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Structural Calculations

In respect of

Alterations for

32 Hillfield Road, Stapleford

Client

Broxtowe Borough Council

Job No. 18-423

Oct 2018

1	17-Oct-18	First issue
Issue no	Date	Description

MICHAEL EVANS & ASSOCIATES LTD Civil and Structural Engineers & Design Consultants	Tel. 01332 871840 Fax. 01332 871841 Date. Oct 2018	Project No. 18-423	Sheet No. 2

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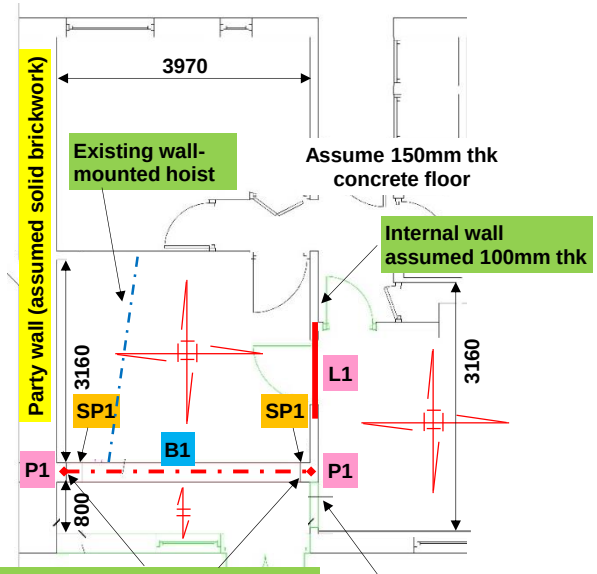
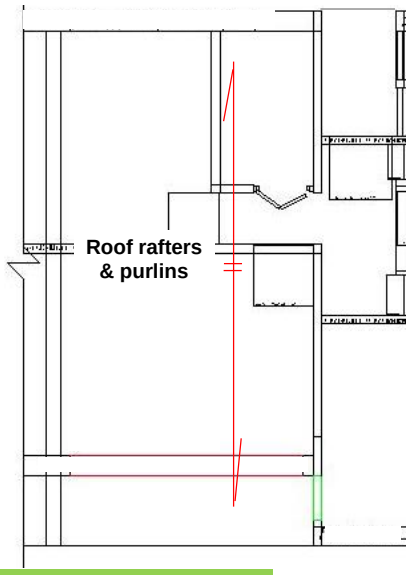
.:. Schematic arrangement.

GROUND FLOOR PLAN INDICATING FIRST FLOOR SLAB ARRANGEMENT ABOVE



FIRST FLOOR LAYOUT INDICATING ROOF STRUCTURE ABOVE



Note: Beam — Lintel — Assumed span direction of existing floor slab/ roof

Dimensions are for design purposes only

.:. Summary

NAME	DESCRIPTION	UDL	Length (m)			
		kN/m	Clear	End 1	End 2	Total
L1	Stressline R22A 100x220	32.3	1.010	0.150	0.150	1.310

Provide soft joint on top of new external wall so as NOT to alter load distribution of balcony.

Ref	Beam	Clear span [mm]	1 end [mm]	2 end [mm]	Total [mm]
B1	Option 1: 2/300 x 90 x 41PFC (275) bolted together @1.0m c/c, wt of each beam ~160kg	3550	200	200	3950
	Option 2: 254 x 254 x 73UC (275), weight of beam ~275kg				

Ref	Padstones
P1	Not required

Beam rests on engineering brick pier (SP1).

STOREY	LOCATION	MASONRY STRENGTH
Grd floor	SP1	min 75N/mm² brickwork in mortar M4

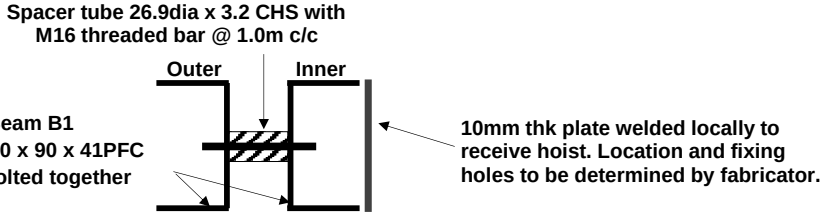
Foundation Underneath New Pier SP1:

Foundation Service Load ~ 85kN. Adequacy of existing foundation to be assessed seeking advice from Local Authority Building Official.

.:. Sketch (N.T.S.)

Option 1 beam:

ELEVATION / SECTION



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.:. Assumptions

EXISTING STRUCTURES

External wall	cavity wall 3.5 kN/m2
Internal wall	blockwork 1.7 kN/m2
Roof + ceiling	timber rafters 2.0 kN/m2
Floor	150mm thick concrete slab 7.2 kN/m2

These assumptions should be checked for compatibility before construction works commence

.:. Loading on lintel

Table of loading on lintels (MEA.T.02). All loads are at service

Lintel		Load on floor						Wall		Point load			Σ	
Name	Length	Roof		2nd floor		1st floor		H	Load	P	*n*	*K*	UDL	Note
	m	*m*	*kN/m²*	*m*	*kN/m²*	*m*	*kN/m²*	*m*	*kN/m²*	*kN*	*x/L*		*kN/m*	
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
L1	1.01	5.00	2.00			6.32	7.20	2.70	1.70				32.3	

(12) n=x/L (x:min distance from point load to either end; L span); (13) K according to BS 5977

> Selecting Internal lintels

Lintel table for Stressline (MEA.T.03)

Lintel				Stressline Lintels	Capacity		Load assessed			Check
Name	Clear	Eff.	Code	Type	Span	Load	UDL	W	M	
	m	*m*			*m*	*kN/m*	*kN/m*	*kN*	*kN-m*	
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
L1	1.01	1.11	*28*	R22A 100x220	1.2	35.28	32.3	35.9	5.0	OK

.:. Padstones

Padstone table (MEA.T.01). All loads are at ultimate

Padstone Ref.	Loading area			Reaction	Wall Strength				Without Padstone			With Padstone					Check
	L1	L2	Load		Mortar	Basic	f_k	γ_m	L_o	W_o	C_o	L_{ps}	W_{ps}	D_{ps}	Code	C_{ps}	
	m	*m*	*N_{ult}/m*	*kN_{ult}*		*kN/m^2*	*kN/m^2*		*mm*	*mm*	*kN_{ult}*	*mm*	*mm*	*mm*		*kN_{ult}*	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
$P1_{in}$	From B1 inner leaf			**69.9**	M4	75	**10.5**	3.5	200	90	**81**					**No**	OK
P1	From beam B1			**109.5**	M4	75	**10.5**	3.5	200	180	**135**					**No**	OK

(2)&(3)are spans of gross loading area; (5)=((2)*(3)*(4))/4;(12) C_o: Capacity without padstone C_o = 1.25*(8)*(10)*(11)/(1000*(9); (17) C_{ps}: Capacity of padstone C_{ps} = 1.25*(8)*(13)*(14)/(1000*(9), but if (12)>(5) then (17)="No" meaning do not need; (18)=OK when (17)≥(12).

.:. Design of required pier SP1 - B1 Build new solid brick pier in place of cavity wall

Loading

Load above pier 0.215 1.0 @ 38.9 = 8.4

Load from B1 (i.e. P1) = 73.0 (refer to Sheet No. 4 or 5)

81.4 kN_{serv} x 1.5 = 122 kN_{ult}

Try single pier 215 length x 325 width **Eccentricity at top say** 0.1 t

Construct in 75 N/mm^2 brickwork **in mortar** M4 f_k = 10.5 N/mm^2

Slenderness $\frac{1.00 \times 2400}{325}$ = 7.4 β say 0.88 **Area reduction factor =** 0.80

Capacity $\frac{215 \times 325 \times 10.5 \times 0.88 \times 0.80}{1000 \times 3.5}$ = 148 > 122 kN_{ult} OK

Adopt min 215 length x 325 width 75N/mm² brickwork in mortar M4

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∴ Consider beam B1 Suitable when concrete slab is discontinuous over cavity wall

Clear span = 3550 mm; Effective span say, L = 3750 mm

Loading:

			Inner	Outer
Main dwelling	3.2 / 2 @ 7.20 =		11.5	
Balcony	1.0 / 1 @ 6.90 =			6.9 (Cantilever)
Block	2.6 / 1 @ 1.50 =		3.8	
Brick	2.6 / 1 @ 2.00 =			5.1
Roof + ceiling	8.2 / 2 @ 2.00 =		8.2	
Block (balcony)	1.0 / 1 @ 1.70 =			1.7
Self weight			0.4	0.4
			23.9	14.1 kN/m$_{serv}$

Point load from hoist (max) 1.6 kN$_{serv}$

(track 30kg, unit 10kg, max working load 130kg)

Inner leaf

0.8 3.6 0.8

42.5 42.5

43.3 43.3

29.0 39.1 29.0

M$_{max}$= 39.1 kNm

UDL$_{eq}$= 24.8 kN/m

+ Inner leaf

L= 3.750 m UDL = 24.8 kN/m L_e = 1.2 L = 4.500 m m_{LT} = 0.925

W = 93.2 kN M = 43.7 kNm R = 46.6 kN (SLS)

x 1.50 W = 139.8 kN M = 65.5 kNm R = 69.9 kN (ULS)

Try 1 300 x 90 x 41 PFC *(code 4)* **grade 275 weight ~ 155 kg** 300 90 D/B= 3.333

Class= Plastic T= 15.5 p_y = 275 N/mm^2; Zx = 481 cm^3; Sx = 568 cm^3; Ix= 7220 cm^4

Shear check $P_v = 0.6 p_y A_v$ = 0.6 x 275 x 9 x 300 = **446 kN**

Fv/xPv = 69.9 / 446 = 0.16 < 0.6 Low shear OK

Mc check Plastic Mcx=py Sx 156.2 1.2 py Zx = 158.7 **1x Mcx = 1 156.2 = 156.2 kNm**

MA / 1Mcx = 65.5 / 156.2 = 0.42 OK

Mb check

ry	*λ*	*u*	*x*	*v*	*β$_w$*	*λ$_{LT}$*	*λ$_0$*	*η$_{LT}$*	*p$_E$*	*Φ$_{LT}$*	*p$_b$*	*Le limit*
2.8	*162.5*	*0.9*	*18.40*	*0.67*	*1.0*	*102.0*	*34.3*	*0.47*	*194*	*281*	*122*	0.950

$M_A = M_{ULT}$ = 65.5 kNm Mb =pb Sx= 69.0 1 Mb = 69.0 kNm

MA/(1Mb/mLT) = 65.5 /(69.0 / 0.925)= 0.88 OK

Deflection Deflection limit to 14 mm and L/ 360 I_x = 7220

$$d_{D+L} = \frac{5 \times 93.2 \times 3750^3}{384 \times 205 \times 7220 \times 10000} = 4.3 \text{ mm} = L/868$$ **OK**

+ Outer leaf

L= 3.750 m UDL = 14.1 kN/m L_e = 1.2 L = 4.500 m m_{LT} = 0.925

W = 52.9 kN$_{serv}$ M = 24.8 kNm$_{serv}$ R = 26.4 kN$_{serv}$

γ_f say = 1.50 W = 79.3 kN$_{ult}$ M = 37.2 kNm$_{ult}$ R = 39.7 kN$_{ult}$

Try 1 300 x 90 x 41 PFC *(code 4)* **grade 275 weight ~ 155 kg** 300 90 D/B= 3.333

Class= Plastic T= 15.5 p_y = 275 N/mm^2; Zx = 481 cm^3; Sx = 568 cm^3; Ix= 7220 cm^4

Shear check $P_v = 0.6 p_y A_v$ = 0.6 x 275 x 9 x 300 = **446 kN**

Fv/xPv = 39.7 / 446 = 0.09 < 0.6 Low shear **OK**

Mc check Plastic Mcx=py Sx= 156.2 1.2 py Zx = 158.7 **1x Mcx = 1 156.2 = 156.2 kNm**

MA / 1Mcx = 37.2 / 156.2 = 0.24 OK

Mb check

ry	*λ*	*u*	*x*	*v*	*β$_w$*	*λ$_{LT}$*	*λ$_0$*	*η$_{LT}$*	*p$_E$*	*Φ$_{LT}$*	*p$_b$*	Le limit
2.8	*162.5*	*0.9*	*18.40*	*0.67*	*1.0*	*102.0*	*34.3*	*0.47*	*194*	*281*	*122*	0.950

$M_A = M_{ULT}$ = 37.2 kNm Mb =pb Sx= 69.0 1 Mb = 69.0 kNm

MA/(1Mb/mLT) = 37.2 /(69.0 / 0.925)= 0.5 OK

Deflection Deflection limit to 14 mm and L/ 360 I_x = 7220

$$d_{D+L} = \frac{5 \times 52.9 \times 3750^3}{384 \times 205 \times 7220 \times 10000} = 2.5 \text{ mm} = L/1529$$ **OK**

Adopt 2/300 x 90 x 41PFC (275) bolted together @1.0m c/c, weight of each beam ~160kg

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Single Beam Option for B1

> **Consider beam** B1 **Suitable when concrete slab is continuous over cavity wall**

Clear span = 3550 mm; Effective span say, L = 3750 mm

Loading:

Roof + ceiling	8.2	/	2 @	2.00	=	8.2	**Hoist load: 1.6 kN_{serv}**
1st floor	3.2	/	2 @	7.20	=	11.5	Considering value, disregard hoist load.
Balcony	1.0	/	1 @	6.90	=	6.9	(Assumed supported on 3 sides - conservatively to cantilever)
Block	2.6	/	1 @	1.50	=	3.8	
Brick	2.6	/	1 @	2.00	=	5.1	
Block (balcony)	1.0	/	1 @	1.70	=	1.7	
Self weight						0.8	
						38.0 kN/m	

\+ **Consider steel beam**

L= 3.750 m UDL = 38.0 kN/m L_e = 1.2 L = 4.500 m m_{LT} = 0.925

W = 142.7 kN M = 66.9 kNm R = 71.3 kN (SLS)

x 1.50 W = 214.0 kN M = 100.3 kNm R = 107.0 kN (ULS)

To support cavity wall in case slab is not continuous:

Try 1 254 x 254 x 73 UC *(code 23)* **grade 275 weight ~ 274 kg** 254 254 D/B= 1

Class= Plastic T= 14.2 p_y = 275 N/mm^2; Zx = 898 cm^3; Sx = 992 cm^3; Ix= 11407 cm^4

Shear check $P_v = 0.6 p_y A_v$ = 0.6 x 275 x 8.6 x 254.1 = **361 kN**

Fv/xPv = 107.0 / 361 = **0.3** < 0.6 Low shear **OK**

Mc check Plastic Mcx=py Sx 272.8 1.2 py Zx = 296.3 1x Mcx = 1 272.8 = 272.8 kNm

MA / 1Mcx = 100.3 / 272.8 = **0.37** **OK**

Mb check

ry	*λ*	*u*	*x*	*v*	β_w	λ_{LT}	λ_0	η_{LT}	p_E	Φ_{LT}	p_b	*Le limit*
6.5	*69.4*	*0.8*	*17.30*	*0.86*	*1.0*	*50.9*	*34.3*	*0.12*	*782*	*574*	*236*	*2.223*

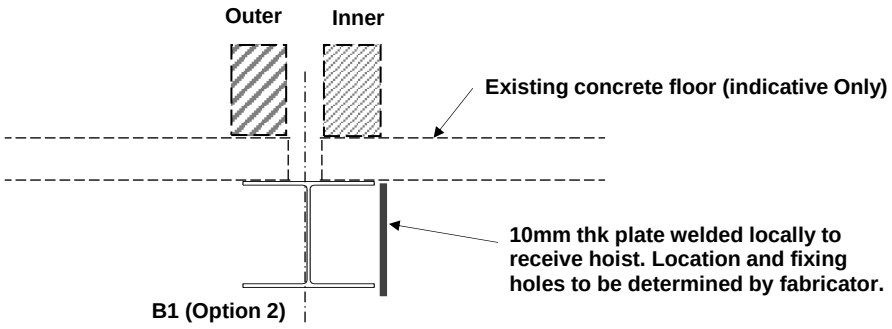
$M_A = M_{ULT}$ = 100.3 kNm Mb =pb Sx= 234.0 1 Mb = 234.0 kNm

MA/(1Mb/mLT) = 100.3 /(234.0 / 0.925)= **0.4** **OK**

Deflection Deflection limit to 14 mm and L/ 360 I_x = 11407

$$d_{D+L} = \frac{5 \times 142.7 \times 3750^3}{384 \times 205 \times 11407 \times 10000} = 4.2 \text{ mm} = L/895$$ **OK**

Adopt 254 x 254 x 73UC (275), weight of beam ~275kg, 200mm end bearing.



ELEVATION / SECTION