

# CALCULATIONS REV A P1-51

|                   |                                        |                   |                          |                    |             |                |
|-------------------|----------------------------------------|-------------------|--------------------------|--------------------|-------------|----------------|
| Project           | 34 Grassmere Way                       |                   |                          | Project No:        | Drg No:     | Date:          |
| Part of Structure |                                        |                   |                          | Calc by:           | Checked by: | Calc. Sheet No |
| REF               | CALCULATIONS                           |                   |                          |                    |             |                |
|                   | <b>LOADINGS:-</b>                      |                   |                          |                    |             |                |
| 1/                | Pitched Roofs                          | 30 degree         | EXISTING                 | Dead               | kN/m2       | Live           |
|                   | Tiles                                  | say               |                          | 0.7                |             |                |
|                   | Battens                                |                   |                          | 0.04               |             |                |
|                   | Felt                                   |                   |                          | 0.06               |             |                |
|                   | Rafters                                |                   |                          | 0.1                |             |                |
|                   |                                        |                   |                          | <u>0.9</u>         |             | <u>0.6</u>     |
|                   |                                        |                   | Pitch= 30 degrees approx | Total Loading      | 1.04 kN/m2  | 0.6 kN/m2      |
|                   |                                        |                   | Plan                     |                    |             |                |
| 2/                | Pitched Roofs                          | 25 degree VAULTED | NEW FRONT DINING EXTN    | Dead               |             | Live           |
|                   | Tiles                                  | say               |                          | 0.7                |             |                |
|                   | Battens                                |                   |                          | 0.04               |             |                |
|                   | Felt                                   |                   |                          | 0.06               |             |                |
|                   | Insulation                             |                   |                          | 0.05               |             |                |
|                   | Rafters                                |                   |                          | 0.1                |             |                |
|                   | plasterboard                           |                   |                          | 0.2                |             |                |
|                   |                                        |                   |                          | <u>1.15</u>        |             | <u>0.6</u>     |
|                   |                                        |                   | Pitch= 25 degrees approx | Total Loading      | 1.27 kN/m2  | 0.6 kN/m2      |
|                   |                                        |                   | Plan                     |                    |             |                |
| 3/                | Roof Space                             |                   |                          |                    |             |                |
|                   | insulation                             |                   |                          | 0.1                |             |                |
|                   | Joists                                 |                   |                          | 0.15               |             |                |
|                   | plasterboard                           |                   |                          | 0.2                |             |                |
|                   | chipboard                              |                   |                          | 0.15               |             |                |
|                   | live                                   |                   |                          |                    |             | <u>0.25</u>    |
|                   |                                        |                   |                          | <u>0.6 kN/m2</u>   |             | 0.25 kN/m2     |
| 4/                | Studwork Walls                         |                   |                          |                    |             |                |
|                   | insulation                             |                   |                          | 0.05               |             |                |
|                   | studs                                  |                   |                          | 0.1                |             |                |
|                   | plasterboard 2 side                    |                   |                          | 0.4                |             |                |
|                   |                                        |                   |                          | <u>0.55 kN/m2</u>  |             |                |
|                   |                                        |                   |                          | 0.75 tiled 1 side  |             |                |
|                   |                                        |                   |                          | 0.95 tiled 2 sides |             |                |
| 5/                | Cavity Walls (MISH LEVEL EXT3 - FRONT) |                   |                          |                    |             |                |
|                   | render                                 |                   |                          | 0.4                |             |                |
|                   | 100 block outer                        |                   |                          | 2                  |             |                |
|                   | 100 block inner                        |                   |                          | 1                  |             |                |
|                   | plaster                                |                   |                          | 0.25               |             |                |
|                   | ins                                    |                   |                          | 0.05               |             |                |
|                   |                                        |                   |                          | <u>3.7 kN/m2</u>   |             |                |
| 6/                | First Floor                            |                   |                          |                    |             |                |
|                   | finishes                               |                   |                          | 0.1                |             |                |
|                   | Boards                                 |                   |                          | 0.2                |             |                |
|                   | Joists                                 |                   |                          | 0.15               |             |                |
|                   | plasterboard                           |                   |                          | 0.15               |             |                |
|                   | live                                   |                   |                          |                    |             | <u>1.5</u>     |
|                   |                                        |                   |                          | <u>0.6 kN/m2</u>   |             | 1.5 kN/m2      |
| 7/                | Extg GF Beam & Block                   |                   |                          |                    |             |                |
|                   | finishes                               |                   |                          | 0.25               |             |                |
|                   | 65 screed                              |                   |                          | 1.65               |             |                |
|                   | Insulation                             |                   |                          | 0.1                |             |                |
|                   | B&B Allow                              |                   |                          | 3                  |             |                |
|                   |                                        |                   |                          | <u>5 kN/m2</u>     |             | 1.5 kN/m2      |



# TREES / FOUNDATIONS

Assume high shrink clay

1) TREE 1 OAK.

$$\frac{\Delta}{H} = \frac{5}{20} = 0.25$$

3.0 m

PILE

2) TREE 4 OAK.

$$\frac{\Delta}{H} = \frac{5}{20} = 0.25$$

3.0 m,

PILE.

3) unhy. sh.

$$\frac{\Delta}{H} = \frac{9.5}{20} = 0.5$$

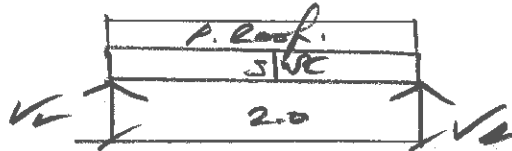
2.5 m.

PILE IT.

|                                 |               |                  |                    |
|---------------------------------|---------------|------------------|--------------------|
| Project Title: 34 GRADSMERE WAY |               | Project No: 1566 |                    |
| Calcs. by: AD                   | Prelim./Final | Checked by: //   | Category of Check: |
| Date: //                        |               | Date: //         | Sht.               |

STEEL (A)

L = 2.0 m.



P. ROOF  $4\frac{1}{2} \times 1.27$   
0.60

S/W

$\Delta$   $\frac{\text{kJ/m}}{\text{L}}$   
2.60  
1.23

0.3

2.90 1.23

Teddo  $\rightarrow$

178 x 102 x 19 WB.

Pedestal  $L_r = \frac{3.5 \times 7.5 \times 10^3}{1.5 \times 2.2 \times 100} = 79.5$

440 L P2

|             |                  |            |            |              |                         |               |
|-------------|------------------|------------|------------|--------------|-------------------------|---------------|
| Tekla.Tedds | Project          |            |            |              | Job no.                 |               |
|             | 34 Grassmere Way |            |            |              | Start page no./Revision |               |
|             | Steel A          |            |            |              | 1                       |               |
|             | Calcs by         | Calcs date | Checked by | Checked date | Approved by             | Approved date |

### STEEL BEAM ANALYSIS & DESIGN (BS5950)

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

TEDDS calculation version 3.0.07

#### Support conditions

|           |                       |
|-----------|-----------------------|
| Support A | Vertically restrained |
|           | Rotationally free     |
| Support B | Vertically restrained |
|           | Rotationally free     |

#### Analysis results

|                                               |                                    |                                |
|-----------------------------------------------|------------------------------------|--------------------------------|
| Maximum moment                                | $M_{max} = 4.5 \text{ kNm}$        | $M_{min} = 0 \text{ kNm}$      |
| Maximum shear                                 | $V_{max} = 7.5 \text{ kN}$         | $V_{min} = -7.5 \text{ kN}$    |
| Deflection                                    | $\delta_{max} = 0.4 \text{ mm}$    | $\delta_{min} = 0 \text{ mm}$  |
| Maximum reaction at support A                 | $R_{A_{max}} = 7.5 \text{ kN}$     | $R_{A_{min}} = 7.5 \text{ kN}$ |
| Unfactored dead load reaction at support A    | $R_{A_{Dead}} = 2.9 \text{ kN}$    |                                |
| Unfactored imposed load reaction at support A | $R_{A_{Imposed}} = 2.1 \text{ kN}$ |                                |
| Maximum reaction at support B                 | $R_{B_{max}} = 7.5 \text{ kN}$     | $R_{B_{min}} = 7.5 \text{ kN}$ |
| Unfactored dead load reaction at support B    | $R_{B_{Dead}} = 2.9 \text{ kN}$    |                                |
| Unfactored imposed load reaction at support B | $R_{B_{Imposed}} = 2.1 \text{ kN}$ |                                |

#### Section details

|                                                       |                       |                        |         |
|-------------------------------------------------------|-----------------------|------------------------|---------|
| Section type                                          | UB 178x102x19 (BS4-1) | Steel grade            | S355    |
| <b>Classification of cross sections - Section 3.5</b> |                       |                        |         |
| Tensile strain coefficient                            | $\epsilon = 0.88$     | Section classification | Plastic |

#### Shear capacity - Section 4.2.3

|                                                                  |                        |                         |                          |
|------------------------------------------------------------------|------------------------|-------------------------|--------------------------|
| Design shear force                                               | $F_v = 7.5 \text{ kN}$ | Design shear resistance | $P_v = 181.8 \text{ kN}$ |
| <b>PASS - Design shear resistance exceeds design shear force</b> |                        |                         |                          |

#### Moment capacity - Section 4.2.5

|                       |                       |                           |                          |
|-----------------------|-----------------------|---------------------------|--------------------------|
| Design bending moment | $M = 4.5 \text{ kNm}$ | Moment capacity low shear | $M_c = 60.8 \text{ kNm}$ |
|-----------------------|-----------------------|---------------------------|--------------------------|

#### Buckling resistance moment - Section 4.3.6.4

|                                                                        |                          |                                   |
|------------------------------------------------------------------------|--------------------------|-----------------------------------|
| Buckling resistance moment                                             | $M_b = 30.8 \text{ kNm}$ | $M_b / m_{LT} = 34.1 \text{ kNm}$ |
| <b>PASS - Buckling resistance moment exceeds design bending moment</b> |                          |                                   |

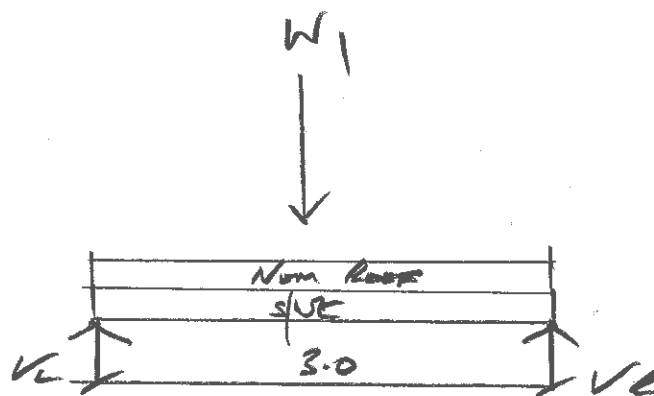
#### Check vertical deflection - Section 2.5.2

Consider deflection due to dead and imposed loads

|                                                                   |                               |                    |                             |
|-------------------------------------------------------------------|-------------------------------|--------------------|-----------------------------|
| Limiting deflection                                               | $\delta_{lim} = 5 \text{ mm}$ | Maximum deflection | $\delta = 0.417 \text{ mm}$ |
| <b>PASS - Maximum deflection does not exceed deflection limit</b> |                               |                    |                             |

|                                 |               |                  |                    |
|---------------------------------|---------------|------------------|--------------------|
| Project Title: 34 GRADSMERE WAY |               | Project No: 1566 |                    |
| Calcs. by: AD                   | Prelim./Final | Checked by: //   | Category of Check: |
| Date: / /                       |               | Date: / /        | Sht.               |

STEEL (B)



$$W_1 = \begin{matrix} 2.9 \text{ kN} \\ 2.1 \text{ kN} \end{matrix}$$

$$\text{Nom P. Roof} \quad 0.3 \times 1.27 = 0.38$$

$$\text{S/W} \quad 0.6 \quad 0.18$$

$$\begin{matrix} 0.7 \\ \hline 1.08 \end{matrix} \quad \begin{matrix} - \\ \hline 0.18 \end{matrix}$$

Tedds →

$$203 \times 102 \times 23 \text{ UB}$$

|             |                             |            |            |              |                              |               |
|-------------|-----------------------------|------------|------------|--------------|------------------------------|---------------|
| Tekla.Tedds | Project<br>34 Grassmere Way |            |            |              | Job no.                      |               |
|             | Calcs for<br>Steel B        |            |            |              | Start page no./Revision<br>1 |               |
|             | Calcs by                    | Calcs date | Checked by | Checked date | Approved by                  | Approved date |

### STEEL BEAM ANALYSIS & DESIGN (BS5950)

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

TEDDS calculation version 3.0.07

#### Support conditions

|           |                                            |
|-----------|--------------------------------------------|
| Support A | Vertically restrained<br>Rotationally free |
| Support B | Vertically restrained<br>Rotationally free |

#### Analysis results

|                                               |                                    |                                |
|-----------------------------------------------|------------------------------------|--------------------------------|
| Maximum moment                                | $M_{max} = 7.6 \text{ kNm}$        | $M_{min} = 0 \text{ kNm}$      |
| Maximum shear                                 | $V_{max} = 6.4 \text{ kN}$         | $V_{min} = -6.4 \text{ kN}$    |
| Deflection                                    | $\delta_{max} = 1 \text{ mm}$      | $\delta_{min} = 0 \text{ mm}$  |
| Maximum reaction at support A                 | $R_{A_{max}} = 6.4 \text{ kN}$     | $R_{A_{min}} = 6.4 \text{ kN}$ |
| Unfactored dead load reaction at support A    | $R_{A_{Dead}} = 3.1 \text{ kN}$    |                                |
| Unfactored imposed load reaction at support A | $R_{A_{Imposed}} = 1.3 \text{ kN}$ |                                |
| Maximum reaction at support B                 | $R_{B_{max}} = 6.4 \text{ kN}$     | $R_{B_{min}} = 6.4 \text{ kN}$ |
| Unfactored dead load reaction at support B    | $R_{B_{Dead}} = 3.1 \text{ kN}$    |                                |
| Unfactored imposed load reaction at support B | $R_{B_{Imposed}} = 1.3 \text{ kN}$ |                                |

#### Section details

|                                                       |                       |                        |         |
|-------------------------------------------------------|-----------------------|------------------------|---------|
| Section type                                          | UB 203x102x23 (BS4-1) | Steel grade            | S355    |
| <b>Classification of cross sections - Section 3.5</b> |                       |                        |         |
| Tensile strain coefficient                            | $\varepsilon = 0.88$  | Section classification | Plastic |

#### Shear capacity - Section 4.2.3

|                                                                  |                        |                         |                          |
|------------------------------------------------------------------|------------------------|-------------------------|--------------------------|
| Design shear force                                               | $F_v = 6.4 \text{ kN}$ | Design shear resistance | $P_v = 233.7 \text{ kN}$ |
| <b>PASS - Design shear resistance exceeds design shear force</b> |                        |                         |                          |

#### Moment capacity - Section 4.2.5

|                       |                       |                           |                          |
|-----------------------|-----------------------|---------------------------|--------------------------|
| Design bending moment | $M = 7.6 \text{ kNm}$ | Moment capacity low shear | $M_c = 83.1 \text{ kNm}$ |
|-----------------------|-----------------------|---------------------------|--------------------------|

#### Buckling resistance moment - Section 4.3.6.4

|                                                                        |                        |                                   |
|------------------------------------------------------------------------|------------------------|-----------------------------------|
| Buckling resistance moment                                             | $M_b = 29 \text{ kNm}$ | $M_b / m_{LT} = 33.4 \text{ kNm}$ |
| <b>PASS - Buckling resistance moment exceeds design bending moment</b> |                        |                                   |

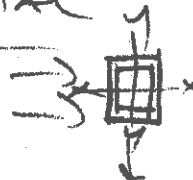
#### Check vertical deflection - Section 2.5.2

Consider deflection due to dead and imposed loads

|                                                                   |                               |                    |                            |
|-------------------------------------------------------------------|-------------------------------|--------------------|----------------------------|
| Limiting deflection                                               | $\delta_{lim} = 3 \text{ mm}$ | Maximum deflection | $\delta = 0.96 \text{ mm}$ |
| <b>PASS - Maximum deflection does not exceed deflection limit</b> |                               |                    |                            |

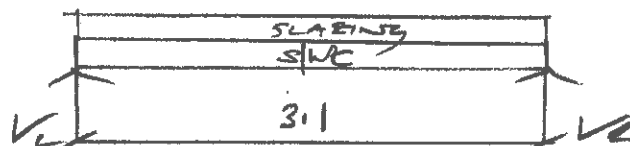
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|---------------------------------|---------------|------------------|-------------------------|
| Project Title: 34. Greenway Way |               | Project No: 1566 |                         |
| Calca. by: AD                   | Prelim./Final | Checked by: =    | Category of Check: Sht. |
| Date: /                         |               | Date: /          |                         |

STEEL (C) - BIAXIAL



$$L = 3.1m.$$

1/ VERTICAL LOADS



$$\text{SLABING av. } 1.0 \times 0.5 = 0.5$$

S/W

$$0.3$$

$$0.8 \text{ kN/m}$$

$$V_L = V_R = 1.74 \text{ kN}$$

$$M_{xx} = 1.35 \text{ kNm}$$

2/ HORIZ. LOADS (WIND)

$$\text{the WIND} = 1.0 \text{ m/s}^2$$

$$W_L = 1.7 \times 1.0 = 1.70 \text{ kN/m U/F.}$$

$$V_L = V_R = 1.70 \times 1.4 \times 3.1/2 = 3.69 \text{ kN}$$

$$M_{yy} = 1.70 \times 1.4 \times 3.1^2/8 = 2.85 \text{ kNm}$$

$$\text{check } \Delta_H \quad I_r = \frac{5 \times 1.70 \times 3.1^4 \times 10^8}{824 \times 205 \times 10^3 \times 0.12} = 161 \text{ cm}^4$$

$$80 \times 80 \times \frac{4500}{8} \text{ SHS } 3355 \quad (I_p = 189 \text{ cm}^4)$$

|                                 |               |                  |                         |
|---------------------------------|---------------|------------------|-------------------------|
| Project Title: 34 Gresswell Way |               | Project No: 1566 |                         |
| Calcs. by: AD                   | Prelim./Final | Checked by: //   | Category of Check: Sht. |
| Date: / /                       |               | Date: / /        |                         |

CALC STEEL (C) END CORN

$$M = 1.74 \times 0.15 = 0.26 \text{ kNm m}$$

$$F_t \text{ top bolts} = \frac{0.26}{0.25}$$

$$= 1.04 \text{ kN}$$

$$\text{welds } F_t \text{ weld} = \frac{0.26}{0.008} = 32.5 \text{ kN}$$

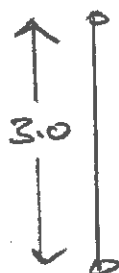
BY INSPECTION,

80 SMS 6 FWFN AL.

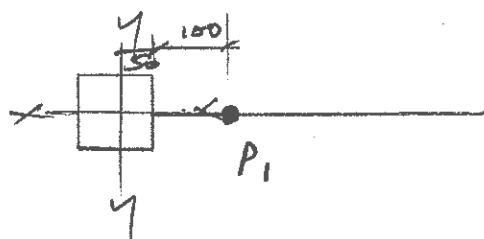
2 M20 ST 8.8's

|                                 |               |                  |                    |
|---------------------------------|---------------|------------------|--------------------|
| Project Title: 34 Grassmere Way |               | Project No: 1566 |                    |
| Calcs. by: AD                   | Prelim./Final | Checked by:      | Category of Check: |
| Date:                           |               | Date:            | Sht.               |

STEEL POSTS SP1 / SP2



$$H_c = 1.0 \times 3.0 \text{ m.}$$



$$\begin{aligned} \Sigma \text{ Loads} & 6.4 \\ & 1.74 \\ & + \text{ post} \\ & 2 \\ \hline & 10.2 \text{ kN.} \\ & (\text{Say } 20 \text{ kN} \\ & \text{WT}) \end{aligned}$$

$$P_1 = 6.4 \text{ kN}$$

$$M_y = 6.4 \times 0.15 = 0.96 \text{ kNm.}$$

$$\begin{aligned} \text{Take } M_x &= \left( 3.63 \times \frac{0.40 \times 2.6}{3.0} \right) + \left( 1.0 \times \frac{1.4}{8} \times 0.3 \times \frac{3^2}{8} \right) \\ &= 1.27 + 0.47 \\ &= 1.74 \text{ kNm.} \end{aligned}$$

EXCEL SPREADSHEET DESIGN →

100 x 100 x 63 SHS S255  
HOT ROLLED

|                   |                  |             |             |                |
|-------------------|------------------|-------------|-------------|----------------|
| Project           | 34 GRASSMERE WAY | Project No: | Drg No:     | Date:          |
| Part of Structure | STEEL POST SP1   | Calc by:    | Checked by: | Calc. Sheet No |

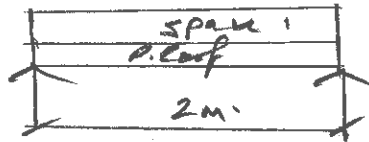
  

| REF | CALCULATIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     | <p><b>100 x 100 x 6.3 SHS S355</b></p> <p><b>1/ Cross Section Capacity</b></p> <div style="margin-left: 40px;"> <p>Fc= 8.2 kN say</p> <p>Mx= 1.74 kNm</p> <p>My= 0.96 kNm</p> <p>Agpy= 823 kN</p> <p>Mcx= 28.6 kNm</p> <p>Mcy= 28.6 kNm</p> </div> <div style="margin-left: 100px; margin-top: 20px;"> <math display="block">\frac{F_c}{A_{gpy}} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = 0.10 &lt; 1 \quad \text{SECTION PASSES}</math> </div> <p><b>2/ Member Buckling Resistance</b> (must satisfy both equations)</p> <div style="margin-left: 40px;"> <p><b>A</b></p> <p>Fc= 8.2 kN</p> <p>mx= 1</p> <p>Mx= 1.74 kNm</p> <p>my= 1</p> <p>My= 0.96 kNm</p> <p>Pc= 555 kN (Pc is smaller of Pcx &amp; Pcy) ie Pcy@3 say</p> <p>pyZx= 23.8 kN</p> <p>pyZy= 23.8 kN</p> </div> <div style="margin-left: 100px; margin-top: 20px;"> <math display="block">\frac{F_c}{P_c} + \frac{m_x M_x}{p_y Z_x} + \frac{m_y M_y}{p_y Z_y} = 0.13 &lt; 1 \quad \text{SECTION PASSES}</math> </div> <div style="margin-left: 40px; margin-top: 20px;"> <p><b>B</b></p> <p>Fc= 8.2 kN</p> <p>mit= 1 4.8.3.3.4 Table 18 1=conservative approach</p> <p>Mit= 1.74 kNm Max major axis moment</p> <p>my= 1 4.8.3.3.4 Table 26 1=conservative approach</p> <p>My= 0.96 kNm</p> <p>Pcy= 555 kN ie Pcy@3m</p> <p>Mb= 28.7 kN</p> <p>pyZy= 23.8 kN</p> </div> <div style="margin-left: 100px; margin-top: 20px;"> <math display="block">\frac{F_c}{P_{cy}} + \frac{m_{it} M_{it}}{M_b} + \frac{m_y M_y}{p_y Z_y} = 0.12 &lt; 1 \quad \text{SECTION PASSES}</math> </div> <div style="text-align: center; margin-top: 40px;"> <p><b>100 x 100 x 6.3 SHS S355 HOT ROLLED</b></p> </div> |

|                                 |               |                  |                    |
|---------------------------------|---------------|------------------|--------------------|
| Project Title: 34 GRADSMERE WAY |               | Project No: 1566 |                    |
| Calcs. by: AD                   | Prelim./Final | Checked by: =    | Category of Check: |
| Date: /                         | Date: /       |                  | Sht.               |

TIMBER VALLEY 2  
L = 2m.

JOIT  
(to get Reactions)  
for studs D+E  
calls.



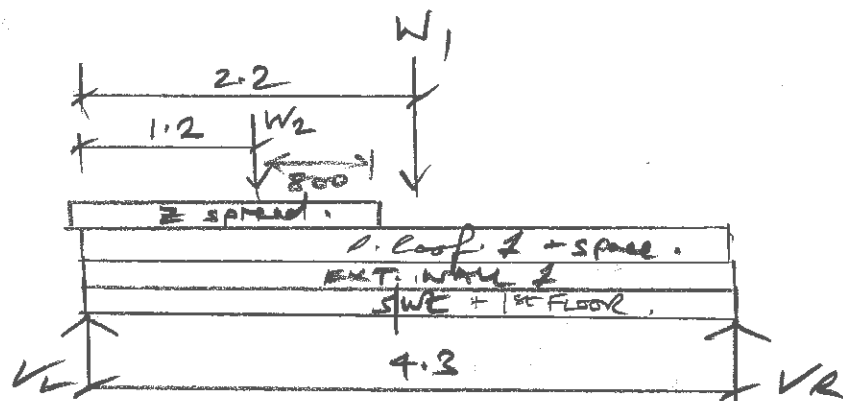
|          |              |      |     |
|----------|--------------|------|-----|
| span 1   | 40/2 x 0.6   | 1.2  |     |
|          | 0.25         |      | 0.5 |
| span 2   | say 2m x 0.6 | 1.2  |     |
|          | 0.25         |      | 0.5 |
| P. Roof. | 4.6 x 1.04   | 4.78 |     |
|          | 1.0          |      | 4.6 |
|          | DRIFT        |      |     |

7.18 5.6

|                                 |               |                  |                    |
|---------------------------------|---------------|------------------|--------------------|
| Project Title: 34 GRADSMERE WAY |               | Project No: 1566 |                    |
| Calcs. by: AD                   | Prelim./Final | Checked by: //   | Category of Check: |
| Date: / /                       |               | Date: / /        | Sht.               |

STEEL (D)

$L = 4.3m$



$W_1 = \text{STEEL (A)}$   
 2.3 W.D.  
 2.1 W.L.

$W_2 = \text{STD ON / OE}$   
 $2.4 \times 0.55 \times 2/2$  1.32 W.D.

P. Roof 1  $1.5 \times 1.04$  1.52  
 0.6 0.9

Space  $2.0 \times 0.6$  0.6  
 0.25 0.25

EXT. WALL (arched).  $2.4 \times 3.7$  8.9

1st  $2/2 \times 0.6$  0.6 1.50  
 1.50

S/W (with 10 plates) 0.7

12.4 2.65

EXT TIMBER VALLEY BEAM (spread)  $7.18 / 3.5$  2.1  
 8.6 1.6

Tedds →

$203 \times 203 = 46 \text{ UC} + 10mm \text{ top plate}$

|                                                                                 |                  |            |              |             |                         |  |
|---------------------------------------------------------------------------------|------------------|------------|--------------|-------------|-------------------------|--|
|  | Project          |            |              |             | Job no.                 |  |
|                                                                                 | 34 Grassmere Way |            |              |             | Start page no./Revision |  |
|                                                                                 | STEEL D          |            |              |             | 1                       |  |
| Calcs by                                                                        | Calcs date       | Checked by | Checked date | Approved by | Approved date           |  |

### STEEL BEAM ANALYSIS & DESIGN (BS5950)

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

TEDDS calculation version 3.0.07

#### Support conditions

|           |                       |
|-----------|-----------------------|
| Support A | Vertically restrained |
|           | Rotationally free     |
| Support B | Vertically restrained |
|           | Rotationally free     |

#### Analysis results

|                                               |                                    |                                 |
|-----------------------------------------------|------------------------------------|---------------------------------|
| Maximum moment                                | $M_{max} = 64.3 \text{ kNm}$       | $M_{min} = 0 \text{ kNm}$       |
| Maximum shear                                 | $V_{max} = 59.8 \text{ kN}$        | $V_{min} = -53.3 \text{ kN}$    |
| Deflection                                    | $\delta_{max} = 9 \text{ mm}$      | $\delta_{min} = 0 \text{ mm}$   |
| Maximum reaction at support A                 | $R_{A_{max}} = 59.8 \text{ kN}$    | $R_{A_{min}} = 59.8 \text{ kN}$ |
| Unfactored dead load reaction at support A    | $R_{A_{Dead}} = 32.3 \text{ kN}$   |                                 |
| Unfactored imposed load reaction at support A | $R_{A_{Imposed}} = 9.2 \text{ kN}$ |                                 |
| Maximum reaction at support B                 | $R_{B_{max}} = 53.3 \text{ kN}$    | $R_{B_{min}} = 53.3 \text{ kN}$ |
| Unfactored dead load reaction at support B    | $R_{B_{Dead}} = 29.5 \text{ kN}$   |                                 |
| Unfactored imposed load reaction at support B | $R_{B_{Imposed}} = 7.5 \text{ kN}$ |                                 |

#### Section details

|              |                       |             |      |
|--------------|-----------------------|-------------|------|
| Section type | UC 203x203x46 (BS4-1) | Steel grade | S355 |
|--------------|-----------------------|-------------|------|

#### Classification of cross sections - Section 3.5

|                            |                   |                        |              |
|----------------------------|-------------------|------------------------|--------------|
| Tensile strain coefficient | $\epsilon = 0.88$ | Section classification | Semi-compact |
|----------------------------|-------------------|------------------------|--------------|

#### Shear capacity - Section 4.2.3

|                                                                  |                         |                         |                          |
|------------------------------------------------------------------|-------------------------|-------------------------|--------------------------|
| Design shear force                                               | $F_v = 59.8 \text{ kN}$ | Design shear resistance | $P_v = 311.6 \text{ kN}$ |
| <b>PASS - Design shear resistance exceeds design shear force</b> |                         |                         |                          |

#### Moment capacity - Section 4.2.5

|                       |                        |                           |                           |
|-----------------------|------------------------|---------------------------|---------------------------|
| Design bending moment | $M = 64.3 \text{ kNm}$ | Moment capacity low shear | $M_c = 174.1 \text{ kNm}$ |
|-----------------------|------------------------|---------------------------|---------------------------|

#### Buckling resistance moment - Section 4.3.6.4

|                                                                        |                         |                                    |
|------------------------------------------------------------------------|-------------------------|------------------------------------|
| Buckling resistance moment                                             | $M_b = 115 \text{ kNm}$ | $M_b / M_{LT} = 125.3 \text{ kNm}$ |
| <b>PASS - Buckling resistance moment exceeds design bending moment</b> |                         |                                    |

#### Check vertical deflection - Section 2.5.2

Consider deflection due to dead and imposed loads

|                                                                   |                                  |                    |                             |
|-------------------------------------------------------------------|----------------------------------|--------------------|-----------------------------|
| Limiting deflection                                               | $\delta_{lim} = 11.9 \text{ mm}$ | Maximum deflection | $\delta = 8.996 \text{ mm}$ |
| <b>PASS - Maximum deflection does not exceed deflection limit</b> |                                  |                    |                             |

Relative AVE

$$L_r = \frac{1.5 \times 53.3 \times 10^3}{1.5 \times 2.2 \times 100}$$

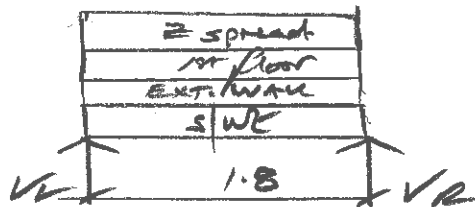
$$\geq 575 \text{ mm}$$

Good spreader

|                                 |               |                  |                    |
|---------------------------------|---------------|------------------|--------------------|
| Project Title: 34 GRADSMERE WAY |               | Project No: 1566 |                    |
| Calcs. by: AD                   | Prelim./Final | Checked by: //   | Category of Check: |
| Date: //                        |               | Date: //         | Sht.               |

STEEL (E)

L = 1.8m



2 spread. 7.18 / 3.5 2-1 1-L  
5.6

1st floor 2/2 x 0.6 0.6 1-50  
1.50

EXT WALL 3m x 2.7 11.1  
(2nd gable)

P. roof 0.3 x 1.3 0.4  
(rib) 0.6 0.18

S/W 0.4

P. roof 0.3 x 1.27 0.38  
xh. 0.6 0.18

spec. 0.3 x 0.6 0.18  
0.25 0.08

15.2 3.5

Tadds →

152 x 152 x 23 UC + 10 top plate

|             |                             |            |            |              |                              |               |
|-------------|-----------------------------|------------|------------|--------------|------------------------------|---------------|
| Tekla.Tedds | Project<br>34 Grassmere Way |            |            |              | Job no.                      |               |
|             | Calcs for<br>STEEL E        |            |            |              | Start page no./Revision<br>1 |               |
|             | Calcs by                    | Calcs date | Checked by | Checked date | Approved by                  | Approved date |

### STEEL BEAM ANALYSIS & DESIGN (BS5950)

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

TEDDS calculation version 3.0.07

#### Support conditions

|           |                                            |
|-----------|--------------------------------------------|
| Support A | Vertically restrained<br>Rotationally free |
| Support B | Vertically restrained<br>Rotationally free |

#### Analysis results

|                                               |                                    |                                 |
|-----------------------------------------------|------------------------------------|---------------------------------|
| Maximum moment                                | $M_{max} = 10.9 \text{ kNm}$       | $M_{min} = 0 \text{ kNm}$       |
| Maximum shear                                 | $V_{max} = 24.2 \text{ kN}$        | $V_{min} = -24.2 \text{ kN}$    |
| Deflection                                    | $\delta_{max} = 1 \text{ mm}$      | $\delta_{min} = 0 \text{ mm}$   |
| Maximum reaction at support A                 | $R_{A_{max}} = 24.2 \text{ kN}$    | $R_{A_{min}} = 24.2 \text{ kN}$ |
| Unfactored dead load reaction at support A    | $R_{A_{Dead}} = 13.7 \text{ kN}$   |                                 |
| Unfactored imposed load reaction at support A | $R_{A_{Imposed}} = 3.2 \text{ kN}$ |                                 |
| Maximum reaction at support B                 | $R_{B_{max}} = 24.2 \text{ kN}$    | $R_{B_{min}} = 24.2 \text{ kN}$ |
| Unfactored dead load reaction at support B    | $R_{B_{Dead}} = 13.7 \text{ kN}$   |                                 |
| Unfactored imposed load reaction at support B | $R_{B_{Imposed}} = 3.2 \text{ kN}$ |                                 |

#### Section details

|              |                       |             |      |
|--------------|-----------------------|-------------|------|
| Section type | UC 152x152x23 (BS4-1) | Steel grade | S355 |
|--------------|-----------------------|-------------|------|

#### Classification of cross sections - Section 3.5

|                            |                      |                        |              |
|----------------------------|----------------------|------------------------|--------------|
| Tensile strain coefficient | $\varepsilon = 0.88$ | Section classification | Semi-compact |
|----------------------------|----------------------|------------------------|--------------|

#### Shear capacity - Section 4.2.3

|                                                                  |                         |                         |                          |
|------------------------------------------------------------------|-------------------------|-------------------------|--------------------------|
| Design shear force                                               | $F_v = 24.2 \text{ kN}$ | Design shear resistance | $P_v = 188.3 \text{ kN}$ |
| <b>PASS - Design shear resistance exceeds design shear force</b> |                         |                         |                          |

#### Moment capacity - Section 4.2.5

|                       |                        |                           |                          |
|-----------------------|------------------------|---------------------------|--------------------------|
| Design bending moment | $M = 10.9 \text{ kNm}$ | Moment capacity low shear | $M_c = 60.5 \text{ kNm}$ |
|-----------------------|------------------------|---------------------------|--------------------------|

#### Buckling resistance moment - Section 4.3.6.4

|                                                                        |                          |                                   |
|------------------------------------------------------------------------|--------------------------|-----------------------------------|
| Buckling resistance moment                                             | $M_b = 52.2 \text{ kNm}$ | $M_b / M_{LT} = 56.4 \text{ kNm}$ |
| <b>PASS - Buckling resistance moment exceeds design bending moment</b> |                          |                                   |

#### Check vertical deflection - Section 2.5.2

Consider deflection due to dead and imposed loads

|                                                                   |                               |                    |                             |
|-------------------------------------------------------------------|-------------------------------|--------------------|-----------------------------|
| Limiting deflection                                               | $\delta_{lim} = 5 \text{ mm}$ | Maximum deflection | $\delta = 0.998 \text{ mm}$ |
| <b>PASS - Maximum deflection does not exceed deflection limit</b> |                               |                    |                             |

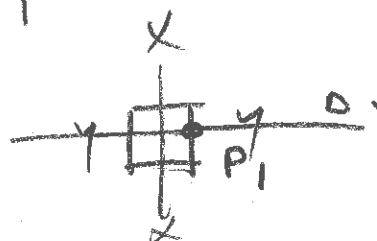
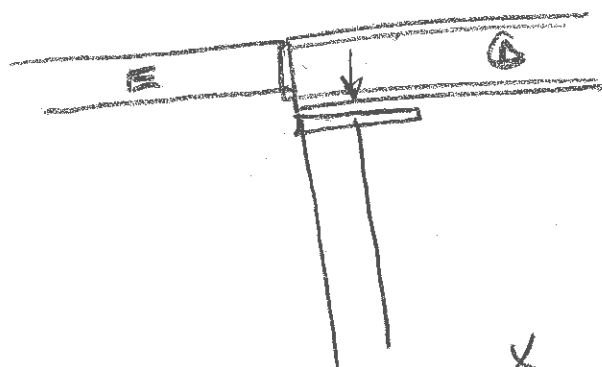
Pade's formula  $L_r = \frac{3.5 \times 24.2 \times 10^3}{1.5 \times 2.2 \times 100} = 257 \text{ mm}$   
 L42.

440 L P2

|                                 |               |                  |                    |      |
|---------------------------------|---------------|------------------|--------------------|------|
| Project Title: 34 GRADSHIRE WAY |               | Project No: 1566 |                    |      |
| Calcs. by: AD                   | Prelim./Final | Checked by:      | Category of Check: | Sht. |
| Date:                           |               | Date:            |                    |      |

POST SP3

100 S4S 6.3



$$M_e = 1.0 \times 3.0$$

$$\begin{aligned} \text{take } P_1 &= 59.8 \text{ kN} + 24.2 \\ &= \underline{\underline{84 \text{ kN WT}}} \end{aligned}$$

$$\begin{aligned} M_x &= 84 \times 0.05 \\ &= 4.2 \text{ kNm} \end{aligned}$$

$$M_y = 0$$

EXCEL SPREADSHEET DESIGN →

100 x 100 x 6.3 S4S S355

|                   |                  |             |             |                |
|-------------------|------------------|-------------|-------------|----------------|
| Project           | 34 GRASSMERE WAY | Project No: | Drg No:     | Date:          |
| Part of Structure | STEEL POST SP3   | Calc by:    | Checked by: | Calc. Sheet No |

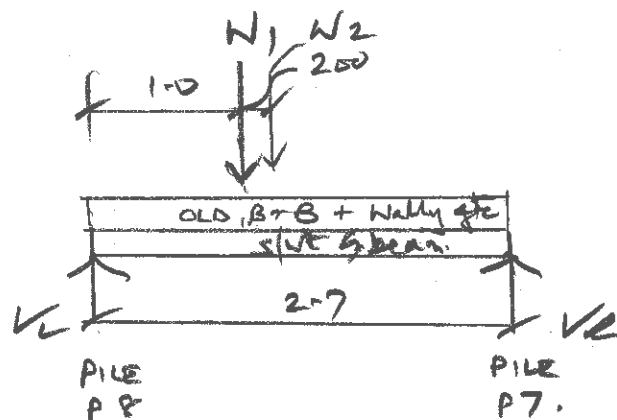
| REF   | CALCULATIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                            |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-------|-----|-----|---------|--|-----|-------|--|-------|--------|--|------|----------|--|------|----------|--|-----|-------|--|-----|---|--|-----|---------|--|-----|---|--|-----|-------|--|-----|--------|-------------------------------------------|-------|---------|--|-------|---------|--|-----|-------|--|------|---|--------------------------------------------|------|---------|-----------------------|-----|---|--------------------------------------------|-----|-------|--|------|--------|-----------|----|---------|--|-------|---------|--|
|       | <p><b>100 x 100 x 6.3 SHS S355</b></p> <p><b>1/ Cross Section Capacity</b></p> <table style="margin-left: 40px;"> <tr><td>Fc=</td><td>84 kN</td><td>say</td></tr> <tr><td>Mx=</td><td>4.2 kNm</td><td></td></tr> <tr><td>My=</td><td>0 kNm</td><td></td></tr> <tr><td>Agpy=</td><td>823 kN</td><td></td></tr> <tr><td>Mcx=</td><td>28.6 kNm</td><td></td></tr> <tr><td>Mcy=</td><td>28.6 kNm</td><td></td></tr> </table><br>$\frac{F_c}{A_{gpy}} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = 0.25 < 1 \quad \text{SECTION PASSES}$<br><p><b>2/ Member Buckling Resistance</b> (must satisfy both equations)</p> <p><b>A</b></p> <table style="margin-left: 40px;"> <tr><td>Fc=</td><td>84 kN</td><td></td></tr> <tr><td>mx=</td><td>1</td><td></td></tr> <tr><td>Mx=</td><td>4.2 kNm</td><td></td></tr> <tr><td>my=</td><td>1</td><td></td></tr> <tr><td>My=</td><td>0 kNm</td><td></td></tr> <tr><td>Pc=</td><td>555 kN</td><td>(Pc is smaller of Pcx &amp; Pcy) ie Pcy@3 say</td></tr> <tr><td>pyZx=</td><td>23.8 kN</td><td></td></tr> <tr><td>pyZy=</td><td>23.8 kN</td><td></td></tr> </table><br>$\frac{F_c}{P_c} + \frac{m_x M_x}{p_y Z_x} + \frac{m_y M_y}{p_y Z_y} = 0.33 < 1 \quad \text{SECTION PASSES}$<br><p><b>B</b></p> <table style="margin-left: 40px;"> <tr><td>Fc=</td><td>84 kN</td><td></td></tr> <tr><td>mlt=</td><td>1</td><td>4.8.3.3.4 Table 18 1=conservative approach</td></tr> <tr><td>Mlt=</td><td>4.2 kNm</td><td>Max major axis moment</td></tr> <tr><td>my=</td><td>1</td><td>4.8.3.3.4 Table 26 1=conservative approach</td></tr> <tr><td>My=</td><td>0 kNm</td><td></td></tr> <tr><td>Pcy=</td><td>555 kN</td><td>ie Pcy@3m</td></tr> <tr><td>Mb</td><td>28.7 kN</td><td></td></tr> <tr><td>pyZy=</td><td>23.8 kN</td><td></td></tr> </table><br>$\frac{F_c}{P_{cy}} + \frac{m_{lt} M_{lt}}{M_b} + \frac{m_y M_y}{p_y Z_y} = 0.30 < 1 \quad \text{SECTION PASSES}$<br><p style="text-align: center; font-weight: bold; font-size: 1.2em;">100 x 100 x 6.3 SHS      S355 HOT ROLLED</p> | Fc=                                        | 84 kN | say | Mx= | 4.2 kNm |  | My= | 0 kNm |  | Agpy= | 823 kN |  | Mcx= | 28.6 kNm |  | Mcy= | 28.6 kNm |  | Fc= | 84 kN |  | mx= | 1 |  | Mx= | 4.2 kNm |  | my= | 1 |  | My= | 0 kNm |  | Pc= | 555 kN | (Pc is smaller of Pcx & Pcy) ie Pcy@3 say | pyZx= | 23.8 kN |  | pyZy= | 23.8 kN |  | Fc= | 84 kN |  | mlt= | 1 | 4.8.3.3.4 Table 18 1=conservative approach | Mlt= | 4.2 kNm | Max major axis moment | my= | 1 | 4.8.3.3.4 Table 26 1=conservative approach | My= | 0 kNm |  | Pcy= | 555 kN | ie Pcy@3m | Mb | 28.7 kN |  | pyZy= | 23.8 kN |  |
| Fc=   | 84 kN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | say                                        |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| Mx=   | 4.2 kNm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                            |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| My=   | 0 kNm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                            |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| Agpy= | 823 kN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                            |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| Mcx=  | 28.6 kNm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                            |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| Mcy=  | 28.6 kNm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                            |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| Fc=   | 84 kN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                            |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| mx=   | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                            |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| Mx=   | 4.2 kNm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                            |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| my=   | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                            |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| My=   | 0 kNm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                            |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| Pc=   | 555 kN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | (Pc is smaller of Pcx & Pcy) ie Pcy@3 say  |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| pyZx= | 23.8 kN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                            |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| pyZy= | 23.8 kN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                            |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| Fc=   | 84 kN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                            |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| mlt=  | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 4.8.3.3.4 Table 18 1=conservative approach |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| Mlt=  | 4.2 kNm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Max major axis moment                      |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| my=   | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 4.8.3.3.4 Table 26 1=conservative approach |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| My=   | 0 kNm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                            |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| Pcy=  | 555 kN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | ie Pcy@3m                                  |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| Mb    | 28.7 kN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                            |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |
| pyZy= | 23.8 kN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                            |       |     |     |         |  |     |       |  |       |        |  |      |          |  |      |          |  |     |       |  |     |   |  |     |         |  |     |   |  |     |       |  |     |        |                                           |       |         |  |       |         |  |     |       |  |      |   |                                            |      |         |                       |     |   |                                            |     |       |  |      |        |           |    |         |  |       |         |  |

|                                 |               |             |                    |      |
|---------------------------------|---------------|-------------|--------------------|------|
| Project Title: 34 GRADEWELL WAY |               |             | Project No: 1566   |      |
| Calcs. by: AD                   | Prelim./Final | Checked by: | Category of Check: | Sht. |
| Date:                           |               | Date:       |                    |      |

Calc check ext<sub>g</sub> RC 500x500 S beam  
for Point Load Post SP3

L = 2.7m.

U/F



D 32.3  
E 13.7 3.2  
3.2

Post 2

48 kW  
12.4 kW

$$W_1 = 84 \text{ kN} + 2 \text{ post } 86 \text{ kW} \rightarrow \text{U/F}$$

$$W_2 = \text{SP STUD WALL } 2.4 \times 0.55 \times 2/2 = 1.32 \text{ kW} \times 1.4 = 1.9 \text{ kW}$$

$$\text{OLD B+B } 2/2 \times 5 = 5 \quad 1.5$$

$$\text{BELOW GND } 0.5 \times 4.5 = 2.25$$

s/w beam

13.3 1.5

Assume simply supported span.

Tedds Run to get  $M_i, V_s$  etc

$$V_L = 84.2 \quad V_R = 61.4$$

$$M_{\text{int}} = 73.7 \text{ kNm}$$

|                                                                                 |                              |            |            |              |                         |               |
|---------------------------------------------------------------------------------|------------------------------|------------|------------|--------------|-------------------------|---------------|
|  | Project                      |            |            |              | Job no.                 |               |
|                                                                                 | 34 Grassmere Way             |            |            |              | Start page no./Revision |               |
|                                                                                 | FOR Ms Vs EXTG 500x500 GBEAM |            |            |              | 1                       |               |
|                                                                                 | Calcs by                     | Calcs date | Checked by | Checked date | Approved by             | Approved date |

### STEEL BEAM ANALYSIS & DESIGN (BS5950)

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

TEDDS calculation version 3.0.07

#### Support conditions

|           |                       |
|-----------|-----------------------|
| Support A | Vertically restrained |
|           | Rotationally free     |
| Support B | Vertically restrained |
|           | Rotationally free     |

#### Analysis results

|                                               |                                    |                                 |
|-----------------------------------------------|------------------------------------|---------------------------------|
| Maximum moment                                | $M_{max} = 73.7 \text{ kNm}$       | $M_{min} = 0 \text{ kNm}$       |
| Maximum shear                                 | $V_{max} = 84.2 \text{ kN}$        | $V_{min} = -61.4 \text{ kN}$    |
| Deflection                                    | $\delta_{max} = 1.4 \text{ mm}$    | $\delta_{min} = 0 \text{ mm}$   |
| Maximum reaction at support A                 | $R_{A_{max}} = 84.2 \text{ kN}$    | $R_{A_{min}} = 84.2 \text{ kN}$ |
| Unfactored dead load reaction at support A    | $R_{A_{Dead}} = 48.9 \text{ kN}$   |                                 |
| Unfactored imposed load reaction at support A | $R_{A_{Imposed}} = 9.8 \text{ kN}$ |                                 |
| Maximum reaction at support B                 | $R_{B_{max}} = 61.4 \text{ kN}$    | $R_{B_{min}} = 61.4 \text{ kN}$ |
| Unfactored dead load reaction at support B    | $R_{B_{Dead}} = 36.3 \text{ kN}$   |                                 |
| Unfactored imposed load reaction at support B | $R_{B_{Imposed}} = 6.6 \text{ kN}$ |                                 |

#### Section details

|              |                       |             |      |
|--------------|-----------------------|-------------|------|
| Section type | UC 254x254x73 (BS4-1) | Steel grade | S355 |
|--------------|-----------------------|-------------|------|

#### Classification of cross sections - Section 3.5

|                            |                   |                        |              |
|----------------------------|-------------------|------------------------|--------------|
| Tensile strain coefficient | $\epsilon = 0.88$ | Section classification | Semi-compact |
|----------------------------|-------------------|------------------------|--------------|

#### Shear capacity - Section 4.2.3

|                                                                  |                         |                         |                          |
|------------------------------------------------------------------|-------------------------|-------------------------|--------------------------|
| Design shear force                                               | $F_v = 84.2 \text{ kN}$ | Design shear resistance | $P_v = 465.5 \text{ kN}$ |
| <b>PASS - Design shear resistance exceeds design shear force</b> |                         |                         |                          |

#### Moment capacity - Section 4.2.5

|                       |                        |                           |                           |
|-----------------------|------------------------|---------------------------|---------------------------|
| Design bending moment | $M = 73.7 \text{ kNm}$ | Moment capacity low shear | $M_c = 350.4 \text{ kNm}$ |
|-----------------------|------------------------|---------------------------|---------------------------|

#### Buckling resistance moment - Section 4.3.6.4

|                                                             |                         |                                    |
|-------------------------------------------------------------|-------------------------|------------------------------------|
| Buckling resistance moment                                  | $M_b = 317 \text{ kNm}$ | $M_b / m_{LT} = 389.8 \text{ kNm}$ |
| <b>PASS - Moment capacity exceeds design bending moment</b> |                         |                                    |

#### Check vertical deflection - Section 2.5.2

Consider deflection due to dead and imposed loads

|                                                                   |                               |                    |                             |
|-------------------------------------------------------------------|-------------------------------|--------------------|-----------------------------|
| Limiting deflection                                               | $\delta_{lim} = 5 \text{ mm}$ | Maximum deflection | $\delta = 1.427 \text{ mm}$ |
| <b>PASS - Maximum deflection does not exceed deflection limit</b> |                               |                    |                             |

|                |                  |                    |             |
|----------------|------------------|--------------------|-------------|
| Project Title: | 34 GRADSMERE WAY | Project No:        | 1566        |
| Calcs. by:     | AD               | Prelim./Final      | Checked by: |
| Date:          |                  | Date:              |             |
|                |                  | Category of Check: | Sht.        |

→ check ex 517 500 x 500 RC 30 g. beam  
pila P8 → P7.

$$V = 84.2$$

$$M = 73.7$$

$$M/bd^2 = \frac{73.7 \times 10^6}{500 \times 432^2}$$

$$= 0.79$$

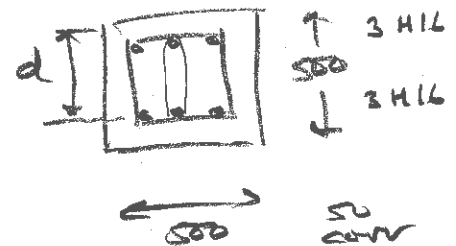
$$A_{I_{reqd.}} = \frac{0.2}{100} \times 500 \times 432$$

$$= 432 \text{ mm}^2$$

3 H16

$$A_{sp} = 603 \text{ mm}^2 > 432$$

✓



$$d = 500 - 50 - 10 - 16/2$$

$$= 432 \text{ mm}$$

check shear

$$V = 84.2$$

$$v = \frac{84.2 \times 10^3}{500 \times 432} = 0.39 \text{ N/mm}^2$$

From prev calcs  $v_c = 0.43$

$$0.5 v_c < v < v_c + 0.4$$

$$0.215 < 0.39 < 0.83$$

✓ MIN LINKS OK ✓

+ MINIMUM LINKS WERE PROVIDED //

deflect

$$L/d = \frac{2700}{432} = 6.25$$

✓ SHEAR OK.

BY INSPECTION deflect Adequate

|                                 |               |                  |                    |
|---------------------------------|---------------|------------------|--------------------|
| Project Title: 34 GRADSMERE WAY |               | Project No: 1566 |                    |
| Calcs. by: AD                   | Prelim./Final | Checked by: =    | Category of Check: |
| Date: / /                       | Date: / /     |                  | Sht.               |

check pile loads for piles P7 + P8

Design SWL = 100 kN per pile

P8 48.9 u/f D  
7.8 u/f L

+ LH 18.3 x 0.8 10.6  
S. beam 1.5 1.2  
etc

≤ 70.5 kN u/f

< 100 ✓

∴ EXISTING  
PILE  
ACCEPTABLE

P7 36.3 u/f D  
6.6 u/f L

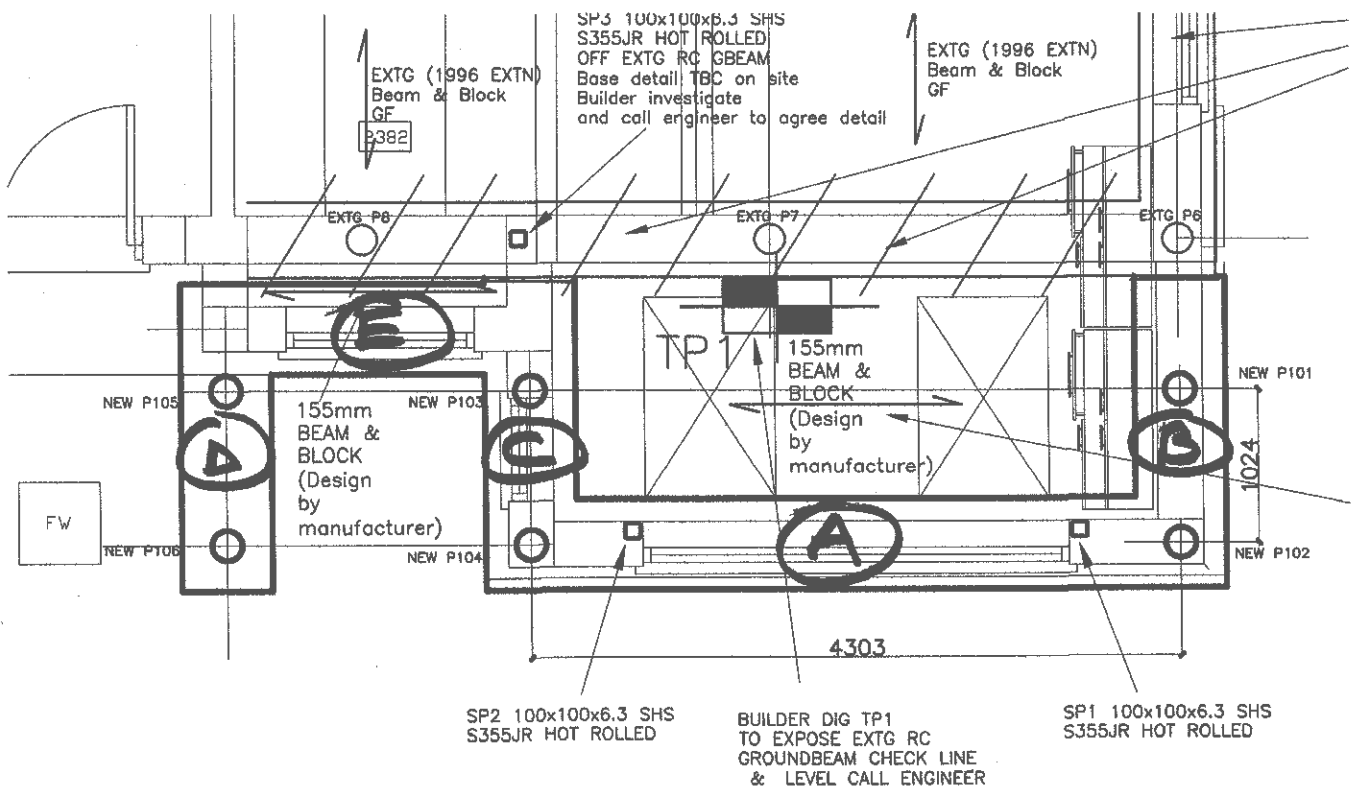
+ RH 13.3 x 27/2 18  
S. beam 1.5 2.1

≤ 63 kN u/f

< 100 ✓

∴ EXISTING  
PILE  
ACCEPTABLE

NEW  
RC GROUND BEAM CALLS



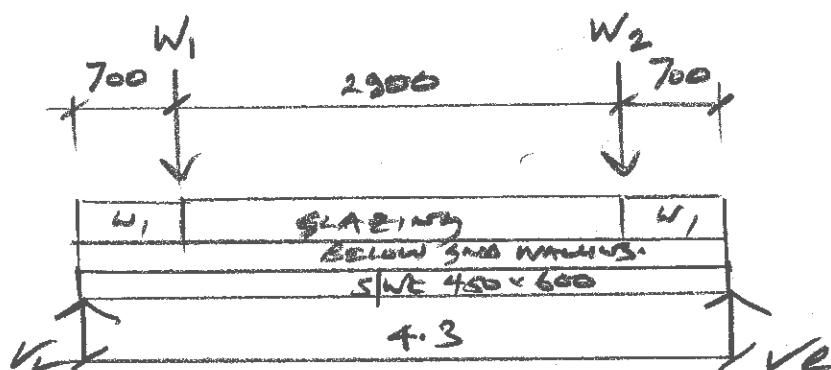
1:50

ALL  
600 w x 450 d

|                                 |               |                  |                    |
|---------------------------------|---------------|------------------|--------------------|
| Project Title: 34 GRADSMERE WAY |               | Project No: 1566 |                    |
| Calcs. by: AD                   | Prelim./Final | Checked by: //   | Category of Check: |
| Date: //                        |               | Date: //         | Sht.               |

GROUND BEAM (A)

L = 4.3 m.



$$W_1 = W_2 = \frac{3.1}{1.3} + 1.24 + 2 = 6.34 \text{ kN u/f.}$$

1.3 kN

SLABING 2 x 0.5 = 1

$$W_1 = 2.6 \times 3.3 = 8.6$$

above  
Gnd.

+ Nom load

$$0.5 \times 1.27 = 0.6$$

$$0.64$$

$$0.3$$

$$9.24$$

$$0.3$$

BELOW GND WALLING

$$0.4 \times 4.5 = 1.8$$

S/W 450 x 600

$$6.5$$

$$8.3 \text{ kN/m}$$

Ticks →

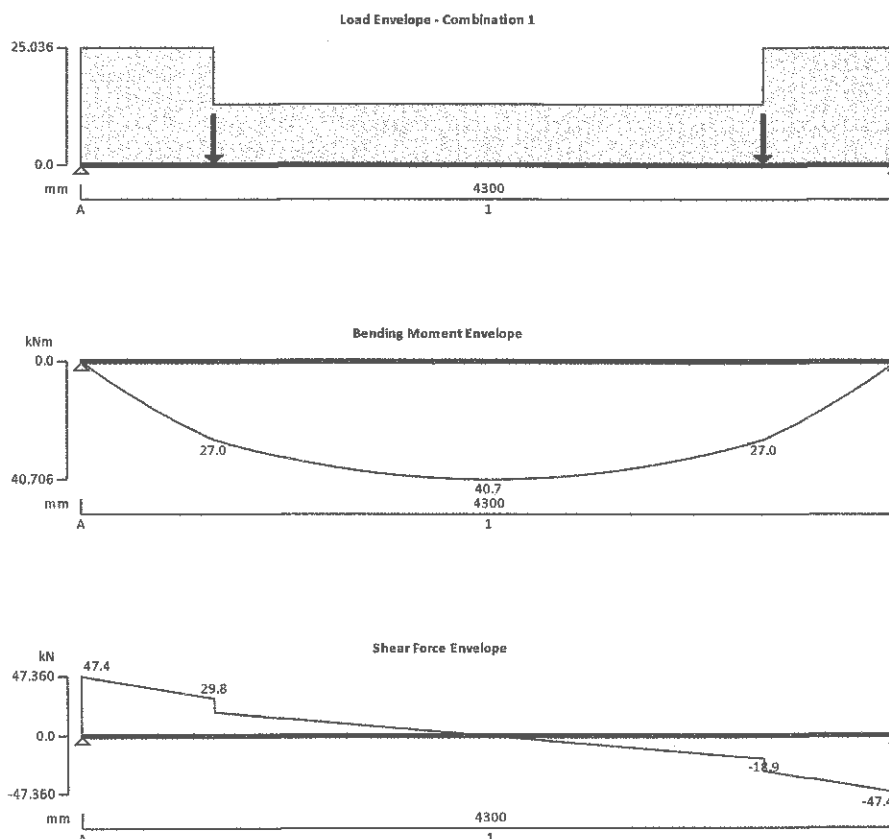
450 dp x 600 W RC 40 S. BEAM.

4 H 12 T + B, 2 H 10 legs @ 250

|                                                                                                       |                             |            |            |              |                              |               |
|-------------------------------------------------------------------------------------------------------|-----------------------------|------------|------------|--------------|------------------------------|---------------|
| <b>Tekla Tedds</b><br>P J Davies Associates Ltd<br>Office 201/4 Langstone Gate<br>Solent Rd<br>Havant | Project<br>34 Grassmere Way |            |            |              | Job no.                      |               |
|                                                                                                       | Calcs for<br>GROUNDBEAM A   |            |            |              | Start page no./Revision<br>1 |               |
|                                                                                                       | Calcs by                    | Calcs date | Checked by | Checked date | Approved by                  | Approved date |

# RC BEAM ANALYSIS & DESIGN BS8110

TEDDS calculation version 2.1.14



## Support conditions

Support A

Vertically restrained

Rotationally free

Support B

Vertically restrained

Rotationally free

## Applied loading

Dead full UDL 8.3 kN/m

Dead partial UDL 9.24 kN/m from 0 mm to 700 mm

Imposed partial UDL 0.3 kN/m from 0 mm to 700 mm

Dead partial UDL 9.24 kN/m from 3600 mm to 4300 mm

Imposed partial UDL 0.3 kN/m from 3600 mm to 4300 mm

Dead point load 6.34 kN at 700 mm

Imposed point load 1.3 kN at 700 mm

Dead point load 6.34 kN at 3600 mm

Imposed point load 1.3 kN at 3600 mm

Dead partial UDL 1 kN/m from 700 mm to 3600 mm

## Load combinations

Load combination 1

Support A

Dead \* 1.40

Imposed \* 1.60

|                                                                                                                                                                                        |                             |            |            |              |                              |               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------|------------|--------------|------------------------------|---------------|
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|                                                                                                                                                                                        | Calcs for<br>GROUNDBEAM A   |            |            |              | Start page no./Revision<br>2 |               |
|                                                                                                                                                                                        | Calcs by                    | Calcs date | Checked by | Checked date | Approved by                  | Approved date |

## Span 1

Dead \* 1.40

Imposed \* 1.60

## Support B

Dead \* 1.40

Imposed \* 1.60

**Analysis results**

Maximum moment support A

 $M_{A\_max} = 0 \text{ kNm}$  $M_{A\_red} = 0 \text{ kNm}$ 

Maximum moment span 1 at 2150 mm

 $M_{s1\_max} = 41 \text{ kNm}$  $M_{s1\_red} = 41 \text{ kNm}$ 

Maximum moment support B

 $M_{B\_max} = 0 \text{ kNm}$  $M_{B\_red} = 0 \text{ kNm}$ 

Maximum shear support A

 $V_{A\_max} = 47 \text{ kN}$  $V_{A\_red} = 47 \text{ kN}$ 

Maximum shear support A span 1 at 400 mm

 $V_{A\_s1\_max} = 37 \text{ kN}$  $V_{A\_s1\_red} = 37 \text{ kN}$ 

Maximum shear support B

 $V_{B\_max} = -47 \text{ kN}$  $V_{B\_red} = -47 \text{ kN}$ 

Maximum shear support B span 1 at 3900 mm

 $V_{B\_s1\_max} = -37 \text{ kN}$  $V_{B\_s1\_red} = -37 \text{ kN}$ 

Maximum reaction at support A

 $R_A = 47 \text{ kN}$ 

Unfactored dead load reaction at support A

 $R_{A\_Dead} = 32 \text{ kN}$ 

Unfactored imposed load reaction at support A

 $R_{A\_Imposed} = 2 \text{ kN}$ 

Maximum reaction at support B

 $R_B = 47 \text{ kN}$ 

Unfactored dead load reaction at support B

 $R_{B\_Dead} = 32 \text{ kN}$ 

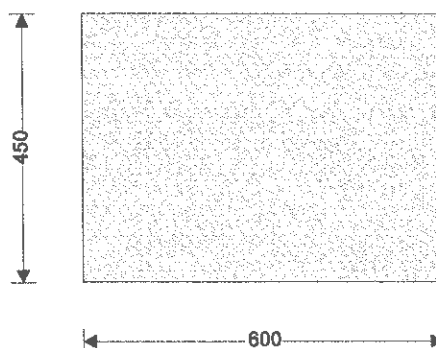
Unfactored imposed load reaction at support B

 $R_{B\_Imposed} = 2 \text{ kN}$ **Rectangular section details**

Section width

 $b = 600 \text{ mm}$ 

Section depth

 $h = 450 \text{ mm}$ **Concrete details**

Concrete strength class

**C40/50**

Characteristic compressive cube strength

 $f_{cu} = 50 \text{ N/mm}^2$ 

Modulus of elasticity of concrete

 $E_c = 20 \text{ kN/mm}^2 + 200 \times f_{cu} = 30000 \text{ N/mm}^2$ 

Maximum aggregate size

 $h_{agg} = 20 \text{ mm}$ **Reinforcement details**

Characteristic yield strength of reinforcement

 $f_y = 500 \text{ N/mm}^2$ Characteristic yield strength of shear reinforcement  $f_{yv} = 500 \text{ N/mm}^2$ **Nominal cover to reinforcement**

Nominal cover to top reinforcement

 $c_{nom\_t} = 50 \text{ mm}$ 

Nominal cover to bottom reinforcement

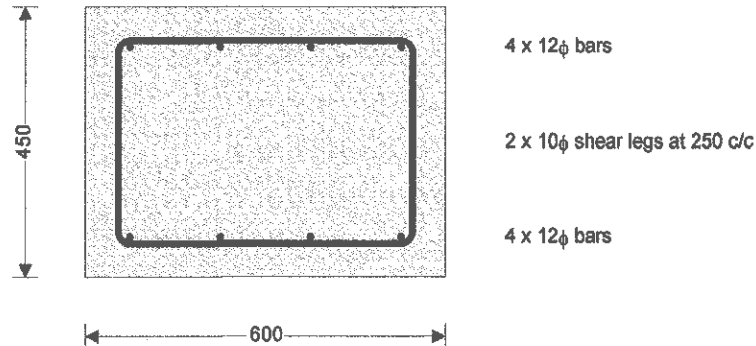
 $c_{nom\_b} = 50 \text{ mm}$ 

Nominal cover to side reinforcement

 $c_{nom\_s} = 50 \text{ mm}$

|                             |            |            |              |                              |               |
|-----------------------------|------------|------------|--------------|------------------------------|---------------|
| Project<br>34 Grassmere Way |            |            |              | Job no.                      |               |
| Calcs for<br>GROUNDBEAM A   |            |            |              | Start page no./Revision<br>3 |               |
| Calcs by                    | Calcs date | Checked by | Checked date | Approved by                  | Approved date |

### Mid span 1



### Design moment resistance of rectangular section (cl. 3.4.4) - Positive moment

Design bending moment  $M = \text{abs}(M_{s1\_red}) = 41 \text{ kNm}$

Depth to tension reinforcement  $d = h - C_{nom\_b} - \phi_v - \phi_{bot} / 2 = 384 \text{ mm}$

Redistribution ratio  $\beta_b = \min(1 - m_{rs1}, 1) = 1.000$

$K = M / (b \times d^2 \times f_{cu}) = 0.009$

$K' = 0.156$

**$K' > K$  - No compression reinforcement is required**

Lever arm  $z = \min(d \times (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 \times d) = 365 \text{ mm}$

Depth of neutral axis  $x = (d - z) / 0.45 = 43 \text{ mm}$

Area of tension reinforcement required  $A_{s,req} = M / (0.87 \times f_y \times z) = 257 \text{ mm}^2$

Tension reinforcement provided **4 \* 12φ bars**

Area of tension reinforcement provided  $A_{s,prov} = 452 \text{ mm}^2$

Minimum area of reinforcement  $A_{s,min} = 0.0013 \times b \times h = 351 \text{ mm}^2$

Maximum area of reinforcement  $A_{s,max} = 0.04 \times b \times h = 10800 \text{ mm}^2$

**PASS - Area of reinforcement provided is greater than area of reinforcement required**

### Rectangular section in shear

Shear reinforcement provided **2 \* 10φ legs at 250 c/c**

Area of shear reinforcement provided  $A_{sv,prov} = 628 \text{ mm}^2/\text{m}$

Minimum area of shear reinforcement (Table 3.7)  $A_{sv,min} = 0.4N/\text{mm}^2 \times b / (0.87 \times f_{yv}) = 552 \text{ mm}^2/\text{m}$

**PASS - Area of shear reinforcement provided exceeds minimum required**

Maximum longitudinal spacing (cl. 3.4.5.5)  $S_{vl,max} = 0.75 \times d = 288 \text{ mm}$

**PASS - Longitudinal spacing of shear reinforcement provided is less than maximum**

Design concrete shear stress  $v_c = 0.79N/\text{mm}^2 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400\text{mm} / d)^{1/4}) \times (\min(f_{cu}, 40N/\text{mm}^2) / 25N/\text{mm}^2)^{1/3} / \gamma_m = 0.434 \text{ N/mm}^2$

Design shear resistance provided  $V_{s,prov} = A_{sv,prov} \times 0.87 \times f_{yv} / b = 0.456 \text{ N/mm}^2$

Design shear stress provided  $V_{prov} = V_{s,prov} + v_c = 0.890 \text{ N/mm}^2$

Design shear resistance  $V_{prov} = V_{prov} \times (b \times d) = 205.0 \text{ kN}$

**Shear links provided valid between 0 mm and 4300 mm with tension reinforcement of 452 mm<sup>2</sup>**

### Spacing of reinforcement (cl 3.12.11)

Actual distance between bars in tension  $s = (b - 2 \times (C_{nom\_s} + \phi_v + \phi_{bot}/2)) / (N_{bot} - 1) - \phi_{bot} = 144 \text{ mm}$

### Minimum distance between bars in tension (cl 3.12.11.1)

Minimum distance between bars in tension  $s_{min} = h_{agg} + 5 \text{ mm} = 25 \text{ mm}$

**PASS - Satisfies the minimum spacing criteria**

|                                                                                                                                                                                        |                                    |            |            |              |                                     |               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------|------------|--------------|-------------------------------------|---------------|
|  <b>Tekla Tedds</b><br>P J Davies Associates Ltd<br>Office 201/4 Langstone Gate<br>Solent Rd<br>Havant | Project<br><b>34 Grassmere Way</b> |            |            |              | Job no.                             |               |
|                                                                                                                                                                                        | Calcs for<br><b>GROUND BEAM A</b>  |            |            |              | Start page no./Revision<br><b>4</b> |               |
|                                                                                                                                                                                        | Calcs by                           | Calcs date | Checked by | Checked date | Approved by                         | Approved date |

**Maximum distance between bars in tension (cl 3.12.11.2)**

Design service stress  $f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = 189.0 \text{ N/mm}^2$ 

Maximum distance between bars in tension  $s_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = 249 \text{ mm}$ 
**PASS - Satisfies the maximum spacing criteria**
**Span to depth ratio (cl. 3.4.6)**

Basic span to depth ratio (Table 3.9)  $\text{span\_to\_depth}_{basic} = 20.0$ 

Design service stress in tension reinforcement  $f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = 189.0 \text{ N/mm}^2$ 

Modification for tension reinforcement

$$f_{tens} = \min(2.0, 0.55 + (477 \text{ N/mm}^2 - f_s) / (120 \times (0.9 \text{ N/mm}^2 + (M / (b \times d^2))))) = 2.000$$

Modification for compression reinforcement

$$f_{comp} = \min(1.5, 1 + (100 \times A_{s2,prov} / (b \times d)) / (3 + (100 \times A_{s2,prov} / (b \times d)))) = 1.061$$

Modification for span length

$$f_{long} = 1.000$$

Allowable span to depth ratio

$$\text{span\_to\_depth}_{allow} = \text{span\_to\_depth}_{basic} \times f_{tens} \times f_{comp} = 42.5$$

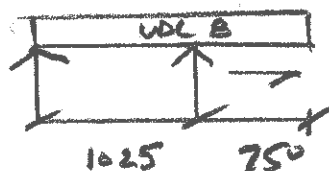
Actual span to depth ratio

$$\text{span\_to\_depth}_{actual} = L_{s1} / d = 11.2$$

**PASS - Actual span to depth ratio is within the allowable limit**

|                                 |               |                  |                    |      |
|---------------------------------|---------------|------------------|--------------------|------|
| Project Title: 34 GRADSMERE WAY |               | Project No: 1566 |                    |      |
| Calcs. by: AD                   | Prelim./Final | Checked by:      | Category of Check: | Sht. |
| Date:                           |               | Date:            |                    |      |

GROUND BEAM (B)



UDL B P. Roof.  $1.4 \times 1.27$   $1.78$   
 $0.6$   $0.84$

EXT WALL  $2.4 \times 3.3$   $7.92$   
above grad. —

below grad.  $0.4 \times 4.5$   $1.8$  —

S/NR G beam.  $6.5$  —

B + Block GF  $10.25$   
 $4 \times 1 \frac{1}{2} \times 5$   $2.1$   
 $1.5$

28.3 3.94

T adds  $\rightarrow$

✓ = Same as G beam A ✓

600 u x 450 dp RC40

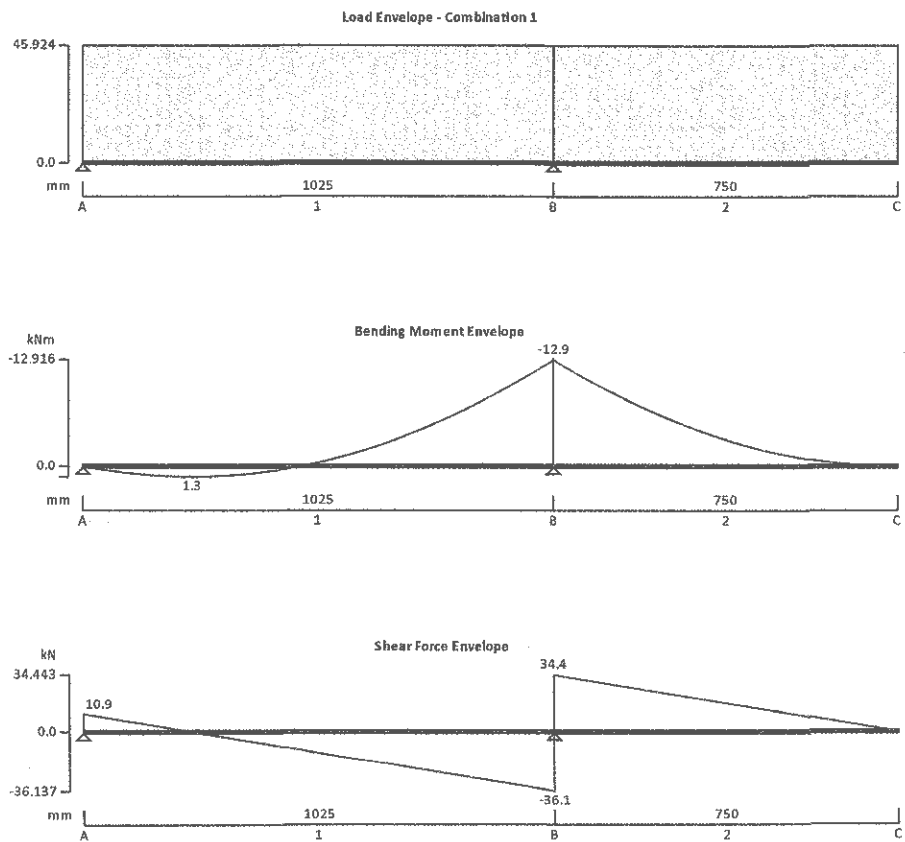
4 M12 T + B

2 M10 legs x 250.

|                                                                                                                                                                                        |                             |            |            |              |                              |               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------|------------|--------------|------------------------------|---------------|
|  <b>Tekla Tedds</b><br>P J Davies Associates Ltd<br>Office 201/4 Langstone Gate<br>Solent Rd<br>Havant | Project<br>34 Grassmere Way |            |            |              | Job no.                      |               |
|                                                                                                                                                                                        | Calcs for<br>GROUND BEAM B  |            |            |              | Start page no./Revision<br>1 |               |
|                                                                                                                                                                                        | Calcs by                    | Calcs date | Checked by | Checked date | Approved by                  | Approved date |

**RC BEAM ANALYSIS & DESIGN BS8110**

TEDDS calculation version 2.1.14



**Support conditions**

|           |                       |
|-----------|-----------------------|
| Support A | Vertically restrained |
|           | Rotationally free     |
| Support B | Vertically restrained |
|           | Rotationally free     |
| Support C | Vertically free       |
|           | Rotationally free     |

**Applied loading**

Dead full UDL 28.3 kN/m  
 Imposed full UDL 3.94 kN/m

**Load combinations**

|                    |           |                               |
|--------------------|-----------|-------------------------------|
| Load combination 1 | Support A | Dead * 1.40<br>Imposed * 1.60 |
|                    | Span 1    | Dead * 1.40<br>Imposed * 1.60 |
|                    | Support B | Dead * 1.40<br>Imposed * 1.60 |
|                    | Span 2    | Dead * 1.40<br>Imposed * 1.60 |

|                                                                                                                                                                                         |                             |            |            |              |                              |               |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------|------------|--------------|------------------------------|---------------|
|  <b>Tekla® Tedds</b><br>P J Davies Associates Ltd<br>Office 201/4 Langstone Gate<br>Solent Rd<br>Havant | Project<br>34 Grassmere Way |            |            |              | Job no.                      |               |
|                                                                                                                                                                                         | Calcs for<br>GROUND BEAM B  |            |            |              | Start page no./Revision<br>2 |               |
|                                                                                                                                                                                         | Calcs by                    | Calcs date | Checked by | Checked date | Approved by                  | Approved date |

## Support C

Dead \* 1.40

Imposed \* 1.60

## Analysis results

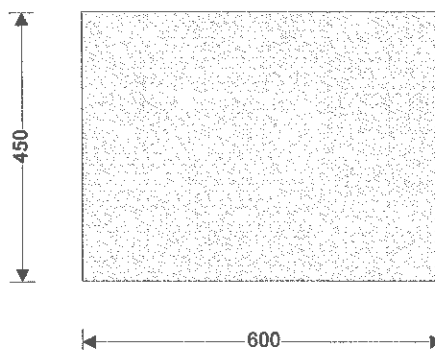
|                                               |                                   |                                   |
|-----------------------------------------------|-----------------------------------|-----------------------------------|
| Maximum moment support A                      | $M_{A\_max} = 0 \text{ kNm}$      | $M_{A\_red} = 0 \text{ kNm}$      |
| Maximum moment span 1 at 238 mm               | $M_{s1\_max} = 1 \text{ kNm}$     | $M_{s1\_red} = 1 \text{ kNm}$     |
| Maximum moment support B                      | $M_{B\_max} = -13 \text{ kNm}$    | $M_{B\_red} = -13 \text{ kNm}$    |
| Maximum moment span 2 at support              | $M_{s2\_max} = 0 \text{ kNm}$     | $M_{s2\_red} = 0 \text{ kNm}$     |
| Maximum moment support C                      | $M_{C\_max} = 0 \text{ kNm}$      | $M_{C\_red} = 0 \text{ kNm}$      |
| Maximum shear support A                       | $V_{A\_max} = 11 \text{ kN}$      | $V_{A\_red} = 11 \text{ kN}$      |
| Maximum shear support A span 1 at 400 mm      | $V_{A\_s1\_max} = -7 \text{ kN}$  | $V_{A\_s1\_red} = -7 \text{ kN}$  |
| Maximum shear support B                       | $V_{B\_max} = -36 \text{ kN}$     | $V_{B\_red} = -36 \text{ kN}$     |
| Maximum shear support B span 1 at 641 mm      | $V_{B\_s1\_max} = -19 \text{ kN}$ | $V_{B\_s1\_red} = -19 \text{ kN}$ |
| Maximum shear support B span 2 at 384 mm      | $V_{B\_s2\_max} = 17 \text{ kN}$  | $V_{B\_s2\_red} = 17 \text{ kN}$  |
| Maximum shear support C                       | $V_{C\_max} = 0 \text{ kN}$       | $V_{C\_red} = 0 \text{ kN}$       |
| Maximum shear support C span 2 at 350 mm      | $V_{C\_s2\_max} = 18 \text{ kN}$  | $V_{C\_s2\_red} = 18 \text{ kN}$  |
| Maximum reaction at support A                 | $R_A = 11 \text{ kN}$             |                                   |
| Unfactored dead load reaction at support A    | $R_{A\_Dead} = 7 \text{ kN}$      |                                   |
| Unfactored imposed load reaction at support A | $R_{A\_Imposed} = 1 \text{ kN}$   |                                   |
| Maximum reaction at support B                 | $R_B = 71 \text{ kN}$             |                                   |
| Unfactored dead load reaction at support B    | $R_{B\_Dead} = 43 \text{ kN}$     |                                   |
| Unfactored imposed load reaction at support B | $R_{B\_Imposed} = 6 \text{ kN}$   |                                   |
| Maximum reaction at support C                 | $R_C = 0 \text{ kN}$              |                                   |
| Unfactored dead load reaction at support C    | $R_{C\_Dead} = 0 \text{ kN}$      |                                   |
| Unfactored imposed load reaction at support C | $R_{C\_Imposed} = 0 \text{ kN}$   |                                   |

## Rectangular section details

Section width

 $b = 600 \text{ mm}$ 

Section depth

 $h = 450 \text{ mm}$ 

## Concrete details

Concrete strength class

C40/50

Characteristic compressive cube strength

 $f_{cu} = 50 \text{ N/mm}^2$ 

Modulus of elasticity of concrete

 $E_c = 20 \text{ kN/mm}^2 + 200 \times f_{cu} = 30000 \text{ N/mm}^2$ 

Maximum aggregate size

 $h_{agg} = 20 \text{ mm}$ 

## Reinforcement details

Characteristic yield strength of reinforcement

 $f_y = 500 \text{ N/mm}^2$ 

Characteristic yield strength of shear reinforcement

 $f_{yv} = 500 \text{ N/mm}^2$

|                             |            |            |              |                              |               |
|-----------------------------|------------|------------|--------------|------------------------------|---------------|
| Project<br>34 Grassmere Way |            |            |              | Job no.                      |               |
| Calcs for<br>GROUNDBEAM B   |            |            |              | Start page no./Revision<br>3 |               |
| Calcs by                    | Calcs date | Checked by | Checked date | Approved by                  | Approved date |

### Nominal cover to reinforcement

Nominal cover to top reinforcement

$$C_{nom\_t} = 50 \text{ mm}$$

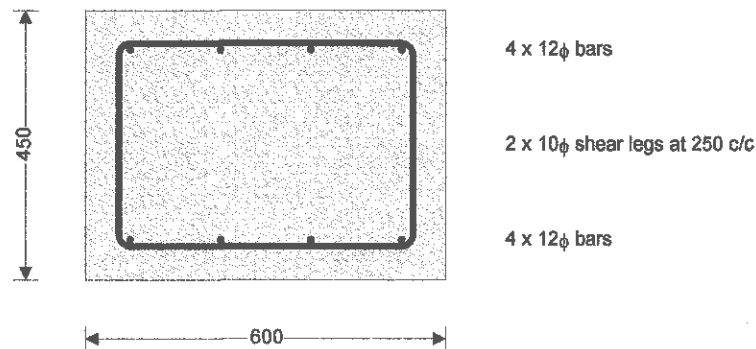
Nominal cover to bottom reinforcement

$$C_{nom\_b} = 50 \text{ mm}$$

Nominal cover to side reinforcement

$$C_{nom\_s} = 50 \text{ mm}$$

### Mid span 1



### Design moment resistance of rectangular section (cl. 3.4.4) - Positive moment

Design bending moment

$$M = \text{abs}(M_{s1\_red}) = 1 \text{ kNm}$$

Depth to tension reinforcement

$$d = h - C_{nom\_b} - \phi_v - \phi_{bot} / 2 = 384 \text{ mm}$$

Redistribution ratio

$$\beta_b = \min(1 - m_{rs1}, 1) = 1.000$$

$$K = M / (b \times d^2 \times f_{cu}) = 0.000$$

$$K' = 0.156$$

***K' > K - No compression reinforcement is required***

Lever arm

$$z = \min(d \times (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 \times d) = 365 \text{ mm}$$

Depth of neutral axis

$$x = (d - z) / 0.45 = 43 \text{ mm}$$

Area of tension reinforcement required

$$A_{s,req} = M / (0.87 \times f_y \times z) = 8 \text{ mm}^2$$

Tension reinforcement provided

$$4 \times 12\phi \text{ bars}$$

Area of tension reinforcement provided

$$A_{s,prov} = 452 \text{ mm}^2$$

Minimum area of reinforcement

$$A_{s,min} = 0.0013 \times b \times h = 351 \text{ mm}^2$$

Maximum area of reinforcement

$$A_{s,max} = 0.04 \times b \times h = 10800 \text{ mm}^2$$

***PASS - Area of reinforcement provided is greater than area of reinforcement required***

### Rectangular section in shear

Shear reinforcement provided

$$2 \times 10\phi \text{ legs at } 250 \text{ c/c}$$

Area of shear reinforcement provided

$$A_{sv,prov} = 628 \text{ mm}^2/\text{m}$$

Minimum area of shear reinforcement (Table 3.7)

$$A_{sv,min} = 0.4 \text{ N/mm}^2 \times b / (0.87 \times f_{yv}) = 552 \text{ mm}^2/\text{m}$$

***PASS - Area of shear reinforcement provided exceeds minimum required***

Maximum longitudinal spacing (cl. 3.4.5.5)

$$s_{vl,max} = 0.75 \times d = 288 \text{ mm}$$

***PASS - Longitudinal spacing of shear reinforcement provided is less than maximum***

Design concrete shear stress

$$v_c = 0.79 \text{ N/mm}^2 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400 \text{ mm} / d)^{1/4}) \times (\min(f_{cu}, 40 \text{ N/mm}^2) / 25 \text{ N/mm}^2)^{1/3} / \gamma_m = 0.434 \text{ N/mm}^2$$

Design shear resistance provided

$$V_{s,prov} = A_{sv,prov} \times 0.87 \times f_{yv} / b = 0.456 \text{ N/mm}^2$$

Design shear stress provided

$$V_{prov} = V_{s,prov} + v_c = 0.890 \text{ N/mm}^2$$

Design shear resistance

$$V_{prov} = V_{prov} \times (b \times d) = 205.0 \text{ kN}$$

***Shear links provided valid between 0 mm and 1025 mm with tension reinforcement of 452 mm***

### Spacing of reinforcement (cl 3.12.11)

Actual distance between bars in tension

$$s = (b - 2 \times (C_{nom\_s} + \phi_v + \phi_{bot}/2)) / (N_{bot} - 1) - \phi_{bot} = 144 \text{ mm}$$

|                                    |            |            |              |                                     |               |
|------------------------------------|------------|------------|--------------|-------------------------------------|---------------|
| Project<br><b>34 Grassmere Way</b> |            |            |              | Job no.                             |               |
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| Calcs by                           | Calcs date | Checked by | Checked date | Approved by                         | Approved date |

#### Minimum distance between bars in tension (cl 3.12.11.1)

Minimum distance between bars in tension  $s_{min} = h_{agg} + 5 \text{ mm} = 25 \text{ mm}$

**PASS - Satisfies the minimum spacing criteria**

#### Maximum distance between bars in tension (cl 3.12.11.2)

Design service stress  $f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = 6.0 \text{ N/mm}^2$

Maximum distance between bars in tension  $s_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = 300 \text{ mm}$

**PASS - Satisfies the maximum spacing criteria**

#### Span to depth ratio (cl. 3.4.6)

Basic span to depth ratio (Table 3.9)  $\text{span\_to\_depth}_{basic} = 26.0$

Design service stress in tension reinforcement  $f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = 6.0 \text{ N/mm}^2$

Modification for tension reinforcement

$$f_{tens} = \min(2.0, 0.55 + (477 \text{ N/mm}^2 - f_s) / (120 \times (0.9 \text{ N/mm}^2 + (M / (b \times d^2)))) = 2.000$$

Modification for compression reinforcement

$$f_{comp} = \min(1.5, 1 + (100 \times A_{s2,prov} / (b \times d)) / (3 + (100 \times A_{s2,prov} / (b \times d)))) = 1.061$$

Modification for span length

$$f_{long} = 1.000$$

Allowable span to depth ratio

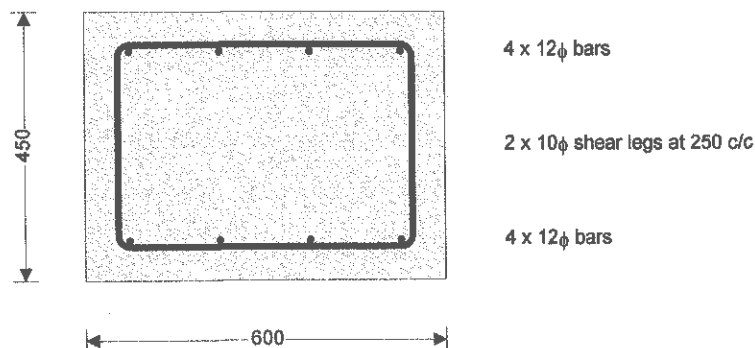
$$\text{span\_to\_depth}_{allow} = \text{span\_to\_depth}_{basic} \times f_{tens} \times f_{comp} = 55.2$$

Actual span to depth ratio

$$\text{span\_to\_depth}_{actual} = L_{e1} / d = 2.7$$

**PASS - Actual span to depth ratio is within the allowable limit**

#### Support B



#### Design moment resistance of rectangular section (cl. 3.4.4)

Design bending moment  $M = \text{abs}(M_{B,red}) = 13 \text{ kNm}$

Depth to tension reinforcement  $d = h - C_{nom,t} - \phi_v - \phi_{top} / 2 = 384 \text{ mm}$

Redistribution ratio  $\beta_b = \min(1 - m_{rB}, 1) = 1.000$

$$K = M / (b \times d^2 \times f_{cu}) = 0.003$$

$$K' = 0.156$$

**K' > K - No compression reinforcement is required**

Lever arm

$$z = \min(d \times (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 \times d) = 365 \text{ mm}$$

Depth of neutral axis

$$x = (d - z) / 0.45 = 43 \text{ mm}$$

Area of tension reinforcement required

$$A_{s,req} = M / (0.87 \times f_y \times z) = 81 \text{ mm}^2$$

Tension reinforcement provided

$$4 \times 12\phi \text{ bars}$$

Area of tension reinforcement provided

$$A_{s,prov} = 452 \text{ mm}^2$$

Minimum area of reinforcement

$$A_{s,min} = 0.0013 \times b \times h = 351 \text{ mm}^2$$

Maximum area of reinforcement

$$A_{s,max} = 0.04 \times b \times h = 10800 \text{ mm}^2$$

**PASS - Area of reinforcement provided is greater than area of reinforcement required**

|                                    |            |            |              |                                     |               |
|------------------------------------|------------|------------|--------------|-------------------------------------|---------------|
| Project<br><b>34 Grassmere Way</b> |            |            |              | Job no.                             |               |
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| Calcs by                           | Calcs date | Checked by | Checked date | Approved by                         | Approved date |

### Rectangular section in shear

Design shear force span 1 at 641 mm

$$V = \text{abs}(\min(V_{B\_s1\_max}, V_{B\_s1\_red})) = 19 \text{ kN}$$

Design shear stress

$$v = V / (b \times d) = 0.080 \text{ N/mm}^2$$

Design concrete shear stress

$$v_c = 0.79 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400/d)^{1/4}) \times$$

$$(\min(f_{cu}, 40) / 25)^{1/3} / \gamma_m$$

$$v_c = 0.434 \text{ N/mm}^2$$

Allowable design shear stress

$$v_{max} = \min(0.8 \text{ N/mm}^2 \times (f_{cu}/1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = 5.000 \text{ N/mm}^2$$

**PASS - Design shear stress is less than maximum allowable**

Value of v from Table 3.7

$$v < 0.5v_c$$

Design shear resistance required

$$v_s = \max(v - v_c, 0.4 \text{ N/mm}^2) = 0.400 \text{ N/mm}^2$$

Area of shear reinforcement required

$$A_{sv,req} = v_s \times b / (0.87 \times f_{yv}) = 552 \text{ mm}^2/\text{m}$$

Shear reinforcement provided

$$2 \times 10\phi \text{ legs at } 250 \text{ c/c}$$

Area of shear reinforcement provided

$$A_{sv,prov} = 628 \text{ mm}^2/\text{m}$$

**PASS - Area of shear reinforcement provided exceeds minimum required**

Maximum longitudinal spacing

$$s_{vl,max} = 0.75 \times d = 288 \text{ mm}$$

**PASS - Longitudinal spacing of shear reinforcement provided is less than maximum**

Design shear force span 2 at 384 mm

$$V = \max(V_{B\_s2\_max}, V_{B\_s2\_red}) = 17 \text{ kN}$$

Design shear stress

$$v = V / (b \times d) = 0.073 \text{ N/mm}^2$$

Design concrete shear stress

$$v_c = 0.79 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400/d)^{1/4}) \times$$

$$(\min(f_{cu}, 40) / 25)^{1/3} / \gamma_m$$

$$v_c = 0.434 \text{ N/mm}^2$$

Allowable design shear stress

$$v_{max} = \min(0.8 \text{ N/mm}^2 \times (f_{cu}/1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = 5.000 \text{ N/mm}^2$$

**PASS - Design shear stress is less than maximum allowable**

Value of v from Table 3.7

$$v < 0.5v_c$$

Design shear resistance required

$$v_s = \max(v - v_c, 0.4 \text{ N/mm}^2) = 0.400 \text{ N/mm}^2$$

Area of shear reinforcement required

$$A_{sv,req} = v_s \times b / (0.87 \times f_{yv}) = 552 \text{ mm}^2/\text{m}$$

Shear reinforcement provided

$$2 \times 10\phi \text{ legs at } 250 \text{ c/c}$$

Area of shear reinforcement provided

$$A_{sv,prov} = 628 \text{ mm}^2/\text{m}$$

**PASS - Area of shear reinforcement provided exceeds minimum required**

Maximum longitudinal spacing

$$s_{vl,max} = 0.75 \times d = 288 \text{ mm}$$

**PASS - Longitudinal spacing of shear reinforcement provided is less than maximum**

### Spacing of reinforcement (cl 3.12.11)

Actual distance between bars in tension

$$s = (b - 2 \times (C_{nom,s} + \phi_v + \phi_{top}/2)) / (N_{top} - 1) - \phi_{top} = 144 \text{ mm}$$

Minimum distance between bars in tension (cl 3.12.11.1)

Minimum distance between bars in tension

$$s_{min} = h_{agg} + 5 \text{ mm} = 25 \text{ mm}$$

**PASS - Satisfies the minimum spacing criteria**

### Maximum distance between bars in tension (cl 3.12.11.2)

Design service stress

$$f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = 60.0 \text{ N/mm}^2$$

Maximum distance between bars in tension

$$s_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = 300 \text{ mm}$$

**PASS - Satisfies the maximum spacing criteria**

### Span to depth ratio (cl. 3.4.6)

Basic span to depth ratio (Table 3.9)

$$\text{span\_to\_depth}_{basic} = 7.0$$

Design service stress in tension reinforcement

$$f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = 60.0 \text{ N/mm}^2$$

Modification for tension reinforcement

$$f_{tens} = \min(2.0, 0.55 + (477 \text{ N/mm}^2 - f_s) / (120 \times (0.9 \text{ N/mm}^2 + (M / (b \times d^2))))) = 2.000$$

|                             |            |            |              |                              |               |
|-----------------------------|------------|------------|--------------|------------------------------|---------------|
| Project<br>34 Grassmere Way |            |            |              | Job no.                      |               |
| Calcs for<br>GROUNDBEAM B   |            |            |              | Start page no./Revision<br>6 |               |
| Calcs by                    | Calcs date | Checked by | Checked date | Approved by                  | Approved date |

Modification for compression reinforcement

$$f_{comp} = \min(1.5, 1 + (100 * A_{s2,prov} / (b * d)) / (3 + (100 * A_{s2,prov} / (b * d)))) = 1.061$$

Modification for span length

$$f_{long} = 1.000$$

Allowable span to depth ratio

$$span\_to\_depth_{allow} = span\_to\_depth_{basic} * f_{tens} * f_{comp} = 14.9$$

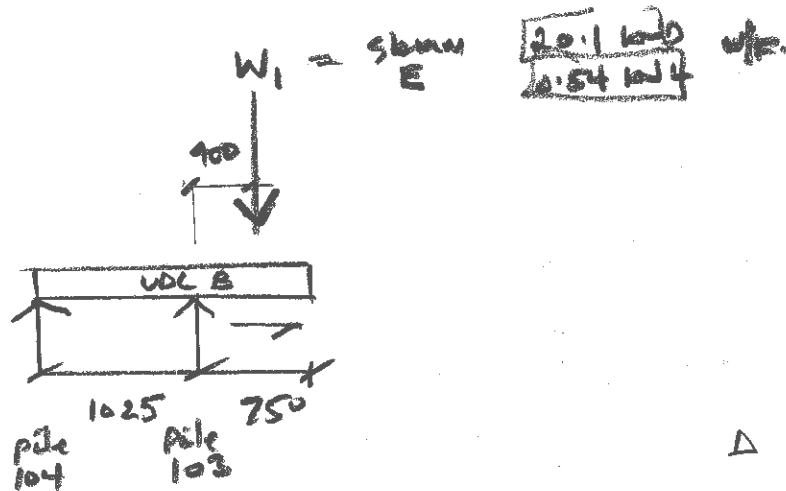
Actual span to depth ratio

$$span\_to\_depth_{actual} = L_{s2} / d = 2.0$$

**PASS - Actual span to depth ratio is within the allowable limit**

|                                 |               |                  |                    |
|---------------------------------|---------------|------------------|--------------------|
| Project Title: 34 GRADEMERE WAY |               | Project No: 1566 |                    |
| Calcs. by: AD                   | Prelim./Final | Checked by:      | Category of Check: |
| Date:                           |               | Date:            | Sht.               |

GROUND BEAM (C)



WDL B P. Roof.  $1.14 \times 1.27 = 1.78$   
 $0.6$   $0.84$

EXT WALL  $2.4 \times 3.3 = 7.92$   
above grad.  
below grad  $0.4 \times 4.5 = 1.8$   
S/nk G beam.  $6.15$

B + Block GF  $10.25$   
 $4 \times 1/2 \times 5 = 10$   
 $1.5$   $3.1$

28.3 3.94

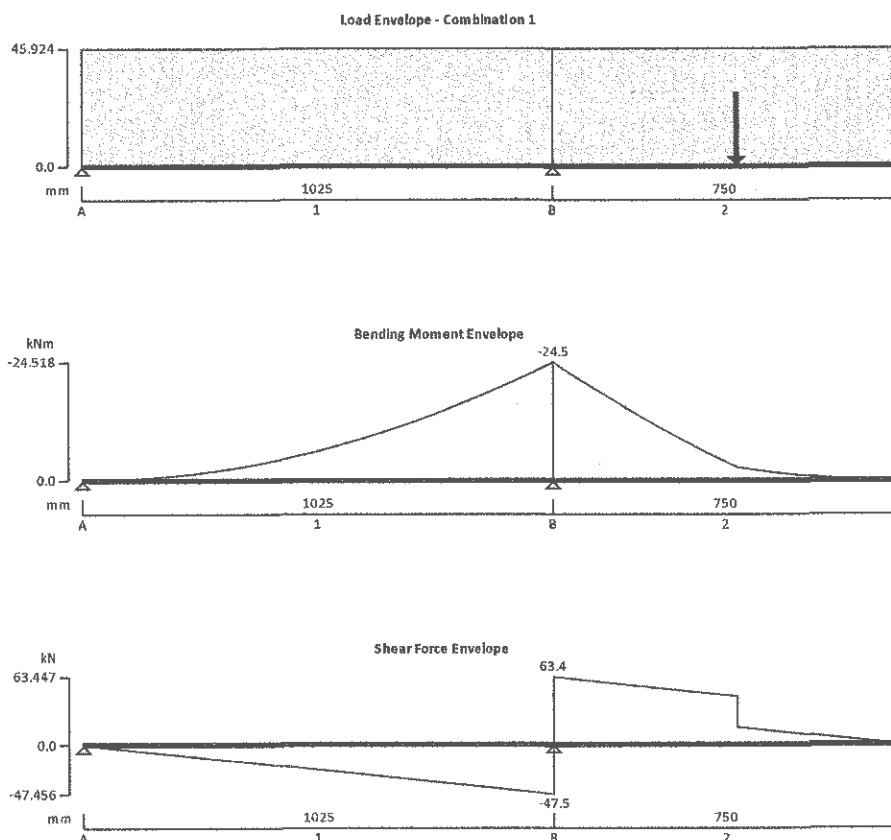
Totals  $\rightarrow$

✓ = Same as G beam A ✓

600 u x 450 dp RCHD  
4 M12 T + B  
2 M10 Hys x 250.

# RC BEAM ANALYSIS & DESIGN BS8110

TEDDS calculation version 2.1.14



## Support conditions

Support A

Vertically restrained

Rotationally free

Support B

Vertically restrained

Rotationally free

Support C

Vertically free

Rotationally free

## Applied loading

Dead full UDL 28.3 kN/m

Imposed full UDL 3.94 kN/m

Dead point load 20.1 kN at 1425 mm

Imposed point load 0.54 kN at 1425 mm

## Load combinations

Load combination 1

Support A

Dead \* 1.40

Imposed \* 1.60

Span 1

Dead \* 1.40

Imposed \* 1.60

Support B

Dead \* 1.40

Imposed \* 1.60

### Span 2

Dead \* 1.40

Imposed \* 1.60

### Support C

Dead \* 1.40

Imposed \* 1.60

#### Analysis results

Maximum moment support A

 $M_{A\_max} = 0 \text{ kNm}$ 
 $M_{A\_red} = 0 \text{ kNm}$ 

Maximum moment span 1 at 0 mm

 $M_{s1\_max} = 0 \text{ kNm}$ 
 $M_{s1\_red} = 0 \text{ kNm}$ 

Maximum moment support B

 $M_{B\_max} = -25 \text{ kNm}$ 
 $M_{B\_red} = -25 \text{ kNm}$ 

Maximum moment span 2 at support

 $M_{s2\_max} = 0 \text{ kNm}$ 
 $M_{s2\_red} = 0 \text{ kNm}$ 

Maximum moment support C

 $M_{C\_max} = 0 \text{ kNm}$ 
 $M_{C\_red} = 0 \text{ kNm}$ 

Maximum shear support A

 $V_{A\_max} = -0 \text{ kN}$ 
 $V_{A\_red} = -0 \text{ kN}$ 

Maximum shear support A span 1 at 400 mm

 $V_{A\_s1\_max} = -19 \text{ kN}$ 
 $V_{A\_s1\_red} = -19 \text{ kN}$ 

Maximum shear support B

 $V_{B\_max} = 63 \text{ kN}$ 
 $V_{B\_red} = 63 \text{ kN}$ 

Maximum shear support B span 1 at 641 mm

 $V_{B\_s1\_max} = -29 \text{ kN}$ 
 $V_{B\_s1\_red} = -29 \text{ kN}$ 

Maximum shear support B span 2 at 384 mm

 $V_{B\_s2\_max} = 16 \text{ kN}$ 
 $V_{B\_s2\_red} = 16 \text{ kN}$ 

Maximum shear support C

 $V_{C\_max} = 0 \text{ kN}$ 
 $V_{C\_red} = 0 \text{ kN}$ 

Maximum shear support C span 2 at 350 mm

 $V_{C\_s2\_max} = 47 \text{ kN}$ 
 $V_{C\_s2\_red} = 47 \text{ kN}$ 

Maximum reaction at support A

 $R_A = -0 \text{ kN}$ 

Unfactored dead load reaction at support A

 $R_{A\_Dead} = -1 \text{ kN}$ 

Unfactored imposed load reaction at support A

 $R_{A\_Imposed} = 1 \text{ kN}$ 

Maximum reaction at support B

 $R_B = 111 \text{ kN}$ 

Unfactored dead load reaction at support B

 $R_{B\_Dead} = 71 \text{ kN}$ 

Unfactored imposed load reaction at support B

 $R_{B\_Imposed} = 7 \text{ kN}$ 

Maximum reaction at support C

 $R_C = 0 \text{ kN}$ 

Unfactored dead load reaction at support C

 $R_{C\_Dead} = 0 \text{ kN}$ 

Unfactored imposed load reaction at support C

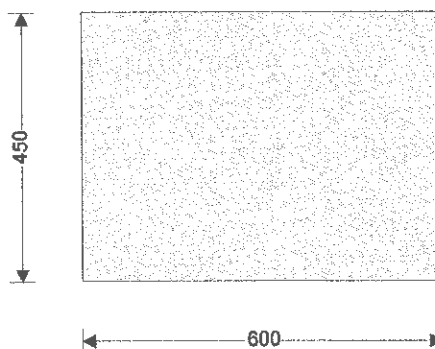
 $R_{C\_Imposed} = 0 \text{ kN}$ 

#### Rectangular section details

Section width

 $b = 600 \text{ mm}$ 

Section depth

 $h = 450 \text{ mm}$ 


#### Concrete details

Concrete strength class

**C40/50**

Characteristic compressive cube strength

 $f_{cu} = 50 \text{ N/mm}^2$ 

Modulus of elasticity of concrete

 $E_c = 20 \text{ kN/mm}^2 + 200 \times f_{cu} = 30000 \text{ N/mm}^2$ 

Maximum aggregate size

 $h_{agg} = 20 \text{ mm}$ 

#### Reinforcement details

Characteristic yield strength of reinforcement

 $f_y = 500 \text{ N/mm}^2$

|                             |            |            |              |                              |               |
|-----------------------------|------------|------------|--------------|------------------------------|---------------|
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| Calcs by                    | Calcs date | Checked by | Checked date | Approved by                  | Approved date |

Characteristic yield strength of shear reinforcement  $f_{yv} = 500 \text{ N/mm}^2$

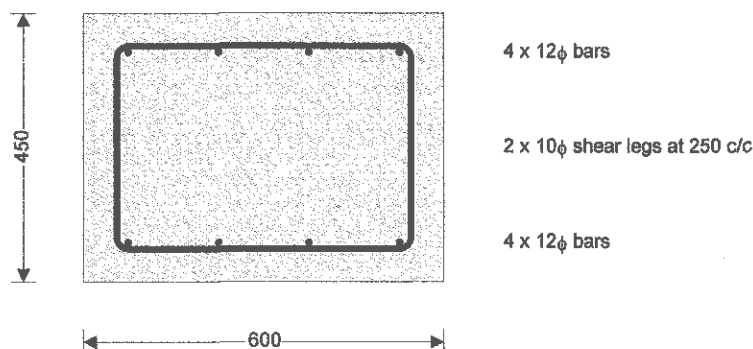
#### Nominal cover to reinforcement

Nominal cover to top reinforcement  $C_{nom\_t} = 50 \text{ mm}$

Nominal cover to bottom reinforcement  $C_{nom\_b} = 50 \text{ mm}$

Nominal cover to side reinforcement  $C_{nom\_s} = 50 \text{ mm}$

#### Mid span 1



#### Design moment resistance of rectangular section (cl. 3.4.4) - Negative moment

Design bending moment  $M = \text{abs}(M_{s1\_neg}) = 25 \text{ kNm}$

Depth to tension reinforcement  $d = h - C_{nom\_t} - \phi_v - \phi_{top} / 2 = 384 \text{ mm}$

Redistribution ratio  $\beta_b = \min(1 - m_{rs1}, 1) = 1.000$

$K = M / (b \times d^2 \times f_{cu}) = 0.006$

$K' = 0.156$

**$K' > K$  - No compression reinforcement is required**

Lever arm  $z = \min(d \times (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 \times d) = 365 \text{ mm}$

Depth of neutral axis  $x = (d - z) / 0.45 = 43 \text{ mm}$

Area of tension reinforcement required  $A_{s,req} = M / (0.87 \times f_y \times z) = 155 \text{ mm}^2$

Tension reinforcement provided **4 \* 12φ bars**

Area of tension reinforcement provided  $A_{s,prov} = 452 \text{ mm}^2$

Minimum area of reinforcement  $A_{s,min} = 0.0013 \times b \times h = 351 \text{ mm}^2$

Maximum area of reinforcement  $A_{s,max} = 0.04 \times b \times h = 10800 \text{ mm}^2$

**PASS - Area of reinforcement provided is greater than area of reinforcement required**

#### Rectangular section in shear

Shear reinforcement provided **2 \* 10φ legs at 250 c/c**

Area of shear reinforcement provided  $A_{sv,prov} = 628 \text{ mm}^2/\text{m}$

Minimum area of shear reinforcement (Table 3.7)  $A_{sv,min} = 0.4 \text{ N/mm}^2 \times b / (0.87 \times f_{yv}) = 552 \text{ mm}^2/\text{m}$

**PASS - Area of shear reinforcement provided exceeds minimum required**

Maximum longitudinal spacing (cl. 3.4.5.5)  $S_{vl,max} = 0.75 \times d = 288 \text{ mm}$

**PASS - Longitudinal spacing of shear reinforcement provided is less than maximum**

Design concrete shear stress  $v_c = 0.79 \text{ N/mm}^2 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400 \text{ mm} / d)^{1/4}) \times (\min(f_{cu}, 40 \text{ N/mm}^2) / 25 \text{ N/mm}^2)^{1/3} / \gamma_m = 0.434 \text{ N/mm}^2$

Design shear resistance provided  $V_{s,prov} = A_{sv,prov} \times 0.87 \times f_{yv} / b = 0.456 \text{ N/mm}^2$

Design shear stress provided  $V_{prov} = V_{s,prov} + v_c = 0.890 \text{ N/mm}^2$

Design shear resistance  $V_{prov} = V_{prov} \times (b \times d) = 205.0 \text{ kN}$

**Shear links provided valid between 0 mm and 1025 mm with tension reinforcement of 452 mm<sup>2</sup>**

|                             |            |            |              |                              |               |
|-----------------------------|------------|------------|--------------|------------------------------|---------------|
| Project<br>34 Grassmere Way |            |            |              | Job no.                      |               |
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| Calcs by                    | Calcs date | Checked by | Checked date | Approved by                  | Approved date |

### Spacing of reinforcement (cl 3.12.11)

Actual distance between bars in tension  $s = (b - 2 * (C_{nom\_s} + \phi_v + \phi_{top}/2)) / (N_{top} - 1) - \phi_{top} = 144 \text{ mm}$

### Minimum distance between bars in tension (cl 3.12.11.1)

Minimum distance between bars in tension  $s_{min} = h_{agg} + 5 \text{ mm} = 25 \text{ mm}$

**PASS - Satisfies the minimum spacing criteria**

### Maximum distance between bars in tension (cl 3.12.11.2)

Design service stress  $f_s = (2 * f_y * A_{s,req}) / (3 * A_{s,prov} * \beta_b) = 113.8 \text{ N/mm}^2$

Maximum distance between bars in tension  $s_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = 300 \text{ mm}$

**PASS - Satisfies the maximum spacing criteria**

### Span to depth ratio (cl. 3.4.6)

Basic span to depth ratio (Table 3.9)  $\text{span\_to\_depth}_{basic} = 26.0$

Design service stress in tension reinforcement  $f_s = (2 * f_y * A_{s,req}) / (3 * A_{s,prov} * \beta_b) = 113.8 \text{ N/mm}^2$

Modification for tension reinforcement

$$f_{tens} = \min(2.0, 0.55 + (477 \text{ N/mm}^2 - f_s) / (120 * (0.9 \text{ N/mm}^2 + (M / (b * d^2)))) = 2.000$$

Modification for compression reinforcement

$$f_{comp} = \min(1.5, 1 + (100 * A_{s2,prov} / (b * d)) / (3 + (100 * A_{s2,prov} / (b * d)))) = 1.061$$

Modification for span length

$$f_{long} = 1.000$$

Allowable span to depth ratio

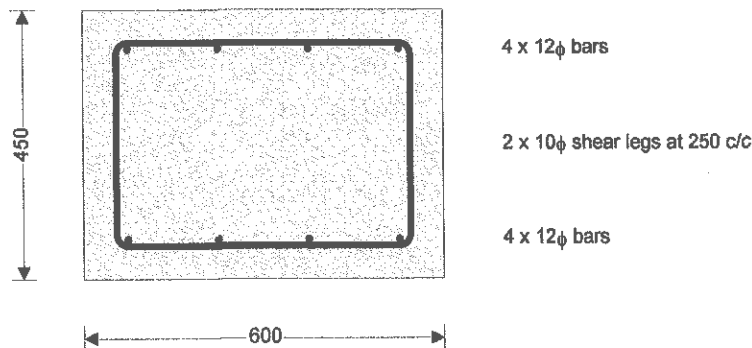
$$\text{span\_to\_depth}_{allow} = \text{span\_to\_depth}_{basic} * f_{tens} * f_{comp} = 55.2$$

Actual span to depth ratio

$$\text{span\_to\_depth}_{actual} = L_{s1} / d = 2.7$$

**PASS - Actual span to depth ratio is within the allowable limit**

### Support B



### Design moment resistance of rectangular section (cl. 3.4.4)

Design bending moment  $M = \text{abs}(M_{B\_red}) = 25 \text{ kNm}$

Depth to tension reinforcement  $d = h - C_{nom\_t} - \phi_v - \phi_{top} / 2 = 384 \text{ mm}$

Redistribution ratio  $\beta_b = \min(1 - m_{rB}, 1) = 1.000$

$$K = M / (b * d^2 * f_{cu}) = 0.006$$

$$K' = 0.156$$

**K' > K - No compression reinforcement is required**

Lever arm  $z = \min(d * (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 * d) = 365 \text{ mm}$

Depth of neutral axis  $x = (d - z) / 0.45 = 43 \text{ mm}$

Area of tension reinforcement required  $A_{s,req} = M / (0.87 * f_y * z) = 155 \text{ mm}^2$

Tension reinforcement provided **4 \* 12 $\phi$  bars**

Area of tension reinforcement provided  $A_{s,prov} = 452 \text{ mm}^2$

Minimum area of reinforcement  $A_{s,min} = 0.0013 * b * h = 351 \text{ mm}^2$

Maximum area of reinforcement  $A_{s,max} = 0.04 * b * h = 10800 \text{ mm}^2$

|                             |            |            |              |                              |               |
|-----------------------------|------------|------------|--------------|------------------------------|---------------|
| Project<br>34 Grassmere Way |            |            |              | Job no.                      |               |
| Calcs for<br>GROUNDBEAM C   |            |            |              | Start page no./Revision<br>5 |               |
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**PASS - Area of reinforcement provided is greater than area of reinforcement required**

**Rectangular section in shear**

Design shear force span 1 at 641 mm

$$V = \text{abs}(\min(V_{B\_s1\_max}, V_{B\_s1\_req})) = 29 \text{ kN}$$

Design shear stress

$$v = V / (b \times d) = 0.126 \text{ N/mm}^2$$

Design concrete shear stress

$$v_c = 0.79 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400/d)^{1/4}) \times$$

$$(\min(f_{cu}, 40) / 25)^{1/3} / \gamma_m$$

$$v_c = 0.434 \text{ N/mm}^2$$

Allowable design shear stress

$$v_{max} = \min(0.8 \text{ N/mm}^2 \times (f_{cu}/1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = 5.000 \text{ N/mm}^2$$

**PASS - Design shear stress is less than maximum allowable**

Value of v from Table 3.7

$$v < 0.5v_c$$

Design shear resistance required

$$v_s = \max(v - v_c, 0.4 \text{ N/mm}^2) = 0.400 \text{ N/mm}^2$$

Area of shear reinforcement required

$$A_{sv,req} = v_s \times b / (0.87 \times f_{yv}) = 552 \text{ mm}^2/\text{m}$$

Shear reinforcement provided

$$2 \times 10\phi \text{ legs at } 250 \text{ c/c}$$

Area of shear reinforcement provided

$$A_{sv,prov} = 628 \text{ mm}^2/\text{m}$$

**PASS - Area of shear reinforcement provided exceeds minimum required**

Maximum longitudinal spacing

$$s_{vl,max} = 0.75 \times d = 288 \text{ mm}$$

**PASS - Longitudinal spacing of shear reinforcement provided is less than maximum**

Design shear force span 2 at 384 mm

$$V = \max(V_{B\_s2\_max}, V_{B\_s2\_req}) = 16 \text{ kN}$$

Design shear stress

$$v = V / (b \times d) = 0.070 \text{ N/mm}^2$$

Design concrete shear stress

$$v_c = 0.79 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400/d)^{1/4}) \times$$

$$(\min(f_{cu}, 40) / 25)^{1/3} / \gamma_m$$

$$v_c = 0.434 \text{ N/mm}^2$$

Allowable design shear stress

$$v_{max} = \min(0.8 \text{ N/mm}^2 \times (f_{cu}/1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = 5.000 \text{ N/mm}^2$$

**PASS - Design shear stress is less than maximum allowable**

Value of v from Table 3.7

$$v < 0.5v_c$$

Design shear resistance required

$$v_s = \max(v - v_c, 0.4 \text{ N/mm}^2) = 0.400 \text{ N/mm}^2$$

Area of shear reinforcement required

$$A_{sv,req} = v_s \times b / (0.87 \times f_{yv}) = 552 \text{ mm}^2/\text{m}$$

Shear reinforcement provided

$$2 \times 10\phi \text{ legs at } 250 \text{ c/c}$$

Area of shear reinforcement provided

$$A_{sv,prov} = 628 \text{ mm}^2/\text{m}$$

**PASS - Area of shear reinforcement provided exceeds minimum required**

Maximum longitudinal spacing

$$s_{vl,max} = 0.75 \times d = 288 \text{ mm}$$

**PASS - Longitudinal spacing of shear reinforcement provided is less than maximum**

**Spacing of reinforcement (cl 3.12.11)**

Actual distance between bars in tension

$$s = (b - 2 \times (C_{nom\_s} + \phi_v + \phi_{top}/2)) / (N_{top} - 1) - \phi_{top} = 144 \text{ mm}$$

**Minimum distance between bars in tension (cl 3.12.11.1)**

Minimum distance between bars in tension

$$s_{min} = h_{agg} + 5 \text{ mm} = 25 \text{ mm}$$

**PASS - Satisfies the minimum spacing criteria**

**Maximum distance between bars in tension (cl 3.12.11.2)**

Design service stress

$$f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = 113.8 \text{ N/mm}^2$$

Maximum distance between bars in tension

$$s_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = 300 \text{ mm}$$

**PASS - Satisfies the maximum spacing criteria**

**Span to depth ratio (cl. 3.4.6)**

Basic span to depth ratio (Table 3.9)

$$\text{span\_to\_depth}_{basic} = 7.0$$

Design service stress in tension reinforcement

$$f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = 113.8 \text{ N/mm}^2$$

Modification for tension reinforcement

$$f_{tens} = \min(2.0, 0.55 + (477N/mm^2 - f_s) / (120 * (0.9N/mm^2 + (M / (b * d^2)))))) = 2.000$$

Modification for compression reinforcement

$$f_{comp} = \min(1.5, 1 + (100 * A_{s2,prov} / (b * d)) / (3 + (100 * A_{s2,prov} / (b * d)))) = 1.061$$

Modification for span length

$$f_{long} = 1.000$$

Allowable span to depth ratio

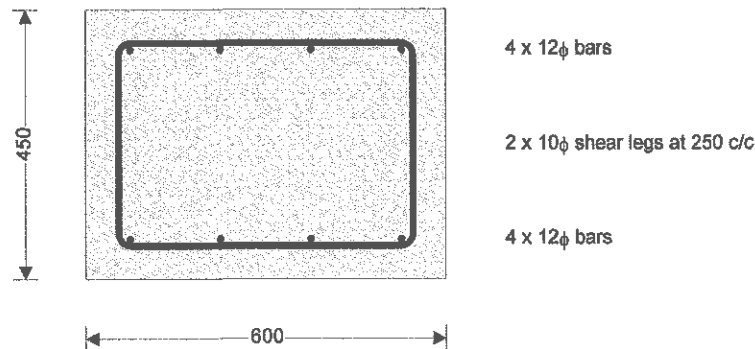
$$span\_to\_depth_{allow} = span\_to\_depth_{basic} * f_{tens} * f_{comp} = 14.9$$

Actual span to depth ratio

$$span\_to\_depth_{actual} = L_{s2} / d = 2.0$$

**PASS - Actual span to depth ratio is within the allowable limit**

### Mid span 2



### Design moment resistance of rectangular section (cl. 3.4.4) - Negative moment

Design bending moment

$$M = \text{abs}(M_{s2\_neg}) = 25 \text{ kNm}$$

Depth to tension reinforcement

$$d = h - C_{nom\_t} - \phi_v - \phi_{top} / 2 = 384 \text{ mm}$$

Redistribution ratio

$$\beta_b = \min(1 - m_{tr2}, 1) = 1.000$$

$$K = M / (b * d^2 * f_{cu}) = 0.006$$

$$K' = 0.156$$

**K' > K - No compression reinforcement is required**

Lever arm

$$z = \min(d * (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 * d) = 365 \text{ mm}$$

Depth of neutral axis

$$x = (d - z) / 0.45 = 43 \text{ mm}$$

Area of tension reinforcement required

$$A_{s,req} = M / (0.87 * f_y * z) = 155 \text{ mm}^2$$

Tension reinforcement provided

$$4 * 12\phi \text{ bars}$$

Area of tension reinforcement provided

$$A_{s,prov} = 452 \text{ mm}^2$$

Minimum area of reinforcement

$$A_{s,min} = 0.0013 * b * h = 351 \text{ mm}^2$$

Maximum area of reinforcement

$$A_{s,max} = 0.04 * b * h = 10800 \text{ mm}^2$$

**PASS - Area of reinforcement provided is greater than area of reinforcement required**

### Rectangular section in shear

Shear reinforcement provided

$$2 * 10\phi \text{ legs at } 250 \text{ c/c}$$

Area of shear reinforcement provided

$$A_{sv,prov} = 628 \text{ mm}^2/\text{m}$$

Minimum area of shear reinforcement (Table 3.7)

$$A_{sv,min} = 0.4N/mm^2 * b / (0.87 * f_{yv}) = 552 \text{ mm}^2/\text{m}$$

**PASS - Area of shear reinforcement provided exceeds minimum required**

Maximum longitudinal spacing (cl. 3.4.5.5)

$$S_{vl,max} = 0.75 * d = 288 \text{ mm}$$

**PASS - Longitudinal spacing of shear reinforcement provided is less than maximum**

Design concrete shear stress

$$v_c = 0.79N/mm^2 * \min(3, [100 * A_{s,prov} / (b * d)]^{1/3}) * \max(1, (400mm / d)^{1/4}) * (\min(f_{cu}, 40N/mm^2) / 25N/mm^2)^{1/3} / \gamma_m = 0.434 \text{ N/mm}^2$$

Design shear resistance provided

$$V_{s,prov} = A_{sv,prov} * 0.87 * f_{yv} / b = 0.456 \text{ N/mm}^2$$

Design shear stress provided

$$V_{prov} = V_{s,prov} + v_c = 0.890 \text{ N/mm}^2$$

Design shear resistance

$$V_{prov} = V_{prov} * (b * d) = 205.0 \text{ kN}$$

**Shear links provided valid between 0 mm and 750 mm with tension reinforcement of 452 mm<sup>2</sup>**

|                                                                                                                                                                                        |                             |            |            |              |                              |               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------|------------|--------------|------------------------------|---------------|
|  <b>Tekla Tedds</b><br>P J Davies Associates Ltd<br>Office 201/4 Langstone Gate<br>Solent Rd<br>Havant | Project<br>34 Grassmere Way |            |            |              | Job no.                      |               |
|                                                                                                                                                                                        | Calcs for<br>GROUNDBEAM C   |            |            |              | Start page no./Revision<br>7 |               |
|                                                                                                                                                                                        | Calcs by                    | Calcs date | Checked by | Checked date | Approved by                  | Approved date |

**Spacing of reinforcement (cl 3.12.11)**

Actual distance between bars in tension  $s = (b - 2 * (C_{nom\_s} + \phi_v + \phi_{top}/2)) / (N_{top} - 1) - \phi_{top} = 144 \text{ mm}$

**Minimum distance between bars in tension (cl 3.12.11.1)**

Minimum distance between bars in tension  $s_{min} = h_{agg} + 5 \text{ mm} = 25 \text{ mm}$

**PASS - Satisfies the minimum spacing criteria**

**Maximum distance between bars in tension (cl 3.12.11.2)**

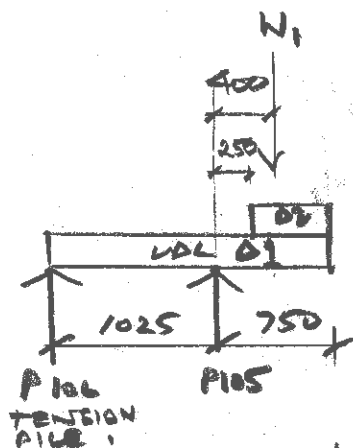
Design service stress  $f_s = (2 \times f_y \times A_{s,req}) / (3 \times A_{s,prov} \times \beta_b) = 113.8 \text{ N/mm}^2$

Maximum distance between bars in tension  $s_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = 300 \text{ mm}$

**PASS - Satisfies the maximum spacing criteria**

|                                 |               |                  |                         |
|---------------------------------|---------------|------------------|-------------------------|
| Project Title: 34 GRADSHIRE WAY |               | Project No: 1566 |                         |
| Calcs. by: AD                   | Prelim./Final | Checked by: =    | Category of Check: Sht. |
| Date: / /                       |               | Date: / /        |                         |

S. BEAM (A)



LDL D1 → s/wt S. beam.

LDL D2 →  
 welding above flange 2.5 x 3.3 8.3  
 B+B say 17/2 x 5 4.3  
 1.5 1.3  
 welding below flange 0.4 x 4.5 1.8  
 14.4 1.3

W1 → (E) subbeam.  
 say 2.3/2 x 17.5 0.47  
 20.1 0.54  
 8 1025

Tedds →

✓ = same as G. beam (A) ✓  
 600W x 450 dp  
 + 412 T+B  
 2 H10 top & 250

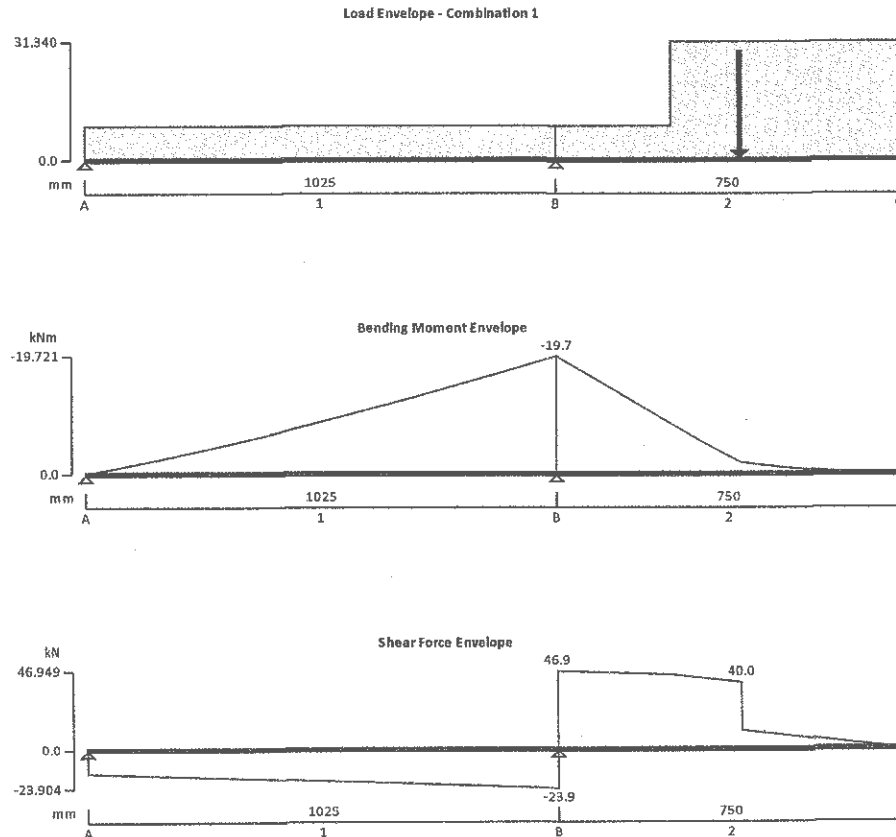
G beam. E VAL

s/wt 6.5  
 below flange 1.8  
 welding 8.3  
 Roof 0.8  
 0.7 x 1.14 0.42  
 0.6  
 spec 0.2 x 0.5 0.1 0.05  
 0.25  
 17.5 0.47  
 1025 1025

6.5

## RC BEAM ANALYSIS & DESIGN BS8110

TEDDS calculation version 2.1.14



### Support conditions

Support A

Vertically restrained

Rotationally free

Support B

Vertically restrained

Rotationally free

Support C

Vertically free

Rotationally free

### Applied loading

Dead full UDL 6.5 kN/m

Dead partial UDL 14.4 kN/m from 1275 mm to 1775 mm

Imposed partial UDL 1.3 kN/m from 1275 mm to 1775 mm

Dead point load 20.1 kN at 1425 mm

Imposed point load 0.54 kN at 1425 mm

### Load combinations

Load combination 1

Support A

Dead \* 1.40

Imposed \* 1.60

Span 1

Dead \* 1.40

Imposed \* 1.60

Support B

Dead \* 1.40

|                                    |            |            |              |                                     |               |
|------------------------------------|------------|------------|--------------|-------------------------------------|---------------|
| Project<br><b>34 Grassmere Way</b> |            |            |              | Job no.                             |               |
| Calcs for<br><b>GROUND BEAM D</b>  |            |            |              | Start page no./Revision<br><b>2</b> |               |
| Calcs by                           | Calcs date | Checked by | Checked date | Approved by                         | Approved date |

Span 2

Support C

Imposed \* 1.60

Dead \* 1.40

Imposed \* 1.60

Dead \* 1.40

Imposed \* 1.60

### Analysis results

|                                               |                                   |                                   |
|-----------------------------------------------|-----------------------------------|-----------------------------------|
| Maximum moment support A                      | $M_{A\_max} = 0 \text{ kNm}$      | $M_{A\_red} = 0 \text{ kNm}$      |
| Maximum moment span 1 at 0 mm                 | $M_{s1\_max} = 0 \text{ kNm}$     | $M_{s1\_red} = 0 \text{ kNm}$     |
| Maximum moment support B                      | $M_{B\_max} = -20 \text{ kNm}$    | $M_{B\_red} = -20 \text{ kNm}$    |
| Maximum moment span 2 at support              | $M_{s2\_max} = 0 \text{ kNm}$     | $M_{s2\_red} = 0 \text{ kNm}$     |
| Maximum moment support C                      | $M_{C\_max} = 0 \text{ kNm}$      | $M_{C\_red} = 0 \text{ kNm}$      |
| Maximum shear support A                       | $V_{A\_max} = -15 \text{ kN}$     | $V_{A\_red} = -15 \text{ kN}$     |
| Maximum shear support A span 1 at 400 mm      | $V_{A\_s1\_max} = -18 \text{ kN}$ | $V_{A\_s1\_red} = -18 \text{ kN}$ |
| Maximum shear support B                       | $V_{B\_max} = 47 \text{ kN}$      | $V_{B\_red} = 47 \text{ kN}$      |
| Maximum shear support B span 1 at 625 mm      | $V_{B\_s1\_max} = -20 \text{ kN}$ | $V_{B\_s1\_red} = -20 \text{ kN}$ |
| Maximum shear support B span 2 at 400 mm      | $V_{B\_s2\_max} = 11 \text{ kN}$  | $V_{B\_s2\_red} = 11 \text{ kN}$  |
| Maximum shear support C                       | $V_{C\_max} = 0 \text{ kN}$       | $V_{C\_red} = 0 \text{ kN}$       |
| Maximum shear support C span 2 at 350 mm      | $V_{C\_s2\_max} = 42 \text{ kN}$  | $V_{C\_s2\_red} = 42 \text{ kN}$  |
| Maximum reaction at support A                 | $R_A = -15 \text{ kN}$            |                                   |
| Unfactored dead load reaction at support A    | $R_{A\_Dead} = -10 \text{ kN}$    |                                   |
| Unfactored imposed load reaction at support A | $R_{A\_Imposed} = -1 \text{ kN}$  |                                   |
| Maximum reaction at support B                 | $R_B = 71 \text{ kN}$             |                                   |
| Unfactored dead load reaction at support B    | $R_{B\_Dead} = 49 \text{ kN}$     |                                   |
| Unfactored imposed load reaction at support B | $R_{B\_Imposed} = 2 \text{ kN}$   |                                   |
| Maximum reaction at support C                 | $R_C = 0 \text{ kN}$              |                                   |
| Unfactored dead load reaction at support C    | $R_{C\_Dead} = 0 \text{ kN}$      |                                   |
| Unfactored imposed load reaction at support C | $R_{C\_Imposed} = 0 \text{ kN}$   |                                   |

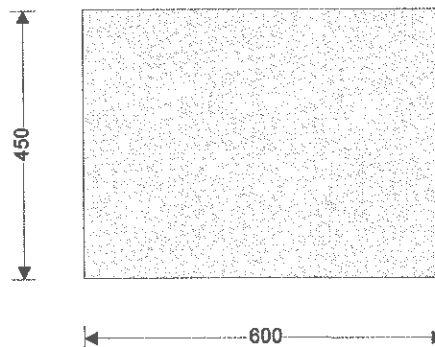
### Rectangular section details

Section width

$b = 600 \text{ mm}$

Section depth

$h = 450 \text{ mm}$



### Concrete details

Concrete strength class

**C40/50**

Characteristic compressive cube strength

$f_{cu} = 50 \text{ N/mm}^2$

Modulus of elasticity of concrete

$E_c = 20 \text{ kN/mm}^2 + 200 \times f_{cu} = 30000 \text{ N/mm}^2$

Maximum aggregate size

$h_{agg} = 20 \text{ mm}$

|                             |            |            |              |                              |               |
|-----------------------------|------------|------------|--------------|------------------------------|---------------|
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| Calcs by                    | Calcs date | Checked by | Checked date | Approved by                  | Approved date |

### Reinforcement details

Characteristic yield strength of reinforcement  $f_y = 500 \text{ N/mm}^2$

Characteristic yield strength of shear reinforcement  $f_{yv} = 500 \text{ N/mm}^2$

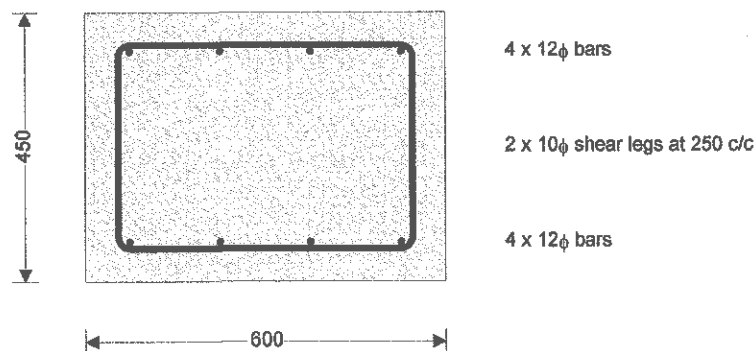
### Nominal cover to reinforcement

Nominal cover to top reinforcement  $C_{nom\_t} = 50 \text{ mm}$

Nominal cover to bottom reinforcement  $C_{nom\_b} = 50 \text{ mm}$

Nominal cover to side reinforcement  $C_{nom\_s} = 50 \text{ mm}$

### Mid span 1



### Design moment resistance of rectangular section (cl. 3.4.4) - Negative moment

Design bending moment  $M = \text{abs}(M_{s1\_neg}) = 20 \text{ kNm}$

Depth to tension reinforcement  $d = h - C_{nom\_t} - \phi_v - \phi_{top} / 2 = 384 \text{ mm}$

Redistribution ratio  $\beta_b = \min(1 - m_{rs1}, 1) = 1.000$

$$K = M / (b \times d^2 \times f_{cu}) = 0.004$$

$$K' = 0.156$$

**$K' > K$  - No compression reinforcement is required**

Lever arm  $z = \min(d \times (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 \times d) = 365 \text{ mm}$

Depth of neutral axis  $x = (d - z) / 0.45 = 43 \text{ mm}$

Area of tension reinforcement required  $A_{s,req} = M / (0.87 \times f_y \times z) = 124 \text{ mm}^2$

Tension reinforcement provided **4 \* 12φ bars**

Area of tension reinforcement provided  $A_{s,prov} = 452 \text{ mm}^2$

Minimum area of reinforcement  $A_{s,min} = 0.0013 \times b \times h = 351 \text{ mm}^2$

Maximum area of reinforcement  $A_{s,max} = 0.04 \times b \times h = 10800 \text{ mm}^2$

**PASS - Area of reinforcement provided is greater than area of reinforcement required**

### Rectangular section in shear

Shear reinforcement provided **2 \* 10φ legs at 250 c/c**

Area of shear reinforcement provided  $A_{sv,prov} = 628 \text{ mm}^2/\text{m}$

Minimum area of shear reinforcement (Table 3.7)  $A_{sv,min} = 0.4 \text{ N/mm}^2 \times b / (0.87 \times f_{yv}) = 552 \text{ mm}^2/\text{m}$

**PASS - Area of shear reinforcement provided exceeds minimum required**

Maximum longitudinal spacing (cl. 3.4.5.5)  $S_{vl,max} = 0.75 \times d = 288 \text{ mm}$

**PASS - Longitudinal spacing of shear reinforcement provided is less than maximum**

Design concrete shear stress

$$v_c = 0.79 \text{ N/mm}^2 \times \min(3, [100 \times A_{s,prov} / (b \times d)]^{1/3}) \times \max(1, (400 \text{ mm} / d)^{1/4}) \times (\min(f_{cu}, 40 \text{ N/mm}^2) / 25 \text{ N/mm}^2)^{1/3} / \gamma_m = 0.434 \text{ N/mm}^2$$

Design shear resistance provided

$$v_{s,prov} = A_{sv,prov} \times 0.87 \times f_{yv} / b = 0.456 \text{ N/mm}^2$$

Design shear stress provided

$$v_{prov} = v_{s,prov} + v_c = 0.890 \text{ N/mm}^2$$

Design shear resistance

$$V_{prov} = v_{prov} \times (b \times d) = 205.0 \text{ kN}$$

|                                    |            |            |              |                                     |               |
|------------------------------------|------------|------------|--------------|-------------------------------------|---------------|
| Project<br><b>34 Grassmere Way</b> |            |            |              | Job no.                             |               |
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**Shear links provided valid between 0 mm and 1025 mm with tension reinforcement of 452 mm<sup>2</sup>**

**Spacing of reinforcement (cl 3.12.11)**

Actual distance between bars in tension  $s = (b - 2 * (C_{nom\_s} + \phi_v + \phi_{top}/2)) / (N_{top} - 1) - \phi_{top} = 144 \text{ mm}$

**Minimum distance between bars in tension (cl 3.12.11.1)**

Minimum distance between bars in tension  $s_{min} = h_{agg} + 5 \text{ mm} = 25 \text{ mm}$

**PASS - Satisfies the minimum spacing criteria**

**Maximum distance between bars in tension (cl 3.12.11.2)**

Design service stress  $f_s = (2 * f_y * A_{s,req}) / (3 * A_{s,prov} * \beta_b) = 91.6 \text{ N/mm}^2$

Maximum distance between bars in tension  $s_{max} = \min(47000 \text{ N/mm} / f_s, 300 \text{ mm}) = 300 \text{ mm}$

**PASS - Satisfies the maximum spacing criteria**

**Span to depth ratio (cl. 3.4.6)**

Basic span to depth ratio (Table 3.9)  $\text{span\_to\_depth}_{basic} = 26.0$

Design service stress in tension reinforcement  $f_s = (2 * f_y * A_{s,req}) / (3 * A_{s,prov} * \beta_b) = 91.6 \text{ N/mm}^2$

Modification for tension reinforcement

$$f_{tens} = \min(2.0, 0.55 + (477 \text{ N/mm}^2 - f_s) / (120 * (0.9 \text{ N/mm}^2 + (M / (b * d^2))))) = 2.000$$

Modification for compression reinforcement

$$f_{comp} = \min(1.5, 1 + (100 * A_{s2,prov} / (b * d)) / (3 + (100 * A_{s2,prov} / (b * d)))) = 1.061$$

Modification for span length

$$f_{long} = 1.000$$

Allowable span to depth ratio

$$\text{span\_to\_depth}_{allow} = \text{span\_to\_depth}_{basic} * f_{tens} * f_{comp} = 55.2$$

Actual span to depth ratio

$$\text{span\_to\_depth}_{actual} = L_{s1} / d = 2.7$$

**PASS - Actual span to depth ratio is within the allowable limit**

|                                 |               |                  |                    |      |
|---------------------------------|---------------|------------------|--------------------|------|
| Project Title: 34 GRADSHIRE WAY |               | Project No: 1566 |                    |      |
| Calcs. by: AD                   | Prelim./Final | Checked by: //   | Category of Check: | Sht. |
| Date: //                        |               | Date: //         |                    |      |

PILE LOADS.

U/F loads.

P101

43 kN D  
6 kN L.

≤ 43 kN D  
6 kN L

↓  
Σ kN  
49

P102

7 kN D  
1 kN L

+ G. beam A.  
32  
2

≤ 39 kN D  
3 kN L

42

P103

71 kN D  
7 kN L

71  
7

78

P104

-1  
1

+ G. beam A.  
32  
2

31  
3

34

P105

49  
2

49  
2

51

P106  
(TENSION  
PILE)

-10  
-1

-10  
-1

-11  
TENSION  
PILE.

|                                 |               |                  |                         |
|---------------------------------|---------------|------------------|-------------------------|
| Project Title: 34 GRADSHIRE WAY |               | Project No: 1566 |                         |
| Calcs. by: AD                   | Prelim./Final | Checked by:      | Category of Check: Sht. |
| Date:                           | Date:         |                  |                         |

FRONT TIMBER RIVER BEAMS  
1+2

L1 - L2 - 4

L = 2.5m.

|        |            |       |     |
|--------|------------|-------|-----|
| p. eaf | 0.5 x 1.27 | 0.64  |     |
|        | 0.6        |       | 0.3 |
| soff   | 0.3 x 0.35 | 0.11  |     |
| s/w    |            | 0.15  |     |
|        |            | <hr/> |     |
|        |            | 0.9   | 0.3 |

Teddy →

2 x 50 x 150 C24

|                                                                                                                                                                                         |                                            |            |            |              |                              |               |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|------------|------------|--------------|------------------------------|---------------|
|  <b>Tekla® Tedds</b><br>P J Davies Associates Ltd<br>Office 201/4 Langstone Gate<br>Solent Rd<br>Havant | Project<br>34 Grassmere Way                |            |            |              | Job no.                      |               |
|                                                                                                                                                                                         | Calcs for<br>Front Timber eaves Beams 2.5m |            |            |              | Start page no./Revision<br>1 |               |
|                                                                                                                                                                                         | Calcs by                                   | Calcs date | Checked by | Checked date | Approved by                  | Approved date |

# TIMBER BEAM ANALYSIS & DESIGN TO BS5268-2:2002

TEDDS calculation version 1.7.02

## Analysis results

|                                               |                                         |                                             |                        |
|-----------------------------------------------|-----------------------------------------|---------------------------------------------|------------------------|
| Design moment                                 | $M = 0.938 \text{ kNm}$                 | Design shear                                | $F = 1.500 \text{ kN}$ |
| Total load on beam                            | $W_{\text{tot}} = 3.000 \text{ kN}$     |                                             |                        |
| Reactions at support A                        | $R_{A_{\text{max}}} = 1.500 \text{ kN}$ | $R_{A_{\text{min}}} = 1.500 \text{ kN}$     |                        |
| Unfactored dead load reaction at support A    |                                         | $R_{A_{\text{Dead}}} = 1.125 \text{ kN}$    |                        |
| Unfactored imposed load reaction at support A |                                         | $R_{A_{\text{imposed}}} = 0.375 \text{ kN}$ |                        |
| Reactions at support B                        | $R_{B_{\text{max}}} = 1.500 \text{ kN}$ | $R_{B_{\text{min}}} = 1.500 \text{ kN}$     |                        |
| Unfactored dead load reaction at support B    |                                         | $R_{B_{\text{Dead}}} = 1.125 \text{ kN}$    |                        |
| Unfactored imposed load reaction at support B |                                         | $R_{B_{\text{imposed}}} = 0.375 \text{ kN}$ |                        |

## Timber section details

|                       |                     |                  |                       |
|-----------------------|---------------------|------------------|-----------------------|
| Breadth of section    | $b = 47 \text{ mm}$ | Depth of section | $h = 150 \text{ mm}$  |
| Number of sections    | $N = 2$             | Breadth of beam  | $b_b = 94 \text{ mm}$ |
| Timber strength class | <b>C24</b>          |                  |                       |

## Member details

|                         |                            |               |                    |
|-------------------------|----------------------------|---------------|--------------------|
| Service class of timber | <b>1</b>                   | Load duration | <b>Medium term</b> |
| Length of span          | $L_{s1} = 2500 \text{ mm}$ |               |                    |
| Length of bearing       | $L_b = 100 \text{ mm}$     |               |                    |

## Lateral support - cl.2.10.8

|                                           |             |                               |             |
|-------------------------------------------|-------------|-------------------------------|-------------|
| Permiss.depth-to-breadth ratio            | <b>2.00</b> | Actual depth-to-breadth ratio | <b>1.60</b> |
| <b>PASS - Lateral support is adequate</b> |             |                               |             |

## Check bearing stress

|                                                                                                 |                                                  |                        |                                       |
|-------------------------------------------------------------------------------------------------|--------------------------------------------------|------------------------|---------------------------------------|
| Permissible bearing stress                                                                      | $\sigma_{c_{\text{adm}}} = 3.300 \text{ N/mm}^2$ | Applied bearing stress | $\sigma_{c_a} = 0.160 \text{ N/mm}^2$ |
| <b>PASS - Applied compressive stress is less than permissible compressive stress at bearing</b> |                                                  |                        |                                       |

## Bending parallel to grain

|                                                                              |                                                   |                        |                                       |
|------------------------------------------------------------------------------|---------------------------------------------------|------------------------|---------------------------------------|
| Permissible bending stress                                                   | $\sigma_{m_{\text{adm}}} = 11.130 \text{ N/mm}^2$ | Applied bending stress | $\sigma_{m_a} = 2.660 \text{ N/mm}^2$ |
| <b>PASS - Applied bending stress is less than permissible bending stress</b> |                                                   |                        |                                       |

## Shear parallel to grain

|                                                                          |                                            |                      |                                 |
|--------------------------------------------------------------------------|--------------------------------------------|----------------------|---------------------------------|
| Permissible shear stress                                                 | $\tau_{\text{adm}} = 0.976 \text{ N/mm}^2$ | Applied shear stress | $\tau_a = 0.160 \text{ N/mm}^2$ |
| <b>PASS - Applied shear stress is less than permissible shear stress</b> |                                            |                      |                                 |

## Deflection

|                                                                    |                                          |                  |                               |
|--------------------------------------------------------------------|------------------------------------------|------------------|-------------------------------|
| Permissible deflection                                             | $\delta_{\text{adm}} = 7.500 \text{ mm}$ | Total deflection | $\delta_a = 2.968 \text{ mm}$ |
| <b>PASS - Total deflection is less than permissible deflection</b> |                                          |                  |                               |