



# **Pattern Associates Ltd** Structural Engineering Consultants

Structural Calculations Report  
20.238

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## **STRUCTURAL CALCULATIONS**

**Proposed Loft Conversion to:**

**57 Woodcote Way**

**Caversham**

**Reading**

**Berkshire RG4 7HL**

**Mr & Mrs Murphy**

**20.238**

**May 2020**

**Project Address: 57 Woodcote Way, Caversham, Reading,  
Berkshire RG4 7HL**

**Project Reference: 20.238**

**Date: May 2020**

**Client: Mr & Mrs Murphy**

**Brief:**

*Pattern Associates Ltd were appointed by Mr & Mrs Murphy to undertake the structural design of the structural elements to the following:*

- *Loft conversion*

Loadings:

TYPICAL LOADINGS FOR ALL GENERAL DOMESTIC EXTENSIONS AND NEW BUILDS

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Rafters 30° Pitch (Tiling slope load)

|                  | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|------------------|-------------------------|-------------------------|
| Tiling           | 0.65                    | -                       |
| Felt and Battens | 0.05                    | -                       |
| Rafters          | 0.15                    | -                       |
| Imposed          | -                       | 0.75                    |
|                  | <hr/>                   | <hr/>                   |
|                  | 0.85                    | 0.75                    |

Total 1.60 KN/m<sup>2</sup>

Rafters 50° Pitch (Tiling slope load)

|                  | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|------------------|-------------------------|-------------------------|
| Tiling           | 0.65                    | -                       |
| Felt and Battens | 0.05                    | -                       |
| Rafters          | 0.15                    | -                       |
| Imposed          | -                       | 0.50                    |
|                  | <hr/>                   | <hr/>                   |
|                  | 0.85                    | 0.50                    |

Total 1.35 KN/m<sup>2</sup>

Rafters 30° Pitch (Slates slope load)

|                  | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|------------------|-------------------------|-------------------------|
| Tiling           | 0.40                    | -                       |
| Felt and Battens | 0.05                    | -                       |
| Rafters          | 0.15                    | -                       |
| Imposed          | -                       | 0.75                    |
|                  | <hr/>                   | <hr/>                   |
|                  | 0.60                    | 0.75                    |

Total 1.35 KN/m<sup>2</sup>

Rafters 50° Pitch (Slates slope load)

|                  | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|------------------|-------------------------|-------------------------|
| Tiling           | 0.40                    | -                       |
| Felt and Battens | 0.05                    | -                       |
| Rafters          | 0.15                    | -                       |
| Imposed          | -                       | 0.50                    |
|                  | <hr/>                   | <hr/>                   |
|                  | 0.60                    | 0.50                    |

Total 1.10 KN/m<sup>2</sup>

Generally for vaulted roof add

|              | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|--------------|-------------------------|-------------------------|
| Insulation   | 0.05                    | -                       |
| Plasterboard | 0.20                    | -                       |
|              | <hr/>                   | <hr/>                   |
|              | 0.25                    | -                       |

Total 0.25 KN/m<sup>2</sup>

#### TYPICAL LOADINGS FOR ALL GENERAL DOMESTIC EXTENSIONS AND NEW BUILDS

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##### Ceilings

|              | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|--------------|-------------------------|-------------------------|
| Joists       | 0.15                    | -                       |
| Insulation   | 0.05                    | -                       |
| Plasterboard | 0.20                    | -                       |
| Imposed      | -                       | 0.25                    |
|              | <hr/>                   | <hr/>                   |
|              | 0.40                    | 0.25                    |

Total 0.65 KN/m<sup>2</sup>

##### Flat roofs

|              | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|--------------|-------------------------|-------------------------|
| Finishes     | 0.25                    | -                       |
| Covering     | 0.10                    | -                       |
| Boarding     | 0.15                    | -                       |
| Joists       | 0.15                    | -                       |
| Insulation   | 0.05                    | -                       |
| Plasterboard | 0.20                    | -                       |
| Imposed      | -                       | 0.75                    |
|              | <hr/>                   | <hr/>                   |
|              | 0.90                    | 0.75                    |

Total 1.65 KN/m<sup>2</sup>

##### Lantern lights

|                   | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|-------------------|-------------------------|-------------------------|
| Frame and Glazing | 0.40                    | -                       |
| Imposed           | -                       | 0.75                    |
|                   | <hr/>                   | <hr/>                   |
|                   | 0.40                    | 0.75                    |

Total 1.15 KN/m<sup>2</sup> Say 1.50 KN/m<sup>2</sup>

##### Walls

|                         | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|-------------------------|-------------------------|-------------------------|
| 9" Brickwork            | 4.50                    | -                       |
| 4 ½" Brickwork          | 2.25                    | -                       |
| 100mm Concrete Block    | 2.00                    | -                       |
| 100mm Lightweight Block | 1.50                    | -                       |
| Plaster                 | 0.20                    | -                       |

|                          |      |   |
|--------------------------|------|---|
| Render                   | 0.40 | - |
| 150/100 Stud and Plaster | 0.50 | - |

#### TYPICAL LOADINGS FOR ALL GENERAL DOMESTIC EXTENSIONS AND NEW BUILDS

##### Upper Floors (Timber)

|              | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|--------------|-------------------------|-------------------------|
| Finishes     | 0.10                    | -                       |
| Boarding     | 0.15                    | -                       |
| Joists       | 0.15                    | -                       |
| Plasterboard | 0.20                    | -                       |
| Insulation   | 0.05                    | -                       |
| Imposed      | -                       | 1.50                    |
|              | <hr/>                   | <hr/>                   |
|              | 0.65                    | 1.50                    |

Total 2.15 KN/m<sup>2</sup>

##### Ground Floor (Timber)

|            | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|------------|-------------------------|-------------------------|
| Finishes   | 0.10                    | -                       |
| Boarding   | 0.15                    | -                       |
| Joists     | 0.15                    | -                       |
| Insulation | 0.05                    | -                       |
| Imposed    | -                       | 1.50                    |
|            | <hr/>                   | <hr/>                   |
|            | 0.45                    | 1.50                    |

Total 1.95 KN/m<sup>2</sup>

##### Staircase (Timber)

|             | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|-------------|-------------------------|-------------------------|
| Self weight | 0.65                    | -                       |
| Imposed     | -                       | 1.50                    |
|             | <hr/>                   | <hr/>                   |
|             | 0.65                    | 1.50                    |

Total 2.15 KN/m<sup>2</sup>

##### Upper Floors (150 Beam and Block)

|                   | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|-------------------|-------------------------|-------------------------|
| Finishes          | 0.10                    | -                       |
| Screed            | 1.80                    | -                       |
| Self weight Floor | 2.50                    | -                       |
| Insulation        | 0.05                    | -                       |
| Ceilings          | 0.25                    | -                       |
| Imposed           | -                       | 1.50                    |
|                   | <hr/>                   | <hr/>                   |
|                   | 4.70                    | 1.50                    |

Total 6.20 KN/m<sup>2</sup>

TYPICAL LOADINGS FOR ALL GENERAL DOMESTIC EXTENSIONS AND NEW BUILDS

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Upper Floors (225 Beam and Block)

|                   | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|-------------------|-------------------------|-------------------------|
| Finishes          | 0.10                    | -                       |
| Screed            | 1.80                    | -                       |
| Self weight Floor | 3.50                    | -                       |
| Insulation        | 0.05                    | -                       |
| Ceilings          | 0.25                    | -                       |
| Imposed           | -                       | 1.50                    |
|                   | <hr/>                   | <hr/>                   |
|                   | 5.70                    | 1.50                    |

Total 7.20 KN/m<sup>2</sup>

Ground Floors (150 Beam and Block)

|                   | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|-------------------|-------------------------|-------------------------|
| Finishes          | 0.10                    | -                       |
| Screed            | 1.80                    | -                       |
| Self weight Floor | 2.50                    | -                       |
| Insulation        | 0.05                    | -                       |
| Imposed           | -                       | 1.50                    |
|                   | <hr/>                   | <hr/>                   |
|                   | 4.45                    | 1.50                    |

Total 5.95 KN/m<sup>2</sup>

Ground Floors (225 Beam and Block)

|                   | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|-------------------|-------------------------|-------------------------|
| Finishes          | 0.10                    | -                       |
| Screed            | 1.80                    | -                       |
| Self weight Floor | 3.50                    | -                       |
| Insulation        | 0.05                    | -                       |
| Imposed           | -                       | 1.50                    |
|                   | <hr/>                   | <hr/>                   |
|                   | 5.45                    | 1.50                    |

Total 6.95 KN/m<sup>2</sup>

Partition loading

|                               | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|-------------------------------|-------------------------|-------------------------|
| 100/150 Stud and Plaster      | 0.50                    | -                       |
| Lightweight Block and Plaster | 1.00                    | -                       |

## TYPICAL LOADINGS FOR ALL GENERAL DOMESTIC EXTENSIONS AND NEW BUILDS

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### Upper Floors (150 Plank)

|                              | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|------------------------------|-------------------------|-------------------------|
| Finishes                     | 0.10                    | -                       |
| Screed                       | 1.80                    | -                       |
| Self weight Floor            | 2.50                    | -                       |
| Insulation                   | 0.05                    | -                       |
| Ceilings                     | 0.25                    | -                       |
| Imposed                      | -                       | 1.50                    |
|                              | <hr/>                   | <hr/>                   |
|                              | 4.70                    | 1.50                    |
| Total 6.20 KN/m <sup>2</sup> |                         |                         |

### Upper Floors (200 Plank)

|                              | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|------------------------------|-------------------------|-------------------------|
| Finishes                     | 0.10                    | -                       |
| Screed                       | 1.80                    | -                       |
| Self weight Floor            | 3.00                    | -                       |
| Insulation                   | 0.05                    | -                       |
| Ceilings                     | 0.25                    | -                       |
| Imposed                      | -                       | 1.50                    |
|                              | <hr/>                   | <hr/>                   |
|                              | 5.20                    | 1.50                    |
| Total 6.70 KN/m <sup>2</sup> |                         |                         |

### Ground Floors (150 Plank)

|                              | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|------------------------------|-------------------------|-------------------------|
| Finishes                     | 0.10                    | -                       |
| Screed                       | 1.80                    | -                       |
| Self weight Floor            | 2.50                    | -                       |
| Insulation                   | 0.05                    | -                       |
| Imposed                      | -                       | 1.50                    |
|                              | <hr/>                   | <hr/>                   |
|                              | 4.45                    | 1.50                    |
| Total 5.95 KN/m <sup>2</sup> |                         |                         |

### Ground Floors (200 Plank)

|                   | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|-------------------|-------------------------|-------------------------|
| Finishes          | 0.10                    | -                       |
| Screed            | 1.80                    | -                       |
| Self weight Floor | 3.00                    | -                       |
| Insulation        | 0.05                    | -                       |
| Imposed           | -                       | 1.50                    |
|                   | <hr/>                   | <hr/>                   |

|                              |      |      |
|------------------------------|------|------|
|                              | 4.95 | 1.50 |
| Total 6.45 KN/m <sup>2</sup> |      |      |

#### TYPICAL LOADINGS FOR ALL GENERAL DOMESTIC EXTENSIONS AND NEW BUILDS

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##### Ground Floors (In situ 150 thick)

|                   | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|-------------------|-------------------------|-------------------------|
| Finishes          | 0.10                    | -                       |
| Screed            | 1.80                    | -                       |
| Self weight Floor | 3.60                    | -                       |
| Insulation        | 0.05                    | -                       |
| Imposed           | -                       | 1.50                    |
|                   | <hr/>                   | <hr/>                   |
|                   | 5.55                    | 1.50                    |

Total 7.05 KN/m<sup>2</sup>

##### Ground Floors (In situ 225 thick)

|                   | DL (KN/m <sup>2</sup> ) | LL (KN/m <sup>2</sup> ) |
|-------------------|-------------------------|-------------------------|
| Finishes          | 0.10                    | -                       |
| Screed            | 1.80                    | -                       |
| Self weight Floor | 5.40                    | -                       |
| Insulation        | 0.05                    | -                       |
| Imposed           | -                       | 1.50                    |
|                   | <hr/>                   | <hr/>                   |
|                   | 7.35                    | 1.50                    |

Total 8.85 KN/m<sup>2</sup>

Site address:  
Job:  
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Job number:  
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Page: 9  
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### Beam: Flat roof

Span: 3.7 m.

| Load name           | Loading w1 | Start x1 | Loading w2 | End x2 | R1comp      | R2comp      |
|---------------------|------------|----------|------------|--------|-------------|-------------|
| U L UDL             | 1.65x.4    | 0        |            | L      | 1.22        | 1.22        |
| Total load: 2.44 kN |            |          |            |        | <u>1.22</u> | <u>1.22</u> |
| Dead:               |            |          |            |        | 0.00        | 0.00        |
| Live:               |            |          |            |        | 1.22        | 1.22        |

Load types: U: UDL D: Dead; L: Live (positions in m. from R1)

Maximum B.M. = 1.13 kNm at 1.85 m. from R1

Maximum S.F. = 1.22 kN at 0.00 m. from R1

Live load deflection =  $1.61 \times 10^8 / EI$  at 1.85 m. from R1 ( $E$  in  $N/mm^2$ ,  $I$  in  $cm^4$ )

Total deflection =  $1.61 \times 10^8 / EI$  at 1.85 m. from R1

Timber beam calculation to BS5268 Part 2: 2002 using C16 timber

**Use 50 x 170 C16** 3.1 kg/m approx

$z = 240.8 \text{ cm}^3$   $I = 2,047 \text{ cm}^4$

Timber grade: C16 Load sharing system:  $K_g = 1.1$  [§2.10.11]

$K_3$  (loading duration factor) = 1.00 (long term)

$K_7$  (depth factor) =  $(300/170)^{0.11} = 1.06$  [§2.10.6]  $K_8$  (load sharing factor) = 1.1 [§2.9,2.10]

$E = 8,800 \text{ N/mm}^2$  ( $E_{\text{mean}}$ )

### Bending

Permissible bending stress,  $s_{m,adm} = s_{m,g} \cdot K_3 \cdot K_7 \cdot K_8 = 5.3 \times 1.00 \times 1.06 \times 1.1 = 6.21 \text{ N/mm}^2$

Applied bending stress,  $s_{m,a} = 1.13 \times 1000/240.8 = 4.69 \text{ N/mm}^2$  OK

### Shear

Permissible shear stress,  $t_{adm,||} = t_{g,||} \cdot K_3 \cdot K_8 = 0.67 \times 1.00 \times 1.1 = 0.74 \text{ N/mm}^2$

Applied shear stress,  $t_a = 1.22 \times 1000 \times 3 / (2 \times 50 \times 170) = 0.22 \text{ N/mm}^2$  OK

### Deflection

Bending deflection =  $1.61 \times 10^8 / (8,800 \times 2,047) = 8.94 \text{ mm}$

Mid-span shear deflection =  $1.2 \times 1.13 \times 10^6 / ((E/16) \times 50 \times 170) = 0.29 \text{ mm}$

Total deflection =  $8.94 + 0.29 = 9.23 \text{ mm}$  ( $0.0025 L$ )  $\leq 0.003L$  OK

Site address:  
Job:  
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Job number:  
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Page: 10  
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### Beam: Ridge beam

Span: 5.8 m.

|                      | Load name | Loading w1 | Start x1 | Loading w2 | End x2 | R1comp       | R2comp       |
|----------------------|-----------|------------|----------|------------|--------|--------------|--------------|
| U L                  | o.w.      | 0.5        | 0        |            | L      | 1.45         | 1.45         |
| U L                  | UDL       | 1.65x3.8/2 | 0        |            | L      | 9.09         | 9.09         |
| U L                  | UDL       | 2x2.5/2    | 0        |            | L      | 7.25         | 7.25         |
| Total load: 35.58 kN |           |            |          |            |        | <b>17.79</b> | <b>17.79</b> |
| Dead:                |           |            |          |            |        | 0.00         | 0.00         |
| Live:                |           |            |          |            |        | 17.79        | 17.79        |

Load types: U: UDL D: Dead; L: Live (positions in m. from R1)

Maximum B.M. = 25.80 kNm at 2.90 m. from R1

Maximum S.F. = 17.79 kN at 0.00 m. from R1

Live load deflection =  $90.4 \times 10^8 / EI$  at 2.90 m. from R1 ( $E$  in  $N/mm^2$ ,  $I$  in  $cm^4$ )

Total deflection =  $90.4 \times 10^8 / EI$  at 2.90 m. from R1

Steel beam calculation to BS449 Part 2 using S275 steel

### SECTION SIZE : 203 x 133 x 30 UB S275

D=206.8 mm B=133.9 mm t=6.4 mm T=9.6 mm  $I_x=2,900 \text{ cm}^4$   $r_y=3.17 \text{ cm}$   $Z_x=280 \text{ cm}^3$

### Bending

Effective length,  $L_e = .75L = 4.35\text{m}$ .  $L_e/r_y = 4.35 \times 100/3.17 = 137$  D/T = 21.5

Permissible bending stress,  $p_{bc} = 105.7 \text{ N/mm}^2$  (Table 3a)

Actual bending stress,  $f_{bc} = 25.80 \times 1000/280 = 92.1 \text{ N/mm}^2$  OK

### Shear

Maximum shear in web,  $f_s = 17.79 \times 1000/(6.4 \times 206.8) = 13.4 \text{ N/mm}^2$  OK

### Beam web

Check unstiffened web capacity with load of 17.79 kN

Bearing:  $p_b = 210 \text{ N/mm}^2$  (Table 9);  $C1 = 40.0 \text{ kN}$ ;  $C2 = 1.34 \text{ kN/mm}$

Buckling:  $p_c = 146 \text{ N/mm}^2$  (Table 17a);  $C1 = 96.6 \text{ kN}$ ;  $C2 = 0.934 \text{ kN/mm}$

Minimum required stiff bearing length,  $L_b = 0 \text{ mm}$

Bearing capacity,  $P_w = C1 + L_b.C2 = 40.0 \text{ kN} <<<$

Buckling capacity,  $P_x = C1 + L_b.C2 = 96.6 \text{ kN}$

### Deflection

Live load deflection =  $90.4 \times 1e8/(205,000 \times 2,900) = 15.2 \text{ mm}$  (L/381) OK

Total deflection =  $90.4 \times 1e8/(205,000 \times 2,900) = 15.2 \text{ mm}$  (L/381)

### Combined bending and shear check (14.c)

Check  $(f_{bc}/p_{bc})^2 + (f_s/p_s)^2 = 0.760$  at 2.90 m. ( $\leq 1.25$  OK) [14.c]

Site address:  
Job:  
Client:

Job number:  
Made by: MJP  
Page: 11  
File copy

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### Beam: Floor beam

Span: 5.4 m.

|                      | Load name | Loading w1 | Start x1 | Loading w2 | End x2 | R1comp       | R2comp       |
|----------------------|-----------|------------|----------|------------|--------|--------------|--------------|
| U L                  | o.w.      | 0.5        | 0        |            | L      | 1.35         | 1.35         |
| U L                  | Wall      | .5x1.2     | 0        |            | L      | 1.62         | 1.62         |
| U L                  | UDL       | 2.15x2.4/2 | 0        |            | L      | 6.97         | 6.97         |
| U L                  | UDL       | 2x4/2      | 0        |            | L      | 10.80        | 10.80        |
| U L                  | UDL       | .65x1.5/2  | 0        |            | L      | 1.32         | 1.32         |
| Total load: 44.10 kN |           |            |          |            |        | <b>22.05</b> | <b>22.05</b> |
| Dead:                |           |            |          |            |        | 0.00         | 0.00         |
| Live:                |           |            |          |            |        | 22.05        | 22.05        |

Load types: U: UDL D: Dead; L: Live (positions in m. from R1)

Maximum B.M. = 29.77 kNm at 2.70 m. from R1

Maximum S.F. = 22.05 kN at 0.00 m. from R1

Live load deflection =  $90.4 \times 10^8 / EI$  at 2.70 m. from R1 ( $E$  in  $N/mm^2$ ,  $I$  in  $cm^4$ )

Total deflection =  $90.4 \times 10^8 / EI$  at 2.70 m. from R1

Steel beam calculation to BS449 Part 2 using S275 steel

### SECTION SIZE : 254 x 146 x 31 UB S275

D=251.4 mm B=146.1 mm t=6.0 mm T=8.6 mm  $I_x=4,410 \text{ cm}^4$   $r_y=3.36 \text{ cm}$   $Z_x=351 \text{ cm}^3$

### Bending

Effective length,  $L_e = .75L = 4.05 \text{ m}$ .  $L_e/r_y = 4.05 \times 100/3.36 = 121$  D/T = 29.2

Permissible bending stress,  $p_{bc} = 106.4 \text{ N/mm}^2$  (Table 3a)

Actual bending stress,  $f_{bc} = 29.77 \times 1000/351 = 84.8 \text{ N/mm}^2$  OK

### Shear

Maximum shear in web,  $f_s = 22.05 \times 1000/(6.0 \times 251.4) = 14.6 \text{ N/mm}^2$  OK

### Beam web

Check unstiffened web capacity with load of 22.05 kN

Bearing:  $p_b = 210 \text{ N/mm}^2$  (Table 9);  $C1 = 35.4 \text{ kN}$ ;  $C2 = 1.26 \text{ kN/mm}$

Buckling:  $p_c = 131 \text{ N/mm}^2$  (Table 17a);  $C1 = 98.6 \text{ kN}$ ;  $C2 = 0.785 \text{ kN/mm}$

Minimum required stiff bearing length,  $L_b = 0 \text{ mm}$

Bearing capacity,  $P_w = C1 + L_b.C2 = 35.4 \text{ kN} <<<$

Buckling capacity,  $P_x = C1 + L_b.C2 = 98.6 \text{ kN}$

### Deflection

Live load deflection =  $90.4 \times 1e8/(205,000 \times 4,410) = 10.0 \text{ mm}$  (L/540) OK

Total deflection =  $90.4 \times 1e8/(205,000 \times 4,410) = 10.0 \text{ mm}$  (L/540)

### Combined bending and shear check (14.c)

Check  $(f_{bc}/p_{bc})^2 + (f_s/p_s)^2 = 0.635$  at 2.70 m. ( $\leq 1.25$  OK) [14.c]

Site address:  
Job:  
Client:

Job number:  
Made by: MJP  
Page: 12  
File copy

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### Beam: Lintols

Span: 1.8 m.

| Load name | Loading w1 | Start x1 | Loading w2          | End x2 | R1comp      | R2comp      |
|-----------|------------|----------|---------------------|--------|-------------|-------------|
| U L UDL   | 1.65x3.8/2 | 0        |                     | L      | 2.82        | 2.82        |
|           |            |          | Total load: 5.64 kN |        | <b>2.82</b> | <b>2.82</b> |
|           |            |          | Dead:               |        | 0.00        | 0.00        |
|           |            |          | Live:               |        | 2.82        | 2.82        |

Load types: U: UDL D: Dead; L: Live (positions in m. from R1)

Maximum B.M. = 1.27 kNm at 0.90 m. from R1

Maximum S.F. = 2.82 kN at 0.00 m. from R1

Live load deflection =  $0.428 \times 10^8 / EI$  at 0.90 m. from R1 ( $E$  in  $N/mm^2$ ,  $I$  in  $cm^4$ )

Total deflection =  $0.428 \times 10^8 / EI$  at 0.90 m. from R1

Timber beam calculation to BS5268 Part 2: 2002 using C16 timber

**Use 2no 50 x 170 C16** 6.3 kg/m approx

$z = 481.7 \text{ cm}^3$   $I = 4,094 \text{ cm}^4$

Timber grade: C16 2 members acting together:  $K_8 = 1.1$  [§2.9]

$K_3$  (loading duration factor) = 1.00 (long term)

$K_7$  (depth factor) =  $(300/170)^{0.11} = 1.06$  [§2.10.6]  $K_8$  (load sharing factor) = 1.1 [§2.9,2.10]

$E = 5,800 \times 1.14 = 6,612 \text{ N/mm}^2$  ( $E_{\min} \cdot K_9$ )

### Bending

Permissible bending stress,  $s_{m,adm} = s_{m,g} \cdot K_3 \cdot K_7 \cdot K_8 = 5.3 \times 1.00 \times 1.06 \times 1.1 = 6.21 \text{ N/mm}^2$

Applied bending stress,  $s_{m,a} = 1.27 \times 1000/482 = 2.64 \text{ N/mm}^2$  OK

### Shear

Permissible shear stress,  $t_{adm,||} = t_{g,||} \cdot K_3 \cdot K_8 = 0.67 \times 1.00 \times 1.1 = 0.74 \text{ N/mm}^2$

Applied shear stress,  $t_a = 2.82 \times 1000 \times 3 / (2 \times 100 \times 170) = 0.25 \text{ N/mm}^2$  OK

### Deflection

Bending deflection =  $0.428 \times 10^8 / (6,612 \times 4,094) = 1.58 \text{ mm}$

Mid-span shear deflection =  $1.2 \times 1.27 \times 10^6 / ((E/16) \times 100 \times 170) = 0.22 \text{ mm}$

Total deflection =  $1.58 + 0.22 = 1.80 \text{ mm}$  ( $0.0010 L$ )  $\leq 0.003L$  OK