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: 4.5 m.**

		Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*
U	D	o.w.	0.45	0		L	1.01	1.01
U	D	PITCHED ROOF	1.60*2.00	0		L	7.20	7.20
U	D	ROOF SPACE	0.55*2.00	0		L	2.48	2.48
U	D	BRICKWORK PARTITION	2.70*2.40	0		L	14.58	14.58
U	D	TIMBER FLOOR	2.0*2.00	0		L	9.00	9.00
					Unfactored reactions (kN)	**Total:**	**34.27**	**34.27**
						Dead:	*34.27*	*34.27*
						Live:	*0.00*	*0.00*
Total load: 68.54/95.95 kN *Unfactored/Factored*						**Factored reactions:**	**47.97**	**47.97**

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

Maximum B.M. (factored) = 54.0 kNm at 2.25 m. from R1

Maximum S.F. (factored) = 48.0 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 = 81.3 x 10^8/EI at 2.25 m. from R1

Beam calculation to BS5950-1:2000 using S275 steel

SECTION SIZE : **152 x 152 x 44 UC S275 (compact)**

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 S_x=372 cm^3

Shear capacity = 0.6 p_y.t.D = 0.6 x 275 x 9.5 x 166.0/1000 = 260 kN (>=48.0) OK

Maximum moment = 53.97 kNm at 2.25 m. from R1

Moment capacity, M_c = p_y.S_x = 275 x 372/1000 = 102.3 kNm OK

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

Effective length (L_F) = 4.50m
Buckling parameter (u) = 0.848
β_w = 1.000 (Class 1/2 compact)
Bending strength, p_b = 207.6 N/mm^2

Slenderness, λ (L_F/r_v) = 4.50 x 100/3.92 = 114.8
Slenderness factor (v) = 0.639 (x = 11.5; λ/x = 9.98)
Equivalent slenderness (λ_{LT}) = u.v.λ.$\sqrt{\beta_w}$ = 62.25

Maximum moment within segment, M_x = 53.97 kNm
Equivalent uniform moment factor, $m_{l\,T}$ = 0.925 (M_2=40.5, M_3=54.0, M_4=40.5)
Equivalent uniform moment = 0.925 x 53.97 = 49.92 kNm
Buckling resistance moment, M_b = p_b.S_x = 207.6 x 372/1000 = 77.23 kNm OK

Check unstiffened web capacity with load of 47.97 kN
C1 = 111 kN; C2 = 2.61 kN/mm; C4 = 1,192; 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 = 111 kN: no minimum stiff bearing length required

LL deflection = 0.000 x 1e8/205,000 x 2703.000 = 0.0 mm OK
TL deflection = 81.31 x 1e8/205,000 x 2703 = 14.7 mm (L/307)

Bearing details

152x152x44 UC stiff bearing length, b_1 = t + 1.6r + 2T = 48.9 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: 326 mm)

Factored reaction = 34.27 x 1.4 + 0.00 x 1.6 = 47.97 kN

Factored stress under padstone = 47.97 x 1000/700 x 100 = 0.69 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 A alternative for 9" wall** **Span: 4.5 m.**

		Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*
U	D	o.w.	0.5	0		L	1.13	1.13
U	D	PITCHED ROOF	1.60*2.00	0		L	7.20	7.20
U	D	ROOF SPACE	0.55*2.00	0		L	2.48	2.48
U	D	9" BRICKWORK	2.70*2.40	0		L	14.58	14.58
U	D	TIMBER FLOOR	2.0*2.00	0		L	9.00	9.00
U	D	PITCHED ROOF	1.60*1.20	0		L	4.32	4.32
U	D	ROOF SPACE	0.55*1.20	0		L	1.49	1.49
					Unfactored reactions (kN)	**Total:**	**40.19**	**40.19**
						Dead:	*40.19*	*40.19*
						Live:	*0.00*	*0.00*
						Factored reactions:	**56.26**	**56.26**

Total load: 80.37/112.52 kN *Unfactored/Factored*

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

Maximum B.M. (factored) = 63.3 kNm at 2.25 m. from R1

Maximum S.F. (factored) = 56.3 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 = 95.4 x 10^8/EI at 2.25 m. from R1

Beam calculation to BS5950-1:2000 using S275 steel

SECTION SIZE : **203 x 203 x 46 UC S275 (compact)**

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 S_x=497 cm^3

Shear capacity = 0.6 p_y.t.D = 0.6 x 275 x 7.2 x 203.2/1000 = 241 kN (>=56.3) OK

Maximum moment = 63.29 kNm at 2.25 m. from R1

Moment capacity, $M_c = p_y.S_x$ = 275 x 497/1000 = 136.7 kNm OK

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

Effective length (L_F) = 4.50m
Buckling parameter (u) = 0.846
β_w = 1.000 (Class 1/2 compact)
Bending strength, p_b = 211.4 N/mm^2

Slenderness, λ (L_F/r_v) = 4.50 x 100/5.13 = 87.72
Slenderness factor (v) = 0.819 (x = 17.7; λ/x = 4.96)
Equivalent slenderness (λ_{LT}) = u.v.λ.$\sqrt{\beta_w}$ = 60.74

Maximum moment within segment, M_x = 63.29 kNm
Equivalent uniform moment factor, $m_{l\,T}$ = 0.925 (M_2=47.5, M_3=63.3, M_4=47.5)
Equivalent uniform moment = 0.925 x 63.29 = 58.54 kNm
Buckling resistance moment, $M_b = p_b.S_x$ = 211.4 x 497/1000 = 105.0 kNm OK

Check unstiffened web capacity with load of 56.26 kN
C1 = 84.0 kN; C2 = 1.98 kN/mm; C4 = 399; 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 4570.000 = 0.0 mm OK
TL deflection = 95.35 x 1e8/205,000 x 4570 = 10.2 mm (L/442)

Bearing details

203x203x46 UC stiff bearing length, b_1 = t + 1.6r + 2T = 45.5 mm

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

R1: 850 x 100 x 425h mm padstone

(minimum padstone height if unreinforced: 403 mm)

Factored reaction = 40.19 x 1.4 + 0.00 x 1.6 = 56.26 kN

Factored stress under padstone = 56.26 x 1000/850 x 100 = 0.66 N/mm^2

R2 as R1

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