Steel grade

S275

Classification of cross sections - Section 3.5

Tensile strain coefficient

$\epsilon = 1.00$

Section classification

Plastic

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Shear capacity - Section 4.2.3

Design shear force $F_v = 13.4$ kN

Design shear resistance $P_v = 140.8$ kN

PASS - Design shear resistance exceeds design shear force

Moment capacity - Section 4.2.5

Design bending moment $M = 16.1$ kNm

Moment capacity low shear $M_c = 47.1$ kNm

Buckling resistance moment - Section 4.3.6.4

Buckling resistance moment $M_b = 16.4$ kNm

$M_b / m_{LT} = 17.7$ kNm

PASS - Buckling resistance moment exceeds design bending moment

Check vertical deflection - Section 2.5.2

Consider deflection due to imposed and wind loads

Limiting deflection $\delta_{lim} = 24$ mm

Maximum deflection $\delta = 9.946$ mm

PASS - Maximum deflection does not exceed deflection limit

EXISTING UB178x102x19 (S275) GABLE POSTS ARE ADEQUATE

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CONCLUSIONS AND RECOMMENDATIONS

- Main frame calculations show that the primary steelwork is sufficient to bear proposed loadings.
- Small areas of steelwork where there is significant degradation and delamination should be cut out and re-plated. This is necessary only to the main portal frames – not to the doorposts and gable columns.
- Depth and extent of foundations has not been established, but there is no reason to suspect that they are not adequate.
- Plan and elevation bracing is adequate.
- Existing gable columns are adequate.
- Calculations have not been performed on the timber siderail system, since it is assumed that the cladding and low blockwork walls will be removed and a masonry cavity wall established at the building perimeter. It should be ensured that masonry wall panels are designed with sufficient restraint.
- Calculations have not been performed on the timber purlin system, since it is assumed that new cold-rolled steel purlins will be installed to suit new insulated cladding. Use new Metsec 172.Z.14 or equivalent butt-system purlins at 1800mm centres.