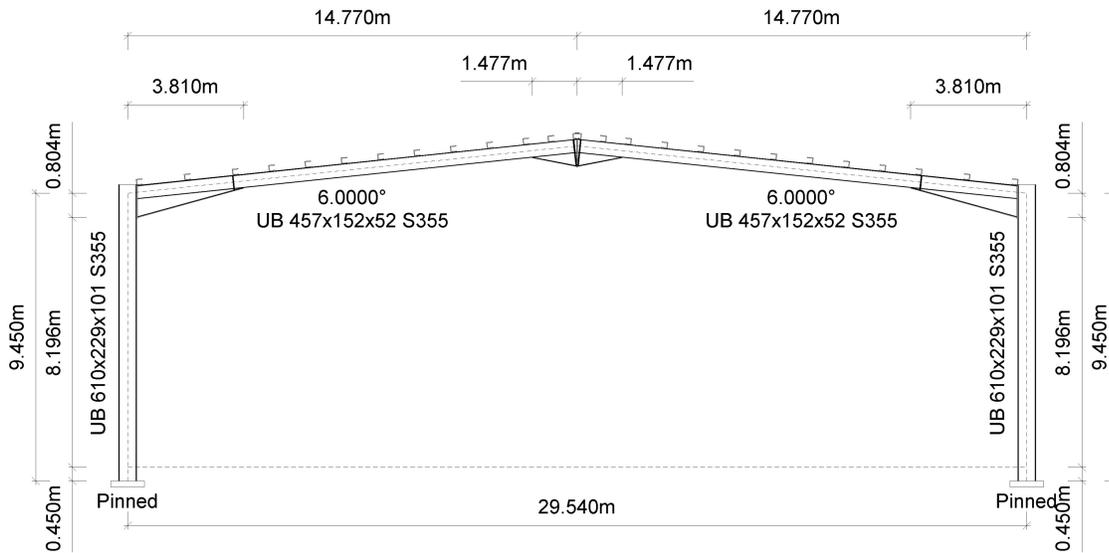


REFERENCE: Portal Frame Check for PV Load

Frame Diagram



Frame Details

No. Spans: 1
Effective Frame Centres: 7.500 m

Span Geometry

| Span | Type | Axis | Lh Eaves [m] | Lh Apex [m] | Apex [m] | Rh Apex [m] | Rh Eaves [m] |
|--------|----------|------|--------------|-------------|----------|-------------|--------------|
| Span 1 | Standard | X | 0.0 | - | 14.770 | - | 29.540 |
| | | Z | 9.000 | - | 10.552 | - | 9.000 |

Wind Options

Wind Method: Standard
Basic Wind Speed (Vb): 22.5 m/s
Ground Roughness: Country
Upwind distance from sea to site: 0.0 km
Altitude factor (Sa): 1.1500
Seasonal factor (Ss): 1.0000
Probability factor (Sp): 1.0000

Haunches

| Haunch | Section | Length [m] | Depth [m] | Beta [°] | Gamma [°] | Offset X1 [mm] | Offset X2 [mm] | Filler Plate |
|-----------------|----------------|------------|-----------|----------|-----------|----------------|----------------|--------------|
| Span 1 Lh Eaves | UB 610x229x101 | 3.810 | 0.804 | 15.3521 | 9.3521 | 156.5 | 3461.6 | |
| Span 1 Apex Lh | UB 457x152x52 | 1.477 | 0.676 | 10.8691 | 16.8691 | 81.6 | 1401.7 | |
| Span 1 Apex Rh | UB 457x152x52 | 1.477 | 0.676 | 10.8691 | 16.8691 | 81.6 | 1401.7 | |
| Span 1 Rh Eaves | UB 610x229x101 | 3.810 | 0.804 | 15.3521 | 9.3521 | 156.5 | 3461.6 | |

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. | 0.400 | - | - | - | 7.500 |

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 | - | - | - | 7.500 |

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 | - | - | - | 7.500 |

ULS, Wind: Side Left, Cpi 0.2000, Roof Cpe -ve

Frame is considered to be in Adjacent/Close zone

| | | |
|---|----------|---|
| Building Length | 50.000 | m |
| Building Width | 29.540 | m |
| Building reference height, H _r | 10.552 | m |
| Building effective height, H _e | 10.552 | m |
| Altitude factor, Sa | 1.1500 | |
| Seasonal factor, Ss | 1.0000 | |
| Probability factor, Sp | 1.0000 | |
| Directional factor, Sd | 1.0000 | |
| Eaves Line orientation EON | 0.0 | ° |
| Critical Wind Angle | 270.0000 | ° |

Wind Speeds

| Member | Sh | Sc | Tc | St | Tt | gt | Sb | Vs [m/s] | Ve [m/s] |
|------------------|-----|-----|-----|-----|-----|-----|--------|-------------|-------------|
| Span 1 Lh Column | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.7877 | 25.9 | 46.3 |
| Span 1 Lh Rafter | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.7877 | 25.9 | 46.3 |
| Span 1 Rh Rafter | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.7877 | 25.9 | 46.3 |
| Span 1 Rh Column | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.7877 | 25.9 | 46.3 |
| Span 1 Lh Column | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Span 1 Lh Rafter | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Span 1 Lh Rafter | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Span 1 Rh Rafter | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Span 1 Rh Rafter | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Span 1 Rh Column | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Wind Loads

| Member | qs [kN/m ²] | Cpi | Cpe | L [m] | a [m] | Cae | Cai | % |
|------------------|----------------------------|--------|---------|----------|----------|--------|--------|--------|
| Span 1 Lh Column | 1.312 | 0.2000 | 0.6728 | 9.450 | 12.065 | 0.9468 | 1.0000 | 100.00 |
| Span 1 Lh Rafter | 1.312 | 0.2000 | -1.7300 | 2.122 | 16.638 | 0.9270 | 1.0000 | 100.00 |
| Span 1 Lh Rafter | | | -0.5800 | 12.729 | | | | |
| Span 1 Rh Rafter | 1.312 | 0.2000 | -0.4100 | 12.729 | 16.638 | 0.9270 | 1.0000 | 100.00 |
| Span 1 Rh Rafter | | | -0.9400 | 2.122 | | | | |
| Span 1 Rh Column | 1.312 | 0.2000 | -0.5000 | 9.450 | 12.065 | 0.9468 | 1.0000 | 100.00 |

Combinations

Sw + Dead + Serv. + Imp.

Frame Imperfection off

| Loadcase | Type | Ultimate P.S.F. | Service P.S.F. |
|--------------------|---------|--------------------|-------------------|
| Self weight | Dead | 1.4000 | 1.0000 |
| Frame Dead Load | Dead | 1.4000 | 1.0000 |
| Frame Imposed Load | Imposed | 1.6000 | 1.0000 |
| Frame Service Load | Dead | 1.4000 | 1.0000 |

Sw + Dead + Serv + Wind

Frame Imperfection off

| Loadcase | Type | Ultimate P.S.F. | Service P.S.F. |
|-----------------|------|--------------------|-------------------|
| Self weight | Dead | 1.2488 | 1.0000 |
| Frame Dead Load | Dead | 1.2488 | 1.0000 |

| Loadcase | Type | Ultimate P.S.F. | Service P.S.F. |
|--|------|-----------------|----------------|
| Frame Service Load | Dead | 1.2488 | 1.0000 |
| ULS, Wind: Side Left, Cpi 0.2000, Roof Cpe -ve | 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 | No Limit |
| Apex Deflection | No Limit |
| Cladding Stiffness | 0.0 % |
| Tie Elongation | No Limit |

Design Code: BS5950

Design Summary

| Design Combination | Lambda p | Lambda r | Status |
|--------------------------|----------|----------|--------|
| Sw + Dead + Serv. + Imp. | 1.102 | 1.000 | Pass |
| Sw + Dead + Serv + Wind | 1.706 | 1.000 | Pass |

Member Stability Status: Invalid

Design Cases

Sw + Dead + Serv. + Imp.

Sections

| Member | Section | Grade | Length | Mass | Weight | Mp | Mpr | UR |
|------------------|----------------|-------|--------|--------|---------|--------|--------|-------|
| Span 1 Lh Column | UB 610x229x101 | S355 | 9.450 | 102.81 | 971.55 | 1043.2 | 1040.1 | 0.869 |
| Span 1 Lh Rafter | UB 457x152x52 | S355 | 14.851 | 52.70 | 782.69 | 392.8 | 391.4 | 0.920 |
| Span 1 Rh Rafter | UB 457x152x52 | S355 | 14.851 | 52.70 | 782.69 | 392.8 | 391.4 | 0.920 |
| Span 1 Rh Column | UB 610x229x101 | S355 | 9.450 | 102.81 | 971.55 | 1043.2 | 1040.1 | 0.869 |
| Total Rafter | | | | | 1565.38 | | | |
| Total Column | | | | | 1943.11 | | | |
| Total Haunch | | | | | 437.66 | | | |
| Total | | | | | 3946.15 | | | |

Hinge History

Hinge History

| Event | Lambda 1st Order | Lambda 2nd Order | Status | Member | Distance(B) | Distance(A) | Status |
|---------|------------------|------------------|--------|------------------|-------------|-------------|--------|
| Event 1 | 1.0838 | - | Formed | Span 1 Rh Rafter | 3.807 | 3.807 | |
| Event 2 | 1.1017 | - | Formed | Span 1 Lh Rafter | 13.343 | 13.343 | |

Strength

Rafters

| Member | U.R. | Status |
|------------------|-------|--------|
| Span 1 Lh Rafter | 0.917 | Pass |
| Span 1 Rh Rafter | 0.917 | Pass |

Columns

| Member | U.R. | Status |
|------------------|-------|--------|
| Span 1 Lh Column | 0.866 | Pass |
| Span 1 Rh Column | 0.866 | Pass |

Haunches

| Member | U.R. | Status |
|---------------------------|-------|--------|
| Span 1 Lh Rafter Lh Eaves | 0.801 | Pass |
| Span 1 Lh Rafter Lh Apex | 0.748 | Pass |
| Span 1 Rh Rafter Rh Eaves | 0.801 | Pass |
| Span 1 Rh Rafter Rh Apex | 0.748 | Pass |

Serviceability

| Span | Status | Lh Eaves(H) | Lh Apex(V) | Apex(V) | Rh Apex(V) | Rh Eaves(H) |
|--------|-------------|-------------|------------|----------|------------|-------------|
| Span 1 | Not Checked | -23.1/na | na | 226.8/na | na | 23.1/na |

Frame Stability

None

Base Loads

| Span | M [kNm] | F [kN] | N [kN] |
|------------------|---------|--------|--------|
| Span 1 Lh Column | 0.0 | 104.5 | 216.1 |
| Span 1 Rh Column | 0.0 | -104.5 | 216.1 |

Connection Forces

| Span | Mf [kNm] | Ff [kN] | Nf [kN] | Mh [kNm] | Fh [kN] | Nh [kN] |
|-----------------|----------|---------|---------|----------|---------|---------|
| Span 1 Lh Eaves | 927.0 | 198.3 | 104.5 | 360.3 | 139.0 | 119.7 |
| Span 1 Lh Apex | -347.0 | 0.0 | 104.6 | -348.0 | 9.6 | 106.1 |
| Span 1 Rh Apex | -347.0 | 0.0 | 104.6 | -348.0 | 9.6 | 106.1 |
| Span 1 Rh Eaves | 927.0 | 198.3 | 104.5 | 360.3 | 139.0 | 119.7 |

Member Stability

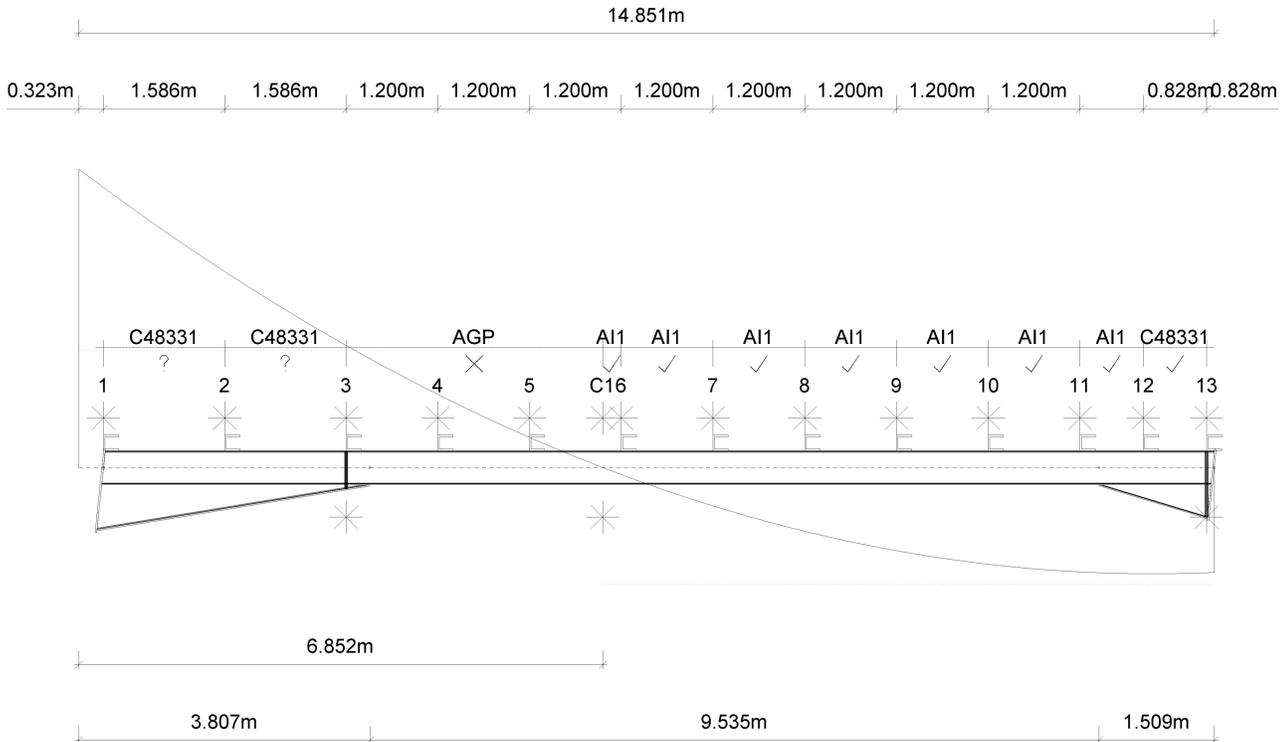
Rafters

| Member | Status |
|------------------|---------|
| Span 1 Lh Rafter | Invalid |
| Span 1 Rh Rafter | Invalid |

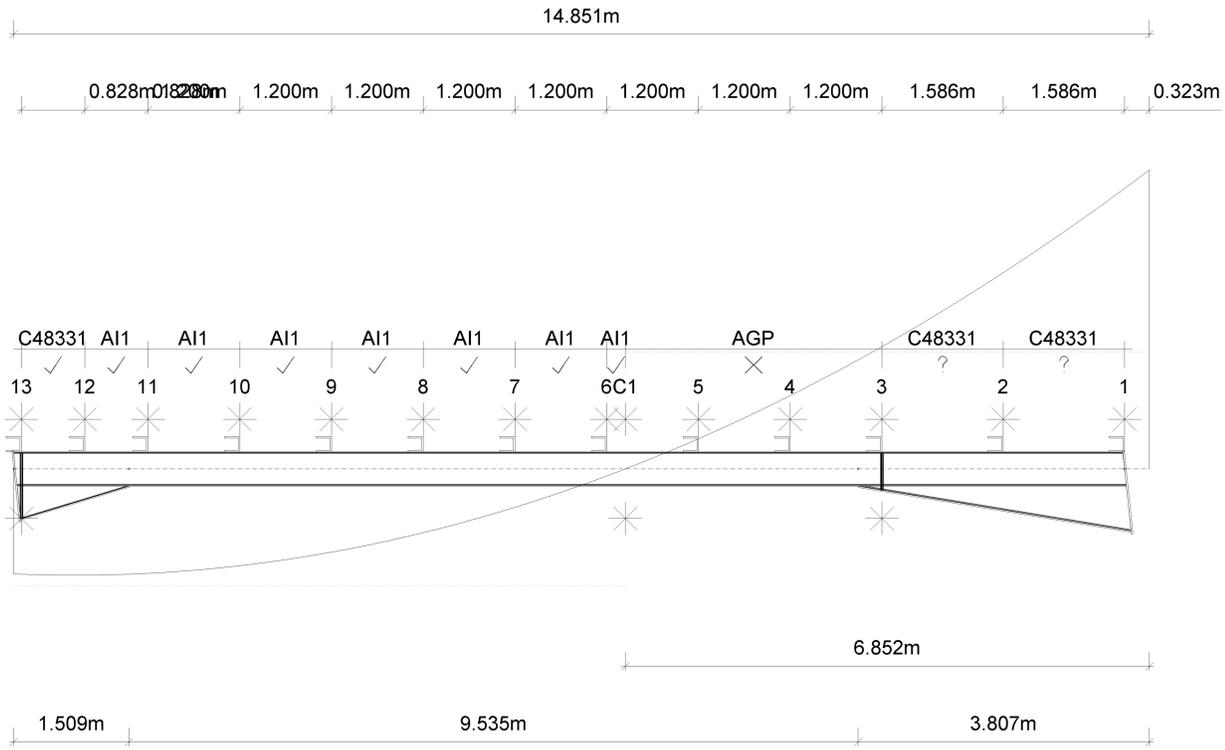
Columns

| Member | Status |
|------------------|-------------|
| Span 1 Lh Column | Not Checked |
| Span 1 Rh Column | Not Checked |

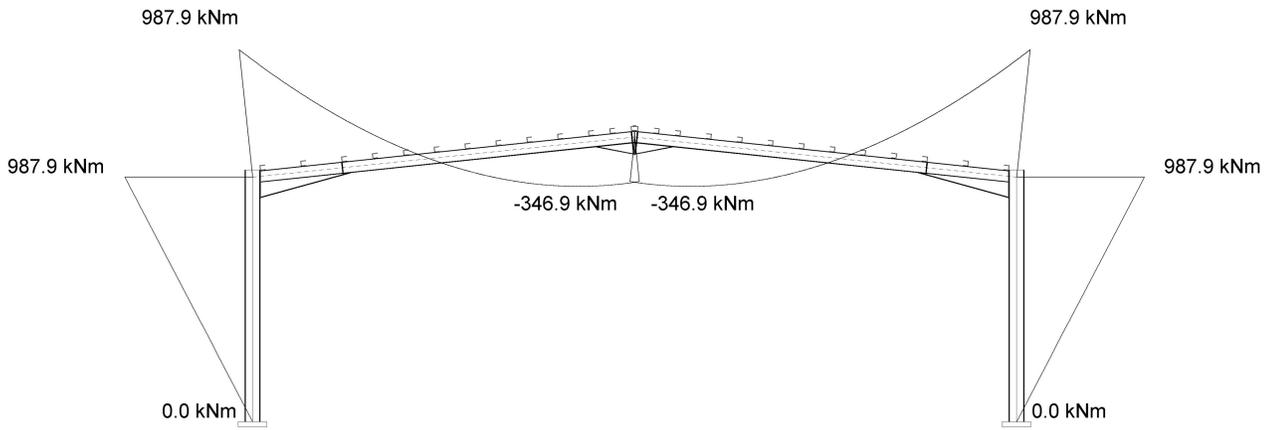
Span 1 Lh Rafter



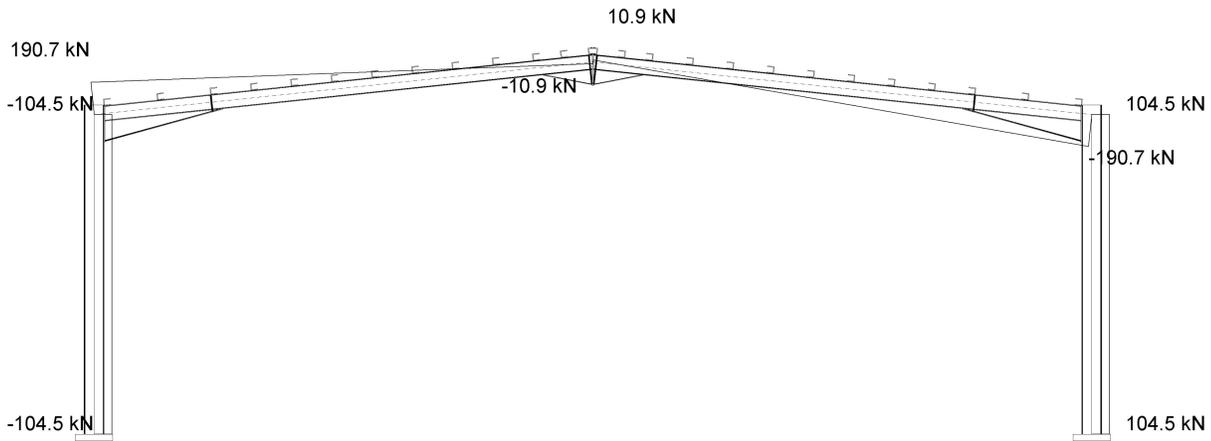
Span 1 Rh Rafter



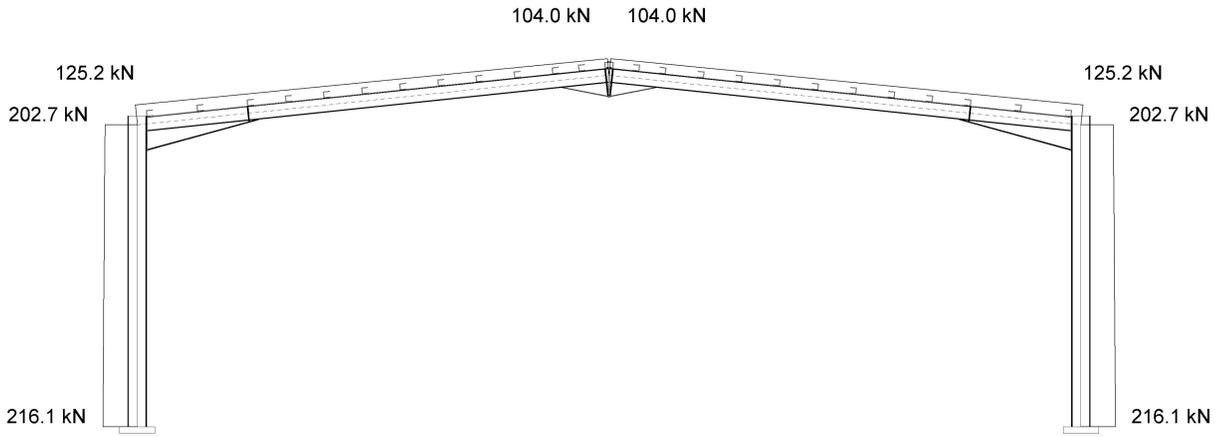
Bending Moment Diagram



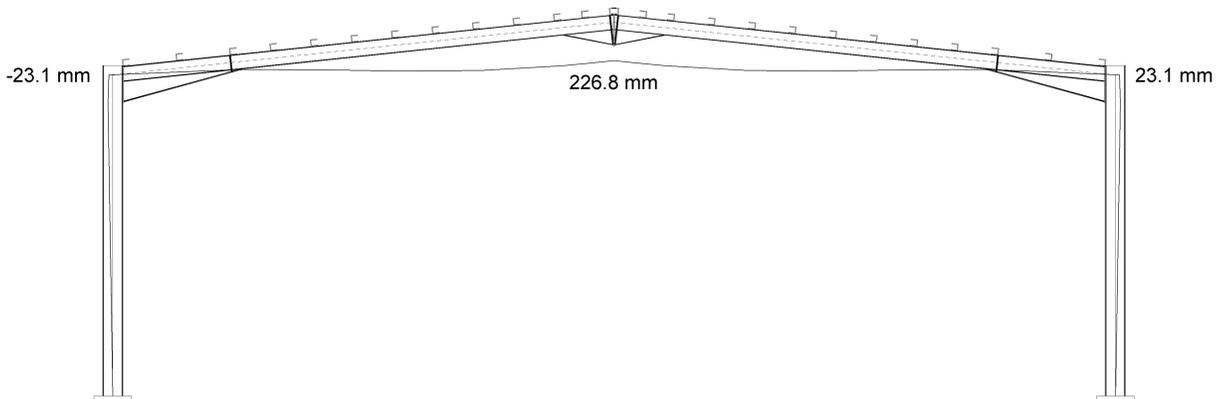
Shear Force Diagram



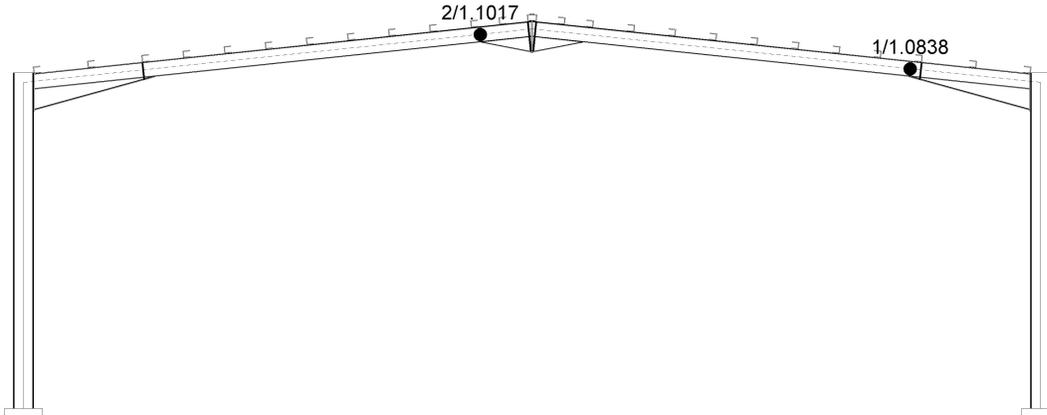
Axial Load Diagram



Deflected Shape Diagram



Hinge History Diagram



Sw + Dead + Serv + Wind

Sections

| Member | Section | Grade | Length | Mass | Weight | Mp | Mpr | UR |
|------------------|----------------|-------|--------|--------|---------|--------|--------|-------|
| Span 1 Lh Column | UB 610x229x101 | S355 | 9.450 | 102.81 | 971.55 | 1043.2 | 1043.2 | 0.553 |
| Span 1 Lh Rafter | UB 457x152x52 | S355 | 14.851 | 52.70 | 782.69 | 392.8 | 392.8 | 0.784 |
| Span 1 Rh Rafter | UB 457x152x52 | S355 | 14.851 | 52.70 | 782.69 | 392.8 | 392.8 | 0.367 |
| Span 1 Rh Column | UB 610x229x101 | S355 | 9.450 | 102.81 | 971.55 | 1043.2 | 1043.2 | 0.111 |
| Total Rafter | | | | | 1565.38 | | | |
| Total Column | | | | | 1943.11 | | | |
| Total Haunch | | | | | 437.66 | | | |
| Total | | | | | 3946.15 | | | |

Hinge History

Hinge History

| Event | Lambda 1st Order | Lambda 2nd Order | Status | Member | Distance(B) | Distance(A) | Status |
|---------|------------------|------------------|--------|------------------|-------------|-------------|--------|
| Event 1 | 1.2689 | - | Formed | Span 1 Lh Rafter | 3.807 | 3.807 | |
| Event 2 | 1.7064 | - | Formed | Span 1 Rh Rafter | 8.575 | 9.568 | |

Strength

Rafters

| Member | U.R. | Status |
|------------------|-------|--------|
| Span 1 Lh Rafter | 0.784 | Pass |
| Span 1 Rh Rafter | 0.367 | Pass |

Columns

| Member | U.R. | Status |
|------------------|-------|--------|
| Span 1 Lh Column | 0.553 | Pass |
| Span 1 Rh Column | 0.111 | Pass |

Haunches

| Member | U.R. | Status |
|---------------------------|-------|--------|
| Span 1 Lh Rafter Lh Eaves | 0.601 | Pass |
| Span 1 Lh Rafter Lh Apex | 0.194 | Pass |
| Span 1 Rh Rafter Rh Eaves | 0.157 | Pass |
| Span 1 Rh Rafter Rh Apex | 0.279 | Pass |

Serviceability

| Span | Status | Lh Eaves(H) | Lh Apex(V) | Apex(V) | Rh Apex(V) | Rh Eaves(H) |
|--------|-------------|-------------|------------|----------|------------|-------------|
| Span 1 | Not Checked | 161.5/na | na | -57.3/na | na | 150.1/na |

Frame Stability

None

Base Loads

| Span | M [kNm] | F [kN] | N [kN] |
|------------------|---------|--------|--------|
| Span 1 Lh Column | 0.0 | -92.8 | -102.1 |
| Span 1 Rh Column | 0.0 | -46.6 | -15.4 |

Connection Forces

| Span | Mf [kNm] | Ff [kN] | Nf [kN] | Mh [kNm] | Fh [kN] | Nh [kN] |
|-----------------|----------|---------|---------|----------|---------|---------|
| Span 1 Lh Eaves | -573.3 | -107.9 | -36.7 | -307.7 | -61.7 | -49.9 |
| Span 1 Lh Apex | 105.6 | 19.0 | -54.9 | 80.8 | -19.8 | -55.7 |
| Span 1 Rh Apex | 105.6 | -19.0 | -54.9 | 132.4 | 11.0 | -51.7 |
| Span 1 Rh Eaves | 34.0 | -26.6 | -41.3 | 97.8 | -14.4 | -45.9 |

Member Stability

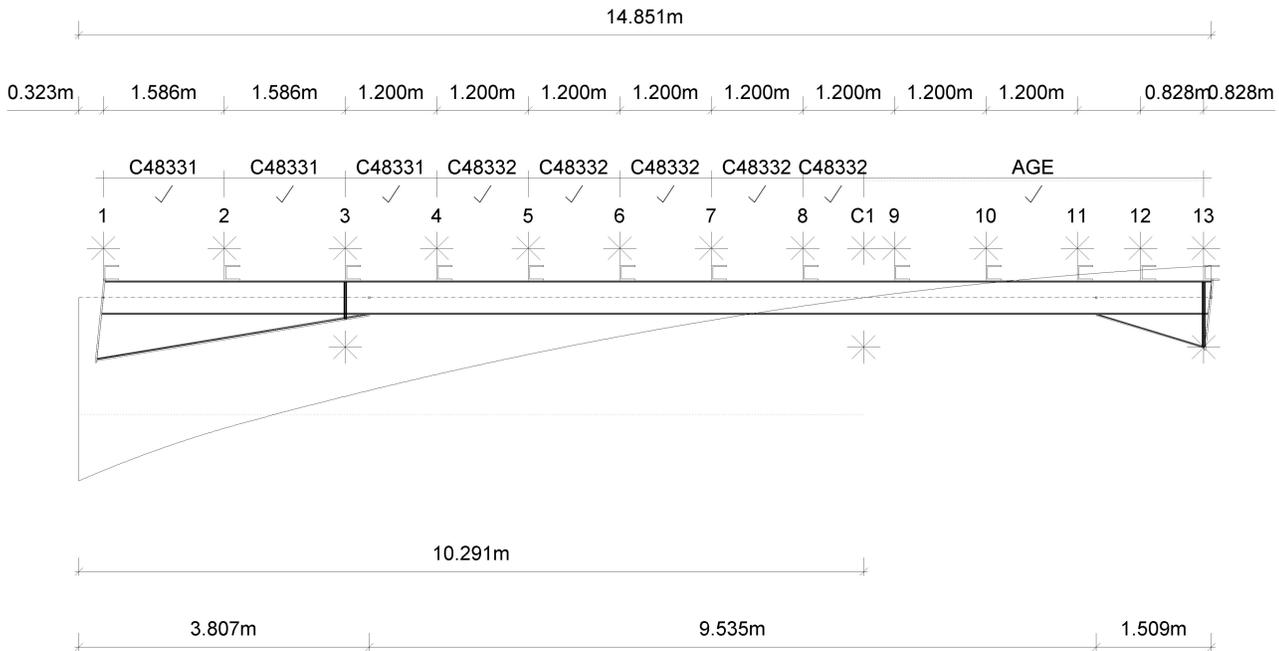
Rafters

| Member | Status |
|------------------|---------|
| Span 1 Lh Rafter | Pass |
| Span 1 Rh Rafter | Invalid |

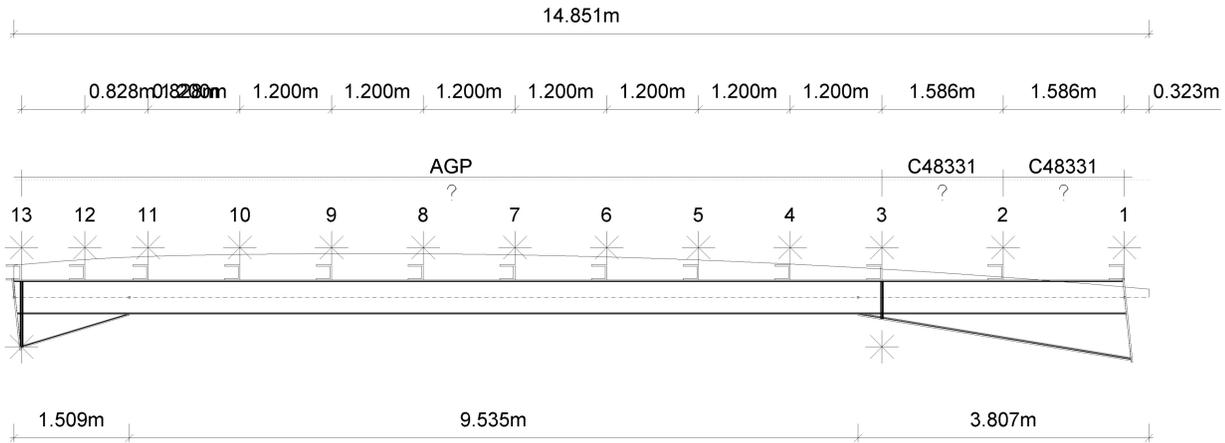
Columns

| Member | Status |
|------------------|-------------|
| Span 1 Lh Column | Not Checked |
| Span 1 Rh Column | Not Checked |

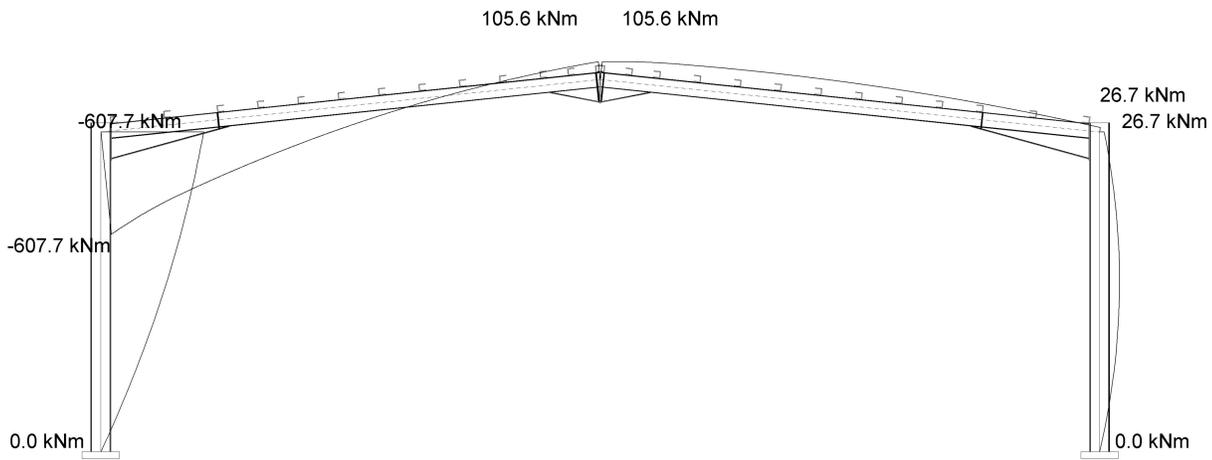
Span 1 Lh Rafter



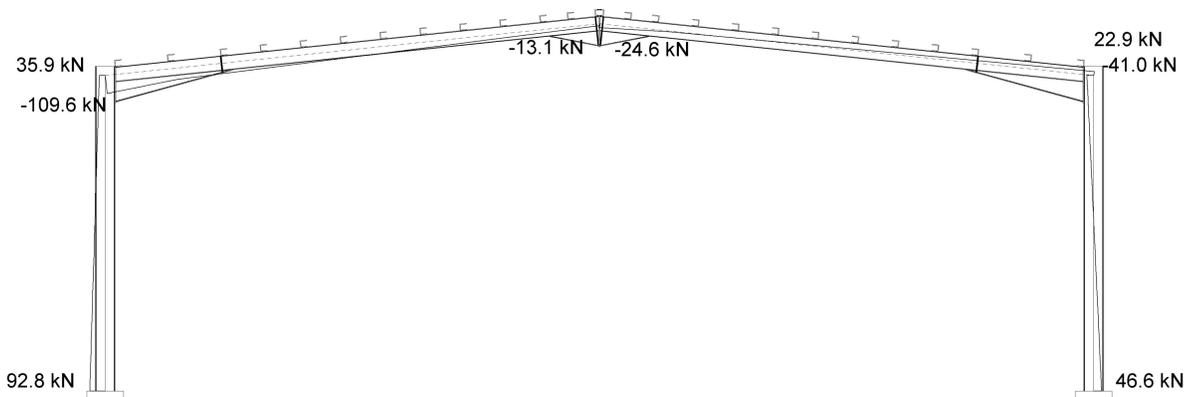
Span 1 Rh Rafter



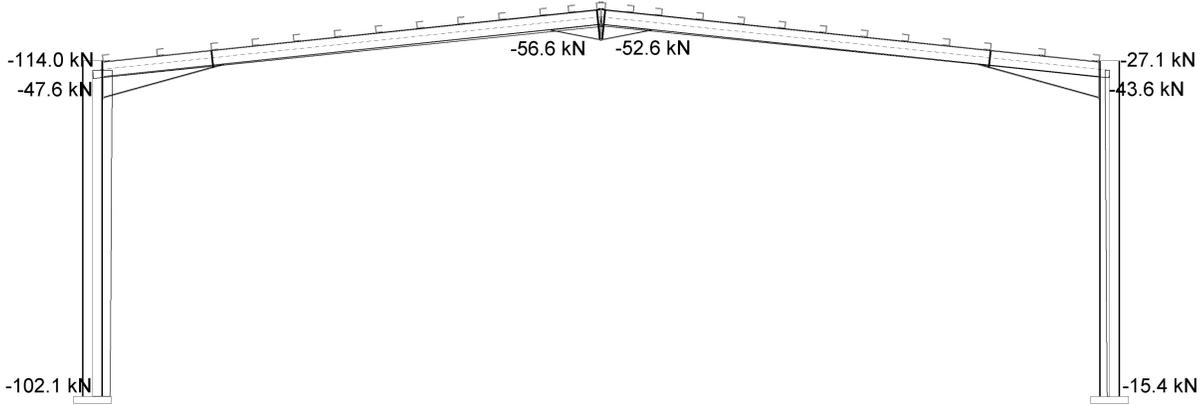
Bending Moment Diagram



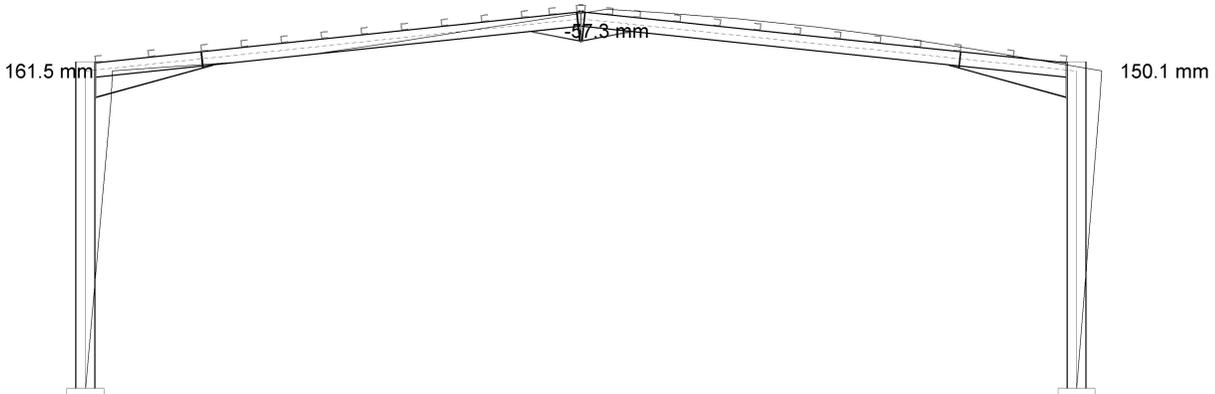
Shear Force Diagram



Axial Load Diagram



Deflected Shape Diagram



Hinge History Diagram

