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: 3.7 m.**

	Load name	Loading w1	Start x1	Loading w2	End x2	R1comp	R2comp
U D	o.w.	0.45	0		L	0.83	0.83
U D	BRICKWORK PARTITION	2.70*2.40	0		L	11.99	11.99
U D	BRICKWORK PARTITION	2.70*2.40	0		L	11.99	11.99
U D	TIMBER FLOOR	2.0*1.3	0		L	4.81	4.81
U D	TIMBER FLOOR	2.0*1.2	0		L	4.44	4.44
				Unfactored reactions (kN)	**Total:**	**34.06**	**34.06**
					Dead:	*34.06*	*34.06*
					Live:	*0.00*	*0.00*
Total load: 68.12/95.36 kN *Unfactored/Factored*					**Factored reactions:**	**47.68**	**47.68**

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

Maximum B.M. (factored) = 44.1 kNm at 1.85 m. from R1

Maximum S.F. (factored) = 47.7 kN at R1

Live load deflection = 0.00 x 10^8/EI at R2 *(E in N/mm^2, I in cm^4)*

Total deflection = 44.9 x 10^8/EI at 1.85 m. from R1

Beam calculation to BS5950-1:2000 using S275 steel

SECTION SIZE : **152 x 152 x 37 UC S275 (compact)**

D=161.8 mm B=154.4 mm t=8.0 mm T=11.5 mm I_x=2,210 cm^4 r_y=3.87 cm S_x=309 cm^3

Shear capacity = 0.6 p_y.t.D = 0.6 x 275 x 8.0 x 161.8/1000 = 214 kN (>=47.7) OK

Maximum moment = 44.11 kNm at 1.85 m. from R1

Moment capacity, $M_c = p_y.S_x$ = 275 x 309/1000 = 84.97 kNm OK

Beam is laterally restrained at supports only: effective length = 1.0L

Effective length (L_F) = 3.70m
Buckling parameter (u) = 0.849
β_w = 1.000 (Class 1/2 compact)
Bending strength, p_b = 215.7 N/mm^2

Slenderness, λ (L_F/r_v) = 3.70 x 100/3.87 = 95.61
Slenderness factor (v) = 0.727 (x = 13.3; λ/x = 7.19)
Equivalent slenderness (λ_{LT}) = u.v.λ.$\sqrt{}\beta_w$ = 58.99

Maximum moment within segment, M_x = 44.11 kNm
Equivalent uniform moment factor, $m_{l\,T}$ = 0.925 (M_2=33.1, M_3=44.1, M_4=33.1)
Equivalent uniform moment = 0.925 x 44.11 = 40.80 kNm
Buckling resistance moment, $M_b = p_b.S_x$ = 215.7 x 309/1000 = 66.66 kNm OK

Check unstiffened web capacity with load of 47.68 kN
C1 = 84.0 kN; C2 = 2.20 kN/mm; C4 = 712; K = min{0.5+(a_e/1.4d),1.0}; p_{vw} = 275N/mm^2
(for derivation of C factors see Steelwork Design Guide to BS5950-1:2000 6th ed.)
Bearing capacity, $P_w = C1+b_1C2$ (b_e taken as zero) Buckling capacity, $P_x = K\sqrt{}(C4.P_w)$
Unstiffened web bearing capacity, P_w = 84.0 kN: no minimum stiff bearing length required

LL deflection = 0.000 x 1e8/205,000 x 2210.000 = 0.0 mm OK
TL deflection = 44.92 x 1e8/205,000 x 2210 = 9.9 mm (L/373)

Bearing details

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

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

R1: 700 x 100 x 350h mm padstone

(minimum padstone height if unreinforced: 329 mm)

Factored reaction = 34.06 x 1.4 + 0.00 x 1.6 = 47.68 kN

Factored stress under padstone = 47.68 x 1000/700 x 100 = 0.68 N/mm^2

R2: 250 x 300 x 125h mm padstone

(minimum padstone height if unreinforced: 104 mm)

Factored reaction = 34.06 x 1.4 + 0.00 x 1.6 = 47.68 kN

Factored stress under padstone = 47.68 x 1000/250 x 300 = 0.64 N/mm^2

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

Beam: **Beams over Bi-fold doors** **Span: 3.6 m.**

		Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*
U	D	o.w.	0.2	0		L	0.36	0.36
U	D	PITCHED ROOF	1.60*1.6	0		L	4.61	4.61
U	D	ROOF SPACE	0.55*1.6	0		L	1.58	1.58
					Unfactored reactions (kN) Total:		**6.55**	**6.55**
						Dead:	*6.55*	*6.55*
						Live:	*0.00*	*0.00*
						Factored reactions:	**9.17**	**9.17**

Total load: 13.10/18.35 kN *Unfactored/Factored*

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

Maximum B.M. (factored) = 8.26 kNm at 1.80 m. from R1

Maximum S.F. (factored) = 9.17 kN at R1

Live load deflection = 0.00 x 10^8/EI at R2 *(E in N/mm^2, I in cm^4)*

Total deflection = 7.96 x 10^8/EI at 1.80 m. from R1

Beam calculation to BS5950-1:2000 using S275 steel

SECTION SIZE : **152 x 89 x 16 UB S275 (compact)**

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 S_x=123 cm^3

Shear capacity = 0.6 p_y.t.D = 0.6 x 275 x 4.5 x 152.4/1000 = 113 kN (>=9.17) OK

Maximum moment = 8.256 kNm at 1.80 m. from R1

Moment capacity, M_c = p_y.S_x = 275 x 123/1000 = 33.83 kNm OK

Beam is laterally restrained at supports only: effective length = 1.0L

Effective length (L_F) = 3.60m
Buckling parameter (u) = 0.889
β_w = 1.000 (Class 1/2 compact)
Bending strength, p_b = 120.1 N/mm^2

Slenderness, λ (L_F/r_v) = 3.60 x 100/2.10 = 171.4
Slenderness factor (v) = 0.675 (x = 19.6; λ/x = 8.75)
Equivalent slenderness (λ_{LT}) = u.v.λ.$\sqrt{\beta_w}$ = 102.8

Maximum moment within segment, M_x = 8.256 kNm
Equivalent uniform moment factor, m_{LT} = 0.925 (M_2=6.19, M_3=8.26, M_4=6.19)
Equivalent uniform moment = 0.925 x 8.256 = 7.636 kNm
Buckling resistance moment, M_b = p_b.S_x = 120.1 x 123/1000 = 14.78 kNm OK

Check unstiffened web capacity with load of 9.173 kN
C1 = 37.9 kN; C2 = 1.24 kN/mm; C4 = 129; K = min{0.5+(a_e/1.4d),1.0}; p_{vw} = 275N/mm^2
(for derivation of C factors see Steelwork Design Guide to BS5950-1:2000 6th ed.)
Bearing capacity, P_w = C1+b_1C2 (b_e taken as zero) Buckling capacity, P_x = K$\sqrt{}$(C4.P_w)
With b_1=0, unstiffened web buckling capacity, P_x = 34.9 kN: no minimum stiff bearing length required

LL deflection = 0.000 x 1e8/205,000 x 834.000 = 0.0 mm OK
TL deflection = 7.960 x 1e8/205,000 x 834 = 4.7 mm (L/773)

Bearing details

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

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

R1: 89 x 150 x 50h mm padstone

(minimum padstone height if unreinforced: 29 mm)

Factored reaction = 6.55 x 1.4 + 0.00 x 1.6 = 9.17 kN

Factored stress under padstone = 9.17 x 1000/89 x 150 = 0.69 N/mm^2

R2 as R1

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