KCRDESIGN
PLANS TO INSPIRE

Structural Calculations
Address removed to protect client confidentiality
April 2016

6 Chada Avenue, Gillingham, kent. ME7 4BN
Compnay registered address: 7 - 7c Snuff Street, Devizes, Wiltshire. SN10 1DU
KCR Design is a trading style of Pickhill Services Ltd. Compnay Reg No. 6949517

Phone 01634 757355 Email enquiries@kcrdesign.co.uk Web www.kcrdesign.co.uk

KCR Design
6 Chada Avenue, Gillingham, Kent, ME7 4BN 01634 757355

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**

Beam: **Beam A** **Span: 2.7 m.**

	Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*
U D	o.w.	0.2	0		L	0.27	0.27
U D	BRICKWORK PARTITION	2.70*2.40	0		L	8.75	8.75
U D	BRICKWORK PARTITION	2.70*2.40	0		L	8.75	8.75
U D	TIMBER FLOOR	2.0*1.20	0		L	3.24	3.24
				Unfactored reactions (kN)	**Total:**	**21.01**	**21.01**
					Dead:	*21.01*	*21.01*
					Live:	*0.00*	*0.00*
Total load: 42.01/58.82 kN *Unfactored/Factored*					**Factored reactions:**	**29.41**	**29.41**

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

Maximum B.M. (factored) = 19.9 kNm at 1.35 m. from R1

Maximum S.F. (factored) = 29.4 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 = 10.8 x 10^8/EI at 1.35 m. from R1

Beam calculation to BS5950-1:2000 using S275 steel

SECTION SIZE : **178 x 102 x 19 UB S275 (compact)**

D=177.8 mm B=101.2 mm t=4.8 mm T=7.9 mm I_x=1,360 cm^4 r_y=2.37 cm S_x=171 cm^3

Shear capacity = 0.6 p_y.t.D = 0.6 x 275 x 4.8 x 177.8/1000 = 141 kN (>=29.4) OK

Maximum moment = 19.85 kNm at 1.35 m. from R1

Moment capacity, $M_c = p_y.S_x$ = 275 x 171/1000 = 47.02 kNm OK

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

Effective length (L_F) = 2.70m
Buckling parameter (u) = 0.886
β_w = 1.000 (Class 1/2 compact)
Bending strength, p_b = 159.9 N/mm^2

Slenderness, λ (L_F/r_v) = 2.70 x 100/2.37 = 113.9
Slenderness factor (v) = 0.815 (x = 22.6; λ/x = 5.04)
Equivalent slenderness (λ_{LT}) = u.v.λ.$\sqrt{\beta_w}$ = 82.23

Maximum moment within segment, M_x = 19.85 kNm
Equivalent uniform moment factor, $m_{l\,T}$ = 0.925 (M_2=14.9, M_3=19.9, M_4=14.9)
Equivalent uniform moment = 0.925 x 19.85 = 18.36 kNm
Buckling resistance moment, $M_b = p_b.S_x$ = 159.9 x 171/1000 = 27.34 kNm OK

Check unstiffened web capacity with load of 29.41 kN
C1 = 40.9 kN; C2 = 1.32 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 = 36.4 kN: no minimum stiff bearing length required

LL deflection = 0.000 x 1e8/205,000 x 1360.000 = 0.0 mm OK
TL deflection = 10.77 x 1e8/205,000 x 1360 = 3.9 mm (L/699)

Bearing details

178x102x19 UB stiff bearing length, b_1 = t + 1.6r + 2T = 32.8 mm

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

R1: 450 x 100 mm bearing plate

Factored reaction = 21.01 x 1.4 + 0.00 x 1.6 = 29.41 kN

20 mm m.s. bearing plate, size 450 x 100 mm
Bearing plate projection beyond stiff bearing length = (450-32.8)/2 = 208.6mm
Factored stress under plate = 29.41 x 1000/450 x 100 = 0.65 N/mm^2
Required plate thickness = $\sqrt{}$(3x0.65x209x209/265) = 17.9 mm: use 20mm
Factored bending stress in plate = 0.65x209x(209/2)/(20x20/6) = 213.3 N/mm^2 (p_y=265 N/mm^2)

R2: 102 x 450 mm bearing plate

Factored reaction = 21.01 x 1.4 + 0.00 x 1.6 = 29.41 kN

5 mm m.s. bearing plate, size 102 x 450 mm
Bearing plate projection beyond stiff bearing length = (102-32.8)/2 = 34.6mm
Factored stress under plate = 29.41 x 1000/102 x 450 = 0.64 N/mm^2
Required plate thickness = $\sqrt{}$(3x0.64x34.6x34.6/275) = 2.89 mm: use 5mm
Factored bending stress in plate = 0.64x34.6x(34.6/2)/(5x5/6) = 92.1 N/mm^2 (p_y=275 N/mm^2)

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

Beam: **Beam B** **Span: 4.0 m.**

	Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*
U D	o.w.	0.5	0		L	1.00	1.00
U D	BRICKWORK PARTITION	2.70*2.40	0		L	12.96	12.96
U D	BRICKWORK PARTITION	2.70*2.40	0		L	12.96	12.96
U D	TIMBER FLOOR	2.0*1.20	0		L	4.80	4.80
				Unfactored reactions (kN)	**Total:**	**31.72**	**31.72**
					Dead:	*31.72*	*31.72*
					Live:	*0.00*	*0.00*
Total load: 63.44/88.82 kN *Unfactored/Factored*					**Factored reactions:**	**44.41**	**44.41**

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

Maximum B.M. (factored) = 44.4 kNm at 2.00 m. from R1

Maximum S.F. (factored) = 44.4 kN at R1

Live load deflection = 0.00 x 10^8/EI at R2 *(E in N/mm², I in cm⁴)*

Total deflection = 52.9 x 10^8/EI at 2.00 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 cm⁴ r_y=5.13 cm S_x=497 cm³

Shear capacity = 0.6 p_y.t.D = 0.6 x 275 x 7.2 x 203.2/1000 = 241 kN (>=44.4) OK

Maximum moment = 44.41 kNm at 2.00 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) = 4.00m
Buckling parameter (u) = 0.846
β_w = 1.000 (Class 1/2 compact)
Bending strength, p_b = 224.0 N/mm²

Slenderness, λ (L_F/r_v) = 4.00 x 100/5.13 = 77.97
Slenderness factor (v) = 0.844 (x = 17.7; λ/x = 4.41)
Equivalent slenderness (λ_{LT}) = u.v.λ.$\sqrt{\beta_w}$ = 55.68

Maximum moment within segment, M_x = 44.41 kNm
Equivalent uniform moment factor, $m_{l\,T}$ = 0.925 (M_2=33.3, M_3=44.4, M_4=33.3)
Equivalent uniform moment = 0.925 x 44.41 = 41.08 kNm
Buckling resistance moment, M_b = p_b.S_x = 224.0 x 497/1000 = 111.3 kNm OK

Check unstiffened web capacity with load of 44.41 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/mm²
(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 = 52.86 x 1e8/205,000 x 4570 = 5.6 mm (L/709)

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/mm² (User-entered value)

R1: 650 x 100 mm bearing plate

Factored reaction = 31.72 x 1.4 + 0.00 x 1.6 = 44.41 kN

30 mm m.s. bearing plate, size 650 x 100 mm
Bearing plate projection beyond stiff bearing length = (650-45.5)/2 = 302.2mm
Factored stress under plate = 44.41 x 1000/650 x 100 = 0.68 N/mm²
Required plate thickness = $\sqrt{}$(3x0.68x302x302/265) = 26.6 mm: use 30mm
Factored bending stress in plate = 0.68x302x(302/2)/(30x30/6) = 208.0 N/mm² (p_y=265 N/mm²)

R2: 204 x 650 mm bearing plate

Factored reaction = 31.72 x 1.4 + 0.00 x 1.6 = 44.41 kN

5 mm m.s. bearing plate, size 204 x 650 mm
Bearing plate projection beyond stiff bearing length = (204-45.5)/2 = 79.2mm
Factored stress under plate = 44.41 x 1000/204 x 650 = 0.33 N/mm^2
Required plate thickness = $\sqrt{}$(3x0.33x79.2x79.2/275) = 4.79 mm: use 5mm
Factored bending stress in plate = 0.33x79.2x(79.2/2)/(5x5/6) = 252.3 N/mm^2 (p_y=275 N/mm^2)

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