BH & B Consultants Ltd
Consulting Engineers
e-mail: ruchik_dave@hotmail.com Mob: 078 9752 7917

Job	16, Cumbrian Gardens		
Author	**Date**	**Revision**	**Sheet No.**
	26/10/2019		1

Ref	Calculations	Output

BS 6399

Derivation of member loadings

Flat Roof

Stone chips and bitumen	0.20 kN/m²
Three layers of felt	0.10 kN/m²
Decking	0.10 kN/m²
Joists	0.15 kN/m²
Finishes & Insulation	0.20 kN/m²
Imposed load due to snow	0.75 kN/m²
	1.50 kN/m²

Pitched Roof

Tiles	0.70 kN/m²
Rafters+battens+insulation	0.20 kN/m²
	0.90
above on plan = 0.9/Cos35 =	1.10 kN/m²
Plaster board + skim	0.20 kN/m²
Imposed load on pitched roof	0.70 kN/m²
	2.00 kN/m²

Stud Partition

Framing+insulation+sheathing+	0.25
lining Skim	0.25
	0.50 kN/m²

Timber Floor

Joists+Boarding+Ceiling	0.50 kN/m²
Imposed Load	1.50 kN/m²
	2.00 kN/m²

Cavity Wall

102mm Bricks	2.25 kN/m²
100mm Blocks	1.15 kN/m²
	3.40 kN/m²
after 30% deduction for windows	2.4 kN/m²
Gym Load	4.0 kN/m²
Ceiling Load	1.00 kN/m²
Dormer Load	1.50 kN/m²

Note: All Calculations must be approved by council authority prior to start any construction works.
All dimensions must be checked by contractors on site.
Please report any query to engineers.

Ref	Calculations	Output

Summary

Floor Joists	Use	50 x 150 C24	
Flat Roof Joists	Use	50 x 175 C24	
Pitched Roof Rafters	Use	Use 50 x 125 C24 as new rafters	
Trimmer T1, T2, T3	2Nos	50 x 175 C24	Joists bolted together
Post P1	Use	90 x 90 C24	

Loft Beams

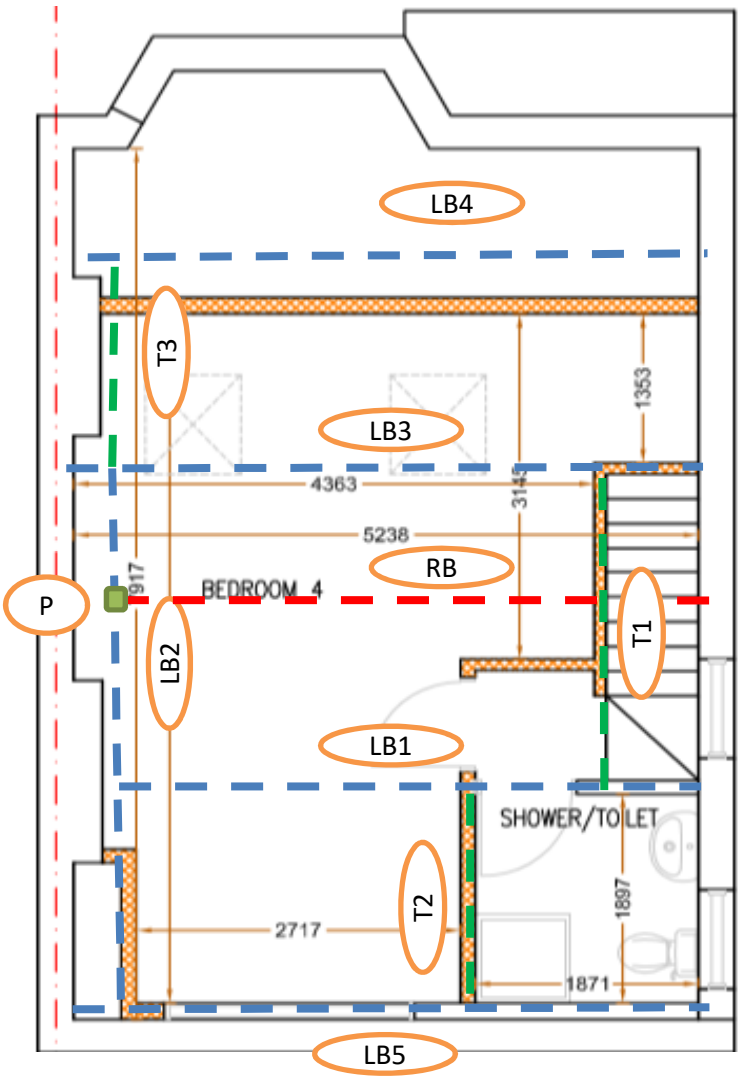
Beam	Size	Bearing plates
RB	152x152x37 UC	225 x 100 x 12
LB1	152x152x37 UC	325 x 100 x 18
LB2	203x203x46 UC	
LB3	203x203x46 UC	375 x 150 x 20
LB4	152x152x37 UC	300 x 100 x 15
LB5	203x203x46 UC	375 X 150 X 20

BH & B Consultants Ltd
Consulting Engineers
e-mail: ruchik_dave@hotmail.com Mob: 078 9752 7917

Job	16, Cumbrian Gardens		
Author	Date	Revision	Sheet No.
	26/10/2019	0	3

Ref	Calculations	Output

Diagram



BH & B Consultants Ltd
Consulting Engineers
e-mail: ruchik_dave@hotmail.com Mob: 078 9752 7917

Job	16, Cumbrian Gardens		
Author	Date	Revision	Sheet No.
	26/10/2019	0	4

Ref	Calculations	Output

BS 5268

Floor Joists

Maximum Span = L = 3.0 m
Spacing = 400 mm c/c

Floor Load = 2.0 x 0.4 = 0.80 KN/m

Max bending moment = $\frac{0.80 \times 3.0^2}{8}$ = **0.90 KNm**

Timber properties

T. 8

Grade	σ_m	σ_{II}	σ_v	E_a	E_m	
C16	5.3	6.8	0.67	8800	5800	N/mm^2
C24	7.3	7.9	0.71	10800	7200	N/mm^2

Try 50 x 150 Joists

$Z = \frac{50 \times 150^2}{6} = 187.50 \times 10^3$ mm^3

$I = \frac{50 \times 150^3}{12} = 14.06 \times 10^6$ mm^4

T. 17 K_3 = 1.00
cl. 2.10.6 $K_7 = (300/150)^{0.11}$ = 1.08
cl. 2.9 K_8 = 1.10

Bending strength check

cl. 2.10.1 Bending strength = $\sigma_m \times K_3 \times K_7 \times K_8 \times Z$

for grade **C24** = $\frac{7.3 \times 1.0 \times 1.08 \times 1.1 \times 187.50 \times 10^3}{1 \times 10^6}$ **=1.62 KNm** **> 0.90 Pass**

Deflection check

cl. 2.10.7 Max allowed deflection = 0.003L = 9.0 mm or 14 mm

Deflection = $\frac{0.104 \times Mx \times L^2}{E_a I}$

Deflection = $\frac{0.104 \times 0.90 \times 10^6 \times (3.0 \times 10^3)^2}{10800 \times 14.06 \times 10^6}$ = **5.55 mm** **< 9.0 Pass**

Use
50 x 150 C24
Joists for floor
at 400c/c

BH & B Consultants Ltd
Consulting Engineers
e-mail: ruchik_dave@hotmail.com Mob: 078 9752 7917

Job	16, Cumbrian Gardens		
Author	**Date**	**Revision**	**Sheet No.**
	26/10/2019	0	5

Ref	Calculations	Output

BS 5268

Flat Roof Joists

Maximum Span = L = 4.00 m
Spacing = 400 mm c/c

Roof Load = 1.5 x 0.4 = 0.60 KN/m

Max bending moment = $\frac{0.60 \times 4.0^2}{8}$ = **1.20 KNm**

Timber properties

T. 8

Grade	σ_m	σ_{II}	σ_v	E_a	E_m	
C16	5.3	6.8	0.67	8800	5800	N/mm^2
C24	7.3	7.9	0.71	10800	7200	N/mm^2

Try 50 x 175 Joists

$Z = \frac{50 \times 175^2}{6} = 255.21 \times 10^3$ mm^3

$I = \frac{50 \times 175^3}{12} = 22.33 \times 10^6$ mm^4

T. 17 K_3 = 1.00
cl. 2.10.6 $K_7 = (300/175)^{0.11}$ = 1.06
cl. 2.9 K_8 = 1.10

Bending strength check

cl. 2.10.1 Bending strength = $\sigma_m \times K_3 \times K_7 \times K_8 \times Z$

for grade **C24** = $\frac{7.3 \times 1.0 \times 1.06 \times 1.1 \times 255.21 \times 10^3}{1 \times 10^6}$ **=2.17 KNm** **>** **1.20** **Pass**

Deflection check

cl. 2.10.7 Max allowed deflection = 0.003L = 12.0 mm or 14 mm

Deflection = $\frac{0.104 \times Mx \times L^2}{E_a I}$

Deflection = $\frac{0.104 \times 1.20 \times 10^6 \times (4.0 \times 10^3)^2}{10800 \times 22.33 \times 10^6}$ = **8.28 mm** **<** **12.0** **Pass**

Use
50 x 175 C24
Joists for ceiling

BH & B Consultants Ltd
Consulting Engineers
e-mail: ruchik_dave@hotmail.com Mob: 078 9752 7917

Job	16, Cumbrian Gardens		
Author	**Date**	**Revision**	**Sheet No.**
	26/10/2019	0	6

Ref	Calculations	Output

BS 5268

Pitched Roof Rafters

Maximum Span = L = 2.8 m
Spacing = 400 mm c/c
Slope angle = 35 °
Pitched roof Load = 2.0 KN/m^2
Normal load/ rafter = 2.0 x Cos 35 x 0.4 = 0.66 KN/m
Max bending moment = $\frac{0.66 \times 2.8^2}{8}$ = **0.64 KNm**

Timber properties

T. 8

Grade	σ_m	σ_{II}	σ_v	E_a	E_m	
C16	5.3	6.8	0.67	8800	5800	N/mm^2
C24	7.3	7.9	0.71	10800	7200	N/mm^2

Check 50 x 125 Joists (New)

$Z = \frac{50 \times 125^2}{6} = 130.21 \times 10^3$ mm^3

$I = \frac{50 \times 125^3}{12} = 8.14 \times 10^6$ mm^4

T. 17 $K_3 = 1.00$
cl. 2.10.6 $K_7 = (300/125)^{0.11} = 1.10$
cl. 2.9 $K_8 = 1.10$

Bending strength check

cl. 2.10.1 Bending strength = $\sigma_m \times K_3 \times K_7 \times K_8 \times Z$

for grade **C24** = $\frac{7.3 \times 1.0 \times 1.10 \times 1.1 \times 130.21 \times 10^3}{1 \times 10^6}$ **=1.15 KNm** **>** **0.64** **Pass**

Deflection check

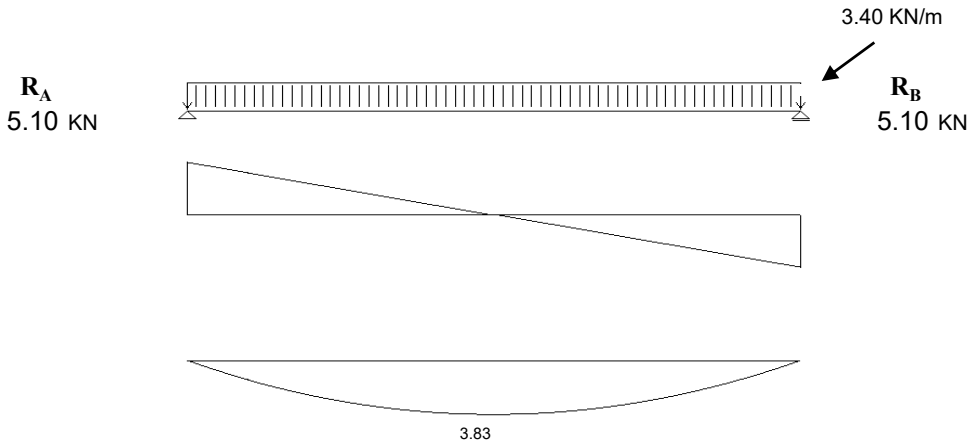
cl. 2.10.7 Max allowed deflection = 0.003L = 8.4 mm or 14 mm

Deflection = $\frac{0.104 \times Mx \times L^2}{E_a I}$

Deflection = $\frac{0.104 \times 0.64 \times 10^6 \times (2.8 \times 10^3)^2}{10800 \times 8.14 \times 10^6}$ = **5.96 mm** **<** **8.4** **Pass**

Use 50 x 125 C24 as new rafters

BH & B Consultants Ltd	Job	16, Cumbrian Gardens		
Consulting Engineers	Author	Date	Revision	Sheet No.
e-mail: ruchik_dave@hotmail.com Mob: 078 9752 7917		26/10/2019		7

Ref	Calculations	Output
BS 5268	**Trimmer T1,T2,T3**	
	Span = L = 3.0 m	
	Loads Unfactored	
	Floor Load = 0.4 x 2 / 2 = 0.40 KN/m	
	Staircase Load = 3.0 x 1.0 = 3.00 KN/m	
	3.40 KN/m	
		
	Max bending moment = $\frac{3.40 \times 3.0^2}{8}$ = **3.83 KNm**	
	Try 3 Nos 50 x 175 C24 Joists	
	$Z = 3 \times \frac{50 \times 175^2}{6} = 765.63 \times 10^3$ mm^3	
	$I = 3 \times \frac{50 \times 175^3}{12} = 66.99 \times 10^6$ mm^4	
T. 17	K_3 = 1.00	
cl. 2.10.6	$K_7 = (300 / 175)^{0.11}$ = 1.06	
cl. 2.9	K_8 = 1.10	
T. 20	K_9 = 1.21	
	Bending strength check	
cl. 2.10.1	Bending strength = $\sigma_m \times K_3 \times K_7 \times K_8 \times Z$	
	$= \frac{7.3 \times 1.0 \times 1.06 \times 1.1 \times 765.63 \times 10^3}{1 \times 10^6}$ = **6.52 KNm**	> 3.83 Pass
	Deflection check	
cl. 2.10.7	Max allowed deflection = 0.003L = 9.0 mm or 14 mm	
cl. 2.10.11	Deflection = $\frac{0.104 \times Mx \times L^2}{E_m K_9 I}$ E_m = 7200 N/mm^2	
	Deflection = $\frac{0.104 \times 3.83 \times 10^6 \times (3.0 \times 10^3)^2}{7200 \times 1.21 \times 66.99 \times 10^6}$ = **6.13 mm**	< 9.0 Pass
		Use 3 Nos 50 x 175 C24 Bolted together

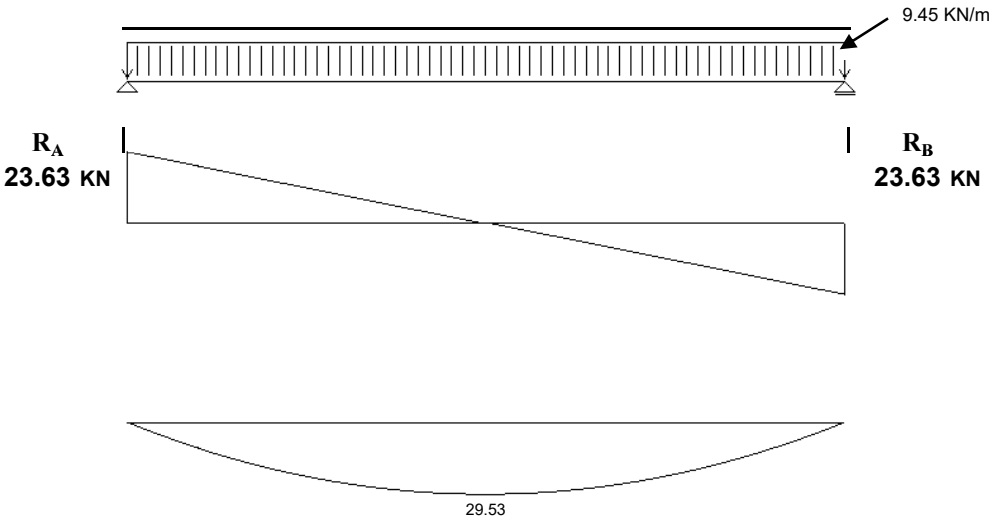
BH & B Consultants Ltd
Consulting Engineers
e-mail: ruchik_dave@hotmail.com Mob: 078 9752 7917

Job	16, Cumbrian Gardens		
Author	Date	Revision	Sheet No.
	26/10/2019		8

Ref	Calculations	Output
BS 5950	**Beam RB**	
	Beam Span = L = 5.0 m	

Loads

	Unfactored	Factored	Imposed	
Self weight of the beam	0.50	0.75		KN/m
Flat Roof Load = 4.0 x 1.5 /2 =	3.00	4.50		KN/m
Pitched Roof Load = 2.8 x 2 / 2 =	2.80	4.20		KN/m
Total UDL	6.30	9.45		KN/m



Max bending moment = **M** = $\frac{9.45 \times 5.0^2}{8}$ = **29.53 KNm**

cl. 4.3.6.2 & T. 18 M m_{LT} = 29.53 x 0.925 = **27.32 KNm**

Try 152x152x37 UC

D= 161.8 mm B= 154.4 mm
I_x= 2210 cm^4

T. 13 L_E = 1.2L+2D = 6.32 m
From SCI moment capacity table for L_E **6.32 m**
Moment capacity = M_b = **50.35 KNm > MmLT OK**

Deflection check

M_{IL}= 0.40 x 29.5 = **11.81 KNm**

cl. 2.5.2 Max allowed deflection for beams carrying brittle finish =L/360= **13.89 mm**
Deflection = $0.104 \times M_{IL} \times L^2 / EI_x$ = **6.78 mm < L/360 OK**

Use 152x152x37 UC with 225 x 100 x 12 bearing plates

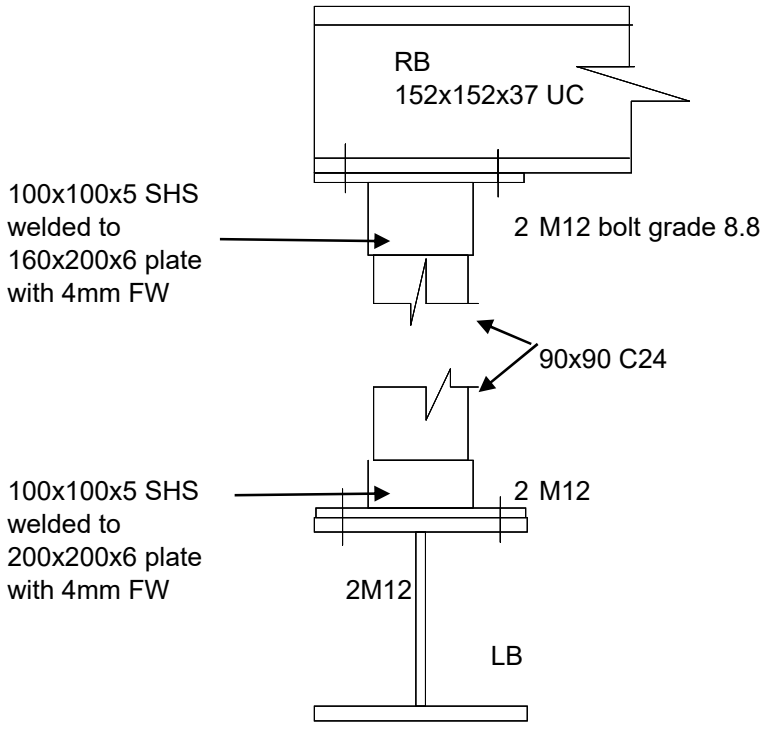
Bearing plates

Factored bearing pressure on brick wall =	1.26	N/mm^2
Width of bearing plate =	100	mm
Thickness of bearing plate =	10.7	mm
Length of bearing plate = (23.63 $\times 10^3$) / (1.26 x 100)=	187.5	mm

BH & B Consultants Ltd
Consulting Engineers
e-mail: ruchik_dave@hotmail.com Mob: 078 9752 7917

Job	16, Cumbrian Gardens		
Author	Date	Revision	Sheet No.
	26/10/2019		9

Ref	Calculations	Output
BS 5268	**Post to support RB at ends**	
	Length of post = L = 2.4 m	
	Unfactored Load from RB = 23.63 KN	
	Try 90 x 90 C24 post	
cl. 2.11.4	r_{yy} = 90 / $\sqrt{12}$ = 25.98 mm	
	$\lambda_{yy} = L_E / r_{yy}$ = 92.4 <180 OK	
cl. 2.11.5	E_m/σ_{cll} = 5800 / 7.3 = 794.52	
T. 22	K_{12} = 0.43	
	Permissible Stress = σ_{cll} x K_3 x K_{12} =	
	= 7.3 x 1.0 x 0.43 = 3.14 N/mm^2	
	Permissible Load = 3.14 x 90 x 90 / 1000 = **25.43 KN**	**> 23.63 Pass**



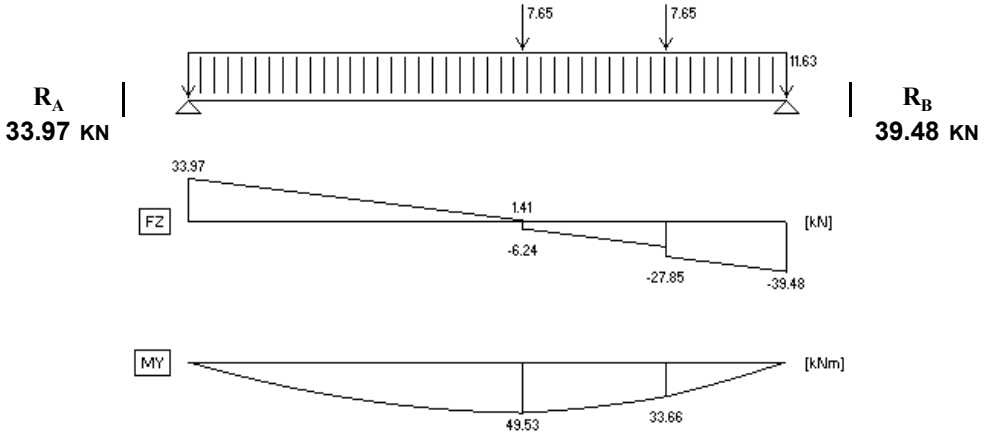
BH & B Consultants Ltd
Consulting Engineers
e-mail: ruchik_dave@hotmail.com Mob: 078 9752 7917

Job	16, Cumbrian Gardens		
Author	**Date**	**Revision**	**Sheet No.**
	26/10/2019		10

Ref	Calculations	Output
BS 5950	**Beam LB1**	
	Beam Span = L = 5.0 m	

Loads

	Unfactored	Factored	
Self weight of the beam	0.50	0.75	KN/m
Floor Load = 6.5 x 2 / 2 =	6.50	9.75	KN/m
Partition Load = 1.5 x 0.5 =	0.75	1.13	
Total UDL =	7.75	11.63	KN/m
Point Load from T2 @ 2.8 m	5.10	7.65	kN
Point Load from T1 @ 4.0 m	5.10	7.65	



Max bending moment = **M = 49.53 KNm**

cl. 4.3.6.2 & T. 18 — M m_{LT} = 49.53 x 0.925 = **45.82 KNm**

Try 152x152x37 UC

D= 161.8 mm B= 154.4
I_x= 2210 cm^4

T. 13 — L_E = 1.2L+2D = 6.32 m
From SCI moment capacity table for L_E **6.32 m**
Moment capacity = M_b = **50.35 KNm > MmLT OK**

Deflection check

M_{IL}= 0.4 x 49.53 = **19.81 KNm**

cl. 2.5.2 — Max allowed deflection for beams carrying brittle finish =L/360= **13.89 mm**

Deflection = $0.104 x M_{IL} x L^2 / EI_x$ = **11.37 mm < L/360 OK**

Bearing plates

Factored bearing pressure on brick wall =	1.26	N/mm^2
Width of bearing plate =	100	mm
Thickness of bearing plate =	16.5	mm
Length of bearing plate = (39.48 $x10^3$) / (1.26 x 100)=	313.3	mm

Use 152x152x37 UC with 325 x 100 x 18 bearing plates

BH & B Consultants Ltd
Consulting Engineers
e-mail: ruchik_dave@hotmail.com Mob: 078 9752 7917

Job	16, Cumbrian Gardens		
Author	**Date**	**Revision**	**Sheet No.**
	26/10/2019		11

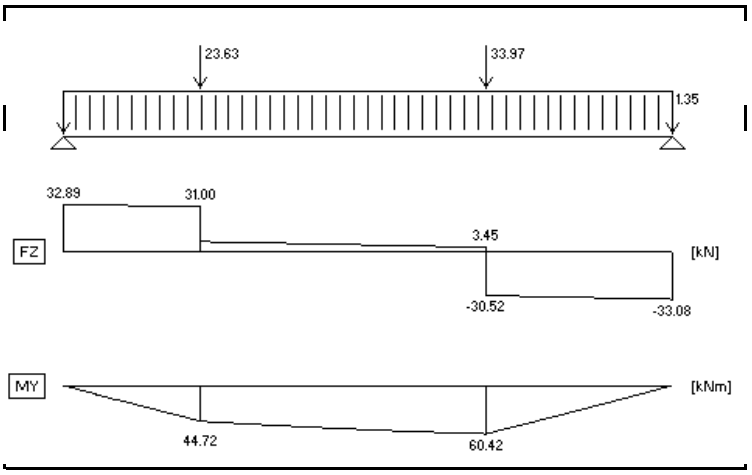
Ref	Calculations	Output

BS 5950

Beam LB2

Beam Span = L = 6.2 m

Loads		Unfactored	Factored	
Self weight of the beam		0.50	0.75	KN/m
Floor Load =	0.4 x 2 / 2 =	0.40	0.60	KN/m
Total UDL =		0.90	1.35	KN/m
Point Load from LB1 @	4.3 m	33.97	33.97	kN
Point Load from Post @	1.4 m	23.63	23.63	



Max bending moment = **M = 60.42 KNm**

cl. 4.3.6.2 & T. 18

M m_{LT} = 60.42 x 0.925 = **55.89 KNm**

Try 203x203x46 UC

D= 203.2 mm B= 203.6

I_x= 4570 cm^4

T. 13 L_E = 1.2L+2D = 7.85 m

From SCI moment capacity table for L_E **7.85 m**

Moment capacity = M_b = **73.62 KNm > MmLT OK**

Deflection check

M_{IL}= 0.4 x 60.42 = **24.17 KNm**

cl. 2.5.2 Max allowed deflection for beams carrying brittle finish =L/360= **17.22 mm**

Deflection = $0.104 x M_{IL} x L^2 / EI_x$ = **10.31 mm < L/360 OK**

Use 203x203x46 UC

BH & B Consultants Ltd
Consulting Engineers
e-mail: ruchik_dave@hotmail.com Mob: 078 9752 7917

Job	16, Cumbrian Gardens		
Author	Date	Revision	Sheet No.
	26/10/2019		12

Ref	Calculations	Output

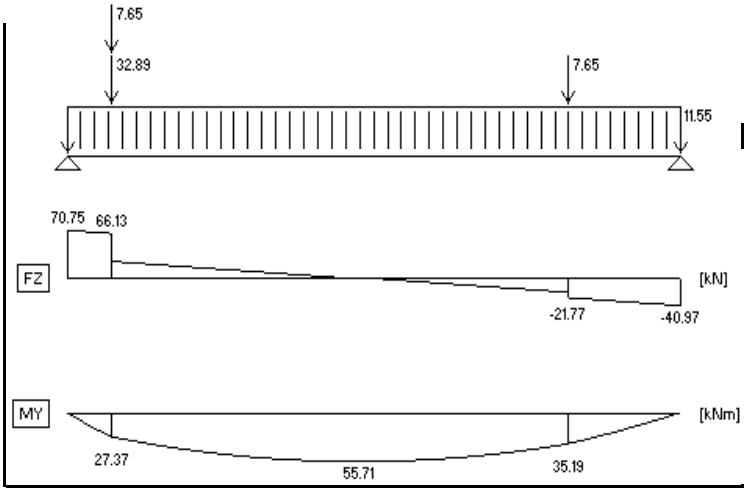
BS 5950

Beam LB3

Beam Span = L = 5.5 m

Loads

		Unfactored	Factored	
Self weight of the beam		0.50	0.75	KN/m
Floor Load =	6.0 x 2 / 2 =	6.00	9.00	KN/m
Partition Load =	2.4 x 0.5 =	1.20	1.80	
Total UDL =		7.70	11.55	KN/m
Point Load from	T3 @ 0.4 m	5.10	7.65	KN
Point Load from	LB2 @ 0.4 m	32.89	32.89	KN
Point Load from	T1 @ 4.5 m	5.10	7.65	



Max bending moment = **M = 55.71 KNm**

cl. 4.3.6.2 & T. 18

M m_{LT} = 55.71 x 0.925 = **51.53 KNm**

Try 203x203x46 UC

D= 203.2 mm B= 203.6

I_x= 4570 cm^4

T. 13 L_E = 1.2L+2D = 7.01 m

From SCI moment capacity table for L_E **7.01 m**

Moment capacity = M_b = **79.75 KNm > MmLT OK**

Deflection check

M_{IL}= 0.4 x 55.71 = **22.28 KNm**

cl. 2.5.2 Max allowed deflection for beams carrying brittle finish =L/360= **15.28 mm**

Deflection = $0.104 x M_{IL} x L^2 / EI_x$ = **7.48 mm < L/360 OK**

Use 203x203x46 UC with 375 x 150 x 20 bearing plates

Bearing plates

Factored bearing pressure on brick wall = 1.26 N/mm^2

Width of bearing plate = 150 mm

Thickness of bearing plate = 19.3 mm

Length of bearing plate = (70.75 $x10^3$) / (1.26 x 150)= 374.3 mm

BH & B Consultants Ltd
Consulting Engineers
e-mail: ruchik_dave@hotmail.com Mob: 078 9752 7917

Job	16, Cumbrian Gardens		
Author	Date	Revision	Sheet No.
	26/10/2019		13

Ref	Calculations	Output

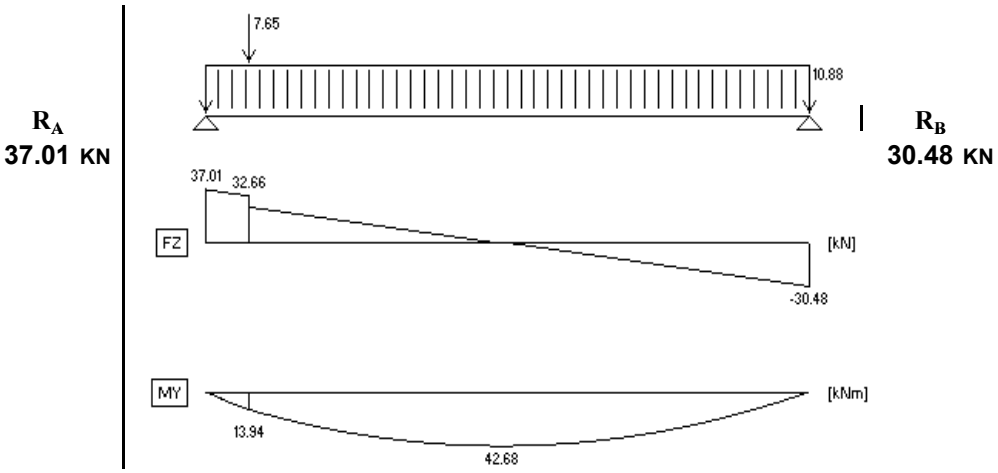
BS 5950

Beam LB4

Beam Span = L = 5.5 m

Loads

	Unfactored	Factored	
Self weight of the beam	0.50	0.75	KN/m
Floor Load = 2.0 x 2 / 2 =	2.00	3.00	KN/m
Partition Load = 1.5 x 0.5 =	0.75	1.13	
Pitched Roof Load = 4.0 X 2/2 =	4.00	6.00	
Total UDL =	7.25	10.88	KN/m
Point Load from T3 @ 0.4 m	5.10	7.65	KN



Max bending moment = **M = 42.68 KNm**

cl. 4.3.6.2 & T. 18

M m_{LT} = 42.68 x 0.925 = **39.48 KNm**

Try 152x152x37 UC

D= 161.8 mm B= 154.4

I_x= 2210 cm^4

T. 13

L_E = 1.2L+2D = 6.92 m

From SCI moment capacity table for L_E **6.92 m**

Moment capacity = M_b = **47.47 KNm > MmLT OK**

Deflection check

M_{IL}= 0.4 x 42.68 = **17.07 KNm**

cl. 2.5.2

Max allowed deflection for beams carrying brittle finish =L/360= **15.28 mm**

Deflection = $0.104 x M_{IL} x L^2 / EI_x$ = **11.85 mm < L/360 OK**

Use 152x152x37 UC with 300 x 100 x 15 bearing plates

Bearing plates

Factored bearing pressure on brick wall = 1.26 N/mm^2

Width of bearing plate = 100 mm

Thickness of bearing plate = 15.1 mm

Length of bearing plate = (37.01 $x10^3$) / (1.26 x 100)= 293.7 mm

BH & B Consultants Ltd
Consulting Engineers
e-mail: ruchik_dave@hotmail.com Mob: 078 9752 7917

Job	16, Cumbrian Gardens		
Author	**Date**	**Revision**	**Sheet No.**
	26/10/2019		14

Ref	Calculations	Output

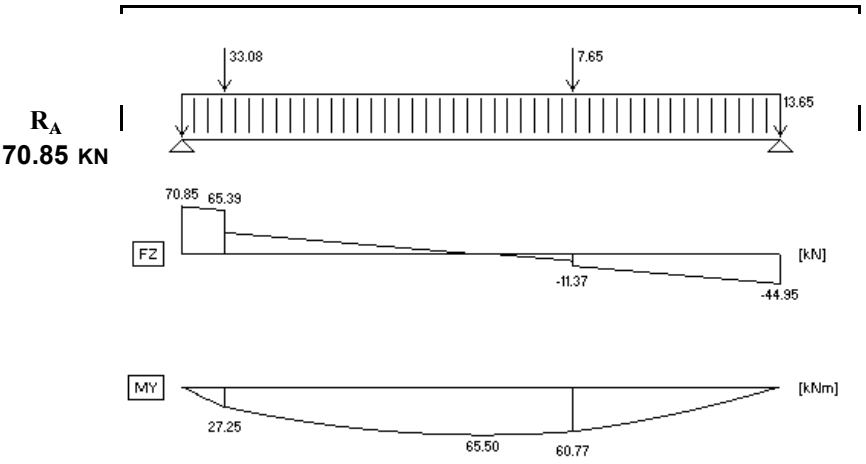
BS 5950

Beam LB5

Beam Span = L = 5.5 m

Loads

		Unfactored	Factored	
Self weight of the beam		0.50	0.75	KN/m
Floor Load =	2.0 x 2 / 2 =	2.00	3.00	KN/m
Flat Roof Load =	4.0 x 1.5/2 =	3.00	4.50	
Dormer Load =	2.4 x 1.5 =	3.60	5.40	
Total UDL =		9.10	13.65	KN/m
Point Load from	T2 @ 3.6 m	5.10	7.65	KN
Point Load from	LB2 @ 0.4 m	33.08	33.08	



Max bending moment = **M = 65.50 KNm**

cl. 4.3.6.2 & T. 18

M m_{LT} = 65.5 x 0.925 = **60.59 KNm**

Try 203x203x46 UC

D= 203.2 mm B= 203.6 mm

I_x= 4570 cm^4

T. 13

L_E = 1.2L+2D = 7.01 m

From SCI moment capacity table for L_E **7.01 m**

Moment capacity = M_b = **79.75 KNm > MmLT OK**

Deflection check

M_{IL}= 0.4 x 65.5 = **26.20 KNm**

cl. 2.5.2

Max allowed deflection for beams carrying brittle finish =L/360= **15.28 mm**

Deflection = $0.104 x M_{IL} x L^2 / EI_x$ = **8.80 mm < L/360 OK**

Use 203x203x46 UC with 375 x 150 x 20 bearing plates

Bearing plates

Factored bearing pressure on brick wall = 1.26 N/mm^2

Width of bearing plate = 150 mm

Thickness of bearing plate = 19.3 mm

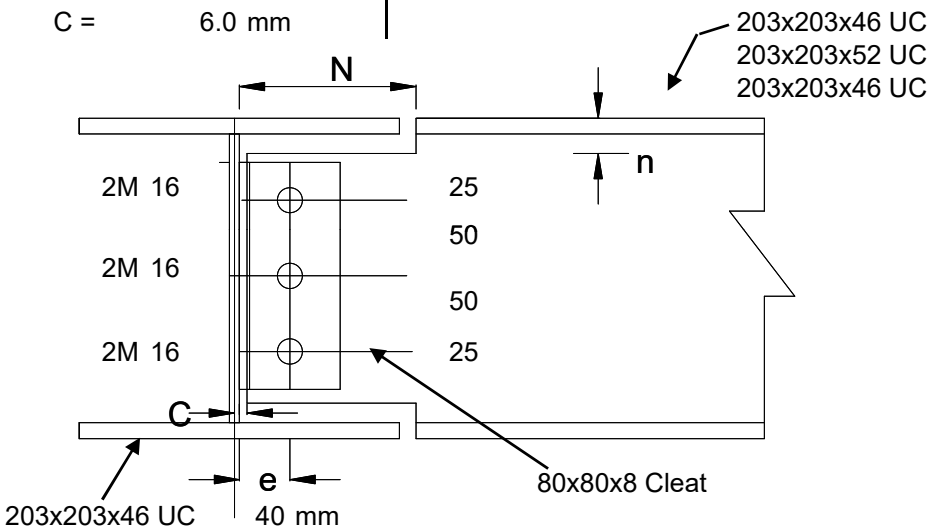
Length of bearing plate = (70.85 $x10^3$) / (1.26 x 150)= 374.9 mm

Ref	Calculations	Output

BS 5950

Connection

	Supporting beam	Supported beam		
	203x203x46 UC	**203x203x46 UC**		
or	203x203x52 UC	203x203x52 UC		
or	203x203x46 UC	203x203x46 UC		
D =	203.2 mm	203.2 mm	d =	160.8 mm
B =	203.6 mm	203.6 mm		
T =	11.0 mm	11.0 mm		
t =	7.2 mm	7.2 mm		
r =	10.2 mm	10.2 mm		
N =	110.0 mm			
n =	22.0 mm			
C =	6.0 mm			



Max shear force = F = **50 KN**

Try M 16 Grade 8.8 bolts

P_s = 58.9 KN $2P_s$ = 117.8 KN
P_t = 70.3 KN
d = 16 mm
Bolt rows = 3 rows
e = 40 mm
Z = 100 mm

Veritical shear force/ bolt = V= F/rows = 50 / 3 = 16.7 KN
Rotational shear force = R= $\frac{F.e}{Z}$ = $\frac{50 \times 40}{100}$ = 20.0 KN

Resultant = $F_r = \sqrt{V^2 + R^2}$ = (16.7 ^{2} + 20.0 ^{2})$^{1/2}$ = **26.03 KN** **< $2P_s$ Pass**

Web bearing capacity

cl.6.3.3.3

$$P_{bs} = K_{bs} dtp_{bs} \leq 0.5 K_{bs} etp_{bs}$$

1 x 16 x 7.2 x 0.460 ≤ 0.5 x 1 x 40 x 7.2 x 0.460

52.99 ≤ 66.24

Lesser Value = **52.99 KN** **> F_r Pass**