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Flat 3.16 St Pancras Chambers

Structural Alterations to Flat No. 3.16

It is proposed to construct a new mezzanine floor within the existing high ceilinged 3rd floor flat.

The mezzanine is to be a steel frame design (bearing on the existing load bearing structure) with a timber joist infill.

New steel beams & timber joists to be designed. Existing structure to be checked as necessary for its capacity to support new loads.

Loads		DL	LL	Total kN/m²
Domestic Timber Floor	:	0.70	1.50	2.2
Mezzanine Timber Floor	:	0.50	1.50	2.0
Balustrade	:	0.30	—	0.3
Stud Partition	:	0.50	—	0.5
112mm Brickwork	:	2.50	—	2.5
225mm Brickwork	:	4.80	—	4.8
330mm Brickwork	:	7.50	—	7.5
450mm Brickwork	:	9.80	—	9.8

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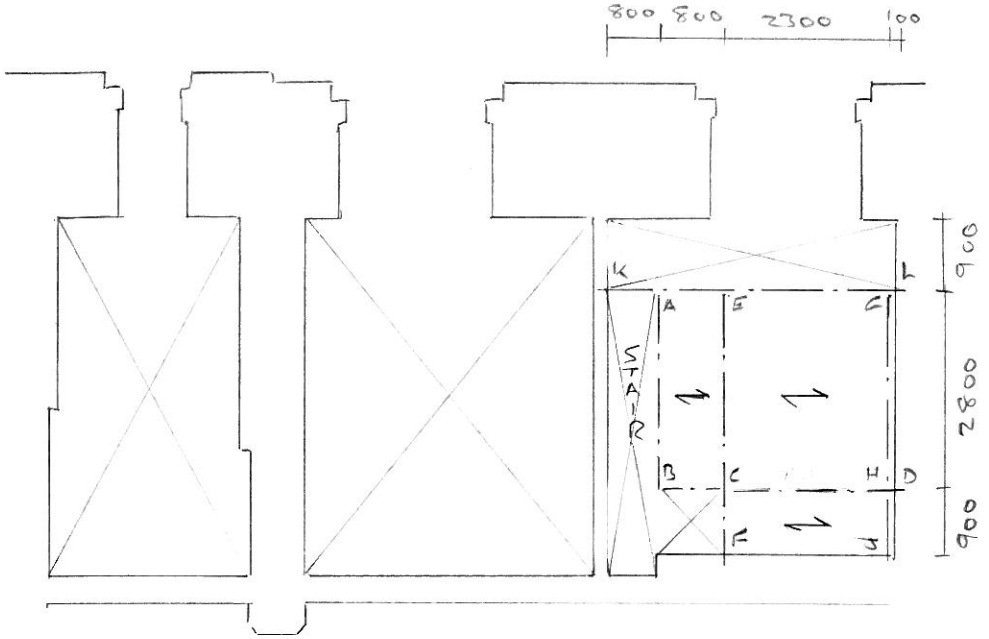
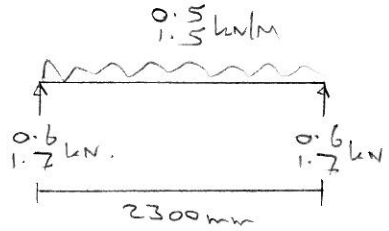
FLAT-3.16 ST PANCRAS CHAMBERS.

DESIGN LAYOUT OPTION-1



FLOOR : JOISTS — SPAN & LOADS ARE NOT EXCESSIVE :. BS-5268 CODE OF PRACTICE DEEMED SUFFICIENTLY ROBUST FOR TIMBER DESIGN.



$$M = \frac{WL^2}{8} = 1.0\,kNm$$

Try 125 x 50 C-16 Joists @ 350mm c/c

$$Z_{req'd} = \frac{1.0 \times 10^6}{5.3 \times 11} = 0.17 \times 10^6$$

$$Z = \frac{50 \times 125^2}{6 \times 0.35} = 0.37 \times 10^6$$

$Z > Z_{req'd}$:. ok

$$\delta = \frac{5}{384} \times \frac{2.0 \times 2300^4}{8800 \times 0.23 \times 10^8} = 3.6mm.$$

$2300 \times 0.003 = 6.9mm$ $\quad 6.9 > 3.6$:. ok

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FLAT 3.16 ST PANCRAS CHAMBERS.

STEEL FRAME : LOADS

		DL	LL	TOTAL
AB : UDL : MEZZ FLOOR :	$0.5 \times \frac{0.8}{2}$ =	0.2		
	$1.5 \times \frac{0.8}{2}$ =		0.6	
BALUSTRADE :	$0.3 \times 1.2 \times 0.85$ =	0.3		
		0.5	0.6	1.1 kN/M
	(ULS)	0.7	0.9	1.6 kN/M
BC : UDL : MEZZ FLOOR :	$0.5 \times \frac{0.35}{2}$ =	0.1		
	$1.5 \times \frac{0.35}{2}$ =		0.3	
BALUSTRADE :	0.3×1.2 =	0.4		
		0.5	0.3	0.8 kN/M
	(ULS)	0.7	0.5	1.2 kN/M
POINT LOAD : REACTION BEAM-AB :	$0.5 \times \frac{2.8}{2}$ =	0.7		
	$0.6 \times \frac{2.8}{2}$ =		0.8	
		0.7	0.8	1.5 kN.
	(ULS)	0.9	1.2	2.1 kN.
CD : UDL : MEZZ FLOOR :	0.5×0.35 =	0.2		
	1.5×0.35 =		0.5	
STUD PARTITION :	0.5×2.2 =	1.1		
		1.3	0.5	1.8 kN/M
	(ULS)	1.8	0.8	2.6 kN/M

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FLAT 3.16 ST PANCRAS CHAMBERS.

LOADING CONTINUED

		DL	LL	TOTAL
CD : POINT LOAD : REACTION BEAMS C-S	: $0.6 \times \frac{3.7}{2}$ =	1.1		
	$1.7 \times \frac{3.2}{2}$ =		3.1	
		1.1	3.1	4.2 kN
	(GM)	1.5	4.7	6.2 kN
EF : UDL-1 : MEZZ FLOOR	: $0.5 \times \frac{3.1}{2}$ =	0.8		
	$1.5 \times \frac{3.1}{2}$ =		2.3	
		0.8	2.3	3.1 kN/M
	(GM)	1.1	3.5	4.6 kN/M
: UDL-2 : MEZZ FLOOR	: $0.5 \times \frac{2.3}{2}$ =	0.6		
	$1.5 \times \frac{2.3}{2}$ =		1.7	
BALUSTRADE	: 0.3×1.2 =	0.4		
		1.0	1.7	2.7 kN/M
	(GM)	1.4	2.6	4.0 kN/M
POINT LOAD : REACTION BC	: SEE SHEET 6 =	1.1		
	" " " =		1.0	
REACTION CD	: SEE SHEET 6 =	1.6		
	" " " =		0.7	
		2.7	1.7	4.4 kN.
	(GM)	3.6	2.6	6.2 kN.

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FLAT 3.16 ST PANCRAS CHAMBERS

LOADING CONTINUED

		DL	LL	TOTAL
GH : UDL : MEZZ FLOOR :	$0.5 \times \frac{2.3}{2}$ =	0.6		
(HS SIMILAR)	$1.5 \times \frac{2.3}{2}$ =		1.7	
		0.6	1.7	2.3 kN/M
	(GN)	0.8	2.6	3.4 kN/M
KL : UDL-1 : STAIR :	$0.5 \times \frac{2.8}{2}$ =	0.7		
	$1.5 \times \frac{2.8}{2}$ =		2.1	
BALUSTRADE :	0.3×1.2 =	0.4		
		1.1	2.1	3.2 kN/M
	(GN)	1.5	3.2	4.7 kN/M
: UDL-2 : MEZZ FLOOR :	0.5×0.35 =	0.1		
	$1.5 \times \frac{0.35}{2}$ =		0.3	
BALUSTRADE :	0.3×1.2 =	0.4		
		0.5	0.3	0.8 kN/M
	(GN)	0.7	0.5	1.2 kN/M
POINT : REACTION : SEE SHEET-2 =		2.2		
LOAD-1 BEAM EF	" " " =		4.6	
		2.2	4.6	6.8 kN.
	(GN)	3.0	6.9	9.9 kN.
POINT : REACTION : SEE SHEET- =		1.1		
LOAD-2 BEAM-GHS	: " " " =		3.2	
		1.1	3.2	4.3 kN.
	(GN)	1.5	4.8	6.3 kN.

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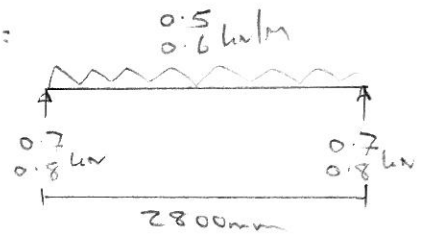
FLAT 3.16 ST PANCRAS CHAMBERS

UNFACTORED

FACTORED

AB :

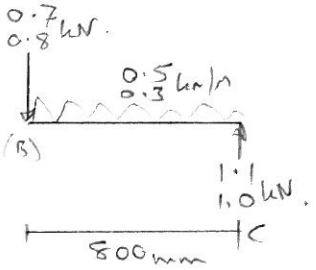


$M = \frac{wl^2}{8} = 1.1\ kNm.$

REACTIONS = 0.9 + 1.2 kN.

MOMENT = 1.6 kNm.

BC :

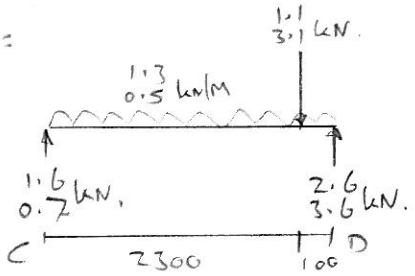


REACTION = 1.5 + 1.5 kN.

MOMENT = 2.1 kNm.

$M = (1.5 \times 0.8) + (0.8 \times 0.8 \times 0.4) = 1.5\ kNm.$

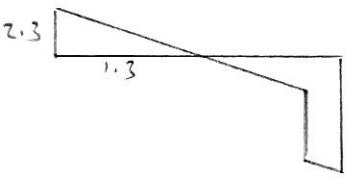
CD :



R_C = 2.2 + 1.1 kN.

R_D = 3.5 + 5.4 kN.

M = 2.1 kNm.



$M = \frac{1}{2} \times 2.3 \times 1.3 = 1.5\ kNm.$

If $M = \frac{wl^2}{8} \Rightarrow w = \frac{8M}{l^2} = 2.1\ kNm.$

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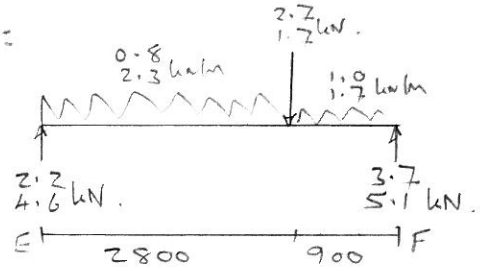
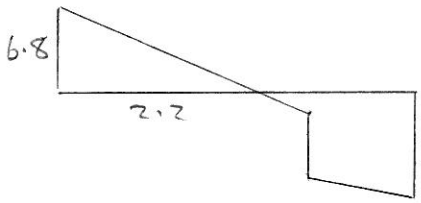
FLAT 3.16 ST PANCRAS CHAMBERS

UNFACTORED

FACTORED

E-F:





$M = \frac{1}{2} \times 6.8 \times 2.2 = 7.5\ kNm$

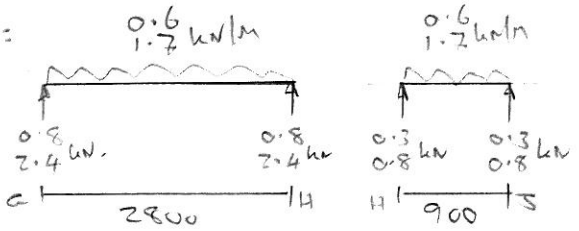
If $M = \frac{Wl^2}{8} = 4.4\ kN/m$

$R_E = 3.0 + 6.9\ kN$

$R_F = 5.0 + 7.7\ kN$

$M = 10.9\ kNm$

G-J:



$M = \frac{Wl}{8} = 2.3\ kNm$

$M = \frac{Wl^2}{8} = 0.2\ kNm$

$R_G = 1.1 + 3.6\ kN$

$R_H = 1.5 + 4.8\ kN$

$R_J = 0.5 + 1.2\ kN$

$M_{GH} = 3.3\ kNm$

$M_{HJ} = 0.3\ kNm$

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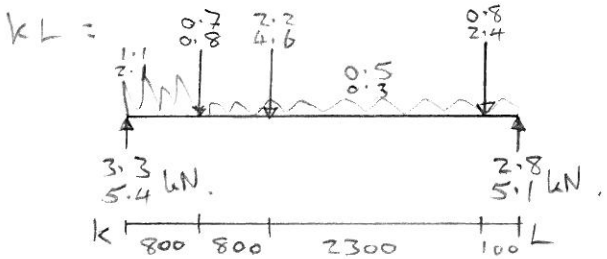
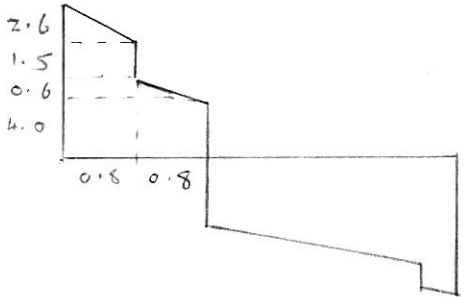
FLAT 3.16 ST PANCRAS CHAMBERS.

UNFACTORED

FACTORED





$R_K = 4.5 + 8.1$ kN.

$R_L = 3.8 + 7.2$ kN.

$M = 13.5$ kNm.

$M = \left(\frac{1}{2} \times 2.6 \times 0.8\right) + (6.1 \times 0.8) + \left(\frac{1}{2} \times 0.6 \times 0.8\right) + (4.0 \times 0.8) = 9.4$ kNm.

If $M = \frac{wl^2}{8} \Rightarrow w = \frac{8M}{l^2} = 4.7$ kN/M.

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FLAT 3.16 ST PANCRAS CHAMBERS.

BEAM DESIGN

TYPICALLY BEAMS TO BE 152 mm DEEP UB OR UC SECTIONS.

BEAMS GH & HS ARE TO BE CHANNELS AS THEY ARE SET AGAINST A MASONRY WALL.

BEAMS TO BE DESIGNED TO EUROCODE EN3 USING BLUE BOOK DESIGN TABLES & A CONSERVATIVE VALUE OF $C_1 = 1.0$.

AB

TRY 152×89 UB16,

$C_1 = 1.0$ $L = 2.8$ ∴ MOMENT RESISTANCE = 22.9 kNm.

$22.9 > 1.6$ ∴ ok

$$\delta = \frac{5}{384} \times \frac{1.1 \times 2800^4}{210\times10^3 \times 834\times10^4} = 0.5\text{mm}.$$

$$\frac{2800}{250} = 11.2\text{mm}$$

$11.2 > 0.5$ ∴ ok

BC

TRY 152×89 UB16

$C_1 = 1.0$ $L = 0.8\times1.2 = 1.0$ ∴ MOMENT RESISTANCE = 32.9 kNm

$32.9 > 2.1$ ∴ ok

$$\delta = \frac{1}{3} \times \frac{1.5\times10^3 \times 800^3}{210\times10^3 \times 834\times10^4} + \frac{1}{8} \times \frac{0.8\times10^3 \times 800^3}{210\times10^3 \times 834\times10^4} = 0.2\text{mm}$$

$$\frac{800}{180} = 4.4\text{mm}$$

$4.4 > 0.2$ ∴ ok

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FLAT 3.16 ST PANCRAS CHAMBERS

CD

TRY 152×89 UB16

$C_1 = 1.0$ $L_e = 2.4$ ∴ MOMENT RESISTANCE = 25.0 kNm.

$25.0 > 2.1$ ∴ ok

$$\delta = \frac{5}{384} \times \frac{2.1 \times 2400^4}{210 \times 10^3 \times 834 \times 10^4} = 0.5\text{mm}$$

$\frac{2400}{250} = 9.6\text{mm}$ $9.6 > 0.5$ ∴ ok

EF

TRY 152×89 UB16.

$C_1 = 1.0$ $L_e = 2.8$ ∴ MOMENT RESISTANCE = 22.9 kNm

$22.9 > 10.9$ ∴ ok

$$\delta = \frac{5}{384} \times \frac{4.4 \times 3700^4}{210 \times 10^3 \times 834 \times 10^4} = 6.1\text{mm}.$$

$\frac{3700}{250} = 14.8\text{mm}$ $14.8 > 6.1$ ∴ ok

CH

TRY 150×90×24 CHANNEL.

(115 SIMILAR) $C_1 = 1.0$ $L = 2.8$ ∴ MOMENT RESISTANCE = 35.9 kNm

$35.9 > 3.3$ ∴ ok

$$\delta = \frac{5}{384} \times \frac{2.3 \times 2800^4}{210 \times 10^3 \times 1160 \times 10^4} = \text{mm} < \frac{2800}{250} = 11.2\text{mm}$$ ∴ ok

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FLAT 3.16 ST PANCRAS CHAMBERS

KL

TRY 152×152 UC 23

$C_1 = 1.0$ $L = 4.0$ ∴ MOMENT RESISTANCE = 34.8 kNm

$34.8 > 13.5$ ∴ ok

$$\delta = \frac{5}{384} \times \frac{4.7 \times 4000^4}{210 \times 10^3 \times 1250 \times 10^4} = 6.0\text{mm}.$$

$$\frac{4000}{250} = 16.0\text{mm}$$

$16.0 > 6.0$ ∴ ok

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FLAT 3.16 ST PANCRAS CHAMBERS.

BEARINGS

EXISTING HISTORIC BRICKWORK HAS BEEN CONSERVATIVELY ASSESSED AS EQUIVALENT TO MODERN 5N/mm² STRENGTH BRICKS IN TYPE-IV MORTAR.

$$\therefore \text{LOCAL DESIGN STRENGTH} = \frac{1.25 f_k}{\gamma_m} = 0.79$$

WHERE $f_k = 2.2$ FOR 5N/mm² BRICKS IN TYPE-IV MORTAR

& $\gamma_m = 3.5$ FOR NORMAL MANUFACTURING & CONSTRUCTION CONTROLS.

$$\text{EXAMPLE @ D}: \frac{8.9 \times 10^3}{112 \times 0.79} = 100.6\text{mm}.$$

∴ PAD DIMS 225×112×150DP

USING SAME METHOD:

BEAM END	LOAD (kN)	MINIMUM LENGTH (mm)	PADSTONE DIMENSIONS (mm) L×W×D
F	12.7	143.5	225 × 112 × 150
J	1.7	19.2	225 × 112 × 150
K	12.6	142.4	225 × 112 × 150
L	11.5	130.0	225 × 112 × 150