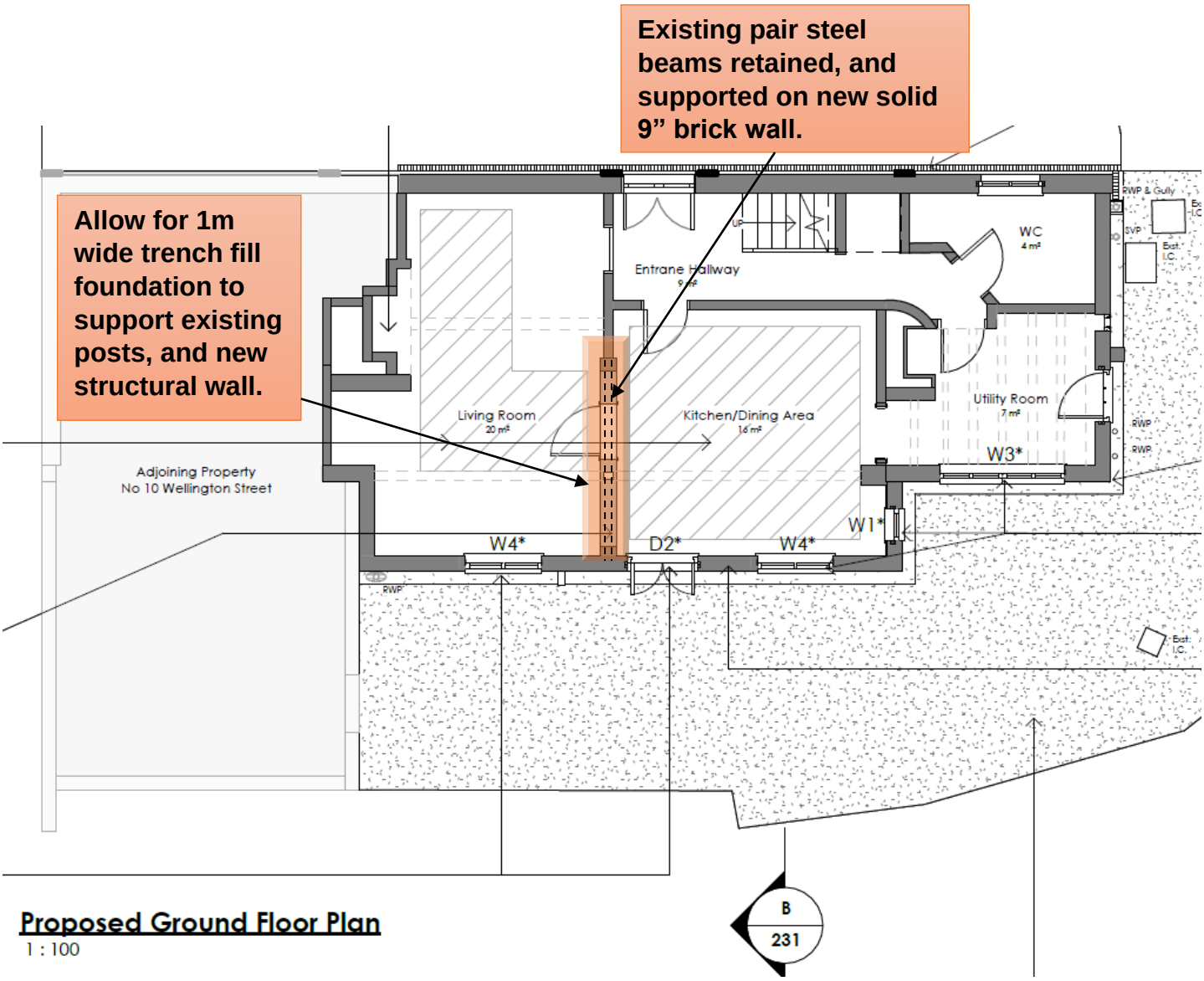
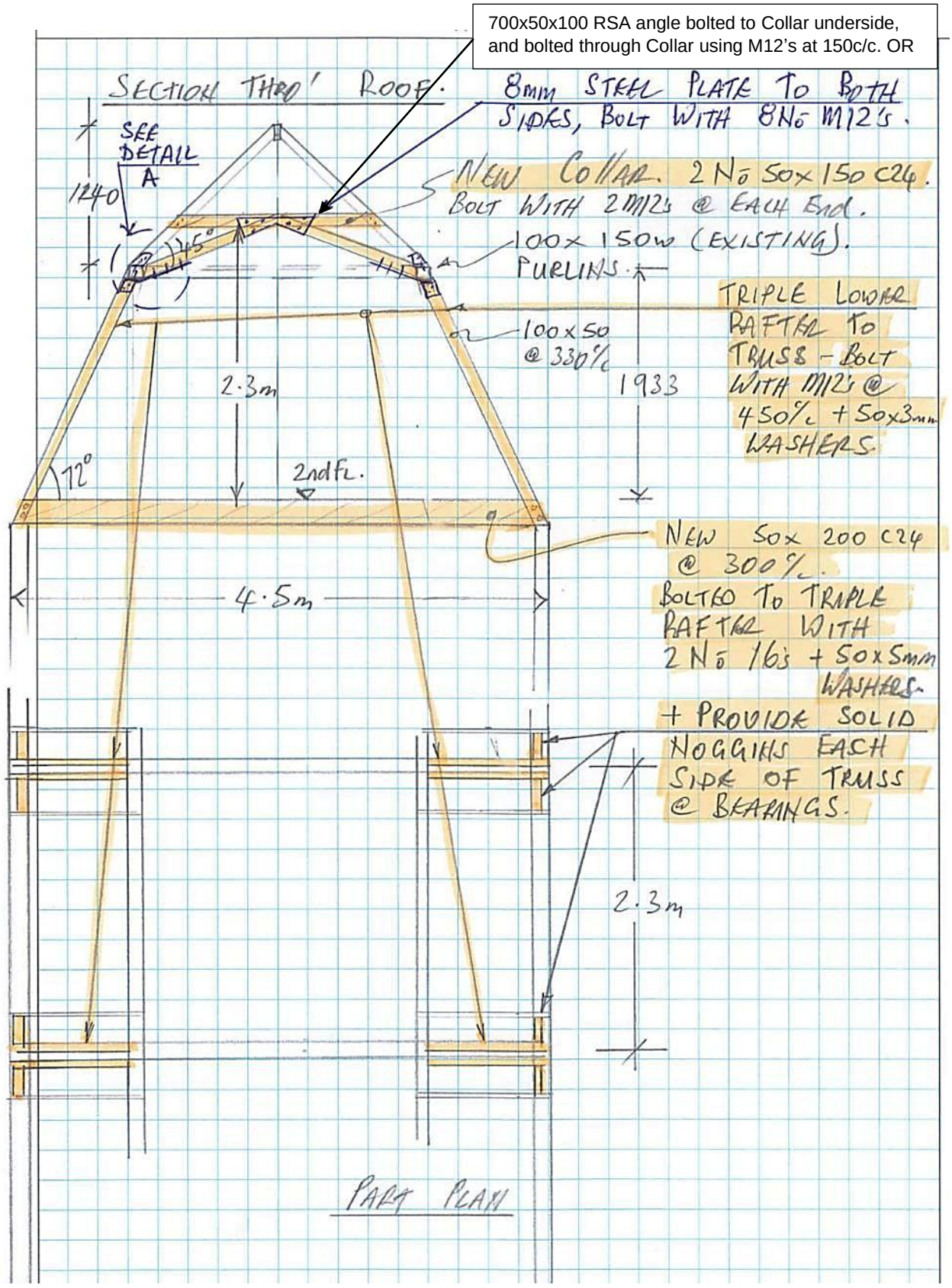



**Proposed Ground Floor Plan**
1 : 100


700x50x100 RSA angle bolted to Collar underside, and bolted through Collar using M12's at 150c/c. OR
SECTION THRO' ROOF.
8mm STEEL PLATE TO BOTH SIDES, BOLT WITH 8Nō M12's.
SEE DETAIL A
1240
NEW COLLAR. 2Nō 50x150 C24. BOLT WITH 2 M12's @ EACH END.
100x150w (EXISTING). PURLINS.
TRIPLE LOWER RAFTER TO TRUSS - BOLT WITH M12's @ 450% + 50x3mm WASHERS
100x50 @ 330%
1933
2·3m
72°
2nd FL.
NEW 50x200 C24 @ 300%. BOLTED TO TRIPLE RAFTER WITH 2Nō 16's + 50x5mm WASHERS.
4·5m
+ PROVIDE SOLID NOGGINS EACH SIDE OF TRUSS @ BEARINGS.
2·3m
PART PLAN

ROOF LOADING.

- UPPER ROOF (45°).

| | |
|---|---|
| Tile/slate | 0.70 KN/m² |
| Felt + Batten | 0.05 |
| RAFTR. | 0.15 |
| Insulation | 0.02 |
| PLASTR BRK + Skim | 0.20. |
| ΣDL. | 1.12 KN/m² on Slope. |

∴ DL on PLAN = 1.12/cos 45° = 1.58

LL = 0.75

2.33 KN/m².

LOWER ROOF RAFTERS. DL = 1.12 KN/m² on Slope

∴ DL on Plan = 1.12/cos 72° = 3.62 KN/m².

LL 0.6/cos 72° = 1.94

5.56 KN/m²

LOWER RAFTR LOAD = 5.56 × 0.33 = 1.83KN/m

∴ LOAD ON RAFTERS.

UPPER = 2.33 × 0.33 = 0.77 KN/m

RAFTR OK.

LOWER = RAFTER OK.

CHECK PURLIN. (150w × 100 Dp). - MAX. SPAN = 2.3m.

LOAD.:- 2.33 × 1.2/2 = 1.40
5.56 × 1.0/2 = 2.78
} 4.18 KN/m.

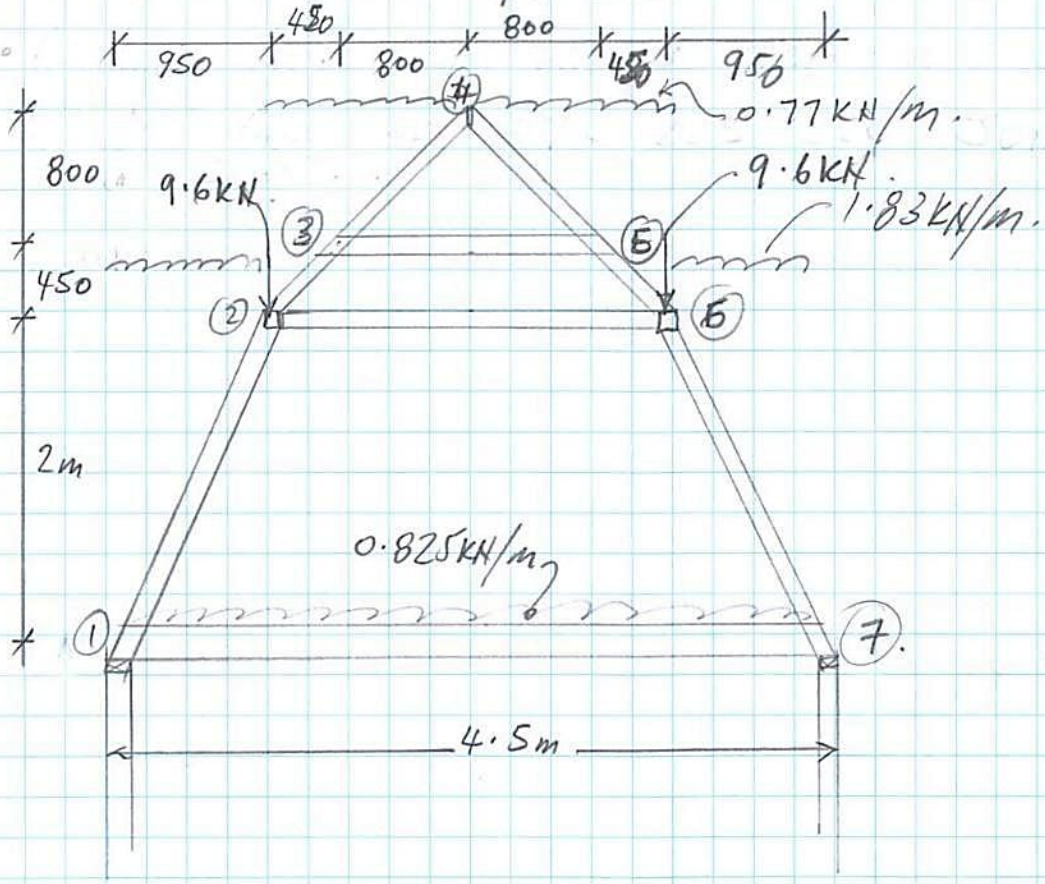
M = 4.18 × 2.3²/8 = 2.76 KNm.

S = 4.18 × 2.3/2 = 4.81 KN.

- Purlin will be fully Restrained.

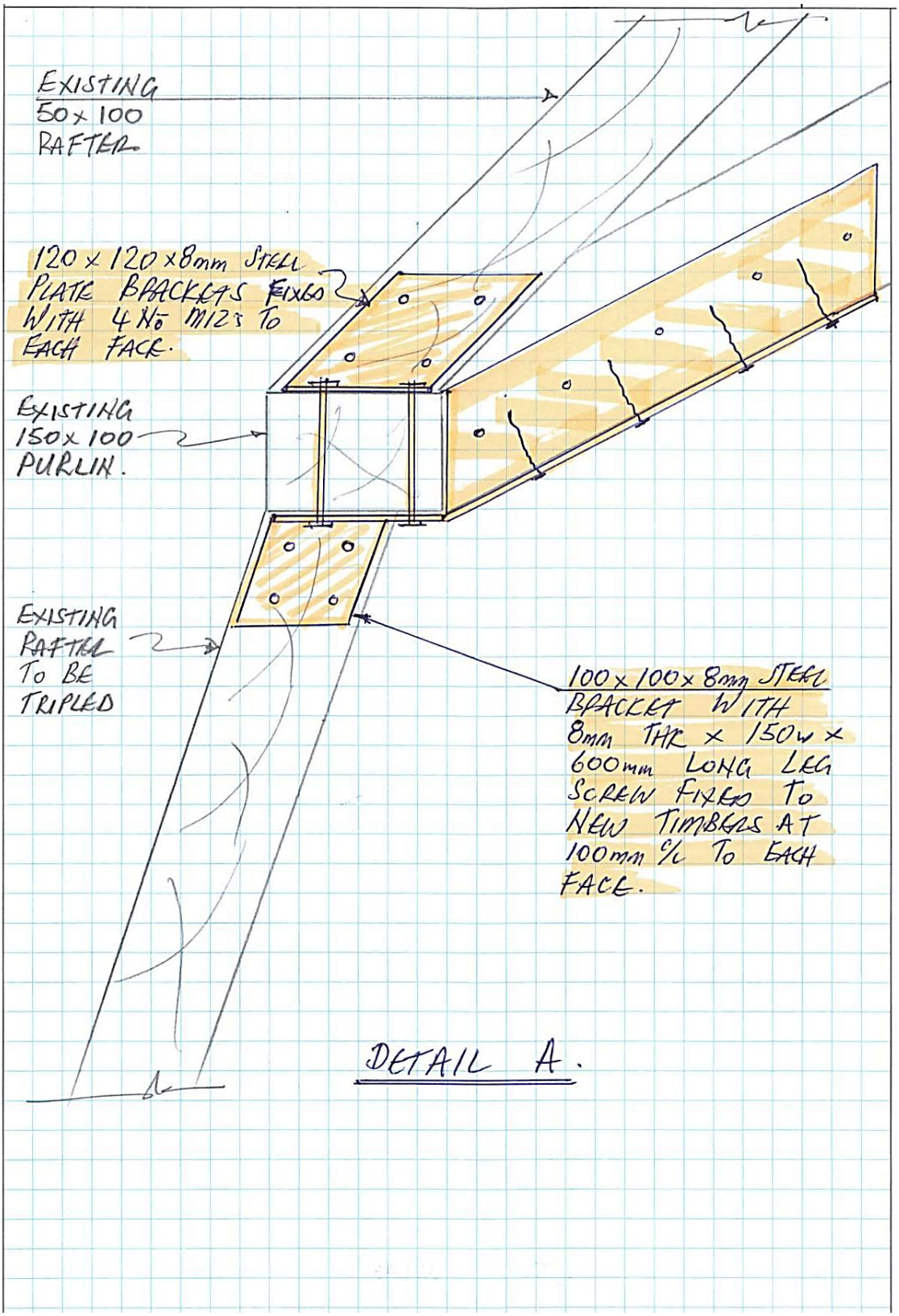
∴ 150 × 100 Dp PURLIN (C22) OK.

1 CHECK TRUSS Proposed...




MAX AXIAL LOAD IN LOWER RAFTERS = 19KN.

∴ TRIPLE RAFTER OR ADD 50 x 150 C24.

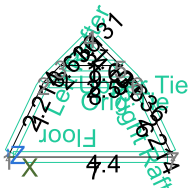

EXISTING 50 x 100 RAFTER.
120 x 120 x 8mm STEEL PLATE BRACKETS FIXED WITH 4 No M12s TO EACH FACE.
EXISTING 150 x 100 PURLIN.
EXISTING RAFTER TO BE TRIPLED
100 x 100 x 8mm STEEL BRACKET WITH 8mm THK x 150w x 600mm LONG LEG SCREW FIXED TO NEW TIMBERS AT 100mm c/c TO EACH FACE.
DETAIL A.

## ANALYSIS OF PROPOSED ROOF TRUSS

Tedds calculation version 1.0.37

### Geometry

**Geometry (m) - C22 (BS5268)**




### Materials

| Name | Density (kg/m³) | Youngs Modulus kN/mm² | Shear Modulus kN/mm² | Thermal Coefficient °C⁻¹ |
|---|---|---|---|---|
| C22 (BS5268) | 410 | 9.7 | 0.60625 | 0 |

### Sections

| Name | Area (cm²) | Moment of inertia | | Shear area parallel to | |
|---|---|---|---|---|---|
| | | Major (cm⁴) | Minor (cm⁴) | Minor (cm²) | Major (cm²) |
| 50x100 | 50 | 416.7 | 104.2 | 41.7 | 41.7 |
| 50x200 | 100 | 3333.3 | 208.3 | 83.3 | 83.3 |

### Nodes

| Node | Co-ordinates | | Freedom | | | Coordinate system | | Spring | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | X (m) | Z (m) | X | Z | Rot. | Name | Angle (°) | X (kN/m) | Z (kN/m) | Rot. kNm/° |
| 1 | 0 | 0 | Fixed | Fixed | Free | | 0 | 0 | 0 | 0 |
| 2 | 0.95 | 2 | Free | Free | Free | | 0 | 0 | 0 | 0 |
| 3 | 1.4 | 2.45 | Free | Free | Free | | 0 | 0 | 0 | 0 |
| 4 | 2.2 | 3.25 | Free | Free | Free | | 0 | 0 | 0 | 0 |
| 5 | 3 | 2.45 | Free | Free | Free | | 0 | 0 | 0 | 0 |
| 6 | 3.45 | 2 | Free | Free | Free | | 0 | 0 | 0 | 0 |
| 7 | 4.4 | 0 | Fixed | Fixed | Free | | 0 | 0 | 0 | 0 |

**Elements**

| Element | Length (m) | Nodes | | Section | Material | Releases | | | Rotated |
|---|---|---|---|---|---|---|---|---|---|
| | | Start | End | | | Start moment | End moment | Axial | |
| 1 | 2.214 | 1 | 2 | 50x100 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 2 | 0.636 | 2 | 3 | 50x100 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 3 | 1.131 | 3 | 4 | 50x100 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 4 | 1.131 | 4 | 5 | 50x100 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 5 | 0.636 | 5 | 6 | 50x100 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 6 | 2.214 | 6 | 7 | 50x100 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 7 | 4.4 | 7 | 1 | 50x200 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 8 | 2.5 | 2 | 6 | 50x200 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 9 | 1.6 | 3 | 5 | 50x200 | C22 (BS5268) | Fixed | Fixed | Fixed | |

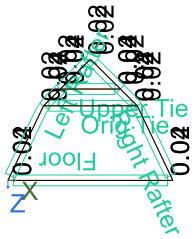
**Members**

| Name | Elements | |
|---|---|---|
| | Start | End |
| Floor | 7 | 7 |
| Left Rafter | 1 | 3 |
| Right Rafter | 4 | 6 |
| Upper Tie | 9 | 9 |
| Orig Tie | 8 | 8 |

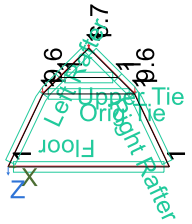
**Loading**

Self weight included (Self weight x 1)

**Self weight - Loading (kN/m)**



**Permanent - Loading (kN/m,kN)**




**Load combination factors**

| Load combination | Self weight | Permanent | Imposed |
|---|---|---|---|
| service (Service) | 1.00 | 1.00 | 1.00 |

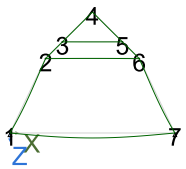
**Member Loads**

| Member | Load case | Load Type | Orientation | Description |
|---|---|---|---|---|
| Floor | Permanent | UDL | GlobalZ | 1 kN/m |
| Left Rafter | Permanent | UDL | GlobalZ | 1 kN/m |
| Right Rafter | Permanent | UDL | GlobalZ | 1 kN/m |
| Left Rafter | Permanent | Point load | GlobalZ | 6.7 kN at 3.982 m |
| Left Rafter | Permanent | Point load | GlobalZ | 9.6 kN at 2.19 m |
| Right Rafter | Permanent | Point load | GlobalZ | 9.6 kN at 1.792 m |

## Results

### Total deflection

**service (Service) - Total deflection**




### Member results

**Load combination: service (Service)**

| Member | Deflection | | | | Axial deflection | | | |
|---|---|---|---|---|---|---|---|---|
| | Pos (m) | Max (mm) | Pos (m) | Min (mm) | Pos (m) | Max (mm) | Pos (m) | Min (mm) |
| Floor | 2.2 | 13.3 | 4.4 | 0 | 0 | 0 | 0 | 0 |
| Left Rafter | 0.903 | 3.9 | 0 | 0 | 0 | 0 | 3.982 | -0.8 |
| Right Rafter | 3.079 | 3.9 | 3.982 | 0 | 0 | 0.8 | 3.982 | 0 |
| Upper Tie | 0.8 | 1.1 | 0 | 1 | 0 | 0 | 1.6 | 0 |
| Orig Tie | 2.5 | 0.9 | 1.25 | 0.3 | 0 | 0 | 2.5 | 0 |

### Node deflections

**Load combination: service (Service)**

| Node | Deflection | | Rotation | Co-ordinate system |
|---|---|---|---|---|
| | X (mm) | Z (mm) | (°) | |
| 1 | 0 | 0 | 0.50338 | |
| 2 | 0 | 0.9 | -0.05644 | |
| 3 | 0 | 1 | 0.01237 | |
| 4 | 0 | 1.2 | 0 | |
| 5 | 0 | 1 | -0.01237 | |

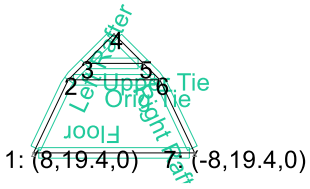
| Node | Deflection | | Rotation | Co-ordinate system |
|---|---|---|---|---|
| | X (mm) | Z (mm) | (°) | |
| 6 | 0 | 0.9 | 0.05644 | |
| 7 | 0 | 0 | -0.50338 | |

**Total base reactions**

| Load case/combination | Force | |
|---|---|---|
| | FX (kN) | FZ (kN) |
| service (Service) | 0 | 38.8 |

**Reactions**

**service (Service) - Local node reactions - Node: (Horiz (kN), Vert (kN), Mom (kNm))**




**Load combination: service (Service)**

| Node | Force | | Moment |
|---|---|---|---|
| | Fx (kN) | Fz (kN) | My (kNm) |
| 1 | 8 | 19.4 | 0 |
| 7 | -8 | 19.4 | 0 |

**Element end forces**

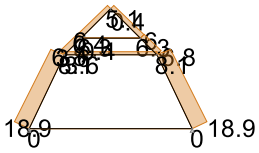
**Load combination: service (Service)**

| Element | Length (m) | Nodes Start/End | Axial force (kN) | Shear force (kN) | Moment (kNm) |
|---|---|---|---|---|---|
| 1 | 2.214 | 1 | -18.9 | -0.1 | -0.4 |
| | | 2 | 8.1 | -5 | -0.5 |
| 2 | 0.636 | 2 | -6.8 | -0.6 | 0.2 |

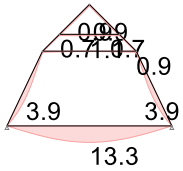
| Element | Length (m) | Nodes Start/End | Axial force (kN) | Shear force (kN) | Moment (kNm) |
|---|---|---|---|---|---|
| | | 3 | 6.3 | 0.1 | 0 |
| 3 | 1.131 | 3 | -6 | -0.4 | 0.1 |
| | | 4 | 0.4 | -5.1 | -0.1 |
| 4 | 1.131 | 4 | -5.1 | -0.4 | 0.1 |
| | | 5 | 6 | -0.4 | -0.1 |
| 5 | 0.636 | 5 | -6.3 | 0.1 | 0 |
| | | 6 | 6.8 | -0.6 | -0.2 |
| 6 | 2.214 | 6 | -8.1 | -5 | 0.5 |
| | | 7 | 18.9 | -0.1 | 0.4 |
| 7 | 4.4 | 7 | 0 | -2.3 | 0.4 |
| | | 1 | 0 | -2.3 | -0.4 |
| 8 | 2.5 | 2 | -3.6 | -0.1 | 0.3 |
| | | 6 | 3.6 | -0.1 | -0.3 |
| 9 | 1.6 | 3 | -0.4 | 0 | -0.1 |
| | | 5 | 0.4 | 0 | 0.1 |

**Forces**

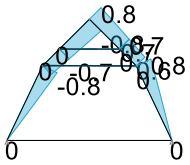
**All combinations - Axial force envelope (kN)**



**Service combinations - Deflection envelope (mm)**




**Service combinations - Axial deflection envelope (mm)**



**Member results**

**Envelope - All combinations**

| Member | Axial force | | | |
|---|---|---|---|---|
| | Pos (m) | Max (kN) | Pos (m) | Min (kN) |
| Floor | 0 | 0 | 0 | 0 |
| Left Rafter | 0 | 18.9 (max) | 3.982 | 0.4 |
| Right Rafter | 3.982 | 18.9 (max) | 0 | 5.1 |
| Upper Tie | 0 | 0.4 | 0 | 0.4 |
| Orig Tie | 0 | 3.6 | 0 | 3.6 |

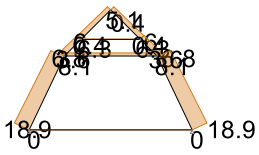
**Envelope - Service combinations**

| Member | Deflection | | | |
|---|---|---|---|---|
| | Pos (m) | Max (mm) | Pos (m) | Min (mm) |
| Floor | 2.2 | 13.3 (max) | 4.4 | 0 |
| Left Rafter | 0.903 | 3.9 | 0 | 0 |
| Right Rafter | 3.079 | 3.9 | 3.982 | 0 |
| Upper Tie | 0.8 | 1.1 | 0 | 1 |
| Orig Tie | 2.5 | 0.9 | 1.25 | 0.3 |

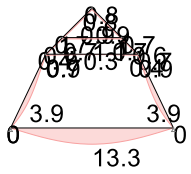
**Envelope - All combinations**

| Member | Axial deflection | | | |
|---|---|---|---|---|
| | Pos (m) | Max (mm) | Pos (m) | Min (mm) |
| Floor | 0 | 0 | 0 | 0 |
| Left Rafter | 0 | 0 | 3.982 | -0.8 (min) |
| Right Rafter | 0 | 0.8 (max) | 3.982 | 0 |
| Upper Tie | 0 | 0 | 1.6 | 0 |
| Orig Tie | 0 | 0 | 2.5 | 0 |

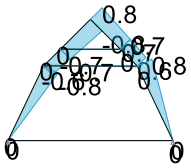
**service (Service) - Axial force (kN)**




**service (Service) - Deflection (mm)**



**service (Service) - Axial deflection**




**Member results**

**Load combination: service (Service)**

| Member | Axial force | | | |
|---|---|---|---|---|
| | Pos (m) | Max (kN) | Pos (m) | Min (kN) |
| Floor | 0 | 0 | 0 | 0 |
| Left Rafter | 0 | 18.9 (max) | 3.982 | 0.4 |
| Right Rafter | 3.982 | 18.9 (max) | 0 | 5.1 |
| Upper Tie | 0 | 0.4 | 0 | 0.4 |
| Orig Tie | 0 | 3.6 | 0 | 3.6 |

**Load combination: service (Service)**

| Member | Deflection | | | |
|---|---|---|---|---|
| | Pos (m) | Max (mm) | Pos (m) | Min (mm) |
| Floor | 2.2 | 13.3 (max) | 4.4 | 0 |
| Left Rafter | 0.903 | 3.9 | 0 | 0 |
| Right Rafter | 3.079 | 3.9 | 3.982 | 0 |
| Upper Tie | 0.8 | 1.1 | 0 | 1 |
| Orig Tie | 2.5 | 0.9 | 1.25 | 0.3 |

**Load combination: service (Service)**

| Member | Axial deflection | | | |
|---|---|---|---|---|
| | Pos (m) | Max (mm) | Pos (m) | Min (mm) |
| Floor | 0 | 0 | 0 | 0 |

| Member | Axial deflection | | | |
|---|---|---|---|---|
| | Pos (m) | Max (mm) | Pos (m) | Min (mm) |
| Left Rafter | 0 | 0 | 3.982 | -0.8 (min) |
| Right Rafter | 0 | 0.8 (max) | 3.982 | 0 |
| Upper Tie | 0 | 0 | 1.6 | 0 |
| Orig Tie | 0 | 0 | 2.5 | 0 |

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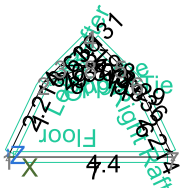
**ANALYSIS - PROPOSED ROOF TRUSS WITH MODIFIED COLLAR** Tedds calculation version 1.0.37

**Geometry**

**Geometry (m) - C22 (BS5268)**




**Materials**

| Name | Density (kg/m³) | Youngs Modulus kN/mm² | Shear Modulus kN/mm² | Thermal Coefficient °C⁻¹ |
|---|---|---|---|---|
| C22 (BS5268) | 410 | 9.7 | 0.60625 | 0 |

**Sections**

| Name | Area (cm²) | Moment of inertia | | Shear area parallel to | |
|---|---|---|---|---|---|
| | | Major (cm⁴) | Minor (cm⁴) | Minor (cm²) | Major (cm²) |
| 50x100 | 50 | 416.7 | 104.2 | 41.7 | 41.7 |
| 50x200 | 100 | 3333.3 | 208.3 | 83.3 | 83.3 |
| 50x150 | 75 | 1406.3 | 156.3 | 62.5 | 62.5 |

**Nodes**

| Node | Co-ordinates | | Freedom | | | Coordinate system | | Spring | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | X (m) | Z (m) | X | Z | Rot. | Name | Angle (°) | X (kN/m) | Z (kN/m) | Rot. kNm/° |
| 1 | 0 | 0 | Fixed | Fixed | Free | | 0 | 0 | 0 | 0 |
| 2 | 0.95 | 2 | Free | Free | Free | | 0 | 0 | 0 | 0 |
| 3 | 1.4 | 2.45 | Free | Free | Free | | 0 | 0 | 0 | 0 |
| 4 | 2.2 | 3.25 | Free | Free | Free | | 0 | 0 | 0 | 0 |
| 5 | 3 | 2.45 | Free | Free | Free | | 0 | 0 | 0 | 0 |
| 6 | 3.45 | 2 | Free | Free | Free | | 0 | 0 | 0 | 0 |
| 7 | 4.4 | 0 | Fixed | Fixed | Free | | 0 | 0 | 0 | 0 |

| Node | Co-ordinates | | Freedom | | | Coordinate system | | Spring | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | X (m) | Z (m) | X | Z | Rot. | Name | Angle (°) | X (kN/m) | Z (kN/m) | Rot. kNm/° |
| 8 | 2.2 | 2.45 | Free | Free | Free | | 0 | 0 | 0 | 0 |

**Elements**

| Element | Length (m) | Nodes | | Section | Material | Releases | | | Rotated |
|---|---|---|---|---|---|---|---|---|---|
| | | Start | End | | | Start moment | End moment | Axial | |
| 1 | 2.214 | 1 | 2 | 50x100 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 2 | 0.636 | 2 | 3 | 50x100 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 3 | 1.131 | 3 | 4 | 50x100 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 4 | 1.131 | 4 | 5 | 50x100 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 5 | 0.636 | 5 | 6 | 50x100 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 6 | 2.214 | 6 | 7 | 50x100 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 7 | 4.4 | 7 | 1 | 50x200 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 8 | 1.329 | 2 | 8 | 50x150 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 9 | 0.8 | 3 | 8 | 50x150 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 10 | 0.8 | 8 | 5 | 50x150 | C22 (BS5268) | Fixed | Fixed | Fixed | |
| 11 | 1.329 | 8 | 6 | 50x150 | C22 (BS5268) | Fixed | Fixed | Fixed | |

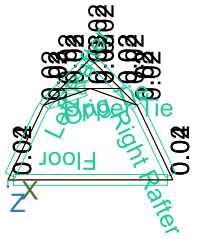
**Members**

| Name | Elements | |
|---|---|---|
| | Start | End |
| Floor | 7 | 7 |
| Left Rafter | 1 | 3 |
| Right Rafter | 4 | 6 |
| Upper Tie | 9 | 9 |
| Orig Tie | 8 | 8 |

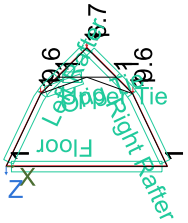
**Loading**

Self weight included (Self weight x 1)

**Self weight - Loading (kN/m)**




**Permanent - Loading (kN/m,kN)**



**Load combination factors**

| Load combination | Self weight | Permanent | Imposed |
|---|---|---|---|
| service (Service) | 1.00 | 1.00 | 1.00 |

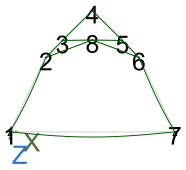
**Member Loads**

| Member | Load case | Load Type | Orientation | Description |
|---|---|---|---|---|
| Floor | Permanent | UDL | GlobalZ | 1 kN/m |
| Left Rafter | Permanent | UDL | GlobalZ | 1 kN/m |
| Right Rafter | Permanent | UDL | GlobalZ | 1 kN/m |
| Left Rafter | Permanent | Point load | GlobalZ | 6.7 kN at 3.982 m |
| Left Rafter | Permanent | Point load | GlobalZ | 9.6 kN at 2.19 m |
| Right Rafter | Permanent | Point load | GlobalZ | 9.6 kN at 1.792 m |

**Results**

**Total deflection**

**service (Service) - Total deflection**




**Member results**

**Load combination: service (Service)**

| Member | Deflection | | | | Axial deflection | | | |
|---|---|---|---|---|---|---|---|---|
| | Pos (m) | Max (mm) | Pos (m) | Min (mm) | Pos (m) | Max (mm) | Pos (m) | Min (mm) |
| Floor | 2.2 | 13.9 | 4.4 | 0 | 0 | 0 | 0 | 0 |

| Member | Deflection | | | | Axial deflection | | | |
|---|---|---|---|---|---|---|---|---|
| | Pos (m) | Max (mm) | Pos (m) | Min (mm) | Pos (m) | Max (mm) | Pos (m) | Min (mm) |
| Left Rafter | 1.035 | 4.9 | 0 | 0 | 0 | 0 | 2.214 | -0.8 |
| Right Rafter | 2.947 | 4.9 | 3.982 | 0 | 1.768 | 0.8 | 3.982 | 0 |
| Upper Tie | 0 | 0.5 | 0.8 | -0.9 | 0.8 | 0 | 0 | 0 |
| Orig Tie | 0 | 1.5 | 1.329 | -0.8 | 0 | 0.4 | 1.329 | 0.3 |

**Node deflections**

**Load combination: service (Service)**

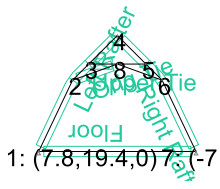
| Node | Deflection | | Rotation | Co-ordinate system |
|---|---|---|---|---|
| | X (mm) | Z (mm) | (°) | |
| 1 | 0 | 0 | 0.53243 | |
| 2 | 0.9 | 1.3 | -0.16588 | |
| 3 | 0 | 0.5 | -0.09313 | |
| 4 | 0 | 0.7 | 0 | |
| 5 | 0 | 0.5 | 0.09313 | |
| 6 | -0.9 | 1.3 | 0.16588 | |
| 7 | 0 | 0 | -0.53243 | |
| 8 | 0 | -0.9 | 0 | |

**Total base reactions**

| Load case/combination | Force | |
|---|---|---|
| | FX (kN) | FZ (kN) |
| service (Service) | 0 | 38.7 |

**Reactions**

**service (Service) - Local node reactions - Node: (Horiz (kN), Vert (kN), Mom (kNm))**



**Load combination: service (Service)**

| Node | Force | | Moment |
|---|---|---|---|
| | Fx (kN) | Fz (kN) | My (kNm) |
| 1 | 7.8 | 19.4 | 0 |
| 7 | -7.8 | 19.4 | 0 |

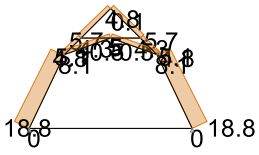
**Element end forces**

**Load combination: service (Service)**

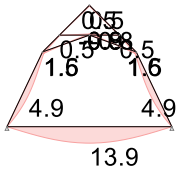
| Element | Length (m) | Nodes Start/End | Axial force (kN) | Shear force (kN) | Moment (kNm) |
|---|---|---|---|---|---|
| 1 | 2.214 | 1 | -18.8 | -0.2 | -0.3 |
| | | 2 | 8.1 | -4.8 | -0.3 |
| 2 | 0.636 | 2 | -4.8 | -0.5 | 0.2 |
| | | 3 | 4.3 | 0.1 | 0 |
| 3 | 1.131 | 3 | -5.7 | -0.7 | 0.3 |
| | | 4 | 0.1 | -4.8 | 0 |
| 4 | 1.131 | 4 | -4.8 | -0.1 | 0 |
| | | 5 | 5.7 | -0.7 | -0.3 |
| 5 | 0.636 | 5 | -4.3 | 0.1 | 0 |
| | | 6 | 4.8 | -0.5 | -0.2 |
| 6 | 2.214 | 6 | -8.1 | -4.8 | 0.3 |
| | | 7 | 18.8 | -0.2 | 0.3 |
| 7 | 4.4 | 7 | 0 | -2.3 | 0.3 |
| | | 1 | 0 | -2.3 | -0.3 |
| 8 | 1.329 | 2 | -5.1 | 0.2 | 0.1 |
| | | 8 | 5 | -0.3 | -0.5 |
| 9 | 0.8 | 3 | 0.5 | 1.4 | -0.3 |
| | | 8 | -0.5 | -1.4 | -0.9 |
| 10 | 0.8 | 8 | 0.5 | -1.4 | 0.9 |
| | | 5 | -0.5 | 1.4 | 0.3 |
| 11 | 1.329 | 8 | -5 | -0.3 | 0.5 |
| | | 6 | 5.1 | 0.2 | -0.1 |

**Forces**

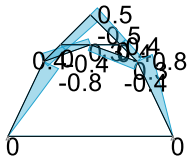
**All combinations - Axial force envelope (kN)**




**Service combinations - Deflection envelope (mm)**



**Service combinations - Axial deflection envelope (mm)**




**Member results**

**Envelope - All combinations**

| Member | Axial force | | | |
|---|---|---|---|---|
| | Pos (m) | Max (kN) | Pos (m) | Min (kN) |
| Floor | 0 | 0 | 0 | 0 |
| Left Rafter | 0 | 18.8 (max) | 3.982 | 0.1 |
| Right Rafter | 3.982 | 18.8 (max) | 1.131 | 4.3 |
| Upper Tie | 0 | -0.5 (min) | 0 | -0.5 (min) |
| Orig Tie | 0 | 5.1 | 1.329 | 5 |

**Envelope - Service combinations**

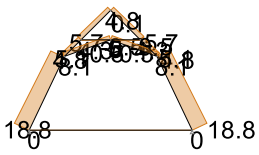
| Member | Deflection | | | |
|---|---|---|---|---|
| | Pos (m) | Max (mm) | Pos (m) | Min (mm) |
| Floor | 2.2 | 13.9 (max) | 4.4 | 0 |
| Left Rafter | 1.035 | 4.9 | 0 | 0 |
| Right Rafter | 2.947 | 4.9 | 3.982 | 0 |
| Upper Tie | 0 | 0.5 | 0.8 | -0.9 (min) |
| Orig Tie | 0 | 1.5 | 1.329 | -0.8 |

**Envelope - All combinations**

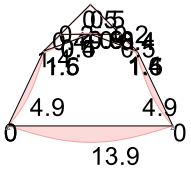
| Member | Axial deflection | | | |
|---|---|---|---|---|
| | Pos (m) | Max (mm) | Pos (m) | Min (mm) |
| Floor | 0 | 0 | 0 | 0 |

| Member | Axial deflection | | | |
|---|---|---|---|---|
| | Pos (m) | Max (mm) | Pos (m) | Min (mm) |
| Left Rafter | 0 | 0 | 2.214 | -0.8 (min) |
| Right Rafter | 1.768 | 0.8 (max) | 3.982 | 0 |
| Upper Tie | 0.8 | 0 | 0 | 0 |
| Orig Tie | 0 | 0.4 | 1.329 | 0.3 |

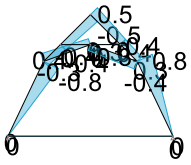
**service (Service) - Axial force (kN)**



**service (Service) - Deflection (mm)**




**service (Service) - Axial deflection**



**Member results**

**Load combination: service (Service)**

| Member | Axial force | | | |
|---|---|---|---|---|
| | Pos (m) | Max (kN) | Pos (m) | Min (kN) |
| Floor | 0 | 0 | 0 | 0 |
| Left Rafter | 0 | 18.8 (max) | 3.982 | 0.1 |
| Right Rafter | 3.982 | 18.8 (max) | 1.131 | 4.3 |
| Upper Tie | 0 | -0.5 (min) | 0 | -0.5 (min) |
| Orig Tie | 0 | 5.1 | 1.329 | 5 |

**Load combination: service (Service)**

| Member | Deflection | | | |
|---|---|---|---|---|
| | Pos (m) | Max (mm) | Pos (m) | Min (mm) |
| Floor | 2.2 | 13.9 (max) | 4.4 | 0 |
| Left Rafter | 1.035 | 4.9 | 0 | 0 |
| Right Rafter | 2.947 | 4.9 | 3.982 | 0 |
| Upper Tie | 0 | 0.5 | 0.8 | -0.9 (min) |
| Orig Tie | 0 | 1.5 | 1.329 | -0.8 |

**Load combination: service (Service)**

| Member | Axial deflection | | | |
|---|---|---|---|---|
| | Pos (m) | Max (mm) | Pos (m) | Min (mm) |
| Floor | 0 | 0 | 0 | 0 |
| Left Rafter | 0 | 0 | 2.214 | -0.8 (min) |
| Right Rafter | 1.768 | 0.8 (max) | 3.982 | 0 |
| Upper Tie | 0.8 | 0 | 0 | 0 |
| Orig Tie | 0 | 0.4 | 1.329 | 0.3 |

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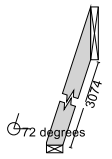
## TIMBER LOWER RAFTER DESIGN CHECK (BS5268-2:2002)

TEDDS calculation version 1.0.03




**Rafter details**

| | |
|---|---|
| Breadth of timber sections; | b = **47** mm |
| Depth of timber sections; | h = **100** mm |
| Rafter spacing; | s = **330** mm |
| Rafter slope; | $\alpha$ = **72.0** deg |
| Clear span of rafter on horizontal; | $L_{clh}$ = **950** mm |
| Clear span of rafter on slope; | $L_{cl} = L_{clh} / \cos(\alpha)$ = **3074** mm |
| Rafter span; | **Single span** |
| Timber strength class; | **C18** |

**Section properties**

| | |
|---|---|
| Cross sectional area of rafter; | $A = b \times h$ = **4700** $mm^2$ |
| Section modulus; | $Z = b \times h^2 / 6$ = **78333** $mm^3$ |
| Second moment of area; | $I = b \times h^3 / 12$ = **3916667** $mm^4$ |
| Radius of gyration; | $r = \sqrt{(I / A)}$ = **28.9** mm |

**Loading details**

| | |
|---|---|
| Rafter self weight; | $F_j = b \times h \times \rho_{char} \times g_{acc}$ = **0.01** kN/m |
| Dead load on slope; | $F_d$ = **1.10** $kN/m^2$ |
| Imposed load on plan; | $F_u$ = **0.75** $kN/m^2$ |
| Imposed point load; | $F_p$ = **0.90** kN |

**Modification factors**

| | |
|---|---|
| Section depth factor; | $K_7 = (300 \text{ mm} / h)^{0.11}$ = **1.13** |
| Load sharing factor; | $K_8$ = **1.10** |

**Consider long term load condition**

Load duration factor; $K_3$ = **1.00**

Total UDL perpendicular to rafter; $F = F_d \times \cos(\alpha) \times s + F_j \times \cos(\alpha)$ = **0.117** kN/m

Notional bearing length; $L_b = F \times L_{cl} / [2 \times (b \times \sigma_{cp1} \times K_8 - F)]$ = **2** mm

Effective span; $L_{eff} = L_{cl} + L_b$ = **3076** mm

**Check bending stress**

Bending stress parallel to grain; $\sigma_m$ = **5.800** N/mm$^2$

Permissible bending stress; $\sigma_{m_adm} = \sigma_m \times K_3 \times K_7 \times K_8$ = **7.200** N/mm$^2$

Applied bending stress; $\sigma_{m_max} = F \times L_{eff}^2 / (8 \times Z)$ = **1.762** N/mm$^2$

***PASS - Applied bending stress within permissible limits***

**Check compressive stress parallel to grain**

Compression stress parallel to grain; $\sigma_c$ = **7.100** N/mm$^2$

Minimum modulus of elasticity; $E_{min}$ = **6000** N/mm$^2$

Compression member factor; $K_{12}$ = **0.35**

Permissible compressive stress; $\sigma_{c_adm} = \sigma_c \times K_3 \times K_8 \times K_{12}$ = **2.730** N/mm$^2$

Applied compressive stress; $\sigma_{c_max} = F \times L_{eff} \times (\cot(\alpha) + 3 \times \tan(\alpha)) / (2 \times A)$ = **0.365** N/mm$^2$

***PASS - Applied compressive stress within permissible limits***

**Check combined bending and compressive stress parallel to grain**

Euler stress; $\sigma_e = \pi^2 \times E_{min} / \lambda^2$ = **5.216** N/mm$^2$

Euler coefficient; $K_{eu} = 1 - (1.5 \times \sigma_{c_max} \times K_{12} / \sigma_e)$ = **0.963**

Combined axial compression and bending check; $\sigma_{m_max} / (\sigma_{m_adm} \times K_{eu}) + \sigma_{c_max} / \sigma_{c_adm}$ = **0.388**; **< 1**

***PASS - Combined compressive and bending stresses are within permissible limits***

**Check shear stress**

Shear stress parallel to grain; $\tau$ = **0.670** N/mm$^2$

Permissible shear stress; $\tau_{adm} = \tau \times K_3 \times K_8$ = **0.737** N/mm$^2$

Applied shear stress; $\tau_{max} = 3 \times F \times L_{eff} / (4 \times A)$ = **0.057** N/mm$^2$

***PASS - Applied shear stress within permissible limits***

**Check deflection**

Permissible deflection; $\delta_{adm} = 0.003 \times L_{eff}$ = **9.228** mm

Bending deflection; $\delta_b = 5 \times F \times L_{eff}^4 / (384 \times E_{mean} \times I)$ = **3.817** mm

Shear deflection; $\delta_s = 12 \times F \times L_{eff}^2 / (5 \times E_{mean} \times A)$ = **0.062** mm

Total deflection; $\delta_{max} = \delta_b + \delta_s$ = **3.879** mm

***PASS - Total deflection within permissible limits***

**Consider medium term load condition**

Load duration factor; $K_3$ = **1.25**

Total UDL perpendicular to rafter; $F = [F_u \times \cos(\alpha)^2 + F_d \times \cos(\alpha)] \times s + F_j \times \cos(\alpha)$ = **0.140** kN/m

Notional bearing length; $L_b = F \times L_{cl} / [2 \times (b \times \sigma_{cp1} \times K_8 - F)]$ = **2** mm

Effective span; $L_{eff} = L_{cl} + L_b$ = **3076** mm

**Check bending stress**

Bending stress parallel to grain; $\sigma_m$ = **5.800** N/mm$^2$

Permissible bending stress; $\sigma_{m_adm} = \sigma_m \times K_3 \times K_7 \times K_8$ = **8.999** N/mm$^2$

Applied bending stress; $\sigma_{m_max} = F \times L_{eff}^2 / (8 \times Z)$ = **2.120** N/mm$^2$

***PASS - Applied bending stress within permissible limits***

**Check compressive stress parallel to grain**

Compression stress parallel to grain; $\sigma_c$ = **7.100** N/mm$^2$

Minimum modulus of elasticity; $E_{min}$ = **6000** N/mm$^2$

Compression member factor; $K_{12}$ = **0.30**

Permissible compressive stress; $\sigma_{c_adm} = \sigma_c \times K_3 \times K_8 \times K_{12}$ = **2.944** N/mm$^2$

Applied compressive stress; $\sigma_{c_max} = F \times L_{eff} \times (\cot(\alpha) + 3 \times \tan(\alpha)) / (2 \times A)$ = **0.439** N/mm$^2$

***PASS - Applied compressive stress within permissible limits***

**Check combined bending and compressive stress parallel to grain**

Euler stress; $\sigma_e = \pi^2 \times E_{min} / \lambda^2$ = **5.215** N/mm$^2$

Euler coefficient; $K_{eu} = 1 - (1.5 \times \sigma_{c_max} \times K_{12} / \sigma_e)$ = **0.962**

Combined axial compression and bending check; $\sigma_{m_max} / (\sigma_{m_adm} \times K_{eu}) + \sigma_{c_max} / \sigma_{c_adm}$ = **0.394**; **< 1**

***PASS - Combined compressive and bending stresses are within permissible limits***

**Check shear stress**

Shear stress parallel to grain; $\tau$ = **0.670** N/mm$^2$

Permissible shear stress; $\tau_{adm} = \tau \times K_3 \times K_8$ = **0.921** N/mm$^2$

Applied shear stress; $\tau_{max} = 3 \times F \times L_{eff} / (4 \times A)$ = **0.069** N/mm$^2$

***PASS - Applied shear stress within permissible limits***

**Check deflection**

Permissible deflection; $\delta_{adm} = 0.003 \times L_{eff}$ = **9.228** mm

Bending deflection; $\delta_b = 5 \times F \times L_{eff}^4 / (384 \times E_{mean} \times I)$ = **4.592** mm

Shear deflection; $\delta_s = 12 \times F \times L_{eff}^2 / (5 \times E_{mean} \times A)$ = **0.075** mm

Total deflection; $\delta_{max} = \delta_b + \delta_s$ = **4.666** mm

***PASS - Total deflection within permissible limits***

**Consider short term load condition**

Load duration factor; $K_3$ = **1.50**

Total UDL perpendicular to rafter; $F = F_d \times \cos(\alpha) \times s + F_j \times \cos(\alpha)$ = **0.117** kN/m

Notional bearing length; $L_b = [F \times L_{cl} + F_p \times \cos(\alpha)] / [2 \times (b \times \sigma_{cp1} \times K_8 - F)]$ = **3** mm

Effective span; $L_{eff} = L_{cl} + L_b$ = **3077** mm

**Check bending stress**

Bending stress parallel to grain; $\sigma_m$ = **5.800** N/mm$^2$

Permissible bending stress; $\sigma_{m_adm} = \sigma_m \times K_3 \times K_7 \times K_8$ = **10.799** N/mm$^2$

Applied bending stress; $\sigma_{m_max} = F \times L_{eff}^2/(8 \times Z) + F_p \times \cos(\alpha) \times L_{eff}/(4 \times Z)$ = **4.495** N/mm$^2$

***PASS - Applied bending stress within permissible limits***

**Check compressive stress parallel to grain**

Compression stress parallel to grain; $\sigma_c$ = **7.100** N/mm$^2$

Minimum modulus of elasticity; $E_{min}$ = **6000** N/mm$^2$

Compression member factor; $K_{12}$ = **0.26**

Permissible compressive stress; $\sigma_{c_adm} = \sigma_c \times K_3 \times K_8 \times K_{12}$ = **3.092** N/mm$^2$

Applied compressive stress; $\sigma_{c_max} = F \times L_{eff} \times (\cot(\alpha) + 3 \times \tan(\alpha)) / (2 \times A) + F_p \times \sin(\alpha) / A$ = **0.547** N/mm$^2$

***PASS - Applied compressive stress within permissible limits***

**Check combined bending and compressive stress parallel to grain**

Euler stress; $\sigma_e = \pi^2 \times E_{min} / \lambda^2 =$ **5.212** N/mm$^2$

Euler coefficient; $K_{eu} = 1 - (1.5 \times \sigma_{c_max} \times K_{12} / \sigma_e) =$ **0.958**

Combined axial compression and bending check; $\sigma_{m_max} / (\sigma_{m_adm} \times K_{eu}) + \sigma_{c_max} / \sigma_{c_adm} =$ **0.611**; **< 1**

***PASS - Combined compressive and bending stresses are within permissible limits***

**Check shear stress**

Shear stress parallel to grain; $\tau =$ **0.670** N/mm$^2$

Permissible shear stress; $\tau_{adm} = \tau \times K_3 \times K_8 =$ **1.106** N/mm$^2$

Applied shear stress; $\tau_{max} = 3 \times F \times L_{eff} / (4 \times A) + 3 \times F_p \times \cos(\alpha) / (2 \times A) =$ **0.146** N/mm$^2$

***PASS - Applied shear stress within permissible limits***

**Check deflection**

Permissible deflection; $\delta_{adm} = 0.003 \times L_{eff} =$ **9.231** mm

Bending deflection; $\delta_b = L_{eff}^3 \times (5 \times F \times L_{eff} / 384 + F_p \times \cos(\alpha) / 48) / (E_{mean} \times I) =$ **8.559** mm

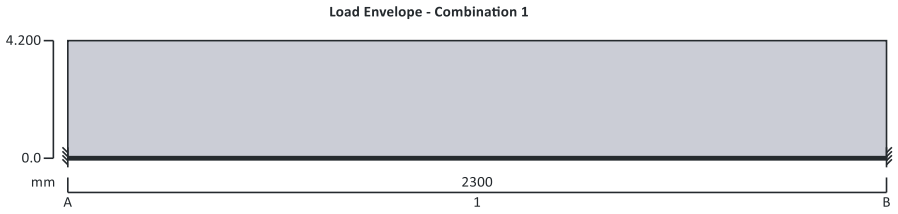
Shear deflection; $\delta_s = 12 \times L_{eff} \times (F \times L_{eff} + 2 \times F_p \times \cos(\alpha)) / (5 \times E_{mean} \times A) =$ **0.158** mm

Total deflection; $\delta_{max} = \delta_b + \delta_s =$ **8.717** mm

***PASS - Total deflection within permissible limits***

## TIMBER PURLIN (EXISTING) BEAM ANALYSIS & DESIGN CHECK TO BS5268-2:2002

TEDDS calculation version 1.7.03




**Applied loading**

**Beam loads**

Dead full UDL 4.200 kN/m

**Load combinations**

| | | |
|---|---|---|
| Load combination 1 | Support A | Dead × 1.00 |
| | | Imposed × 1.00 |
| | Span 1 | Dead × 1.00 |
| | | Imposed × 1.00 |
| | Support B | Dead × 1.00 |
| | | Imposed × 1.00 |

**Analysis results**

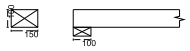
Maximum moment; $M_{max} =$ **0.926** kNm; $M_{min} =$ **-1.852** kNm

Design moment; $M = \max(\text{abs}(M_{max}), \text{abs}(M_{min})) =$ **1.852** kNm

Maximum shear; $F_{max} =$ **4.830** kN; $F_{min} =$ **-4.830** kN

Design shear; $F = \max(\text{abs}(F_{max}), \text{abs}(F_{min})) =$ **4.830** kN

| | | |
|---|---|---|
| Total load on beam; | $W_{tot}$ = **9.660** kN | |
| Reactions at support A; | $R_{A_max}$ = **4.830** kN; | $R_{A_min}$ = **4.830** kN |
| Unfactored dead load reaction at support A; | $R_{A_Dead}$ = **4.830** kN | |
| Reactions at support B; | $R_{B_max}$ = **4.830** kN; | $R_{B_min}$ = **4.830** kN |
| Unfactored dead load reaction at support B; | $R_{B_Dead}$ = **4.830** kN | |



**Timber section details**

| | |
|---|---|
| Breadth of sections; | b = **150** mm |
| Depth of sections; | h = **100** mm |
| Number of sections in member; | N = **1** |
| Overall breadth of member; | $b_b$ = N × b = **150** mm |
| Timber strength class; | **C22** |

**Member details**

| | |
|---|---|
| Service class of timber; | **1** |
| Load duration; | **Long term** |
| Length of span; | $L_{s1}$ = **2300** mm |
| Length of bearing; | $L_b$ = **100** mm |

**Section properties**

| | |
|---|---|
| Cross sectional area of member; | A = N × b × h = **15000** $mm^2$ |
| Section modulus; | $Z_x$ = N × b × $h^2$ / 6 = **250000** $mm^3$ |
| | $Z_y$ = h × (N × b)$^2$ / 6 = **375000** $mm^3$ |
| Second moment of area; | $I_x$ = N × b × $h^3$ / 12 = **12500000** $mm^4$ |
| | $I_y$ = h × (N × b)$^3$ / 12 = **28125000** $mm^4$ |
| Radius of gyration; | $i_x$ = √($I_x$ / A) = **28.9** mm |
| | $i_y$ = √($I_y$ / A) = **43.3** mm |

**Modification factors**

| | |
|---|---|
| Duration of loading - Table 17; | $K_3$ = **1.00** |
| Bearing stress - Table 18; | $K_4$ = **1.00** |
| Total depth of member - cl.2.10.6; | $K_7$ = (300 mm / h)$^{0.11}$ = **1.13** |
| Load sharing - cl.2.9; | $K_8$ = **1.00** |

**Lateral support - cl.2.10.8**

Ends held in position and members held in line, as by direct connection of sheathing, deck or joists, together with adequate bridging or blocking spaced at intervals not exceeding 6 x depth

| | |
|---|---|
| Permissible depth-to-breadth ratio - Table 19; | **6.00** |
| Actual depth-to-breadth ratio; | h / (N × b) = **0.67** |

***PASS - Lateral support is adequate***

**Compression perpendicular to grain**

| | |
|---|---|
| Permissible bearing stress (no wane); | $\sigma_{c_adm}$ = $\sigma_{cp1}$ × $K_3$ × $K_4$ × $K_8$ = **2.300** $N/mm^2$ |
| Applied bearing stress; | $\sigma_{c_a}$ = $R_{B_max}$ / (N × b × $L_b$) = **0.322** $N/mm^2$ |

$\sigma_{c_a} / \sigma_{c_adm}$ = **0.140**

***PASS - Applied compressive stress is less than permissible compressive stress at bearing***

**Bending parallel to grain**

Permissible bending stress; $\sigma_{m_adm} = \sigma_m \times K_3 \times K_7 \times K_8$ = **7.673** N/mm$^2$

Applied bending stress; $\sigma_{m_a} = M / Z_x$ = **7.406** N/mm$^2$

$\sigma_{m_a} / \sigma_{m_adm}$ = **0.965**

***PASS - Applied bending stress is less than permissible bending stress***

**Shear parallel to grain**

Permissible shear stress; $\tau_{adm} = \tau \times K_3 \times K_8$ = **0.710** N/mm$^2$

Applied shear stress; $\tau_a = 3 \times F / (2 \times A)$ = **0.483** N/mm$^2$

$\tau_a / \tau_{adm}$ = **0.680**

***PASS - Applied shear stress is less than permissible shear stress***

**Deflection**

Modulus of elasticity for deflection; $E = E_{min}$ = **6500** N/mm$^2$

Permissible deflection; $\delta_{adm} = \min(0.551 \text{ in}, 0.003 \times L_{s1})$ = **6.900** mm

Bending deflection; $\delta_{b_s1}$ = **3.767** mm

Shear deflection; $\delta_{v_s1}$ = **0.182** mm

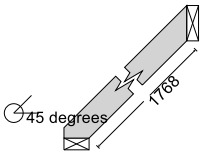
Total deflection; $\delta_a = \delta_{b_s1} + \delta_{v_s1}$ = **3.949** mm

$\delta_a / \delta_{adm}$ = **0.572**

***PASS - Total deflection is less than permissible deflection***

## TIMBER UPPER RAFTER DESIGN CHECK (BS5268-2:2002)

TEDDS calculation version 1.0.03




**Rafter details**

| | |
|---|---|
| Breadth of timber sections; | b = **47** mm |
| Depth of timber sections; | h = **100** mm |
| Rafter spacing; | s = **330** mm |
| Rafter slope; | $\alpha$ = **45.0** deg |
| Clear span of rafter on horizontal; | $L_{clh}$ = **1250** mm |
| Clear span of rafter on slope; | $L_{cl} = L_{clh} / \cos(\alpha)$ = **1768** mm |
| Rafter span; | **Single span** |
| Timber strength class; | **C16** |

**Section properties**

| | |
|---|---|
| Cross sectional area of rafter; | $A = b \times h$ = **4700** $mm^2$ |
| Section modulus; | $Z = b \times h^2 / 6$ = **78333** $mm^3$ |
| Second moment of area; | $I = b \times h^3 / 12$ = **3916667** $mm^4$ |
| Radius of gyration; | $r = \sqrt{(I / A)}$ = **28.9** mm |

**Loading details**

| | |
|---|---|
| Rafter self weight; | $F_j = b \times h \times \rho_{char} \times g_{acc}$ = **0.01** kN/m |
| Dead load on slope; | $F_d$ = **1.10** $kN/m^2$ |
| Imposed load on plan; | $F_u$ = **0.75** $kN/m^2$ |
| Imposed point load; | $F_p$ = **0.90** kN |

**Modification factors**

| | |
|---|---|
| Section depth factor; | $K_7 = (300 \text{ mm} / h)^{0.11}$ = **1.13** |
| Load sharing factor; | $K_8$ = **1.10** |

**Consider long term load condition**

Load duration factor; $K_3$ = **1.00**

Total UDL perpendicular to rafter; $F = F_d \times \cos(\alpha) \times s + F_j \times \cos(\alpha)$ = **0.267** kN/m

Notional bearing length; $L_b = F \times L_{cl} / [2 \times (b \times \sigma_{cp1} \times K_8 - F)]$ = **2** mm

Effective span; $L_{eff} = L_{cl} + L_b$ = **1770** mm

**Check bending stress**

Bending stress parallel to grain; $\sigma_m$ = **5.300** N/mm$^2$

Permissible bending stress; $\sigma_{m_adm} = \sigma_m \times K_3 \times K_7 \times K_8$ = **6.579** N/mm$^2$

Applied bending stress; $\sigma_{m_max} = F \times L_{eff}^2 / (8 \times Z)$ = **1.333** N/mm$^2$

***PASS - Applied bending stress within permissible limits***

**Check compressive stress parallel to grain**

Compression stress parallel to grain; $\sigma_c$ = **6.800** N/mm$^2$

Minimum modulus of elasticity; $E_{min}$ = **5800** N/mm$^2$

Compression member factor; $K_{12}$ = **0.65**

Permissible compressive stress; $\sigma_{c_adm} = \sigma_c \times K_3 \times K_8 \times K_{12}$ = **4.851** N/mm$^2$

Applied compressive stress; $\sigma_{c_max} = F \times L_{eff} \times (\cot(\alpha) + 3 \times \tan(\alpha)) / (2 \times A)$ = **0.201** N/mm$^2$

***PASS - Applied compressive stress within permissible limits***

**Check combined bending and compressive stress parallel to grain**

Euler stress; $\sigma_e = \pi^2 \times E_{min} / \lambda^2$ = **15.229** N/mm$^2$

Euler coefficient; $K_{eu} = 1 - (1.5 \times \sigma_{c_max} \times K_{12} / \sigma_e)$ = **0.987**

Combined axial compression and bending check; $\sigma_{m_max} / (\sigma_{m_adm} \times K_{eu}) + \sigma_{c_max} / \sigma_{c_adm}$ = **0.247**; **< 1**

***PASS - Combined compressive and bending stresses are within permissible limits***

**Check shear stress**

Shear stress parallel to grain; $\tau$ = **0.670** N/mm$^2$

Permissible shear stress; $\tau_{adm} = \tau \times K_3 \times K_8$ = **0.737** N/mm$^2$

Applied shear stress; $\tau_{max} = 3 \times F \times L_{eff} / (4 \times A)$ = **0.075** N/mm$^2$

***PASS - Applied shear stress within permissible limits***

**Check deflection**

Permissible deflection; $\delta_{adm} = 0.003 \times L_{eff}$ = **5.310** mm

Bending deflection; $\delta_b = 5 \times F \times L_{eff}^4 / (384 \times E_{mean} \times I)$ = **0.989** mm

Shear deflection; $\delta_s = 12 \times F \times L_{eff}^2 / (5 \times E_{mean} \times A)$ = **0.048** mm

Total deflection; $\delta_{max} = \delta_b + \delta_s$ = **1.037** mm

***PASS - Total deflection within permissible limits***

**Consider medium term load condition**

Load duration factor; $K_3$ = **1.25**

Total UDL perpendicular to rafter; $F = [F_u \times \cos(\alpha)^2 + F_d \times \cos(\alpha)] \times s + F_j \times \cos(\alpha)$ = **0.391** kN/m

Notional bearing length; $L_b = F \times L_{cl} / [2 \times (b \times \sigma_{cp1} \times K_8 - F)]$ = **3** mm

Effective span; $L_{eff} = L_{cl} + L_b$ = **1771** mm

**Check bending stress**

Bending stress parallel to grain; $\sigma_m$ = **5.300** N/mm$^2$

Permissible bending stress; $\sigma_{m_adm} = \sigma_m \times K_3 \times K_7 \times K_8$ = **8.224** N/mm$^2$

Applied bending stress; $\sigma_{m_max} = F \times L_{eff}^2 / (8 \times Z)$ = **1.954** N/mm$^2$

***PASS - Applied bending stress within permissible limits***

**Check compressive stress parallel to grain**

Compression stress parallel to grain; $\sigma_c$ = **6.800** N/mm$^2$

Minimum modulus of elasticity; $E_{min}$ = **5800** N/mm$^2$

Compression member factor; $K_{12}$ = **0.61**

Permissible compressive stress; $\sigma_{c_adm} = \sigma_c \times K_3 \times K_8 \times K_{12}$ = **5.733** N/mm$^2$

Applied compressive stress; $\sigma_{c_max} = F \times L_{eff} \times (\cot(\alpha) + 3 \times \tan(\alpha)) / (2 \times A)$ = **0.294** N/mm$^2$

***PASS - Applied compressive stress within permissible limits***

**Check combined bending and compressive stress parallel to grain**

Euler stress; $\sigma_e = \pi^2 \times E_{min} / \lambda^2$ = **15.213** N/mm$^2$

Euler coefficient; $K_{eu} = 1 - (1.5 \times \sigma_{c_max} \times K_{12} / \sigma_e)$ = **0.982**

Combined axial compression and bending check; $\sigma_{m_max} / (\sigma_{m_adm} \times K_{eu}) + \sigma_{c_max} / \sigma_{c_adm}$ = **0.293**; **< 1**

***PASS - Combined compressive and bending stresses are within permissible limits***

**Check shear stress**

Shear stress parallel to grain; $\tau$ = **0.670** N/mm$^2$

Permissible shear stress; $\tau_{adm} = \tau \times K_3 \times K_8$ = **0.921** N/mm$^2$

Applied shear stress; $\tau_{max} = 3 \times F \times L_{eff} / (4 \times A)$ = **0.110** N/mm$^2$

***PASS - Applied shear stress within permissible limits***

**Check deflection**

Permissible deflection; $\delta_{adm} = 0.003 \times L_{eff}$ = **5.312** mm

Bending deflection; $\delta_b = 5 \times F \times L_{eff}^4 / (384 \times E_{mean} \times I)$ = **1.451** mm

Shear deflection; $\delta_s = 12 \times F \times L_{eff}^2 / (5 \times E_{mean} \times A)$ = **0.071** mm

Total deflection; $\delta_{max} = \delta_b + \delta_s$ = **1.522** mm

***PASS - Total deflection within permissible limits***

**Consider short term load condition**

Load duration factor; $K_3$ = **1.50**

Total UDL perpendicular to rafter; $F = F_d \times \cos(\alpha) \times s + F_j \times \cos(\alpha)$ = **0.267** kN/m

Notional bearing length; $L_b = [F \times L_{cl} + F_p \times \cos(\alpha)] / [2 \times (b \times \sigma_{cp1} \times K_8 - F)]$ = **5** mm

Effective span; $L_{eff} = L_{cl} + L_b$ = **1773** mm

**Check bending stress**

Bending stress parallel to grain; $\sigma_m$ = **5.300** N/mm$^2$

Permissible bending stress; $\sigma_{m_adm} = \sigma_m \times K_3 \times K_7 \times K_8$ = **9.868** N/mm$^2$

Applied bending stress; $\sigma_{m_max} = F \times L_{eff}^2/(8 \times Z) + F_p \times \cos(\alpha) \times L_{eff}/(4 \times Z)$ = **4.938** N/mm$^2$

***PASS - Applied bending stress within permissible limits***

**Check compressive stress parallel to grain**

Compression stress parallel to grain; $\sigma_c$ = **6.800** N/mm$^2$

Minimum modulus of elasticity; $E_{min}$ = **5800** N/mm$^2$

Compression member factor; $K_{12}$ = **0.58**

Permissible compressive stress; $\sigma_{c_adm} = \sigma_c \times K_3 \times K_8 \times K_{12}$ = **6.473** N/mm$^2$

Applied compressive stress; $\sigma_{c_max} = F \times L_{eff} \times (\cot(\alpha) + 3 \times \tan(\alpha)) / (2 \times A) + F_p \times \sin(\alpha) / A$ = **0.337** N/mm$^2$

***PASS - Applied compressive stress within permissible limits***

**Check combined bending and compressive stress parallel to grain**

Euler stress; $\sigma_e = \pi^2 \times E_{min} / \lambda^2 =$ **15.181** N/mm$^2$

Euler coefficient; $K_{eu} = 1 - (1.5 \times \sigma_{c_max} \times K_{12} / \sigma_e) =$ **0.981**

Combined axial compression and bending check; $\sigma_{m_max} / (\sigma_{m_adm} \times K_{eu}) + \sigma_{c_max} / \sigma_{c_adm} =$ **0.562**; **< 1**

***PASS - Combined compressive and bending stresses are within permissible limits***

**Check shear stress**

Shear stress parallel to grain; $\tau =$ **0.670** N/mm$^2$

Permissible shear stress; $\tau_{adm} = \tau \times K_3 \times K_8 =$ **1.106** N/mm$^2$

Applied shear stress; $\tau_{max} = 3 \times F \times L_{eff} / (4 \times A) + 3 \times F_p \times \cos(\alpha) / (2 \times A) =$ **0.279** N/mm$^2$

***PASS - Applied shear stress within permissible limits***

**Check deflection**

Permissible deflection; $\delta_{adm} = 0.003 \times L_{eff} =$ **5.318** mm

Bending deflection; $\delta_b = L_{eff}^3 \times (5 \times F \times L_{eff} / 384 + F_p \times \cos(\alpha) / 48) / (E_{mean} \times I) =$ **3.138** mm

Shear deflection; $\delta_s = 12 \times L_{eff} \times (F \times L_{eff} + 2 \times F_p \times \cos(\alpha)) / (5 \times E_{mean} \times A) =$ **0.180** mm

Total deflection; $\delta_{max} = \delta_b + \delta_s =$ **3.317** mm

***PASS - Total deflection within permissible limits***