TITLE:	**STRUCTURAL CALCULATIONS**
PROJECT TITLE:	**PROPOSED ALTERATIONS** **30 HALL STREET** **CLITHEROE**
CLIENT:	**MR & MRS RICE**
REF. NO.	**1490**
DATE:	**9TH AUGUST 2023.**

These calculations are to be read in conjunction with the following drawings:
Existing Ground & First Floor Plans
Proposed Ground Floor Plan

PD Construction Consultants

[redacted]

Paul Derbyshire Dip.Surv.

[redacted]

LOADING DETAILS:

* NOTE:

Reference to "clear span" is the maximum distance between supports not actual beam length.

Actual beam length to include for bearings at each end and to be measured on site prior to ordering beams.

Beam sizes calculated are minimum sizes. Beam sizes may be increased to suit site conditions as required.

Padstone sizes calculated are minimum sizes and may be increased to suit site conditions as required.

1. CALCULATION FOR FLAT ROOF JOISTS TO NEW EXTENSION

Clear span of beam between supports = 2.22m

UD load from roof	= 2.22 x 0.40 @ 2.00kN/m²	= 21.78kN = (0.80kN/m)

2. CALCULATION FOR BEAM IN KITCHEN SUPPORTING SIDE WALL & NEW ROOF

Max clear span of beam between supports = 3.83m

UD load from proposed roof	= 0.5(3.83 x 2.22) @ 2.00kN/m²	= 8.50kN
UD load from existing roof	= 0.5(3.83 x 2.46) @ 2.00kN/m²	= 9.42kN
UD load from existing wall	= 0.5(3.83 x 3.83) @ 3.35kN/m²	= 14.67kN
UD load from existing first floor	= 0.5(3.83 x 2.46) @ 2.00kN/m²	= 9.42kN
	TOTAL UDL	= 42.01kN = (10.97kN/m)

3. CALCULATION FOR BEAM IN KITCHEN / DINING SUPPORTING REAR WALL

Max clear span of beam between supports = 4.68m

UD load from rear wall	= 4.68 x 3.20 @ 4.25kN/m²	= 63.65kN = (13.60kN/m)
Point load from beam ref 2 above @ 2.22 from R1	= 42.01 x 0.5	= 21.01kN

4. CALCULATION FOR STEEL BEAM LINTEL TO REAR BIFOLD DOORWAY

Max clear span of beam between supports = 3.86m

UD load from wall	= 3.86 x 0.50 @ 3.35kN/m²	= 6.47kN = (1.68kN/m)
Point load from beam ref 2 above @ 1.62 from R1	= 42.01 x 0.5	= 21.01kN

5. CALCULATION FOR STEEL BEAM TO LOUNGE

Max clear span of beam between supports = 3.15m

UD load from first floor	= 0.5(3.15 x 4.68) @ 2.00kN/m²	= 14.74kN = (4.68kN/m)

6. CALCULATION FOR LINTEL TO LOUNGE / DINING ROOM DOORWAY

Max clear span of beam between supports = 1.80m

UD load from first floor wall	= 0.5(1.80 x 1.80) @ 2.25kN/m²	= 3.65kN = (2.03kN/m)

From Naylor Lintels loadings tables 1no Economy Range ER2 140 x 100mm pre-cast concrete lintel is satisfactory, SWL = 4.81kN/m > 2.03kN/m imposed load.

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Beam: 1. FLAT ROOF JOISTS **Span: 2.22 m.**

	Load name	Loading w1	Start x1	Loading w2	End x2	R1comp	R2comp	Defl.
U T		0.80	0		L	0.89	0.89	0.25
				Total load (unfactored): **1.78 kN**		**0.89**	**0.89**	0.25

Load types: U:UDL; Load positions are measured in m. from R1; Load durations: D: Dead; L: Live

Maximum B.M. = 0.49 kNm (unfactored (all loads applied)) at 1.11 m. from R1

Maximum S.F. = 0.89 kN (unfactored) at R1

Total mid-span deflection: $0.25 \times 10^8/EI$ *(E in N/mm², I in cm⁴)*

Timber beam calculation to BS5268 Part 2: 2002 using C24 timber

Use 50 x 125 C24 *2.6 kg/m approx*

$z = 130\ cm^3$ $I = 814\ cm^4$

Timber grade: C24 Single member: No load sharing

K_3 (loading duration factor) = 1.00 (long term)

K_7 (depth factor) = $(300/125)^{0.11} = 1.10$ K_8 (load sharing factor) = 1.0

$E = 7{,}200\ N/mm^2$ (E_{min})

Bending

Permissible bending stress, $\sigma_{m,adm} = \sigma_{m,g}.K_3.K_7.K_8 = 7.5 \times 1.00 \times 1.10 \times 1.0 = 8.26\ N/mm^2$

Applied bending stress, $\sigma_{m,a} = 0.493 \times 1000/130 = 3.79\ N/mm^2$ OK

Shear

Permissible shear stress, $\tau_{adm,//} = \tau_{g,//}.K_3.K_8 = 0.71 \times 1.00 \times 1.0 = 0.71\ N/mm^2$

Applied shear stress, $\tau_a = 0.89 \times 1000 \times 3/(2 \times 50 \times 125) = 0.21\ N/mm^2$ OK

Deflection

Bending deflection $= 0.253 \times 10^8/(7{,}200 \times 814) = 4.3$ mm

Mid-span shear deflection = $1.2M_0/GA$ (G=E/16) = $1.2 \times 0.493 \times 10^6/((7200/16) \times 50 \times 125) = 0.2$ mm

Total deflection = 4.3 + 0.2 = 4.5 mm (0.0020 L) <= 0.003L OK

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Beam: 2. BEAM IN KITCHEN SUPPORTING SIDE WALL & NEW ROOF **Span: 3.83 m.**

	Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*	*Defl.*
U	T	10.97	0		L	21.01	21.01	30.7
				Total load (unfactored): **42.02 kN**		**21.01**	**21.01**	30.7

Load types: U:UDL; Load positions are measured in m. from R1; Load durations: D: Dead; L: Live

Maximum B.M. = 20.11 kNm (unfactored (all loads applied)) at 1.91 m. from R1

Maximum S.F. = 21.01 kN (unfactored) at R1

Total mid-span deflection: 30.7 x 10^8/EI *(E in N/mm², I in cm⁴)*

Steel beam calculation to BS449 Part 2 using S355 steel

SECTION SIZE : 2No 152 x 89 x 16 UB S355

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 *(per section)*

Bending

L_E/r_y = 3.83 x 100/2.10 = 182 D/T = 19.8

Permissible bending stress, p_{bc} = 99.8 N/mm^2

Actual bending stress, f_{bc} = 20.11 x 1000/(2 x 109) = 92.3 N/mm^2 OK

Shear

Permissible shear stress, p_s = 140 N/mm^2

Maximum shear in web, f_s = 21.01 x 1000/(2 x 4.5 x 152.4) = 15.3 N/mm^2 OK

Beam web

Check unstiffened web capacity with load of 21.01/2 = 10.50 kN

Bearing: p_b = 260N/mm^2 ; C1 = 31.0 kN C2 = 1.17 kN/mm
Buckling: p_c = 187N/mm^2 ; C1 = 64.2 kN; C2 = 0.842 kN/mm

Minimum required stiff bearing length, L_b = 0mm
Bearing capacity, P_w = C1 + L_b.C2 = 31.0kN ← OK
Buckling capacity, P_x = C1 + L_b.C2 = 64.2kN

Deflection

Total deflection = 30.7 x 1e8/(2 x 205,000 x 834) = 9.0 mm (L/426) OK

Combined bending and shear check (14.c)

Check $(f_{bc}/p_{bc})^2 + (f_s/p_s)^2$ = 0.854 + 0.000 = 0.854 at 1.91 (<=1.25 OK)

Bearings

152 x 89 x 16 UB stiff bearing length, b_1 = t + 1.6r + 2T = 32.1 mm; O/A b_1 taken as 120.8 mm

R1: 225 x 100 x 150 mm Padstone

Factored reaction = 1.40 x 21.01 = 29.4 kN

Masonry: 20N/mm^2 brick, class (iii) mortar, normal const/normal mfr

Local design strength (factored) = 5/3.5 = 1.43N/mm^2

Factored stress under padstone = 29.4 x 1000/225 x 100 = 1.31 N/mm^2 OK

R2: None

Beam to beam connection to be 100 x 100mm mild steel angle nominal 110mm length with 2no grade 8.8 M12 steel bolts per connection. Beams to be bolted together using grade 4.6 M10 bolts complete with spacer tubes at each end and at max. 900mm centres.

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Beam: 3. BEAM TO SUPPORT EXISTING REAR WALL **Span: 4.68 m.**

	Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*	*Defl.*
U	T	13.60	0		L	31.82	31.82	85
P	T	21.01	2.22			11.04	9.97	45
				Total load (unfactored): **84.7 kN**		**42.87**	**41.79**	130

Load types: U:UDL; P:Point load; Load positions are measured in m. from R1
Load durations: D: Dead; L: Live

Maximum B.M. = 61.7 kNm (unfactored (all loads applied)) at 2.22 m. from R1

Maximum S.F. = 42.9 kN (unfactored) at R1

Total mid-span deflection: 130 x 10^8/EI *(E in N/mm², I in cm⁴)*

Steel beam calculation to BS449 Part 2 using S355 steel

SECTION SIZE : 2No 203 x 133 x 30 UB S355

D=206.8 mm B=133.9 mm t=6.4 mm T=9.6 mm I_x=2,900 cm^4 r_y=3.17 cm Z_x=280 cm^3 *(per section)*

Bending

L_E/r_y = 4.68 x 100/3.17 = 148 D/T = 21.5

Permissible bending stress, p_{bc} = 115 N/mm^2

Actual bending stress, f_{bc} = 61.7 x 1000/(2 x 280) = 110 N/mm^2 OK

Shear

Permissible shear stress, p_s = 140 N/mm^2

Maximum shear in web, f_s = 42.9 x 1000/(2 x 6.4 x 206.8) = 16.2 N/mm^2 OK

Beam web

Check unstiffened web capacities with loads of 42.9/2 = 21.4 kN and 41.8/2 = 20.9 kN

Bearing: p_b = 260N/mm^2 ; C1 = 49.6 kN C2 = 1.66 kN/mm
Buckling: p_c = 187N/mm^2 ; C1 = 124 kN; C2 = 1.20 kN/mm

R1: Minimum required stiff bearing length, L_b = 0mm
Bearing capacity, P_w = C1 + L_b.C2 = 49.6kN ← OK
Buckling capacity, P_x = C1 + L_b.C2 = 124kN

R2: Minimum required stiff bearing length, L_b = 0mm
Bearing capacity, P_w = C1 + L_b.C2 = 49.6kN ← OK
Buckling capacity, P_x = C1 + L_b.C2 = 124kN

Deflection

Total deflection = 130 x 1e8/(2 x 205,000 x 2,900) = 10.9 mm (L/429) OK

Combined bending and shear check (14.c)

Check $(f_{bc}/p_{bc})^2 + (f_s/p_s)^2$ = 0.905 + 0.001 = 0.906 at 2.25 (<=1.25 OK)

Bearings

203 x 133 x 30 UB stiff bearing length, b_1 = t + 1.6r + 2T = 37.8 mm; O/A b_1 taken as 171.7 mm

Masonry: 20N/mm^2 brick, class (iii) mortar, normal const/normal mfr
Local design strength (factored) = 5/3.5 = 1.43N/mm^2

R1: 450 x 100 x 150 mm Padstone

Factored reaction = 1.40 x 42.9 = 60.0 kN

Factored stress under padstone = 60.0 x 1000/450 x 100 = 1.33 N/mm^2 OK

R2: 450 x 100 x 150 mm Padstone

Factored reaction = 1.40 x 41.8 = 58.5 kN

Factored stress under padstone = 58.5 x 1000/450 x 100 = 1.30 N/mm^2 OK

Beams to be bolted together using grade 4.6 M10 bolts complete with spacer tubes at each end and at max. 900mm centres.

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Beam: 4. LINTEL BEAM TO BI-FOLD DOORWAY **Span: 3.86 m.**

	Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*	*Defl.*
U T		1.68	0		L	3.24	3.24	4.9
P T		21.01	1.62			12.19	8.82	24.3
				Total load (unfactored): **27.49 kN**		**15.43**	**12.06**	29.1

Load types: U:UDL; P:Point load; Load positions are measured in m. from R1
Load durations: D: Dead; L: Live

Maximum B.M. = 22.80 kNm (unfactored (all loads applied)) at 1.62 m. from R1

Maximum S.F. = 15.43 kN (unfactored) at R1

Total mid-span deflection: 29.1 x 10^8/EI *(E in N/mm², I in cm⁴)*

Steel beam calculation to BS449 Part 2 using S355 steel

SECTION SIZE : 203 x 133 x 25 UB S355

D=203.2 mm B=133.2 mm t=5.7 mm T=7.8 mm I_x=2,340 cm^4 r_y=3.10 cm Z_x=230 cm^3

Bending

L_E/r_y = 3.86 x 100/3.10 = 125 D/T = 26.1

Permissible bending stress, p_{bc} = 126 N/mm^2

Actual bending stress, f_{bc} = 22.80 x 1000/230 = 99.1 N/mm^2 OK

Shear

Permissible shear stress, p_s = 140 N/mm^2

Maximum shear in web, f_s = 15.43 x 1000/(5.7 x 203.2) = 13.3 N/mm^2 OK

Beam web

Check unstiffened web capacities with loads of 15.43 kN and 12.06 kN

Bearing: p_b = 260N/mm^2 ; C1 = 39.5 kN C2 = 1.48 kN/mm
Buckling: p_c = 181N/mm^2 ; C1 = 105 kN; C2 = 1.03 kN/mm

R1: Minimum required stiff bearing length, L_b = 0mm
Bearing capacity, P_w = C1 + L_b.C2 = 39.5kN ← OK
Buckling capacity, P_x = C1 + L_b.C2 = 105kN

R2: Minimum required stiff bearing length, L_b = 0mm
Bearing capacity, P_w = C1 + L_b.C2 = 39.5kN ← OK
Buckling capacity, P_x = C1 + L_b.C2 = 105kN

Deflection

Total deflection = 29.1 x 1e8/(205,000 x 2,340) = 6.1 mm (L/636) OK

Combined bending and shear check (14.c)

Check $(f_{bc}/p_{bc})^2 + (f_s/p_s)^2$ = 0.618 + 0.003 = 0.621 at 1.62 (<=1.25 OK)

8mm mild steel plate to be welded to bottom flange of beam to carry outer leaf of masonry. Nominal 250mm width.

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Beam: 5. BEAM TO LOUNGE **Span: 3.15 m.**

	Load name	*Loading w1*	*Start x1*	*Loading w2*	*End x2*	*R1comp*	*R2comp*	*Defl.*
U	T	4.68	0		L	7.37	7.37	6.00
				Total load (unfactored): **14.74 kN**		**7.37**	**7.37**	6.00

Load types: U:UDL; Load positions are measured in m. from R1; Load durations: D: Dead; L: Live

Maximum B.M. = 5.80 kNm (unfactored (all loads applied)) at 1.58 m. from R1

Maximum S.F. = 7.37 kN (unfactored) at R1

Total mid-span deflection: 6.00 x 10^8/EI *(E in N/mm², I in cm⁴)*

Steel beam calculation to BS449 Part 2 using S355 steel

SECTION SIZE : 127 x 76 x 13 UB S355

D=127.0 mm B=76.0 mm t=4.0 mm T=7.6 mm I_x=473 cm^4 r_y=1.84 cm Z_x=75.0 cm^3

Bending

L_E/r_y = 3.15 x 100/1.84 = 171 D/T = 16.7

Permissible bending stress, p_{bc} = 118 N/mm^2

Actual bending stress, f_{bc} = 5.80 x 1000/75.0 = 77.4 N/mm^2 OK

Shear

Permissible shear stress, p_s = 140 N/mm^2

Maximum shear in web, f_s = 7.37 x 1000/(4.0 x 127.0) = 14.5 N/mm^2 OK

Beam web

Check unstiffened web capacity with load of 7.37 kN

Bearing: p_b = 260N/mm^2 ; C1 = 27.4 kN C2 = 1.04 kN/mm
Buckling: p_c = 192N/mm^2 ; C1 = 48.8 kN; C2 = 0.769 kN/mm

Minimum required stiff bearing length, L_b = 0mm
Bearing capacity, P_w = C1 + L_b.C2 = 27.4kN ← OK
Buckling capacity, P_x = C1 + L_b.C2 = 48.8kN

Deflection

Total deflection = 6.00 x 1e8/(205,000 x 473) = 6.2 mm (L/509) OK

Combined bending and shear check (14.c)

Check $(f_{bc}/p_{bc})^2 + (f_s/p_s)^2$ = 0.430 + 0.000 = 0.430 at 1.58 (<=1.25 OK)

Bearings

127 x 76 x 13 UB stiff bearing length, b_1 = t + 1.6r + 2T = 31.4 mm

Masonry: 20N/mm^2 brick, class (iii) mortar, normal const/normal mfr
Local design strength (factored) = 5/3.5 = 1.43N/mm^2

R1: 150 x 100 x 150 mm Padstone

Factored reaction = 1.40 x 7.37 = 10.32 kN

Factored stress under padstone = 10.32 x 1000/150 x 100 = 0.69 N/mm^2 OK

R2 as R1