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13 Clifton Vale,
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BS8 4PT

Project Summary

Site address: 231 Seafield Road, Bournemouth BH6 5LL
Job: Side Two Storey Extension / Loft
Client: Baya Architects
Job number: A01

ITEMS:

1: OLE object: Paint.Picture *

2: OLE object: Paint.Picture *

3: OLE object: Paint.Picture *

4: OLE object: Paint.Picture *

5: Beam: Pitch Roof Rafters @ 400 c/c
Span: 3.25 m.
Reactions (unfactored/factored): R1: 1.90/1.90 kN; R2: 1.90/1.90 kN Use 50 x 175 C24
Double up around roof light

6: Beam: Small Dormer Pitch Roof Rafters @ 400 c/c
Span: 0.84 m.
Reactions (unfactored/factored): R1: 0.49/0.49 kN; R2: 0.49/0.49 kN Use 50 x 100 C24

7: Beam: Stair Trim 1
Span: 2.18 m.
Reactions (unfactored/factored): R1: 3.20/3.20 kN; R2: 2.86/2.86 kN Use 2no 50 x 150 C24
Use 12mm dia. bolts @ 450mm c/c + connectors.

8: Beam: Stair Trim 2 (Each End)
Span: 3.68 m.
Reactions (unfactored/factored): R1: 1.40/1.40 kN; R2: 2.17/2.17 kN
Use 3no 50 x 150 C24
Use 12mm dia. bolts @ 450mm c/c + connectors.

9: Beam: Loft Floor Joists @ 400 c/c
Span: 3.215 m.
Reactions (unfactored/factored): R1: 1.29/1.29 kN; R2: 1.29/1.29 kN
Use 50 x 150 C24

10: Beam: First Floor Joists @ 400 c/c
Span: 3.215 m.
Reactions (unfactored/factored): R1: 1.29/1.29 kN; R2: 1.29/1.29 kN
Use 50 x 150 C24

11: Beam: BM1 Cross Beam Lintel
Span: 2.42 m.
Reactions (unfactored/factored): R1: 20.66/20.66 kN; R2: 20.66/20.66 kN Use 203 x 203 x 46 UC S355
Bearing R1: 8 mm m.s. bearing plate, size 204 x 250 mm
Bearing R2: As R1
5mm steel plate fillet welded to top flange full length and width if brick wall has a cavity.

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12: Beam: BM2 Cross Beam Lintel
Span: 2.73 m.
Reactions (unfactored/factored): R1: 23.30/23.30 kN; R2: 23.30/23.30 kN Use 203 x 203 x 46 UC S355
Bearing R1: 8 mm m.s. bearing plate, size 204 x 250 mm
Bearing R2: As R1
5mm steel plate fillet welded to top flange full length and width if brick wall has a cavity.

13: Beam: BM3 Cross Beam
Span: 3.315 m.
Reactions (unfactored/factored): R1: 34.04/34.04 kN; R2: 34.04/34.04 kN Use 203 x 203 x 46 UC S355
Bearing R1: 10 mm m.s. bearing plate, size 204 x 250 mm
Bearing R2: As R1
5mm steel plate fillet welded to top flange full length and width if brick wall has a cavity.

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NEW TIMBER TRUSS DESIGN INFORMATION

TIMBER TRUSSES @ 400 c/c – 35° PITCH

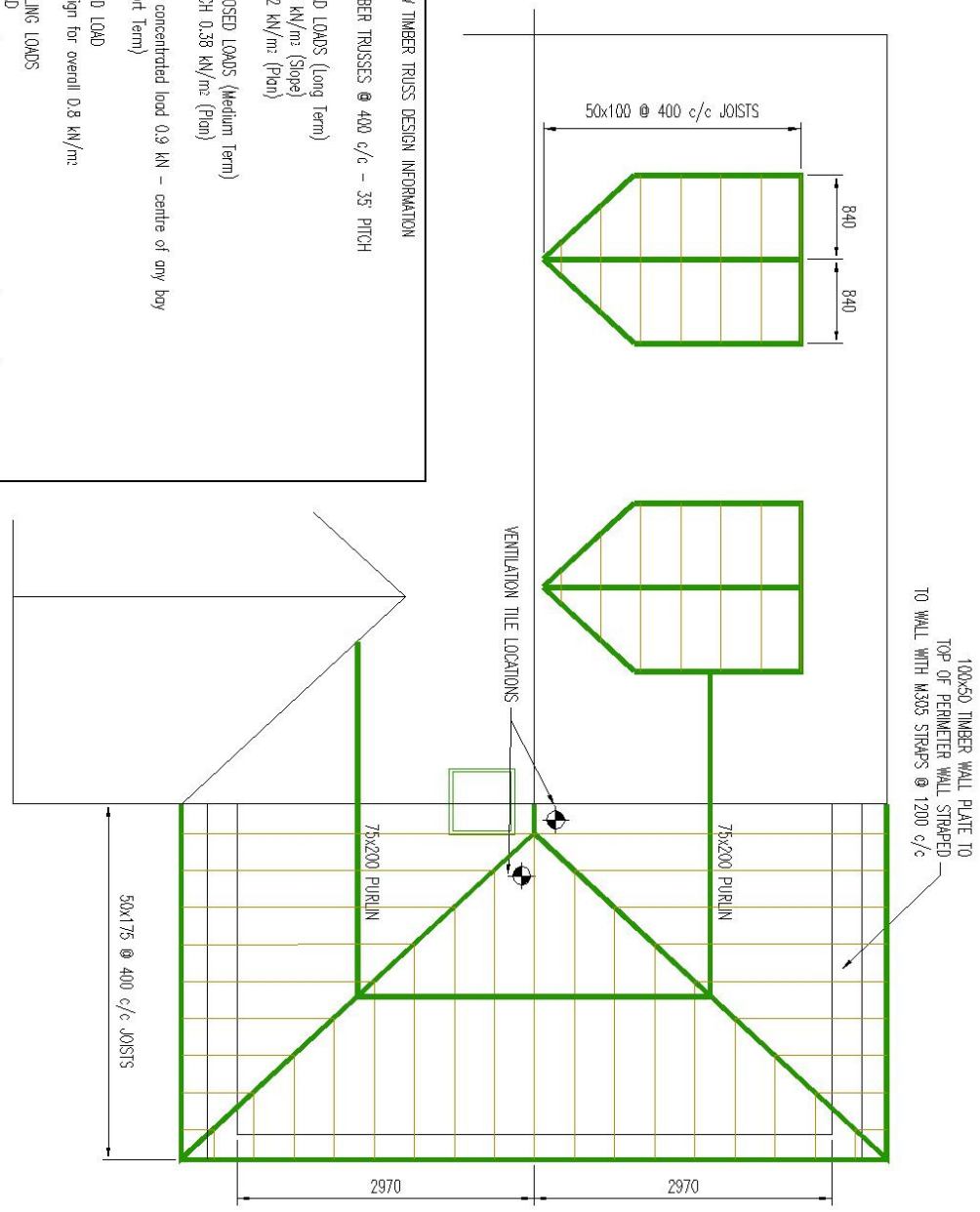
DEAD LOADS (Long Term)
0.5 kN/m² (Slope)
0.92 kN/m² (Plan)

IMPOSED LOADS (Medium Term)
PITCH 0.38 kN/m² (Plan)

(or concentrated load 0.9 kN – centre of any bay
Short Term)

WIND LOAD
Design for overall 0.8 kN/m²

CEILING LOADS
DEAD
0.25 kN/m² UDL For full length of ceiling tie (Long Term)
Plus
2 x 0.45 kN Concentrated load for water tank or actual load if greater.
IMPOSED
0.25 kN/m² UDL For full length (Long Term) for storage loading.
Or
0.9 kN Concentrated load at centre or either end of any bay (Short Term).



Roof Plan

SCALE 1/50

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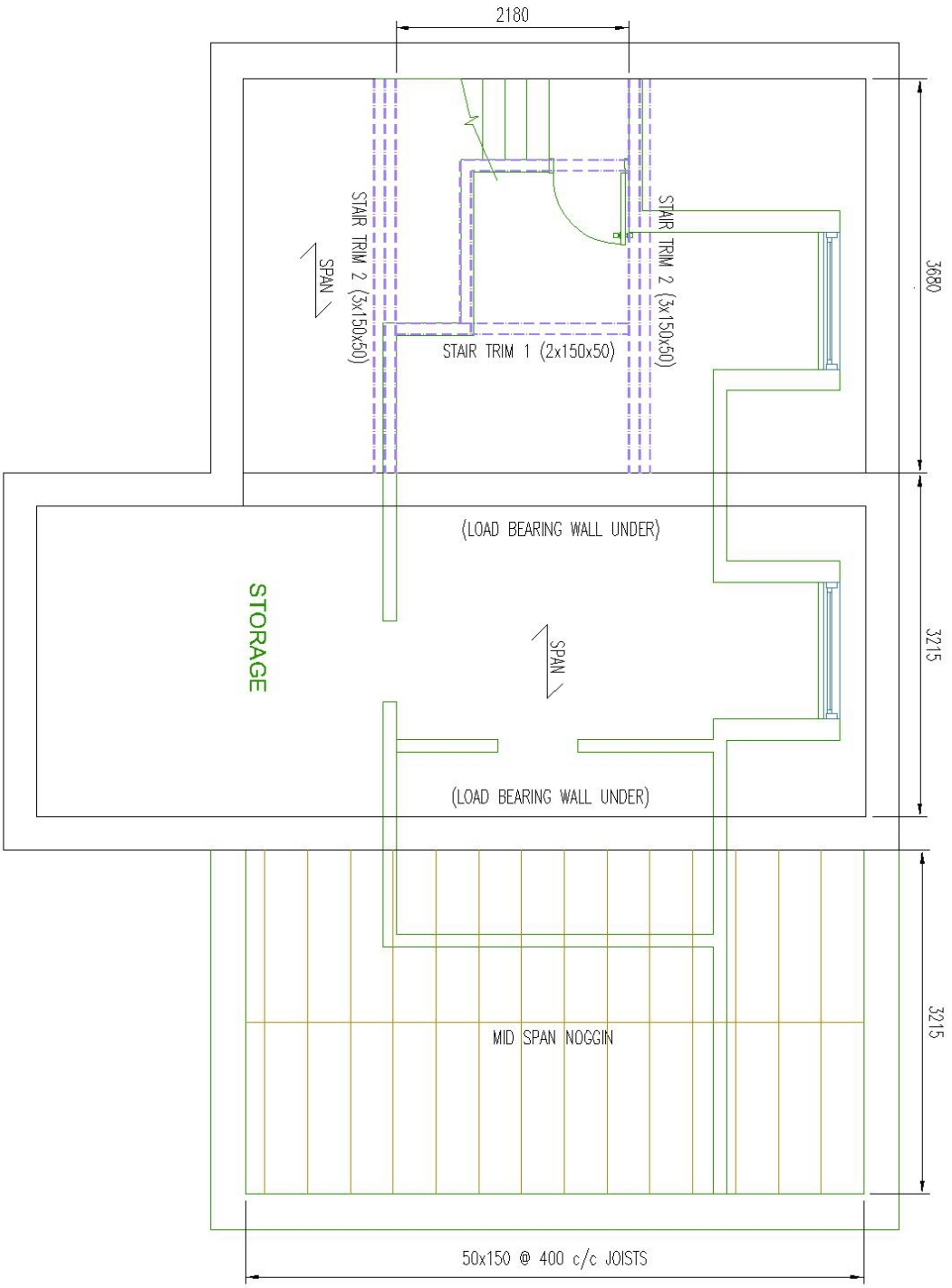
Loft Floor Plan

SCALE 1/50



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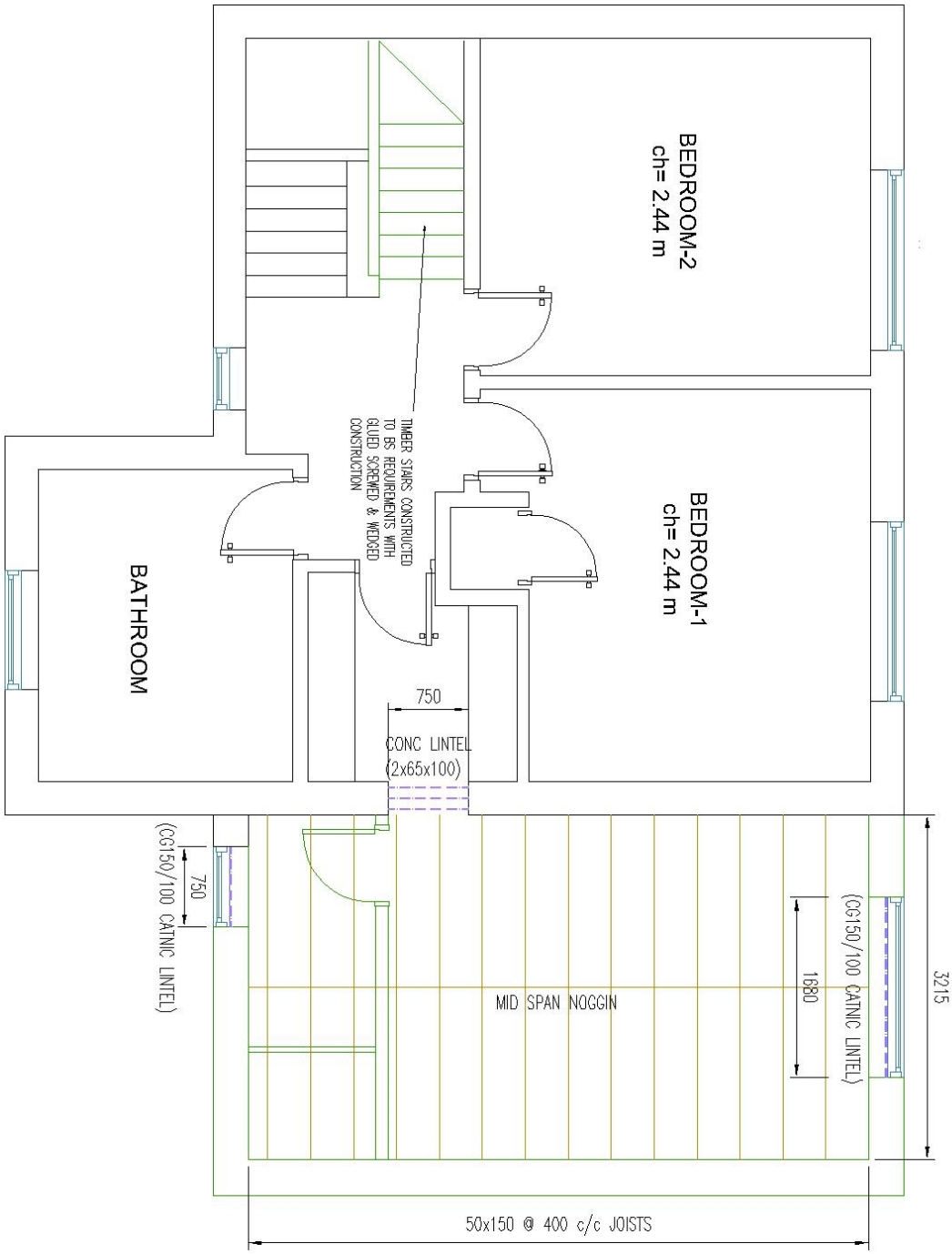
First Floor Plan

SCALE 1/50



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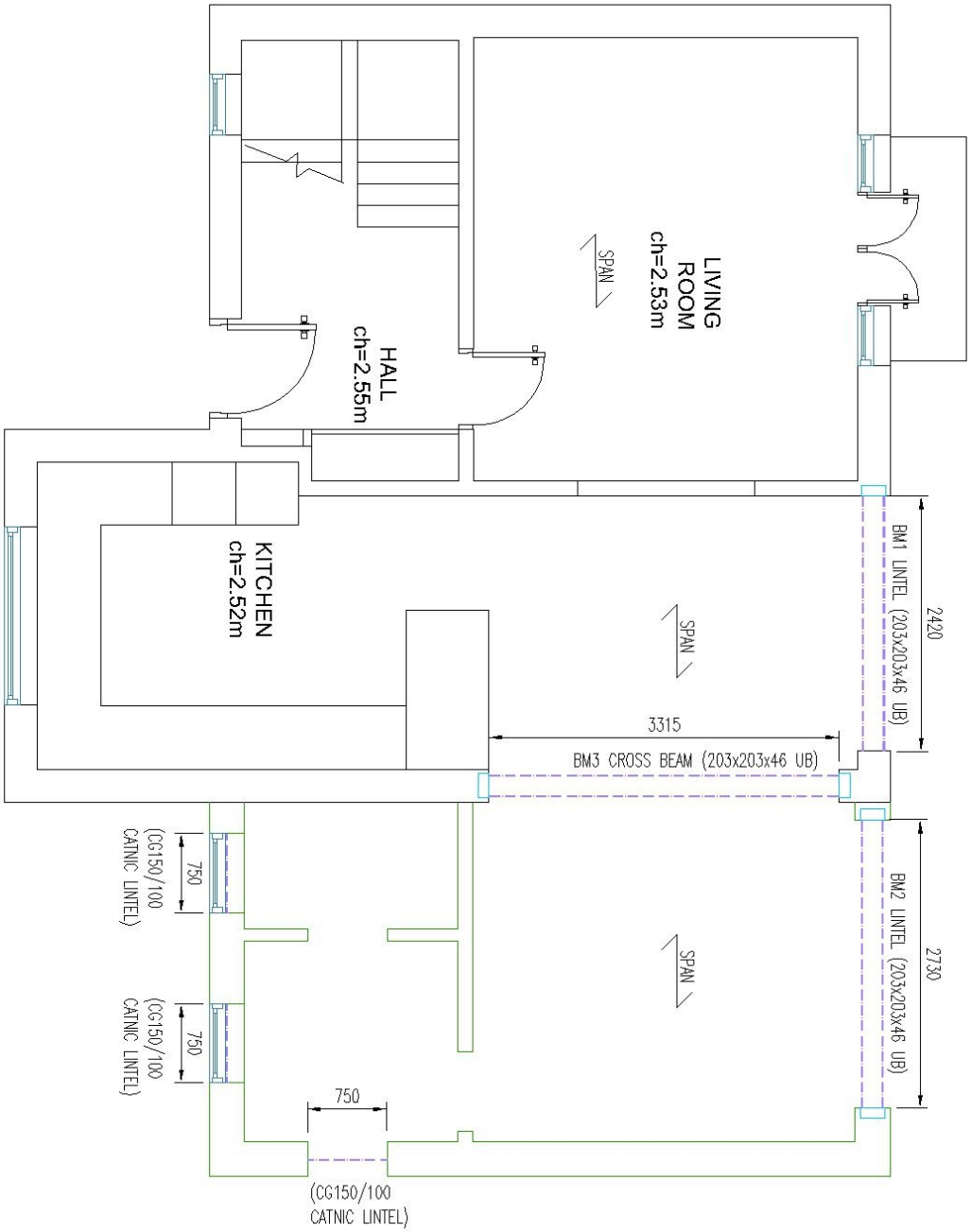
Ground Floor Plan

SCALE 1/50



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Beam: Pitch Roof Rafters @ 400 c/c **Span: 3.25 m.**

	Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*	*Defl.*
O D	o.w.	0.6	0		L	0.98	0.98	0.87
U L	Pitch roof Live	0.5*0.4	0		L	0.33	0.33	0.29
U D	Pitch Roof	0.92*0.4	0		L	0.60	0.60	0.53
	Dead			Total load (unfactored):	**3.80 kN**	**1.90**	**1.90**	1.70
				Dead/Permanent (unfactored):	3.15 kN	1.57	1.57	1.41
				Live/Variable (unfactored):	0.65 kN	0.33	0.33	0.29

Load types: O:Beam o.w.; U:UDL; Load positions: m. from R1; Load durations: D: Dead; L: Live

Maximum B.M. = 1.54 kNm (unfactored) at 1.63 m. from R1

Maximum S.F. = 1.90 kN (unfactored) at R1

Mid-span deflections: Dead: 1.41 x 10^8/EI *(E in N/mm², I in cm⁴)*

Live: 0.29 x 10^8/EI

Total: 1.70 x 10^8/EI

Timber beam calculation to BS5268 Part 2: 2002 using C24 timber

Use 50 x 175 C24 *3.7 kg/m approx*

z = 255 cm^3 I = 2,233 cm^4

Timber grade: C24 4 members acting together: K_8 = 1.1 [§2.9]

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

K_7 (depth factor) = $(300/175)^{0.11}$ = 1.06 [§2.10.6] K_8 (load sharing factor) = 1.1 [§2.9,2.10]

E = 7,200 x 1.24 = 8,928 N/mm^2 ($E_{min}.K_9$)

Bending

Permissible bending stress, $s_{m,adm} = s_{m,g}.K_3.K_7.K_8$ = 7.5 x 1.00 x 1.06 x 1.1 = 8.75 N/mm^2

Applied bending stress, $s_{m,a}$ = 1.54 x 1000/255 = 6.04 N/mm^2 OK

Shear

Permissible shear stress, $t_{adm,//} = t_{g,//}.K_3.K_8$ = 0.71 x 1.00 x 1.1 = 0.78 N/mm^2

Applied shear stress, t_a = 1.90 x 1000 x 3/(2 x 50 x 175) = 0.33 N/mm^2 OK

Deflection

Bending deflection = 1.70 x 10^8/(8,928 x 2,233) = 8.5 mm

Mid-span shear deflection = 1.2M_0/GA (G=E/16) = 1.2 x 1.54 x 10^6/((8928/16) x 50 x 175) = 0.4 mm Total deflection = 8.5 + 0.4 = 8.9 mm (0.0027 L) <= 0.003L OK

Double up around roof light

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Beam: Small Dormer Pitch Roof Rafters @ 400 c/c **Span: 0.84 m.**

	Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*	*Defl.*
O D	o.w.	0.6	0		L	0.25	0.25	0.004
U L	Pitch roof Live	0.5*0.4	0		L	0.08	0.08	0.001
U D	Pitch Roof Dead	0.92*0.4	0		L	0.15	0.15	0.002
				Total load (unfactored):	**0.98 kN**	**0.49**	**0.49**	0.008
				Dead/Permanent (unfactored):	0.81 kN	0.41	0.41	0.006
				Live/Variable (unfactored):	0.17 kN	0.08	0.08	0.001

Load types: O:Beam o.w.; U:UDL; Load positions: m. from R1; Load durations: D: Dead; L: Live

Maximum B.M. = 0.103 kNm (unfactored) at 0.42 m. from R1

Maximum S.F. = 0.491 kN (unfactored) at R1

Mid-span deflections: Dead: $0.006 \times 10^8/EI$ *(E in N/mm², I in cm⁴)*

Live: $0.001 \times 10^8/EI$

Total: $0.008 \times 10^8/EI$

Timber beam calculation to BS5268 Part 2: 2002 using C24 timber

Use 50 x 100 C24 *2.1 kg/m approx*

$z = 83.3\ cm^3$ $I = 417\ cm^4$

Timber grade: C24 4 members acting together: $K_8 = 1.1$ [§2.9]

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

K_7 (depth factor) = $(300/100)^{0.11} = 1.13$ [§2.10.6] K_8 (load sharing factor) = 1.1 [§2.9,2.10]

$E = 7{,}200 \times 1.24 = 8{,}928\ N/mm^2$ ($E_{min}.K_9$)

Bending

Permissible bending stress, $s_{m,adm} = s_{m,g}.K_3.K_7.K_8 = 7.5 \times 1.00 \times 1.13 \times 1.1 = 9.31\ N/mm^2$

Applied bending stress, $s_{m,a} = 0.103 \times 1000/83.3 = 1.24\ N/mm^2$ OK

Shear

Permissible shear stress, $t_{adm,//} = t_{g,//}.K_3.K_8 = 0.71 \times 1.00 \times 1.1 = 0.78\ N/mm^2$

Applied shear stress, $t_a = 0.491 \times 1000 \times 3/(2 \times 50 \times 100) = 0.15\ N/mm^2$ OK

Deflection

Bending deflection $= 0.008 \times 10^8/(8{,}928 \times 417) = 0.2$ mm

Mid-span shear deflection $= 1.2M_0/GA$ (G=E/16) $= 1.2 \times 0.103 \times 10^6/((8928/16) \times 50 \times 100) = 0.0$ mm Total deflection $= 0.2 + 0.0 = 0.2$ mm (0.0003 L) <= 0.003L OK

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Beam: Stair Trim 1 **Span: 2.18 m.**

	Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*	*Defl.*
O D	o.w.	0.1	0		L	0.11	0.11	0.03
U L	Floor live	1.5*2.8/2	0		L	2.29	2.29	0.62
U D	Floor dead	0.25*2.8/2	0		L	0.38	0.38	0.10
R D	Stud partition	0.4*1.8	0		0.7	0.42	0.08	0.05
				Total load (unfactored):	**6.06**	**3.20**	**2.86**	0.80
				Dead/Permanent (unfactored):	1.49 kN	0.91	0.57	0.18
				Live/Variable (unfactored):	4.58 kN	2.29	2.29	0.62

Load types: O:Beam o.w.; U:UDL; R:Part UDL; Load positions: m. from R1
Load durations: D: Dead; L: Live

Maximum B.M. = 1.60 kNm (unfactored) at 1.05 m. from R1

Maximum S.F. = 3.20 kN (unfactored) at R1

Mid-span deflections: Dead: 0.18 x 10^8/EI *(E in N/mm², I in cm⁴)*
Live: 0.62 x 10^8/EI
Total: 0.80 x 10^8/EI

Timber beam calculation to BS5268 Part 2: 2002 using C24 timber

Use 2no 50 x 150 C24 *6.3 kg/m approx*

z = 375 cm^3 I = 2,813 cm^4

Timber grade: C24 2 members acting together: K_8 = 1.1 [§2.9]

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

K_7 (depth factor) = $(300/150)^{0.11}$ = 1.08 [§2.10.6] K_8 (load sharing factor) = 1.1 [§2.9,2.10]

E = 7,200 x 1.14 = 8,208 N/mm^2 ($E_{min}.K_9$)

Bending

Permissible bending stress, $s_{m,adm} = s_{m,g}.K_3.K_7.K_8$ = 7.5 x 1.00 x 1.08 x 1.1 = 8.90 N/mm^2

Applied bending stress, $s_{m,a}$ = 1.60 x 1000/375 = 4.28 N/mm^2 OK

Shear

Permissible shear stress, $t_{adm,//} = t_{g,//}.K_3.K_8$ = 0.71 x 1.00 x 1.1 = 0.78 N/mm^2

Applied shear stress, t_a = 3.20 x 1000 x 3/(2 x 100 x 150) = 0.32 N/mm^2 OK

Deflection

Bending deflection = 0.799 x 10^8/(8,208 x 2,813) = 3.5 mm

Mid-span shear deflection = $1.2M_O/GA$ (G=E/16) = 1.2 x 1.60 x 10^6/((8208/16) x 100 x 150) = 0.2 mm Total deflection = 3.5 + 0.2 = 3.7 mm (0.0017 L) <= 0.003L OK

Use 12mm dia. bolts @ 450mm c/c + connectors.

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Beam: **Stair Trim 2 (Each End)** **Span: 3.68 m.**

	Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*	*Defl.*
O D	o.w.	0.1	0		L	0.18	0.18	0.24
P D	Beam: Stair Trim 1 : R1	0.91 [B/F]	2.28			0.35	0.57	0.87
P L	Beam: Stair Trim 1 : R1	2.29 [B/F]	2.28			0.87	1.42	2.19
			Total load (unfactored):		**3.57 kN**	**1.40**	**2.17**	3.30
			Dead/Permanent (unfactored):		1.28 kN	0.53	0.75	1.11
			Live/Variable (unfactored):		2.29 kN	0.87	1.42	2.19

Load types: O:Beam o.w.; P:Point load; Load positions: m. from R1
Load durations: D: Dead; L: Live

Maximum B.M. = 2.94 kNm (unfactored) at 2.28 m. from R1

Maximum S.F. = -2.17 kN (unfactored) at R2

Mid-span deflections: Dead: 1.11 x 10^8/EI *(E in N/mm², I in cm⁴)*
Live: 2.19 x 10^8/EI
Total: 3.30 x 10^8/EI

Timber beam calculation to BS5268 Part 2: 2002 using C24 timber

Use 3no 50 x 150 C24 *9.4 kg/m approx*

z = 563 cm^3 I = 4,219 cm^4

Timber grade: C24 3 members acting together: K_8 = 1.1 [§2.9]

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

K_7 (depth factor) = $(300/150)^{0.11}$ = 1.08 [§2.10.6] K_8 (load sharing factor) = 1.1 [§2.9,2.10]

E = 7,200 x 1.21 = 8,712 N/mm^2 ($E_{min}.K_9$)

Bending

Permissible bending stress, $s_{m,adm} = s_{m,g}.K_3.K_7.K_8$ = 7.5 x 1.00 x 1.08 x 1.1 = 8.90 N/mm^2

Applied bending stress, $s_{m,a}$ = 2.94 x 1000/563 = 5.22 N/mm^2 OK

Shear

Permissible shear stress, $t_{adm,//} = t_{g,//}.K_3.K_8$ = 0.71 x 1.00 x 1.1 = 0.78 N/mm^2

Applied shear stress, t_a = 2.17 x 1000 x 3/(2 x 150 x 150) = 0.14 N/mm^2 OK

Deflection

Bending deflection = 3.30 x 10^8/(8,712 x 4,219) = 9.0 mm

Mid-span shear deflection = $1.2M_0$/GA (G=E/16) = 1.2 x 2.41 x 10^6/((8712/16) x 150 x 150) = 0.2 mm

Total deflection = 9.0 + 0.2 = 9.2 mm (0.0025 L) <= 0.003L OK

Use 12mm dia. bolts @ 450mm c/c + connectors.

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Beam: Loft Floor Joists @ 400 c/c **Span: 3.215 m.**

	Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*	*Defl.*
O D	o.w. Floor	0.1	0		L	0.16	0.16	0.14
U L	live Floor	1.5*0.4	0		L	0.96	0.96	0.83
U D	dead	0.25*0.4	0		L	0.16	0.16	0.14
				Total load (unfactored):	**2.57 kN**	**1.29**	**1.29**	1.11
				Dead/Permanent (unfactored):	0.64 kN	0.32	0.32	0.28
				Live/Variable (unfactored):	1.93 kN	0.96	0.96	0.83

Load types: O:Beam o.w; U:UDL; Load positions: m. from R1; Load durations: D: Dead; L: Live

Maximum B.M. = 1.03 kNm (unfactored) at 1.61 m. from R1

Maximum S.F. = 1.29 kN (unfactored) at R1

Mid-span deflections: Dead: 0.28 x 10^8/EI *(E in N/mm², I in cm⁴)*

Live: 0.83 x 10^8/EI

Total: 1.11 x 10^8/EI

Timber beam calculation to BS5268 Part 2: 2002 using C24 timber

Use 50 x 150 C24 *3.2 kg/m approx*

z = 188 cm^3 I = 1,406 cm^4

Timber grade: C24 4 members acting together: K_8 = 1.1 [§2.9]

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

K_7 (depth factor) = $(300/150)^{0.11}$ = 1.08 [§2.10.6] K_8 (load sharing factor) = 1.1 [§2.9,2.10]

E = 7,200 x 1.24 = 8,928 N/mm^2 ($E_{min}.K_9$)

Bending

Permissible bending stress, $s_{m,adm} = s_{m,g}.K_3.K_7.K_8$ = 7.5 x 1.00 x 1.08 x 1.1 = 8.90 N/mm^2

Applied bending stress, $s_{m,a}$ = 1.03 x 1000/188 = 5.51 N/mm^2 OK

Shear

Permissible shear stress, $t_{adm,//} = t_{g,//}.K_3.K_8$ = 0.71 x 1.00 x 1.1 = 0.78 N/mm^2

Applied shear stress, t_a = 1.29 x 1000 x 3/(2 x 50 x 150) = 0.26 N/mm^2 OK

Deflection

Bending deflection = 1.11 x 10^8/(8,928 x 1,406) = 8.9 mm

Mid-span shear deflection = 1.2M_0/GA (G=E/16) = 1.2 x 1.03 x 10^6/((8928/16) x 50 x 150) = 0.3 mm Total deflection = 8.9 + 0.3 = 9.2 mm (0.0028 L) <= 0.003L OK

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Beam: First Floor Joists @ 400 c/c **Span: 3.215 m.**

	Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*	*Defl.*
O D	o.w. Floor	0.1	0		L	0.16	0.16	0.14
U L	live Floor	1.5*0.4	0		L	0.96	0.96	0.83
U D	dead	0.25*0.4	0		L	0.16	0.16	0.14
				Total load (unfactored):	**2.57 kN**	**1.29**	**1.29**	1.11
				Dead/Permanent (unfactored):	0.64 kN	0.32	0.32	0.28
				Live/Variable (unfactored):	1.93 kN	0.96	0.96	0.83

Load types: O:Beam o.w; U:UDL; Load positions: m. from R1; Load durations: D: Dead; L: Live

Maximum B.M. = 1.03 kNm (unfactored) at 1.61 m. from R1

Maximum S.F. = 1.29 kN (unfactored) at R1

Mid-span deflections: Dead: 0.28 x 10^8/EI *(E in N/mm², I in cm⁴)*

Live: 0.83 x 10^8/EI

Total: 1.11 x 10^8/EI

Timber beam calculation to BS5268 Part 2: 2002 using C24 timber

Use 50 x 150 C24 *3.2 kg/m approx*

z = 188 cm^3 I = 1,406 cm^4

Timber grade: C24 4 members acting together: K_8 = 1.1 [§2.9]

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

K_7 (depth factor) = $(300/150)^{0.11}$ = 1.08 [§2.10.6] K_8 (load sharing factor) = 1.1 [§2.9,2.10]

E = 7,200 x 1.24 = 8,928 N/mm^2 ($E_{min}.K_9$)

Bending

Permissible bending stress, $s_{m,adm} = s_{m,g}.K_3.K_7.K_8$ = 7.5 x 1.00 x 1.08 x 1.1 = 8.90 N/mm^2

Applied bending stress, $s_{m,a}$ = 1.03 x 1000/188 = 5.51 N/mm^2 OK

Shear

Permissible shear stress, $t_{adm,//} = t_{g,//}.K_3.K_8$ = 0.71 x 1.00 x 1.1 = 0.78 N/mm^2

Applied shear stress, t_a = 1.29 x 1000 x 3/(2 x 50 x 150) = 0.26 N/mm^2 OK

Deflection

Bending deflection = 1.11 x 10^8/(8,928 x 1,406) = 8.9 mm

Mid-span shear deflection = 1.2M_0/GA (G=E/16) = 1.2 x 1.03 x 10^6/((8928/16) x 50 x 150) = 0.3 mm Total deflection = 8.9 + 0.3 = 9.2 mm (0.0028 L) <= 0.003L OK

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Beam: BM1 Cross Beam Lintel **Span: 2.42 m.**

	Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*	*Defl.*
O D	o.w.	0.5	0		L	0.61	0.61	0.22
U D	Cavity wall	5.5*2.6	0		L	17.30	17.30	6.39
U L	Pitch roof Live	0.5*3.2/2	0		L	0.97	0.97	0.36
U D	Pitch Roof	0.92*3.2/2	0		L	1.78	1.78	0.66
	Dead			Total load (unfactored):	**41.31 kN**	**20.66**	**20.66**	7.62
				Dead/Permanent (unfactored):	39.38 kN	19.69	19.69	7.27
				Live/Variable (unfactored):	1.94 kN	0.97	0.97	0.36

Load types: O:Beam o.w; U:UDL; Load positions: m. from R1; Load durations: D: Dead; L: Live

Maximum B.M. = 12.50 kNm (unfactored) at 1.21 m. from R1

Maximum S.F. = 20.66 kN (unfactored) at R1

Mid-span deflections: Dead: $7.27 \times 10^8/EI$ *(E in N/mm², I in cm⁴)*
Live: $0.36 \times 10^8/EI$
Total: $7.62 \times 10^8/EI$

Steel beam calculation to BS449 Part 2 using S355 steel

SECTION SIZE : 203 x 203 x 46 UC S355

D=203.2 mm B=203.6 mm t=7.2 mm T=11.0 mm I_x=4,570 cm^4 r_y=5.13 cm Z_x=450 cm^3

Bending

$L_E/r_y = 2.42 \times 100/5.13 = 47$ D/T = 18.5

Permissible bending stress, p_{bc} = 230 N/mm² (Table 3b)

Actual bending stress, $f_{bc} = 12.50 \times 1000/450 = 27.8$ N/mm² OK

Shear

Permissible shear stress, p_s = 140 N/mm² [Table 11]

Maximum shear in web, $f_s = 20.66 \times 1000/(7.2 \times 203.2) = 14.1$ N/mm² OK

Beam web

Check unstiffened web capacity with load of 20.66 kN [28.a]

Bearing: p_b = 260N/mm² (Table 9); C1 = 68.7 kN [27.e] C2 = 1.87 kN/mm
Buckling: p_c = 194N/mm² (Table 17b); C1 = 142 kN; C2 = 1.40 kN/mm

Minimum required stiff bearing length, L_b = 0mm
Bearing capacity, $P_w = C1 + L_b.C2$ = 68.7kN ¬ OK
Buckling capacity, $P_x = C1 + L_b.C2$ = 142kN

Deflection

Live load deflection = 0.357 x 1e8/(205,000 x 4,570) = 0.0 mm OK

Total deflection = 7.62 x 1e8/(205,000 x 4,570) = 0.8 mm (L/2974)

Combined bending and shear check (14.c)

Check $(f_{bc}/p_{bc})^2 + (f_s/p_s)^2 = 0.015 + 0.000 = 0.015$ at 1.21 (<=1.25 OK) [14.c]

Bearings

(bearing plate sizing is to BS5950-1:2000)

203 x 203 x 46 UC stiff bearing length, $b_1 = t + 1.6r + 2T$ = 45.5 mm

Masonry: 7N/mm² brick, class (iv) mortar, normal const/normal mfr, Class 2

bearing Local design strength (factored) = 2.44 x 1.5/3.5 = 1.05N/mm²

(BS5628-1:2005 Table 2a)

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R1: 204 x 250 x 8 mm S275 bearing plate

Factored reaction = 1.4 x 19.69 + 1.6 x 0.97 = 29.1 kN

Factored stress under plate = 29.1 x 1000/204 x 250 = 0.57 N/mm^2 OK

Bearing plate projection beyond stiff bearing length = (204-45.5)/2 = 79.2mm
Required plate thickness = $\sqrt{}$ (3 x 0.57 x 79.2 x 79.2/275) = 6.25 mm: use 8mm
Factored bending stress in plate = 0.57 x 79.2 x (79.2/2)/(8 x 8/6) = 168 N/mm^2 (p_y=275 N/mm^2)

R2 as R1

5mm steel plate fillet welded to top flange full length and width if brick wall has a cavity.

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Beam: BM2 Cross Beam Lintel **Span: 2.73 m.**

	Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*	*Defl.*
O D	o.w.	0.5	0		L	0.68	0.68	0.36
U D	Cavity wall	5.5*2.6	0		L	19.52	19.52	10.34
U L	Pitch roof Live	0.5*3.2/2	0		L	1.09	1.09	0.58
U D	Pitch Roof	0.92*3.2/2	0		L	2.01	2.01	1.06
	Dead			Total load (unfactored):	**46.61 kN**	**23.30**	**23.30**	12.35
				Dead/Permanent (unfactored):	44.42 kN	22.21	22.21	11.77
				Live/Variable (unfactored):	2.18 kN	1.09	1.09	0.58

Load types: O:Beam o.w.; U:UDL; Load positions: m. from R1; Load durations: D: Dead; L: Live

Maximum B.M. = 15.90 kNm (unfactored) at 1.37 m. from R1

Maximum S.F. = 23.30 kN (unfactored) at R1

Mid-span deflections: Dead: 11.77 x 10^8/EI *(E in N/mm², I in cm⁴)*
Live: 0.58 x 10^8/EI
Total: 12.35 x 10^8/EI

Steel beam calculation to BS449 Part 2 using S355 steel

SECTION SIZE : 203 x 203 x 46 UC S355

D=203.2 mm B=203.6 mm t=7.2 mm T=11.0 mm I_x=4,570 cm^4 r_y=5.13 cm Z_x=450 cm^3

Bending

L_E/r_y = 2.73 x 100/5.13 = 53 D/T = 18.5

Permissible bending stress, p_{bc} = 228 N/mm² (Table 3b)

Actual bending stress, f_{bc} = 15.90 x 1000/450 = 35.3 N/mm² OK

Shear

Permissible shear stress, p_s = 140 N/mm² [Table 11]

Maximum shear in web, f_s = 23.30 x 1000/(7.2 x 203.2) = 15.9 N/mm² OK

Beam web

Check unstiffened web capacity with load of 23.30 kN [28.a]

Bearing: p_b = 260N/mm² (Table 9); C1 = 68.7 kN [27.e] C2 = 1.87 kN/mm
Buckling: p_c = 194N/mm² (Table 17b); C1 = 142 kN; C2 = 1.40 kN/mm

Minimum required stiff bearing length, L_b = 0mm
Bearing capacity, P_w = C1 + L_b.C2 = 68.7kN ¬ OK
Buckling capacity, P_x = C1 + L_b.C2 = 142kN

Deflection

Live load deflection = 0.579 x 1e8/(205,000 x 4,570) = 0.1 mm OK

Total deflection = 12.3 x 1e8/(205,000 x 4,570) = 1.3 mm (L/2071)

Combined bending and shear check (14.c)

Check $(f_{bc}/p_{bc})^2 + (f_s/p_s)^2$ = 0.024 + 0.000 = 0.024 at 1.37 (<=1.25 OK) [14.c]

Bearings

(bearing plate sizing is to BS5950-1:2000)

203 x 203 x 46 UC stiff bearing length, b_1 = t + 1.6r + 2T = 45.5 mm

Masonry: 7N/mm² brick, class (iv) mortar, normal const/normal mfr, Class 2

bearing Local design strength (factored) = 2.44 x 1.5/3.5 = 1.05N/mm²

(BS5628-1:2005 Table 2a)

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R1: 204 x 250 x 8 mm S275 bearing plate

Factored reaction = 1.4 x 22.21 + 1.6 x 1.09 = 32.8 kN

Factored stress under plate = 32.8 x 1000/204 x 250 = 0.64 N/mm^2 OK

Bearing plate projection beyond stiff bearing length = (204-45.5)/2 = 79.2mm
Required plate thickness = $\sqrt{}$ (3 x 0.64 x 79.2 x 79.2/275) = 6.64 mm: use 8mm
Factored bending stress in plate = 0.64 x 79.2 x (79.2/2)/(8 x 8/6) = 190 N/mm^2 (p_y=275 N/mm^2)

R2 as R1

5mm steel plate fillet welded to top flange full length and width if brick wall has a cavity.

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Beam: BM3 Cross Beam **Span: 3.315 m.**

	Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*	*Defl.*
O D	o.w.	0.9	0		L	1.49	1.49	1.4
U D	Cavity	5.5*2.6	0		L	23.70	23.70	22.5
U L	wall Floor	1.5*6.1/2	0		L	7.58	7.58	7.2
U D	live Floor	0.25*6.1/2	0		L	1.26	1.26	1.2
	dead			Total load (unfactored):	**68.1 kN**	**34.04**	**34.04**	32.3
				Dead/Permanent (unfactored):	52.9 kN	26.46	26.46	25.1
				Live/Variable (unfactored):	15.2 kN	7.58	7.58	7.2

Load types: O:Beam o.w; U:UDL; Load positions: m. from R1; Load durations: D: Dead; L: Live

Maximum B.M. = 28.21 kNm (unfactored) at 1.66 m. from R1

Maximum S.F. = 34.0 kN (unfactored) at R1

Mid-span deflections: Dead: 25.1 x 10^8/EI *(E in N/mm², I in cm⁴)*
Live: 7.2 x 10^8/EI
Total: 32.3 x 10^8/EI

Steel beam calculation to BS449 Part 2 using S355 steel

SECTION SIZE : 203 x 203 x 46 UC S355

D=203.2 mm B=203.6 mm t=7.2 mm T=11.0 mm I_x=4,570 cm^4 r_y=5.13 cm Z_x=450 cm^3

Bending

L_E/r_y = 3.32 x 100/5.13 = 65 D/T = 18.5

Permissible bending stress, p_{bc} = 213 N/mm² (Table 3b)

Actual bending stress, f_{bc} = 28.2 x 1000/450 = 62.7 N/mm² OK

Shear

Permissible shear stress, p_s = 140 N/mm² [Table 11]

Maximum shear in web, f_s = 34.0 x 1000/(7.2 x 203.2) = 23.3 N/mm² OK

Beam web

Check unstiffened web capacity with load of 34.0 kN [28.a]

Bearing: p_b = 260N/mm² (Table 9); C1 = 68.7 kN [27.e] C2 = 1.87 kN/mm
Buckling: p_c = 194N/mm² (Table 17b); C1 = 142 kN; C2 = 1.40 kN/mm

Minimum required stiff bearing length, L_b = 0mm
Bearing capacity, P_w = C1 + L_b.C2 = 68.7kN ¬ OK
Buckling capacity, P_x = C1 + L_b.C2 = 142kN

Deflection

Live load deflection = 7.19 x 1e8/(205,000 x 4,570) = 0.8 mm (L/4319) OK

Total deflection = 32.3 x 1e8/(205,000 x 4,570) = 3.4 mm (L/962)

Combined bending and shear check (14.c)

Check $(f_{bc}/p_{bc})^2 + (f_s/p_s)^2$ = 0.087 + 0.000 = 0.087 at 1.66 (<=1.25 OK) [14.c]

Bearings

(bearing plate sizing is to BS5950-1:2000)

203 x 203 x 46 UC stiff bearing length, b_1 = t + 1.6r + 2T = 45.5 mm

Masonry: 7N/mm² brick, class (iv) mortar, normal const/normal mfr, Class 2

bearing Local design strength (factored) = 2.44 x 1.5/3.5 = 1.05N/mm²

(BS5628-1:2005 Table 2a)

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R1: 204 x 250 x 10 mm S275 bearing plate

Factored reaction = 1.4 x 26.46 + 1.6 x 7.58 = 49.2 kN

Factored stress under plate = 49.2 x 1000/204 x 250 = 0.96 N/mm^2 OK

Bearing plate projection beyond stiff bearing length = (204-45.5)/2 = 79.2mm
Required plate thickness = $\sqrt{}$(3 x 0.96 x 79.2 x 79.2/275) = 8.13 mm: use 10mm
Factored bending stress in plate = 0.96 x 79.2 x (79.2/2)/(10 x 10/6) = 182 N/mm^2 (p_y=275 N/mm^2)

R2 as R1

5mm steel plate fillet welded to top flange full length and width if brick wall has a cavity.