The following output is from the MasterKey Timber Design and MasterBeam Timber Beam Designer programs.

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   Beam Design to BS 5268 Pt 2
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8 Element Designs –
   Domestic Floor Joist
   Timber Beam
   Typical Floor Joist
   Flat Roof Joist with access
   Tension Member
**Summary Design Data**

- **Design Cases Covered**: 1 D1 + 1 L1, 1 L1
- **Deflection Cases Covered**: 1 D1 + 1 L1, 1 L1
- **Section Properties (cm², cm³, cm)**: Area 191.1, Zx 468.2, Zy 414.1, rx 4.24, ry 3.75
- **Specification**: Service class 1: Internal use in continuously heated building
  - Long Term loading, 2 pieces of softwood
- **Integrated Design**: Critical Case 1
- **Member Details**: F = 5.568 kN, Lx = 4.162 m, Ly = 4.162 m, Lex = 1.0 Lx, Ley = 1.0 Ly
  - Bearing length B 75, Distance to Bearing 150 mm

**Grade and Admissible Stresses (Strength Class C24)**

- \( \sigma_{mx,adm} = K_d K_s K_{n_y} K_{n_m} \sigma_{\text{m}} \)
  - 1.00 x 1.00 x 1.08 x 1.00 x 7.50
  - 8.11 N/mm²
- \( \sigma_{my,adm} = K_d K_s K_{n_y} K_{n_m} \sigma_{\text{n}} \)
  - 1.00 x 1.00 x 1.10 x 1.00 x 7.50
  - 8.22 N/mm²
- \( \sigma_{L,adm} = K_d K_s K_{n_y} \sigma_{\text{L}} \)
  - 1.00 x 1.00 x 1.00 x 7.90
  - 7.90 N/mm²
**Compression Resistance**

\[ \lambda = \text{Max} \left( \frac{L}{r_x}, \frac{L}{r_y} \right) \]

\[ K_{12} = f_n(\lambda, K_3, c, E) \]

\[ \sigma_{L,\text{adm}} = K_3, K_4, K_8, \sigma_L \]

\[ \sigma_{t,\text{adm}} = K_3, K_4, t \]

\[ E = K_3, K_9, E_{\text{min}} \text{(Compression)} \]

\[ E = K_3, E_{\text{mean}} \text{(Deflection)} \]

\[ \delta = 0.13 \leq 0.003 L \]

\[ \sigma_{c,\text{adm}} = 1.00 \times 1.00 \times 1.14 \times 1.00 \times 1.90 \]

\[ \sigma_{L,\text{adm}} = 1.00 \times 1.00 \times 1.00 \times 0.70 \]

\[ E = 1.00 \times 1.14 \times 7200 \]

\[ E = 1.00 \times 10800 \]

\[ 2.17 \text{ N/mm}^2 \]

\[ 0.70 \text{ N/mm}^2 \]

\[ 8208 \text{ N/mm}^2 \]

\[ 10800 \text{ N/mm}^2 \]

**Axial Load with Moments Check**

\[ X = 1.374 \]

\[ \sigma_{m,a} = 2.320 / 468.2 \leq 8.11 \]

\[ \sigma_{m,\text{adm}} = 8.11 \times (1-1.5 \times 0.373 \times 0.29 / 6.59) \]

\[ 4.96 \text{ N/mm}^2 \]

\[ 7.91 \text{ N/mm}^2 \]

**Shear and Bearing Check**

\[ X = 3.079 \]

\[ \tau_2 = 1.5 \times 3.411 / 191.1 \leq 0.70 \]

\[ \tau_{L,\text{adm}} = 3.411 / (130 \times 75) \leq 2.17 \]

\[ 0.27 \text{ N/mm}^2 \]

\[ 0.35 \text{ N/mm}^2 \]

**Deflection Check (Shear Deflection NOT Included)**

\[ \delta = 5.13 \leq 0.003 L \]

\[ 5.13 \text{ mm} \]
**MASTERFRAME + MASTERKEY TIMBER DESIGN**

**AXIAL LOAD WITH MOMENT DESIGN TO BS 5268 : PART 2**

**Member 12 (N.3-N.10) @ Level 2**

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**Summary Design Data**
- **Design Cases Covered**: 1 D1 + 1 L1, 1 L1, 1 D1 + 1 W1 + 1 W4, 1 D2 + 1 L2
- **Deflection Cases Covered**: 1 D1 + 1 L1, 1 L1, 1 D1 + 1 W1 + 1 W4, 1 D2 + 1 L2
- **Section Size**: b = 72, h = 194, Regularized Section in Strength Class C20
- **Section Properties (cm², cm³, cm)**:
  - Area = 139.7
  - Zx = 451.6
  - Zy = 167.6
  - rx = 5.6
  - ry = 2.08
- **Specification**:
  - Service class 1: Internal use in continuously heated building
  - Long Term loading
- **Integrated Design**:
  - Critical Case 4
- **Member Details**:
  - F = 6.186 kN, Lx = 1.398 m, Ly = 1.398 m, Lex = 1.398, Ley = 1.0
  - Bearing length = B 75, Distance to Bearing = 150 mm
- **Grade and Admissible Stresses (Strength Class C20)**
  - \( \sigma_{\text{adm}} = K_2 K_3 K_7 x K_8 \cdot m \)
  - \( m = 1.00 \times 1.00 \times 1.05 \times 1.00 \times 6.30 \)
  - \( 6.61 \text{ N/mm}^2 \)
  - \( \sigma_{\text{adm}} = K_2 K_3 K_7 y K_8 \cdot m \)
  - \( m = 1.00 \times 1.00 \times 1.17 \times 1.00 \times 6.30 \)
  - \( 7.37 \text{ N/mm}^2 \)
  - \( c_{\text{adm}} = K_2 K_3 K_8 \cdot c \)
  - \( c = 1.00 \times 1.00 \times 1.14 \times 1.00 \times 1.70 \)
  - \( 1.94 \text{ N/mm}^2 \)
  - \( 0.60 \text{ N/mm}^2 \)
- **E** = \( K_2 K_9 E_{\text{min}}(\text{Compression}) \)
  - \( 1.00 \times 9400 \)
  - \( 6250 \text{ N/mm}^2 \)
- **Compression Resistance**
  - \( \lambda = \max(\text{Lex/ry, Ley/ry}) \)
  - \( \lambda = \max(140/5.600, 140/2.078) = 180 \)
  - \( 67.3 \text{ OK} \)
- **Axial Load with Moments Check**
  - Critical Design Location
  - \( X = 0.000 \)
  - \( 0.44/4.41 \)
  - \( 0.100 \text{ OK} \)
MASTERBEAM TIMBER DESIGNER

SUMMARY OF INPUT DATA

Loading Cases and Load Combination
Load Group Labels
Load Group UT  Unity Load Factor (All Cases)
Load Group D1  Dead Load
Load Group L1  Live Load

Load Case 001 : All Spans Loaded  (Ultimate: 1.0D1+1.0L1)
Load Combination  + 1.00 D1 + 1.00 L1

Load Case 002 : Live Only (Serviceability)
Load Combination  + 1.00 L1

Load Case 003 : All Spans Loaded  (Serviceability: 1.0D1+1.0L1)
Load Combination  + 1.00 D1 + 1.00 L1

The Nodal Co-ordinates

<table>
<thead>
<tr>
<th>Node</th>
<th>X (m)</th>
<th>Y (m)</th>
<th>Z (m)</th>
<th>Node</th>
<th>X (m)</th>
<th>Y (m)</th>
<th>Z (m)</th>
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<tr>
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<td>0.000</td>
<td>0.000</td>
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<td>3</td>
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<td>0.000</td>
<td>4</td>
<td>7.170</td>
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</table>

Member Properties
Spans 1-3
M ... ... 38x220 C30 E 12.30E6 G .769E6 TG C30 10000
A 83.6E-4   Ix 3372E-8   Iy 100.6E-8   J 402.4E-8

Member Loading
Span 1
D1 UDLW -000.038  ( kN/m )  D1 UDLY -000.300  ( kN/m )
L1 UDLW -000.600  ( kN/m )  L1 UDLY -000.600  ( kN,m )
Span 2
D1 UDLW -000.038  ( kN/m )  D1 UDLY -000.300  ( kN/m )
L1 UDLW -000.600  ( kN/m )  L1 UDLY -000.600  ( kN,m,m)
D1 PDLY -000.710  2.150 3.570 (kN,m,m)
Span 3
D1 UDLW -000.038  ( kN/m )  D1 UDLY -000.300  ( kN/m )
L1 UDLW -000.600  ( kN/m )  L1 PDLY -000.040  0.000 0.080 (kN,m,m)

Support Conditions
NODES 1-3
UT Re 1 1 1 0 0 0

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ANALYSIS RESULTS

Nodal Deflections (003 : All Spans Loaded (Serviceability: 1.0D1+1.0L1))

<table>
<thead>
<tr>
<th>Node</th>
<th>ΔX</th>
<th>ΔY</th>
<th>ΘX</th>
<th>ΔXY</th>
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<th>ΔY</th>
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<tr>
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Member Forces (003 : All Spans Loaded (Serviceability: 1.0D1+1.0L1))

<table>
<thead>
<tr>
<th>Span No.</th>
<th>Axial Force (kN)</th>
<th>Shear Force (kN)</th>
<th>Bending Moment (kN.m)</th>
<th>Maximum Moment (kN.m)</th>
<th>Max Deflection (mm@m)</th>
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<tbody>
<tr>
<td></td>
<td>End 1</td>
<td>End 2</td>
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<td>End 2</td>
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Support Reactions (003 : All Spans Loaded (Serviceability: 1.0D1+1.0L1))

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<th>Node</th>
<th>RX (kN)</th>
<th>RY (kN)</th>
<th>Mz (kN.m)</th>
<th>Node</th>
<th>RX (kN)</th>
<th>RY (kN)</th>
<th>Mz (kN.m)</th>
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</table>

MASTERKEY : TIMBER DESIGN

AXIAL LOAD WITH MOMENT DESIGN TO BS 5268 : PART 2
Span 2 : Axial with Moment Member

Summary Design Data
- Design Cases Covered: 1 D1 + 1 L1, 1 L1, 1 D1 + 1 L1
- Deflection Cases Covered: 1 D1 + 1 L1, 1 L1, 1 D1 + 1 L1
- Section Size: b = 38, h 220 Regularized Section in Strength Class C30
- Section Properties (cm²,cm³,cm): Area 83.6, Zx 306.5, Zy 52.9, rx 6.35, ry 1.1
- Specification: Service class 1 : Internal use in continuously heated building
- Medium Term loading
- Integrated Design: Critical Case
- Bearing length B 75, Distance to Bearing 150 mm

Grade and Admissible Stresses (Strength Class C30)

- σm,a = Kc.Ks.Kv.Kp.σm 1.00 x 1.25 x 1.03 x 1.00 x 1.10 14.23 N/mm²
- σm,s = Kc.Ks.Kv.Kp.σm 1.00 x 1.25 x 1.17 x 1.00 x 11.00 16.09 N/mm²
- σl = Kc.Ks.Kv.Kp.σl 1.00 x 1.25 x 1.14 x 1.00 x 1.20 3.14 N/mm²
- τadm = Kc.Ks.Kv.Kp.τ 1.00 x 1.25 x 1.00 x 1.20 1.50 N/mm²
- E = Ks.Emean 1.00 x 12300 12300 N/mm²

Axial Load with Moments Check
- Critical Design Location: X = 0.000
- σm,a = Mx/Zx 1.428 / 306.53 14.23 OK
- σm,s = 4.66/14.23 0.328 OK

Shear and Bearing Check
- Critical Design Location: X = 0.000
- τ = 1.5 Fv / Area 1.5 x 2.582 / 383.6 1.50 OK
- τs = Fv / (b.Bx) 2.582 / (38 x 75) 3.14 OK

Deflection Check
- δ = δs + δt 2.71 ≤ 0.003 L 2.71 mm OK
**MASTERKEY : TIMBER DESIGN**

**AXIAL LOAD WITH MOMENT DESIGN TO BS EN 1995-1-1:2004**

Span 2 comparison : Axial with Moment Member

---

### Summary Design Data
- **Design Cases Covered**: 1.25 D1 + 1.5 L1
- **Deflection Cases Covered**: 1 L1, 1 D1 + 1 L1
- **Section Size**: b = 38, h = 220 Regularized Section in Strength Class C30
- **Section Properties (cm², cm³, cm)**: Area 83.6, W_{el,y} 306.5, W_{el,z} 52.9, i_y 6.35, i_z 1.1
- **Specification**: Service class 1: Internal use in continuously heated building
- **Medium Term loading**: Integrated Design
- **Critical Case 1**: Bearing length l = 75, Distance to Bearing 150 mm

### Grade and Admissible Stresses (Strength Class C30)
- \[ f_{m,y,d} = K_{mod} K_{hy} f_{m,y} \]
  - \[ f_{m,y,d} = 0.80 \times 1.00 \times 30.00/1.3 \] 18.46 N/mm²
- \[ f_{m,z,d} = K_{mod} K_{hz} f_{m,z} \]
  - \[ f_{m,z,d} = 0.80 \times 1.30 \times 2.59/1.3 \] 4.30 N/mm²
- \[ f_{c,90,d} = K_{mod} K_{c,90} f_{c,90} \]
  - \[ f_{c,90,d} = 0.80 \times 3.00/1.3 \] 1.85 N/mm²
- \[ E_{inst} \] Instantaneous Deflection
  - 12000 N/mm²

### Axial Load with Moments Check
- **Critical Design Location**: X = 0.000
- \[ \sigma_{m,y,d} = M/W_{el,y} \]
  - \[ \sigma_{m,y,d} = 1.933 / 306.53 \leq 18.46 \] 6.31 N/mm² \text{OK}
- \[ U_{m,y} = \sigma_{m,y,d}/f_{m,y} \]
  - \[ U_{m,y} = 6.31/18.46 \] 0.342 \text{OK}
- \[ U_{m,y} = 0.342 \text{OK} \]

### Shear and Bearing Check
- **Critical Design Location**: X = 0.000
- \[ \tau_{m,dy} = 1.5 V_{y,d} / \text{Area} \]
  - \[ \tau_{m,dy} = 1.5 \times 3.504 / 83.6 \leq 1.85 \] 0.63 N/mm² \text{OK}
- \[ \sigma_{c,d,ax} = V_{y,d} / (b, i_y) \]
  - \[ \sigma_{c,d,ax} = 3.504 / (38 \times 75) \leq 4.30 \] 1.23 N/mm² \text{OK}

### Deflection Check
- \[ \delta = \delta_0 + \delta_i \]
  - \[ \delta = 2.78 \leq 0.003 L \] 2.78 mm \text{OK}
Element Design – MasterKey Timber Design

DOMESTIC FLOOR JOISTS DESIGN TO BS 5268 : PART 7.1

Summary Design Data
Design Cases Covered: Deflection Cases Covered
Section Size: b = 47, h = 195 Regularized Section in Strength Class C16
Section Properties (cm², cm⁴, cm³): Area 91.7, Iₓ 2904.2, Z 297.9
Specification: Service class 1: Internal use in continuously heated building, Load sharing
Joist data: Span 3.0 m, Spacing 0.6 m, Bearing length B 75, Distance to Bearing 150 mm

Joist loading: Dead load 0.5 kN/m², Live load As per BS 5268 Part 7.1

Grade and Admissible Stresses (Strength Class C16)

<table>
<thead>
<tr>
<th>Grading</th>
<th>Admissible Stress (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>m.adm</td>
<td>6.11</td>
</tr>
<tr>
<td>c.adm</td>
<td>2.13</td>
</tr>
<tr>
<td>adm</td>
<td>0.66</td>
</tr>
</tbody>
</table>

E = 8800 N/mm²

Design Loads
Density and Selfweight
Timber Density 370 kg/m³, Fj 0.03 kN/m

Design Equation: w = \[\text{Max}(1.5, 3.6/L) + F_d]\\*s + F_j

Bending Check
M = w.L²/8
\(\sigma_m = M/Z\) 6.11 N/mm²

Shear and Bearing Check
Fv = w.L/2
\(\sigma_{vb} = 1.5 \times F_v / \text{Area}\) 2.13 kN
\(\sigma_{vb} = F_v / (b \times B)\) 5.08 mm

Deflection Check
\(\delta_m = 5 \times w. L^4/(384 \times E \times I_x)\) 5.41 mm OK

BEAM DESIGN TO BS 5268 : PART 2
TIMBER TRIMMER BEAMS AT 1.8M CENTRES
Summary Design Data
Design Cases Covered
Deflection Cases Covered
Section Size
Section Properties (cm², cm⁴, cm⁶)
Specification
Beam data
Beam loading

Grade and Admissible Stresses (Strength Class C24)
σ_m,adm = K_2 K_3 K_4 K_5 σ_m
σ_c,adm = K_2 K_3 K_4 K_5 σ_c
σ_t,adm = K_2 K_3 K_4 K_5 σ_t
E = K_2 K_3 E_0

Design Loads
Density and Selfweight
w = (F_d+F_L)s + F_j

Bending Check
M = wL²/8
σ_m = M/Z

Shear and Bearing Check
F_v = wL/2
a = 1.5 F_v / Area

Deflection Check
δ_m = 5wL⁴/(384E_0I_x)
δ_s = 12wL²/(5E.Area)
δ = δ_m + δ_s

JOIST DESIGN TO BS 5268: PART 2
TIMBER FLOOR JOISTS AT 0.6M CENTRES

Summary Design Data
Design Cases Covered
Deflection Cases Covered
Section Size
Section Properties (cm², cm⁴, cm⁶)
Specification
Joist data
Joist loading

Grade and Admissible Stresses (Strength Class C16)
σ_m,adm = K_2 K_3 K_4 K_5 σ_m
σ_c,adm = K_2 K_3 K_4 K_5 σ_c
σ_t,adm = K_2 K_3 K_4 K_5 σ_t
E = K_2 E_0

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### Design Loads

**Density and Selfweight**
- Timber Density 370 kg/m³, Fj 0.03 kN/m
- w = (Fd+Fj)s+Fj
- (0.50 + 1.50) x 0.6 + 0.03 = 1.23 kN/m

**Bending Check**
- M = wL²/8
- Max (wd, ws, wL)
- M = 1.23 x 3.0² / 8 = 1.148 kN.m

**Shear and Bearing Check**
- Fv = wL/2
- 1.02 x 3.0 / 2 = 1.530 kN
- ßa = 1.5 Fv / (Area)
- 1.5 x 1.53 / 85 ≤ 0.83

**Deflection Check**
- δ = δm + δs
- 7.20 + 0.36 = 7.56 mm OK

### Summary Data

**Design Cases Covered**
- b = 50, h 170 Regularized Section in Strength Class C16
- Area 85, 1x 2047.1, Z 240.8

**Specification**
- Class 2 : Covered and generally unheated, Load sharing
- Span 3.0 m, Spacing 0.6 m, Bearing length B 75, Distance to Bearing 150 mm
- Dead load 0.5 kN/m², Live load As per BS 5268 Part 7.2

**Grade and Admissible Stresses** (Strength Class C16)

- 1.00 x 1.00 x 1.06 x 1.10 x 5.30 = 6.21 N/mm²

**Grade and Admissible Stresses** (Strength Class C16)

- 1.00 x 1.00 x 1.14 x 1.10 x 1.70 = 2.13 N/mm²

- E = K2.Emean
- 1.00 x 8800 = 8800 N/mm²

**Design Loads**
- w = (1.5+Fj)s+Fj
- 1.5 x 1.8 / 3.0 + 0.50 x 0.6 + 0.03 = 1.53 kN/m Short

**Bending Check**
- M= wL²/8
- 1.02 x 3.0² / 8 = 1.148 kN.m
- 1.29 kN/m Deflection

**Shear and Bearing Check**
- Fv = wL/2
- 1.02 x 3.0 / 2 = 1.530 kN
- 0.27 N/mm² OK

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Deflection Check
\[ w = \max(w_m, w_d) \]
\[ \delta_m = 5wL^3/(384EI) \]
\[ w = \max(w_m, w_d) \]
\[ \delta_m = 12wL^2/(5EI) \]
\[ \delta = \delta_m + \delta_s \]

Deflection Check
\[ w = \max(w_m, w_d) \]
\[ \delta_m = 5wL^3/(384EI) \]
\[ w = \max(w_m, w_d) \]
\[ \delta_m = 12wL^2/(5EI) \]
\[ \delta = \delta_m + \delta_s \]

Tension Member Design to BS 5268: Part 2

Summary Design Data
Design Cases Covered
Deflection Cases Covered
Section Size \( b = 50, h = 97 \) Regularized Section in Strength Class C16
Section Properties (cm²) Area 48.5
Specification Service class 1: Internal use in continuously heated building
Medium Term loading
Tensile Force \( F = 20.0 \text{kN} \)

Grade and Admissible Stresses (Strength Class C16)
\[ \sigma_{adm} = K_2K_3K_8K_{14}\sigma_t \]
1.00 x 1.25 x 1.00 x 1.13 x 3.20
4.53 N/mm²

Tensile Resistance
\[ \sigma_{ta} = F/\text{Area} \]
20.0 / 48.5 ≤ 4.53
4.12 N/mm² OK