KCRDESIGN
PLANS TO INSPIRE

Structural Calculations
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The span quoted is solely for the purpose of producing these structural calculations. Measurements must be taken on site before ordering any materials.

Beams specified for load bearing walls of cavity construction, are often two beams, one for each skin of brick/blockwork. Check the comments at the bottom of the page for each beam specified, before ordering any materials.

Loading Data

9"BRICKWORK:

215mm Brickwork	=4.80kN/m2
Plaster	=0.60kN/m2
Total Load	**=5.40kN/m2**

BRICKWORK PARTITION:

100mm Brickwork	=2.10kN/m2
2 No. Plaster Faces	=0.60kN/m2
Total Load	**=2.70kN/m2**

BLOCKWORK PARTITION:

100mm Blockwork	=1.00kN/m2
2 No. Plaster Faces	=0.50kN/m2
Total Load	**=1.50kN/m2**

TILE HANGING TO TIMBER FRAME:

Concrete Tiles	=0.55kN/m2
Battens & Felt	=0.10kN/m2
Timber Studs	=0.10kN/m2
Plasterboard	=0.15kN/m2
Insulation	=0.05kN/m2
Plaster	=0.25kN/m2
Total Load	**=1.20kN/m2**

TIMBER STUD PARTITION:

2 No. Plasterboard Faces	=0.30kN/m2
Timber Studs	=0.10kN/m2
2 No. Plaster Faces	=0.30kN/m2
Insulation	=0.05kN/m2
Total Load	**=0.75kN/m2**

PITCHED ROOF:

Concrete Tiles	=0.60kN/m2
Battens & Felt	=0.10kN/m2
Rafters	=0.15kN/m2
Total Dead Load	=0.85kN/m2
Imposed Load	=0.75kN/m2
Total Load	**=1.60kN/m2**

ROOF SPACE:

Joists & Insulation	=0.15kN/m2
Ceiling	=0.15kN/m2
Total Dead Load	=0.30kN/m2
Imposed Load	=0.25kN/m2
Total Load	**=0.55kN/m2**

SLOPING CEILING:

Plasterboard	=0.15kN/m2
Insulation	=0.10kN/m2
Total Dead Load	=0.25kN/m2
Total Load	**=0.45kN/m2**

FLAT ROOF:

Chipping & Felt	=0.35kN/m2
Boards, Joists & Firings	=0.30kN/m2
Ceiling & Insulation	=0.15kN/m2
Total Dead Load	=0.80kN/m2
Imposed Load	=0.75kN/m2
Total Load	**=1.55kN/m2**

TIMBER ROOF:

Boards & Joists	=0.35kN/m2
Ceiling	=0.15kN/m2
Total Dead Load	=0.50kN/m2
Imposed Load	=1.50kN/m2
Total Load	**=2.00kN/m2**

EXTERNAL RENDER WALL:

Render 2 No. Skins	=0.30kN/m2
100mm Blockwork	=2.00kN/m2
Insulation	=0.05kN/m2
Plaster	=0.25kN/m2
Total Load	**=2.60kN/m2**

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Beam: **Beam A** **Span: 3.9 m.**

		Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*
U	T	o.w.	0.55	0		L	1.07	1.07
U	T	BRICKWORK PARTITION	2.70*2.40	0		L	12.64	12.64
U	T	BRICKWORK PARTITION	2.70*2.40	0		L	12.64	12.64
U	T	PITCHED ROOF	1.60*2.00	0		L	6.24	6.24
U	T	TIMBER FLOOR	2.00*1.00	0		L	3.90	3.90
							36.48	36.48

Total load: 72.97 kN

Load types: U:UDL T: Total (positions in m. from R1)

Maximum B.M. = 35.6 kNm at 1.95 m. from R1

Maximum S.F. = 36.5 kN at R1

Total deflection = 56.4 x 10^8/EI at 1.95 m. from R1 *(E in N/mm^2, I in cm^4)*

Steel calculation to BS449 Part 2 using S275 (Grade 43) steel

SECTION SIZE : **152 x 152 x 44 UC Grade 43**

D=166.0 mm B=155.9 mm t=9.5 mm T=13.6 mm I_x=2,703 cm^4 r_y=3.92 cm Z_x=326 cm^3

L_E/r_y = 3.90x100/3.92 = 99 D/T = 12.2

Permissible bending stress, p_{bc} = 153.6 N/mm^2 (Table 3a)

Actual bending stress, f_{bc} = 35.57 x 1000/326.0 = 109.1 N/mm^2 OK

Maximum shear in web, f_s = 36.48 x 1000/(9.5 x 166.0) = 23.1 N/mm^2 OK

Check unstiffened web capacity with load of 36.48 kN

Bearing: p_h = 210N/mm^2 (Table 9); C1 = 73.2 kN; C2 = 2.00 kN/mm

Buckling: p_c = 158N/mm^2 (Table 17a); C1 = 125 kN; C2 = 1.50 kN/mm

Unstiffened web bearing capacity, P_w = 73.2kN: no minimum stiff bearing length required

Total deflection = 56.4 x 1e8/(205,000 x 2,703) = 10.2 mm (L/383) OK

Combined bending and shear check (14.c): $(f_{bc}/p_{bc})^2 + (f_s/p_s)^2$ = 0.504 at 1.95 m. (<=1.25 OK)

Bearing details

152x152x44 UC stiff bearing length, b_1 = t + 1.6r + 2T = 48.9 mm

Factor reactions by 1.55 (user selected value)

Local design strength of masonry (factored) = 0.700 N/mm^2 (User-entered value)

R1: 850 x 100 mm padstone

Factored reaction = 36.48 x 1.55 = 56.55 kN

Factored stress under padstone = 1.55 x 36.48 x 1000/850 x 100 = 0.67 N/mm^2

R2 as R1

Encase beam to provide half-hour fire resistance as per specification Use 2No. beams, one for each skin

Beam: **Beam B** **Span: 3.4 m.**

		Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*
U	T	o.w.	0.55	0		L	0.94	0.94
U	T	BRICKWORK PARTITION	2.70*2.40	0		L	11.02	11.02
U	T	BRICKWORK PARTITION	2.70*2.40	0		L	11.02	11.02
U	T	PITCHED ROOF	1.60*2.00	0		L	5.44	5.44
U	T	TIMBER FLOOR	2.00*1.00	0		L	3.40	3.40
							31.81	31.81

Total load: 63.61 kN

Load types: U:UDL T: Total (positions in m. from R1)

Maximum B.M. = 27.0 kNm at 1.70 m. from R1

Maximum S.F. = 31.8 kN at R1

Total deflection = 32.6 x 10^8/EI at 1.70 m. from R1 *(E in N/mm^2, I in cm^4)*

Steel calculation to BS449 Part 2 using S275 (Grade 43) steel

SECTION SIZE : **152 x 152 x 30 UC Grade 43**

D=157.6 mm B=152.9 mm t=6.5 mm T=9.4 mm I_x=1,750 cm^4 r_y=3.83 cm Z_x=222 cm^3

L_E/r_y = 3.40x100/3.83 = 89 D/T = 16.8

Permissible bending stress, p_{bc} = 150.2 N/mm^2 (Table 3a)

Actual bending stress, f_{bc} = 27.04 x 1000/222.0 = 121.8 N/mm^2 OK

Maximum shear in web, f_s = 31.81 x 1000/(6.5 x 157.6) = 31.0 N/mm^2 OK

Check unstiffened web capacity with load of 31.81 kN

Bearing: p_h = 210N/mm^2 (Table 9); C1 = 40.2 kN; C2 = 1.37 kN/mm

Buckling: p_c = 153N/mm^2 (Table 17a); C1 = 78.4 kN; C2 = 0.994 kN/mm

Unstiffened web bearing capacity, P_w = 40.2kN: no minimum stiff bearing length required

Total deflection = 32.6 x 1e8/(205,000 x 1,750) = 9.1 mm (L/375) OK

Combined bending and shear check (14.c): $(f_{bc}/p_{bc})^2 + (f_s/p_s)^2$ = 0.658 at 1.70 m. (<=1.25 OK)

Bearing details

152x152x30 UC stiff bearing length, b_1 = t + 1.6r + 2T = 37.5 mm

Factor reactions by 1.55 (user selected value)

Local design strength of masonry (factored) = 0.700 N/mm^2 (User-entered value)

R1: 750 x 100 mm padstone

Factored reaction = 31.81 x 1.55 = 49.30 kN

Factored stress under padstone = 1.55 x 31.81 x 1000/750 x 100 = 0.66 N/mm^2

R2 as R1

Encase beam to provide half-hour fire resistance as per specification Use 2No. beams, one for each skin

Beam: **Beam C** **Span: 2.6 m.**

	Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*
U T	o.w.	0.2	0		L	0.26	0.26
U T	PITCHED ROOF	1.60*2.00	0		L	4.16	4.16
U T	BRICKWORK PARTITION	2.70*2.40	0		L	8.42	8.42
						12.84	12.84

Total load: 25.69 kN

Load types: U:UDL T: Total (positions in m. from R1)

Maximum B.M. = 8.35 kNm at 1.30 m. from R1

Maximum S.F. = 12.8 kN at R1

Total deflection = 5.88 x 10^8/EI at 1.30 m. from R1 *(E in N/mm^2, I in cm^4)*

Steel calculation to BS449 Part 2 using S275 (Grade 43) steel

SECTION SIZE : **152 x 89 x 16 UB Grade 43**

D=152.4 mm B=88.7 mm t=4.5 mm T=7.7 mm I_x=834 cm^4 r_y=2.10 cm Z_x=109 cm^3

L_E/r_y = 2.60x100/2.10 = 124 D/T = 19.8

Permissible bending stress, p_{bc} = 117.9 N/mm^2 (Table 3a)

Actual bending stress, f_{bc} = 8.349 x 1000/109.0 = 76.6 N/mm^2 OK

Maximum shear in web, f_s = 12.84 x 1000/(4.5 x 152.4) = 18.7 N/mm^2 OK

Check unstiffened web capacity with load of 12.84 kN
Bearing: p_h = 210N/mm^2 (Table 9); C1 = 25.0 kN; C2 = 0.945 kN/mm
Buckling: p_c = 146N/mm^2 (Table 17a); C1 = 50.1 kN; C2 = 0.657 kN/mm
Unstiffened web bearing capacity, P_w = 25.0kN: no minimum stiff bearing length required

Total deflection = 5.88 x 1e8/(205,000 x 834) = 3.4 mm (L/756) OK

Combined bending and shear check (14.c): $(f_{bc}/p_{bc})^2 + (f_s/p_s)^2$ = 0.422 at 1.30 m. (<=1.25 OK)

Bearing details *(bearing plate sizing to BS5950-1:2000)*

152x89x16 UB stiff bearing length, b_1 = t + 1.6r + 2T = 32.1 mm

Factor reactions by 1.55 (user selected value)

Local design strength of masonry (factored) = 0.700 N/mm^2 (User-entered value)

R1: 300 x 100 mm bearing plate

Factored reaction = 12.84 x 1.55 = 19.91 kN

15 mm m.s. bearing plate, size 300 x 100 mm
Bearing plate projection beyond stiff bearing length = (300-32.1)/2 = 134mm
Factored stress under plate = 1.55 x 12.84 x 1000/300 x 100 = 0.66 N/mm^2
Required plate thickness = $\sqrt{}$(3x0.66x134x134/275) = 11.4 mm: use 15mm
Factored bending stress in plate = 0.66x134x(134/2)/(15x15/6) = 158.8 N/mm^2 (p_y=275 N/mm^2)

R2 as R1

Encase beam to provide half-hour fire resistance as per specification Use 2No. beams, one for each skin

Beam: **Beam D** **Span: 3.9 m.**

		Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*
U	T	o.w.	0.4	0		L	0.78	0.78
U	T	BRICKWORK PARTITION	2.70*2.40	0		L	12.64	12.64
U	T	TIMBER FLOOR	2.00*1.1	0		L	4.29	4.29
U	T	TIMBER FLOOR	2.00*1.0	0		L	3.90	3.90
							21.61	21.61

Total load: 43.21 kN

Load types: U:UDL T: Total (positions in m. from R1)

Maximum B.M. = 21.1 kNm at 1.95 m. from R1

Maximum S.F. = 21.6 kN at R1

Total deflection = 33.4 x 10^8/EI at 1.95 m. from R1 *(E in N/mm², I in cm⁴)*

Steel calculation to BS449 Part 2 using S275 (Grade 43) steel

SECTION SIZE : **152 x 152 x 37 UC Grade 43**

D=161.8 mm B=154.4 mm t=8.0 mm T=11.5 mm I_x=2,210 cm⁴ r_y=3.87 cm Z_x=273 cm³

L_E/r_y = 3.90x100/3.87 = 101 D/T = 14.1

Permissible bending stress, p_{bc} = 147.3 N/mm² (Table 3a)

Actual bending stress, f_{bc} = 21.07 x 1000/273.0 = 77.2 N/mm² OK

Maximum shear in web, f_s = 21.61 x 1000/(8.0 x 161.8) = 16.7 N/mm² OK

Check unstiffened web capacity with load of 21.61 kN

Bearing: p_h = 210N/mm² (Table 9); C1 = 55.6 kN; C2 = 1.68 kN/mm

Buckling: p_c = 156N/mm² (Table 17a); C1 = 101 kN; C2 = 1.25 kN/mm

Unstiffened web bearing capacity, P_w = 55.6kN: no minimum stiff bearing length required

Total deflection = 33.4 x 1e8/(205,000 x 2,210) = 7.4 mm (L/529) OK

Combined bending and shear check (14.c): $(f_{bc}/p_{bc})^2 + (f_s/p_s)^2$ = 0.274 at 1.95 m. (<=1.25 OK)

Bearing details *(bearing plate sizing to BS5950-1:2000)*

152x152x37 UC stiff bearing length, b_1 = t + 1.6r + 2T = 43.2 mm

Factor reactions by 1.55 (user selected value)

Local design strength of masonry (factored) = 0.700 N/mm² (User-entered value)

R1: 500 x 100 mm bearing plate

Factored reaction = 21.61 x 1.55 = 33.49 kN

20 mm m.s. bearing plate, size 500 x 100 mm
Bearing plate projection beyond stiff bearing length = (500-43.2)/2 = 228.4mm
Factored stress under plate = 1.55 x 21.61 x 1000/500 x 100 = 0.67 N/mm²
Required plate thickness = √(3x0.67x228x228/265) = 19.9 mm: use 20mm
Factored bending stress in plate = 0.67x228x(228/2)/(20x20/6) = 262.1 N/mm² (p_y=265 N/mm²)

R2 as R1

Encase beam to provide half-hour fire resistance as per specification.