LOCATION	CALCULATIONS	OPTIONS

10 Clorane Gardens
London NW3 7PR

DESIGN DATA SHEETS & STRUCTURAL CALCULATIONS.
for
New Basement and Upper Floor Alterations

PREPARED BY: **Ian Neads BSc(Hons) CEng MIStructE MICE**

DATE: **Jan-16**

10 Clorane Gardens, London NW3
New basement and upper floor alterations

LOCATION	CALCULATIONS		OPTIONS
	Calculation Index		
		Sheet numbers	
	Design data sheet and loading data.	**Data 1 to 4**	
	Loads on walls supported on suspended ground floor slab	**Load1 to Load3**	
	Ground Floor Slab design	**GFS1 to GFS40**	
	including:		
	Ground Floor slab reinforcement summary.	**GFS39 & GFS40**	
	Column Loading Assessment	**Col L1**	
	Perimeter wall loads	**Wall1 to Wall3**	
	Pad Foundations below central columns	**PF1 to PF3**	
	Steel Column Design - supporting ground floor slab.	**Col1**	
	Basement Retaining Wall.	**RW1 to RW6**	
	Basement Slab.	**BS1 to BS11**	
	including:		
	Retaining wall & basement slab reinforcement summary.	**BS9 to BS11**	
	Rear Ground Floor Extension	**RE1 to RE11**	
	First Floor Beam supporting rear wall over opening.	**BM1**	
	Steel Stool Design.	**Stool1**	
	General Notes and Construction Guidance	**Notes**	

LOCATION	CALCULATIONS	OPTIONS

STRUCTURAL DESIGN DATA SHEET

Description of the Structural Works

The development proposals at 10 Clorane Gardens include the construction of a basement below the complete footprint of the existing property. A single storey ground floor extension is also to be constructed at the rear of the property.

To provide support to the existing walls and loadbearing structure of the house, a ground floor slab in the form of an underpinned raft is to be constructed prior to the excavation for the basement. To construct this slab, a continuous slot is to be created at the base of existing internal load bearing walls, using steel stools installed in an underpinning type sequence to provide temporary support to the walls. With the new ground floor slab in place, excavation to the basement will commence in a “Top down” manner, removing dug soil from a “mole hole” left at the front of the property.

The basement is to be constructed as a reinforced concrete box designed to resist ground pressures and uplift forces . Retaining walls are to be constructed under the existing walls of the property in a staged underpinning sequence in order to maintain support to the existing walls at all time.

Alterations within the building’s upper floors primarily consist of relocation of existing non loadbearing walls to create the new room layouts. Internal loadbearing walls and timber floor structures will remain in place retaining the stability of the existing house.

Relevant Design Standards and guidance notes

BS 8103-1: 1995	Structural Design of Low Rise Buildings
BS 648: 1964	Schedule of Weights of Building Materials
BS 6399: Part 1: 1996	Loading for Buildings: Code of Practice for Dead and Imposed Loads
BS 6399: Part 3: 1988	Loading for Buildings: Code of Practice for Imposed Roof Loads
BS8102:2009	Protection of below ground structures
BS 8110;Part 1: 1997	Structural use of Concrete
BS 5628-1: 2005	Structural use of unreinforced masonry
BS 5950: Part 1: 2000	Structural use of Steelwork in Building
BS 5268-2: 2002	Structural use of timber

Steel designers Manual, 6th edition - The Steel Construction Institute.
Tata steel section Interactive 'Blue book'

LOCATION	CALCULATIONS	OPTIONS

Loading Data **Roof and upper floors**

Pitched roof

Dead	Tiles	0.64	
	Timbers joists	0.08	
	Battens	0.03	
	12.5mm plasterboard + skim	0.18	
	Insulation & Roofing felt	0.04	
	Total	0.97	kN/m^2

Pitch= 35 ° Dead load on plan = 0.97 /cos 35 = 1.18 kN/m^2

BS6399-3 cl 4.3.2 — Live at 35 ° pitch = 0.75 x (60- 35)/30 = 0.63 kN/m^2

Flat Roof (to rear single storey extension)

Dead	Timbers joists	0.16	
	double 12.5mm plasterbaord + skim	0.32	
	sarking board	0.15	
	Roof finish including waterproofing	0.13	
	insulation	0.02	
	Total	0.78	kN/m^2
Live	(allowing maintenance access)	0.75	kN/m^2

Suspended floors (first and second) [see Data 4 for ground floor]

Dead	Timbers joists	0.16	
	double 12.5mm plasterbaord + skim	0.32	
	Floorboards / T&G chipboard	0.12	
	Floor coverings	0.16	
	insulation	0.02	
	Total	0.78	kN/m^2
Live		1.50	kN/m^2

10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS				OPTIONS
	Loading Data	**Walls**			
	External solid walls (Existing)				
	Dead	Brickwork (215 mm thk.)	3.87		
		plastering	0.17		
		Total	4.04	kN/m^2	
	Existing internal loadbearing walls (100 thk brick)				
	Dead	Brickwork (100 thk)	1.80		
		plastering to wall both faces	0.34		
		Total	2.14	kN/m^2	
	New Internal wall in basement (Blockwork)				
	Dead	Medium density concrete blocks (100 thk)	1.80		
		12.5mm plasterbaord + skim (both sides)	0.34		
		Total	2.14	kN/m^2	
	Partition wall (studwork)				
	Dead	Timbers studs	0.09		
		12.5mm plasterbaord + skim (both sides)	0.34		
		insulation	0.02		
		Total	0.45	kN/m^2	
	Partition wall (studwork) to bathroom allowing for tiling				
	Dead	Timbers studs	0.09		
		12.5mm plasterbaord + skim (both sides)	0.34		
		tiling (one side of wall)	0.20		
		insulation	0.02		
		Total	0.65	kN/m^2	
	Perimeter basement retaining walls (Reinforced underpin)				
	Dead	Concrete retaining wall (300mm ave.)	7.20		
		Cavity drainage membrane & insulation	0.05		
		Blockwork liner wall (7.3 N/mm^2 aerated)	0.75		
		Plasterboard on dot and dabs	0.17		
		Total	8.17	kN/m^2	

LOCATION	CALCULATIONS			OPTIONS
	Loading Data **Basement and ground floor**			
	Basement slab			
	Dead slab 300 mm thk.	7.20		
	screed and cavity drainage	1.70		
	Floor coverings (allowing for tiled finish)	0.30		
	insulation	0.02		
	Total	9.22	kN/m^2	
	Live	1.50	kN/m^2	
	Ground Floor suspended slab			
	Dead slab 250 mm thk.	6.00		
	screed	1.10		
	Floor coverings (allowing for tiled finish)	0.30		
	12.5mm plasterbaord + skim on battens	0.18		
	partition allowance	1.00		
	Total	8.58	kN/m^2	
	Live	1.50	kN/m^2	
	Ground Floor suspended slab to rear extension			
	Dead beam block floor (1450 kg/m^3 block infill)	2.15		
	50mm screed	1.10		
	Tile bedding	0.12		
	Floor coverings, tiled / stone	0.30		
	insulation	0.04		
	Partition allowance	1.00		
	Total	4.71	kN/m^2	
	Live	1.50	kN/m^2	
	New cavity walls to rear extension			
	Dead Blockwork outer leaf (medium density concrete)	1.50		
	Cavity insulation	0.02		
	Blockwork innear leaf (7.3 N/mm^2 aerated)	0.75		
	External render	0.40		
	Plasterboard on dot and dabs	0.17		
	Total	2.84	kN/m^2	

Sheet No:	Load1	Project No:	K697
By	IN	Date	Jan-16
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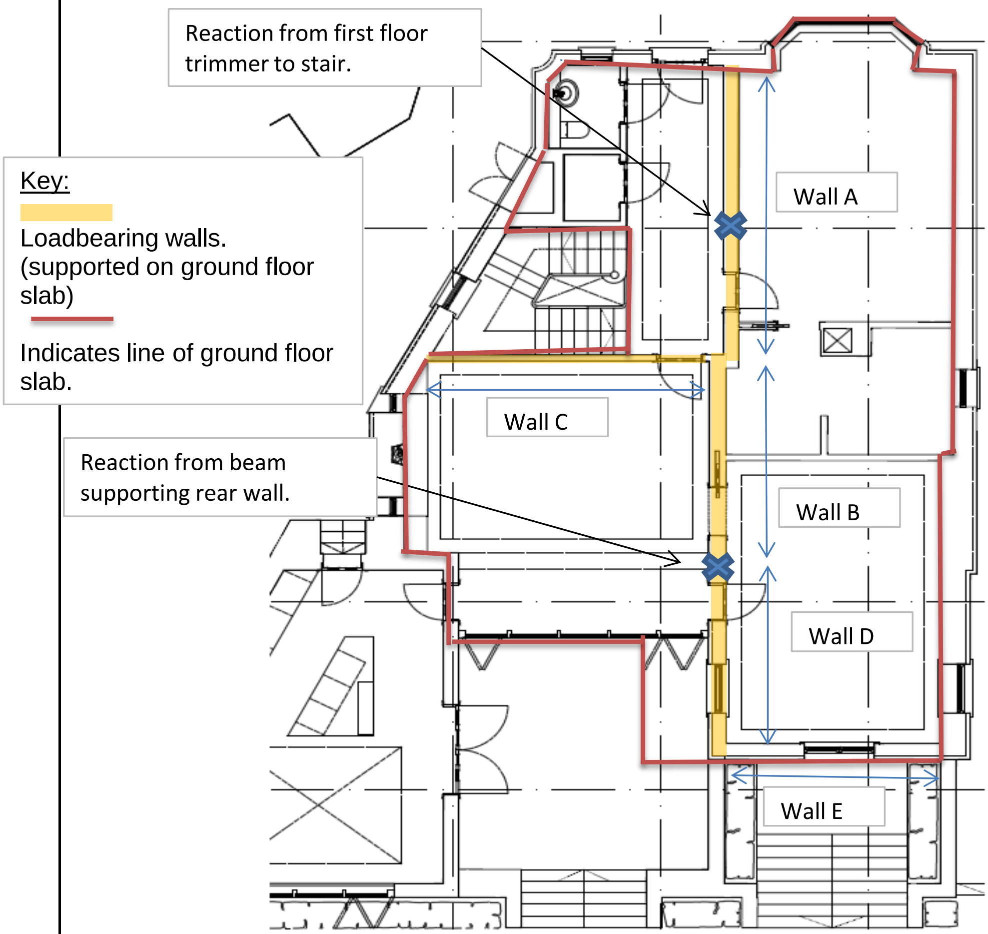
10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Wall Loading

Loads on walls supported on suspended ground floor slab



Ground floor plan showing walls supported on ground floor slab.

Refer to following calculation pages for load assessment.

Summary of wall loads

	Dead	Live	Ultimate	
Wall A	18.4	10.0	41.8	kN/m
Wall B	16.3	8.9	37.1	kN/m
Wall C	18.1	12.2	44.8	kN/m
Wall D	30.6	8.8	56.9	kN/m
Wall E rear wall	25.5	2.0	38.9	kN/m
Reaction from first floor trimmer	21.1	20.5	62.3	kN
Reaction from beam supporting rear wall.	50.6	27.6	115.0	kN

10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS							OPTIONS
	Wall Loading Assessment - Walls supported on ground floor slab							
	Loading on internal wall		**Wall A**					
						Dead	**Live**	
	Roof	(1.18 ,	0.63)x	4 x	1	4.7	2.5	
	Wall	0.45	x	2.2 x	1	1.0	0	
	Second	(0.78 ,	1.50)x	2.2 x	1	1.7	3.3	
	Wall	0.45	x	2.6 x	1	1.2	0	
	First	(0.78 ,	1.50)x	2.2 x	1	1.7	3.3	
	Wall	2.14	x	3 x	1	6.4	0	
	Total					16.7	9.1	kN/m
	Plus 10% design development contingency					18.4	10.0	kN/m
						28.4		kN/m
	Loading on internal wall		**Wall B**					
						Dead	**Live**	
	Roof	(1.18 ,	0.63)x	2.4 x	1	2.8	1.5	
	Wall	0.45	x	2.2 x	1	1.0	0	
	Second	(0.78 ,	1.50)x	2.2 x	1	1.7	3.3	
	Wall	0.45	x	2.6 x	1	1.2	0	
	First	(0.78 ,	1.50)x	2.2 x	1	1.7	3.3	
	Wall	2.14	x	3 x	1	6.4	0	
	Total					14.9	8.1	kN/m
	Plus 10% design development contingency					16.3	8.9	kN/m
						25.2		kN/m
	Loading on internal wall		**Wall C**					
						Dead	**Live**	
	Roof	(1.18 ,	0.63)x	2.4 x	1	2.8	1.5	
	Wall	0.45	x	2.2 x	1	1.0	0	
	Second	(0.78 ,	1.50)x	2.2 x	1	1.7	3.3	
	Stair	(0.78 ,	1.50)x	1 x	1	0.8	1.5	
	Wall	0.45	x	2.6 x	1	1.2	0	
	First	(0.78 ,	1.50)x	2.2 x	1	1.7	3.3	
	Stair	(0.78 ,	1.50)x	1 x	1	0.8	1.5	
	Wall	2.14	x	3 x	1	6.4	0	
	Total					16.4	11.1	kN/m
	Plus 10% design development contingency					18.1	12.2	kN/m
						30.3		kN/m
	Loading on wall D	Refer to perimeter wall load assessment sht. Wall L2.						
	Total					27.9	8.0	kN/m
	Plus 10% design development contingency					30.6	8.8	kN/m
	Loading on wall E	Refer to rear wall load assessment sht. Wall L1.						
	Total					23.2	1.8	kN/m
	Plus 10% design development contingency					25.5	2.0	kN/m

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Sheet No:	Load3	Project No:	K697
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10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

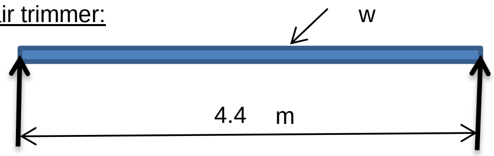
Wall Loading Assessment - Walls supported on ground floor slab

Reaction from first floor trimmer to stair

Loading on suported wall alongside stair

								Dead	Live	
Roof	(	1.18	,	0.63)x	2.5	x	1	3.0	1.6	
Wall		0.45		x	2.2	x	1	1.0	0	
Second	(	0.78	,	1.50)x	1.8	x	1	1.4	2.7	
Stair	(	0.78	,	1.50)x	1	x	1	0.8	1.5	
Wall		0.45		x	2.6	x	1	1.2	0	
First	(	0.78	,	1.50)x	1.8	x	1	1.4	2.7	
Total								8.7	8.5	kN/m
Plus 10% design development contingency								9.6	9.3	kN/m
								18.9		kN/m

Reaction from stair trimmer:



R

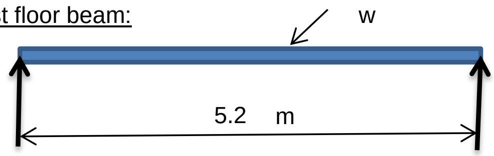
				Dead	Live	
R = w.L/2 =	w.	4.4	/2	21.1	20.5	kN

Reaction from first floor beam supporting rear wall

Loading on rear wall

								Dead	Live	
Roof	(	1.18	,	0.63)x	2.5	x	1	3.0	1.6	
Second	(	0.78	,	1.50)x	2.2	x	1	1.7	3.3	
balcony 1st	(	0.78	,	1.50)x	1	x	1	0.8	1.5	
Wall		4.04		x	2.6	x	1	10.5	0	
First	(	0.78	,	1.50)x	2.2	x	1	1.7	3.3	
Total								17.7	9.7	kN/m
Plus 10% design development contingency								19.4	10.6	kN/m
								30.1		kN/m

Reaction from first floor beam:



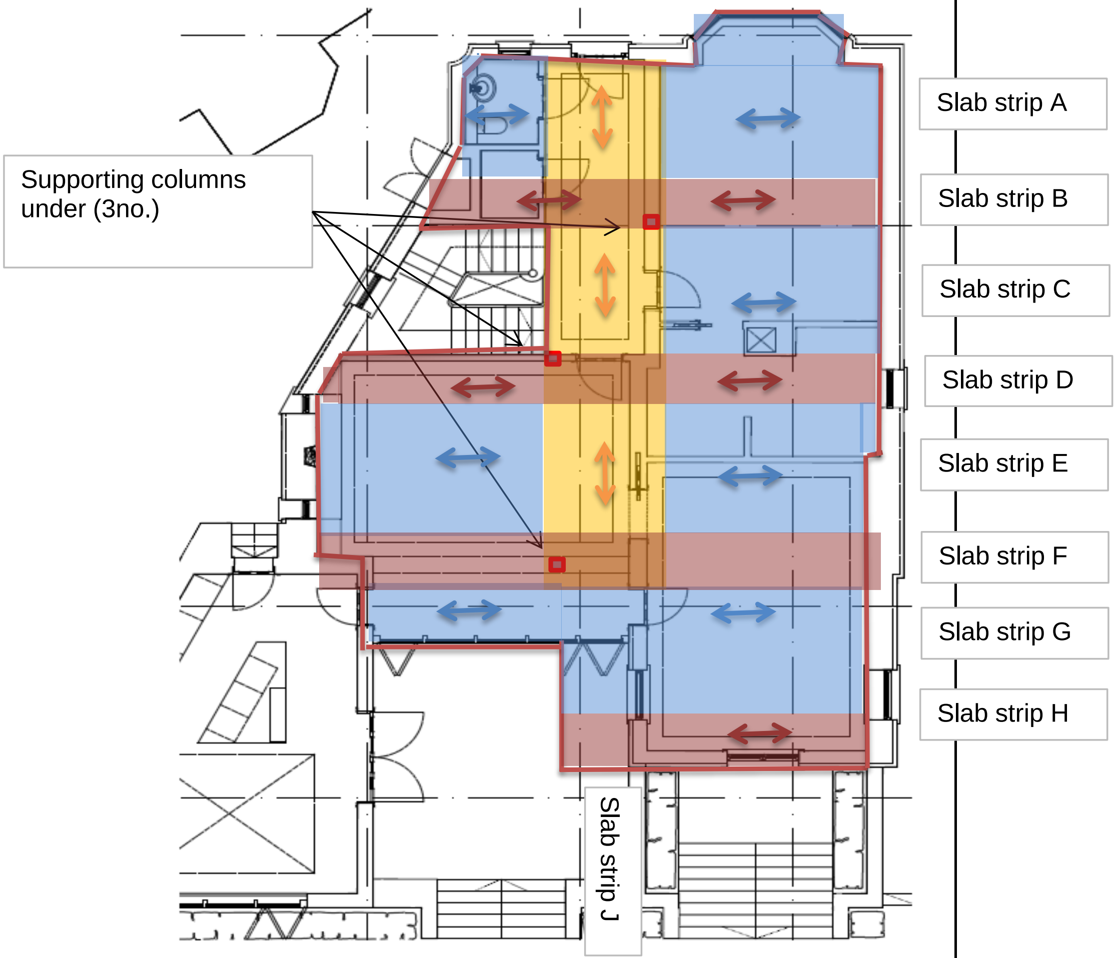
R

				Dead	Live	
R = w.L/2 =	w.	5.2	/2	50.6	27.6	kN

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design

Design arrangement of ground floor slab:



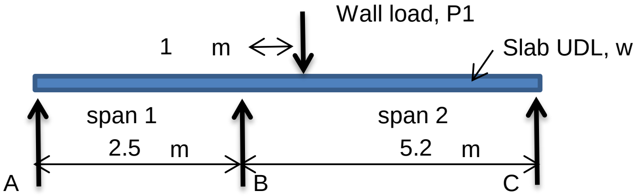
Ground floor plan showing arrangement of slab strips.

Slab strips are designed for the worst span configuration to either the centreline of supporting column or the centreline of supporting slab strip (Slab strip H) in order to take account of basement columns being non-concentric with the centreline of slab strips.

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design

Slab strip A **Continuous slab strip .**



Ultimate Loads:

Wall load, P1 = (From wall load calcs) = 41.8 kN/m (Wall A)

Slab UDL, w = 1.4 x 8.58 + 1.6 x 1.50 = 14.4 kN/m^2

Calculate Span moments using Moment Distribution, Hardy Cross method.

Relative stiffness of spans:

With EI being constant along length of slab strip, the stiffness is based an end support conditions and length of spans between supports.

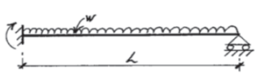
Span 1 = $0.75 \times \dfrac{1}{2.5} = 0.30$ Span 2 = $0.75 \times \dfrac{1}{5.2} = 0.14$

For a non-continuous support.

Distribution factors about support B:

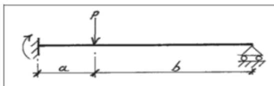
Span 1 = $\dfrac{0.30}{0.30 + 0.14} = 0.68$ Span 2 = $\dfrac{0.14}{0.30 + 0.14} = 0.32$

Fixed End Moments:

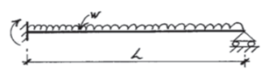


$\dfrac{wL^2}{8}$

FEM (BA) = $\dfrac{14.4 \times 2.5^2}{8} = 11.3$ kNm



$\dfrac{Pab(2L-a)}{2L^2}$



$\dfrac{wL^2}{8}$

FEM (BC) = $\dfrac{41.81 \times 1.00 \times 4.20\ (2 \times 5.20 - 1.00)}{2 \times 5.20^2} + \dfrac{14.4 \times 5.2^2}{8} = 79.2$ kNm

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design **Slab strip A**

Moment Distribution:

	A			B		C
DF			0.68	0.32		
FEM		0.0	-11.3	79.2	0.0	
DIST			-45.9	-22.1		
FINAL		0.0	-57.2	57.2	0.0	

kNm

Calculate support reactions:

Taking moments about support B: (Span 1)

$$RA \times 2.50 - w \times \frac{2.50^2}{2} = -57.2$$

$$RA = \frac{14.41 \times 2.50^2 /2 + -57.2}{2.50} = -5 \text{ kN}$$

Taking moments about support B: (Span 2)

$$RC \times 5.20 - P1 \times 1.00 - w \times \frac{5.20^2}{2} = -57.16$$

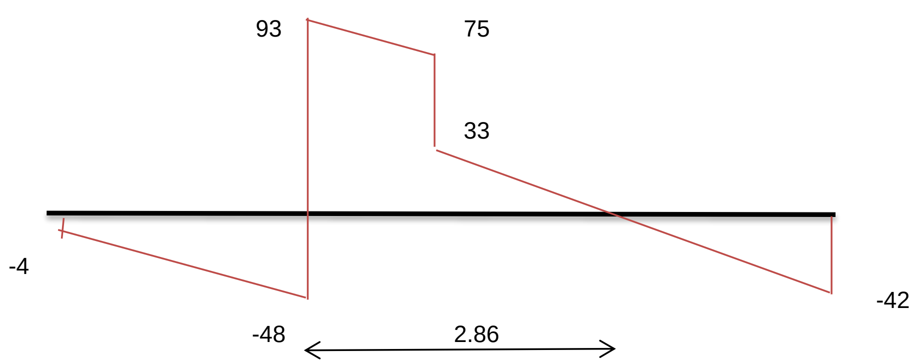
$$RC = \frac{41.81 \times 1.00 + 14.41 \times 5.20^2 /2 + -57.16}{5.20} = 35 \text{ kN}$$

Resolving forces vertically:

RB = P1 + w x 7.7 - RA - RC

RB = 41.81 + 14.41 x 7.7 - -4.851 - 34.52 = 123 kN

Shear Force diagram:



LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design **Slab strip A**

Calculate maximum span moments:

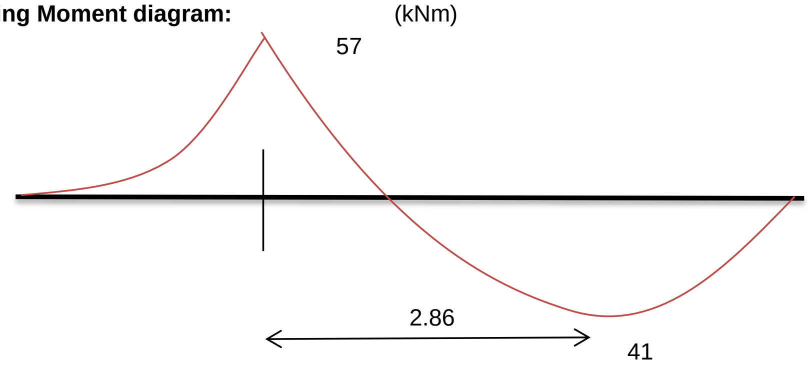
Taking moments about points of zero shear

Span 2 (x = 2.34 m[5.2 - 2.86])

$$RC \times 2.34 - w \times \frac{2.34^2}{2} =$$

$$34.52 \times 2.34 - 14.41 \times \frac{2.34^2}{2} = 41 \text{ kNm}$$

Bending Moment diagram: (kNm)



Slab strip B

Reaction on wall from first floor trimmer occurs directly over basement column. Hence take loading and span configuration for Slab strip B as being the same as for Slab strip A.

Hence: analysis and bending moments for Slab strip B are as Slab strip A.

LOCATION	CALCULATIONS	OPTIONS
	Ground floor Slab Reinforcement design	
	Slab strip A **Reinforcement design for maximum span moment**	
	M = **41** **kNm** **(Sagging)** strip width = 1000 mm	
	Slab depth = 250 mm Cover (bottom) = 20 mm	
	Effective depth, d = 250 - 20 - 10 = 220 mm	
	Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2	
	$k = M/bd^2f_{cu}$ $k = \frac{41.3 \times 10^6}{1000 \times 220^2 \times 35} = 0.024$	
	$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\}$ = (not greater than 0.95.d) = 214 mm	
	0.95d = 209 mm	
	$A_s\text{ (req)} = M/0.87f_yz = \frac{41.3 \times 10^6}{0.87 \times 500 \times 209} = 454.4\ mm^2$	**Provide**
	A_s (min) = 0.13% = 325 mm^2/m	**H16 @ 150**
		(1340)
	Reinforcement provided: **H16 @ 150** A_s (prov) = 1340 mm^2/m	**Bottom**
	A_s (prov) = 1340 mm^2	
	Deflection Check: basic l/d = 26 For continuous strip.	
		H12 @ 150
table 3.10	$M/b.d^2 = \frac{41 \times 10^6}{1000 \times 220^2} = 0.85$ $f_s = \frac{2.f_y.A_s\text{ req}}{3.A_s\text{ prov}} = 113\ N/mm^2$	**(753)**
		Top
	Modification factor, Mod (T) = $0.55 + \frac{(477 - f_s)}{120.(0.9 + M/b.d^2)} = 2.28 \leq 2.00$	
	(tension reinforcement)	Hence:
table 3.11	Modification factor, Mod (C) = 1.08 $100A'_s\text{ prov}/bd$ = 0.257	
	(compression reinforcement)	
	Allowable l/d = 26 x 2.28 x 1.08 = 63.9	l/d acceptable.
	Act. l/d = $\frac{5800}{220}$ = 26.4	

LOCATION	CALCULATIONS	OPTIONS

Ground floor Slab Reinforcement design

Slab strip A **Reinforcement design for maximum support moment**

M = **57** **kNm** **(Hogging)** strip width = 1000 mm

Slab depth = 250 mm Cover (top) = 20 mm
Effective depth, d = 250 - 20 - 10 = 220 mm
Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2

$k = M/bd^2f_{cu}$ $k = \dfrac{57.2 \times 10^6}{1000 \times 220^2 \times 35} = 0.034$

z = d{0.5 + √(0.25 - K/0.9)} = (not greater than 0.95.d) = 211 mm
0.95d = 209 mm

A_s (req) = $M/0.87f_yz$ = $\dfrac{57.2 \times 10^6}{0.87 \times 500 \times 209}$ = 628.8 mm^2

A_s (min) = 0.13% = 325 mm^2/m

Reinforcement provided: **H16 @ 150** A_s (prov) = 1340 mm^2/m
A_s (prov) = 1340 mm^2

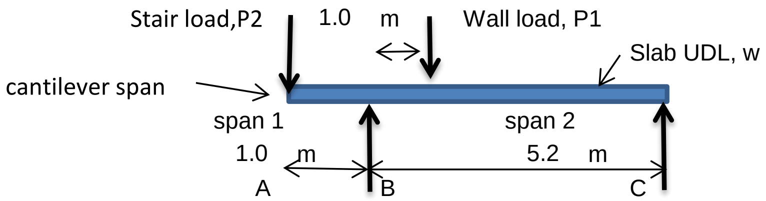
OPTIONS:
Provide
H16 @ 150
(1340)
Top

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design

Slab strip C

Design as slab with cantilever at one end to account for inbalance of loading and support line across width of continuous supporting slab strip.



Ultimate Loads:

Wall load, P1 = (From wall load calcs) = 41.8 kN/m (Wall A)

Stair load,P2 = (1.4 x 0.78 + 1.6 x 1.50) x 1.6 = 5.6 kN/m

Slab UDL, w = 1.4 x 8.58 + 1.6 x 1.50 = 14.4 kN/m^2

Analysis:

taking moments about support B (span1, cantilever span)

$$M = P2 \times 1.0 + w \times \frac{1.0^2}{2}$$

$$M = 5.6 \times 1.0 + 14.4 \times \frac{1.0^2}{2} = 12.8 \text{ kNm}$$

taking moments about support B (span 2)

$$RC \times 5.2 - P1 \times 1.0 - w \times \frac{5.2^2}{2} = -12.8$$

$$RC = \frac{41.8 \times 1.0 + 14.4 \times 5.2^2 /2 + -12.8}{5.2} = 43.1 \text{ kN}$$

Resolving forces vertically:

RB + RC = P1 + P2 + w x 6.2

RB = 41.8 + 5.6 + 14.4 x 6.2 - 43.1 = 93.7 kN

Sheet No:	GFS8	Project No:	K697
By	IN	Date	Jan-16
Checked:	GS	Date	

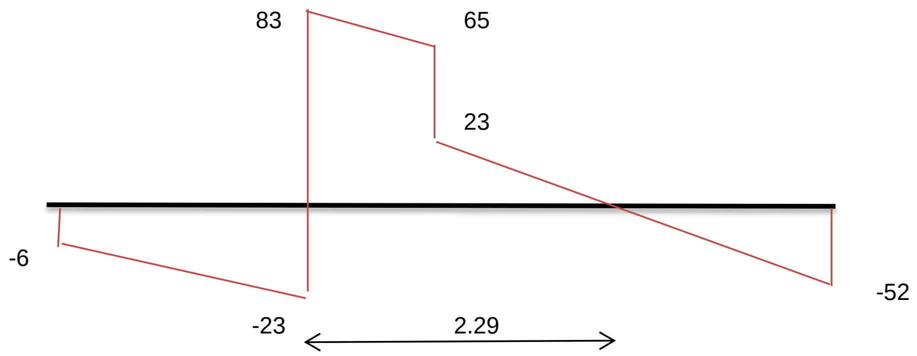
10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design **Slab strip C**

Shear Force diagram:



Calculate maximum span moments:

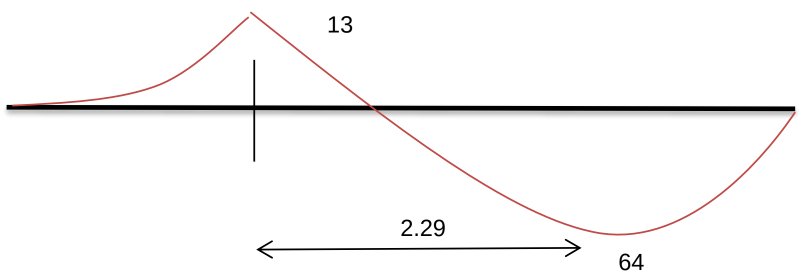
Taking moments about points of zero shear

Span 2 (x = 2.91 m[5.2 - 2.29])

$$RC \times 2.91 - w \times \frac{2.91^2}{2} =$$

$$43.05 \times 2.91 - 14.41 \times \frac{2.91^2}{2} = 64 \text{ kNm}$$

Bending Moment diagram: (kNm)



LOCATION	CALCULATIONS	OPTIONS

Ground floor Slab Reinforcement design

Slab strip C **Reinforcement design for maximum span moment**

M = **64** **kNm** **(Sagging)** strip width = 1000 mm

Slab depth = 250 mm Cover (bottom) = 20 mm
Effective depth, d = 250 - 20 - 10 = 220 mm
Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2

$k = M/bd^2f_{cu}$ $k = \dfrac{64.3 \times 10^6}{1000 \times 220^2 \times 35} = 0.038$

$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\}$ = (not greater than 0.95.d) = 210 mm
0.95d = 209 mm

A_s (req) = $M/0.87f_yz$ = $\dfrac{64.3 \times 10^6}{0.87 \times 500 \times 209}$ = 706.8 mm^2

A_s (min) = 0.13% = 325 mm^2/m

Reinforcement provided: **H16 @ 150** A_s (prov) = 1340 mm^2/m
A_s (prov) = 1340 mm^2

Provide

H16 @ 150
(1340)
Bottom

Deflection Check: basic l/d = 26 For continuous strip.

H12 @ 150
(753)
Top

table 3.10

$M/b.d^2 = \dfrac{64 \times 10^6}{1000 \times 220^2}$ **=** 1.33 $f_s = \dfrac{2.f_y.A_s \text{ req}}{3.A_s \text{ prov}}$ = 176 N/mm^2

Modification factor, Mod (T) = $\dfrac{0.55 + (477 - f_s)}{120.(0.9 + M/b.d^2)}$ = 1.68 ≤ 2.00
(tension reinforcement)

Hence:

table 3.11

Modification factor, Mod (C) = 1.08 $100A'_s$ prov/bd = 0.257
(compression reinforcement)
Allowable l/d = 26 x 1.68 x 1.08 = 47.0

l/d acceptable.

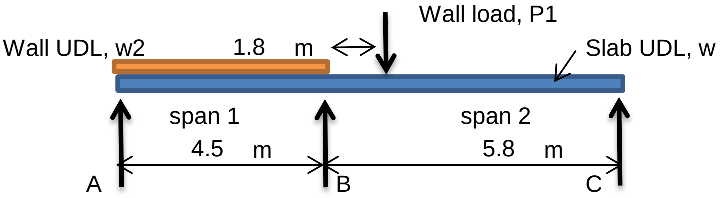
Act. l/d = $\dfrac{5800}{220}$ = 26.4

LOCATION	CALCULATIONS	OPTIONS
	Ground floor Slab Reinforcement design	
	Slab strip C **Reinforcement design for maximum support moment**	
	M = **14** **kNm** **(Hogging)** strip width = 1000 mm	
	Slab depth = 250 mm Cover (top) = 20 mm	
	Effective depth, d = 250 - 20 - 10 = 220 mm	
	Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2	
	$k = M/bd^2f_{cu}$ $k = \dfrac{14.0 \times 10^6}{1000 \times 220^2 \times 35} = 0.008$	
	$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\} =$ (not greater than 0.95.d) = 218 mm	
	0.95d = 209 mm	
	A_s (req) = $M/0.87f_yz$ = $\dfrac{14.0 \times 10^6}{0.87 \times 500 \times 209} = 154$ mm^2	**Provide**
	A_s (min) = 0.13% = 325 mm^2/m	**H16 @ 150** **(1340)** **Top**
	Reinforcement provided: **H16 @ 150** A_s (prov) = 1340 mm^2/m	
	A_s (prov) = 1340 mm^2	

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design

Slab strip D **Continuous slab strip .**



Ultimate Loads:

Wall load, P1 = (From wall load calcs) = 37.1 kN/m (Wall B)

Slab UDL, w = 1.4 x 8.58 + 1.6 x 1.50 = 14.4 kN/m^2
Wall UDL, w2 = (From wall load calcs.) = 44.81 kN/m (Wall C)

Calculate Span moments using Moment Distribution, Hardy Cross method.

Relative stiffness of spans:

With EI being constant along length of slab strip, the stiffness is based an end support conditions and length of spans between supports.

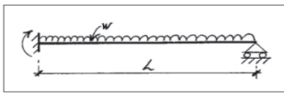
Span 1 = $0.75 \times \frac{1}{4.5} = 0.17$ Span 2 = $0.75 \times \frac{1}{5.8} = 0.13$

For a non-continuous support.

Distribution factors about support B:

Span 1 = $\frac{0.17}{0.17 + 0.13} = 0.56$ Span 2 = $\frac{0.13}{0.17 + 0.13} = 0.44$

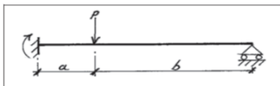
Fixed End Moments:



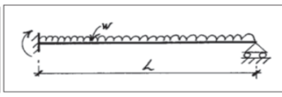
$\frac{wL^2}{8}$

w = 14.4 + 44.8 = 59.2 kN/m

FEM (BA) = $\frac{59.2 \times 4.5^2}{8} = 149.9$ kNm



$\frac{Pab(2L-a)}{2L^2}$



$\frac{wL^2}{8}$

FEM (BC) = $\frac{37.13 \times 1.80 \times 4.00 \; (2 \times 5.80 - 1.80)}{2 \times 5.80^2} + \frac{14.4 \times 5.8^2}{8} = 99.5$ kNm

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design **Slab strip D**

Moment Distribution:

	A			B		C
DF			0.56	0.44		
FEM		0.0	-149.9	99.5	0.0	
DIST			28.4	22.0		
FINAL		0.0	-121.6	121.6	0.0	

kNm

Calculate support reactions:

Taking moments about support B: (Span 1)

$$RA \times 4.50 - w \times \frac{4.50^2}{2} = -121.6$$

$$RA = \frac{59.23 \times 4.50^2 /2 + -121.6}{4.50} = 106 \text{ kN}$$

Taking moments about support B: (Span 2)

$$RC \times 5.80 - P1 \times 1.80 - w \times \frac{5.80^2}{2} = -121.6$$

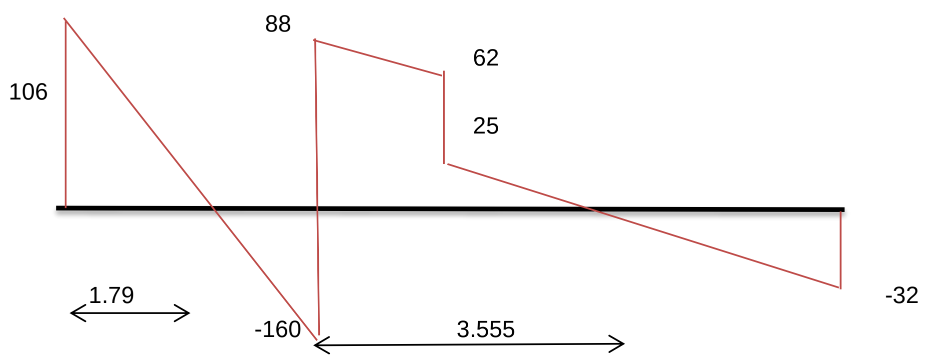
$$RC = \frac{37.13 \times 1.80 + 14.41 \times 5.80^2 /2 + -121.6}{5.80} = 32 \text{ kN}$$

Resolving forces vertically:

RB = P1 + w x 10.3 + w2 x 4.5 - RA - RC

RB = 37.13 + 14.41 x 10.3 + 44.81 x 4.5 - 106.2 - 32.36

Shear Force diagram: = 249 kN



LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design **Slab strip D**

Calculate maximum span moments:

Taking moments about points of zero shear

Span 1 (x = 1.79 m

$$RA \times 1.79 - w \times \frac{1.79^2}{2} =$$

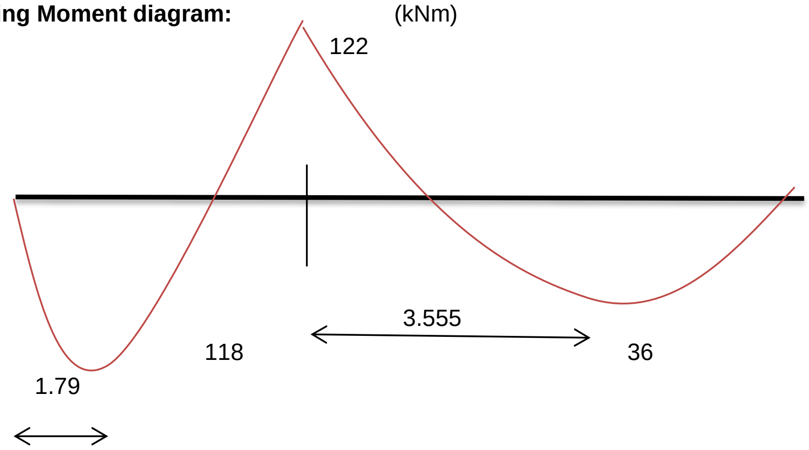
$$106 \times 1.79 - 44.81 \times \frac{1.79^2}{2} = 118 \text{ kNm}$$

Span 2 (x = 2.245 m[5.8 - 3.555])

$$RC \times 2.25 - w \times \frac{2.25^2}{2} =$$

$$32.36 \times 2.25 - 14.41 \times \frac{2.25^2}{2} = 36 \text{ kNm}$$

Bending Moment diagram: (kNm)



10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS
	Ground floor Slab Reinforcement design	
	Slab strip D **Reinforcement design for maximum span moment**	
	M = **118** **kNm** **(Sagging)** strip width = 1000 mm	
	Slab depth = 250 mm Cover (bottom) = 20 mm	
	Effective depth, d = 250 - 20 - 10 = 220 mm	
	Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2	
	$k = M/bd^2f_{cu}$ $k = \dfrac{118.5 \times 10^6}{1000 \times 220^2 \times 35} = 0.070$	
	$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\}$ = (not greater than 0.95.d) = 201 mm	
	0.95d = 209 mm	
	A_s (req) = $M/0.87f_yz$ = $\dfrac{118.5 \times 10^6}{0.87 \times 500 \times 201}$ = 1353 mm^2	**Provide**
	A_s (min) = 0.13% = 325 mm^2/m	**H16 @ 125** **(1608)**
	Reinforcement provided: **H16 @ 125** A_s (prov) = 1608 mm^2/m	**Bottom**
	A_s (prov) = 1608 mm^2	
	Deflection Check: basic l/d = 26 For continuous strip.	**H12 @ 125**
table 3.10	$M/b.d^2 = \dfrac{118 \times 10^6}{1000 \times 220^2}$ **=** 2.45 $f_s = \dfrac{2.f_y.A_s \text{ req}}{3.A_s \text{ prov}}$ = 280 N/mm^2	**(905)** **Top**
	Modification factor, Mod (T) = $0.55 + \dfrac{(477 - f_s)}{120.(0.9 + M/b.d^2)}$ = 1.04 ≤ 2.00	
	(tension reinforcement)	Hence:
table 3.11	Modification factor, Mod (C) = 1.09 100A'$_s$ prov/bd = 0.309	
	(compression reinforcement)	
	Allowable l/d = 26 x 1.04 x 1.09 = 29.5	l/d acceptable.
	Act. l/d = $\dfrac{4500}{220}$ = 20.5	

10 Clorane Gardens, London NW3

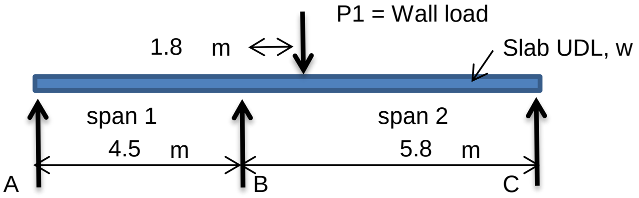
New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS
	Ground floor Slab Reinforcement design	
	Slab strip D **Reinforcement design for maximum support moment**	
	M = **122** **kNm** **(Hogging)** strip width = 1000 mm	
	Slab depth = 250 mm Cover (top) = 20 mm	
	Effective depth, d = 250 - 20 - 10 = 220 mm	
	Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2	
	$k = M/bd^2f_{cu}$ $k = \dfrac{121.6 \times 10^6}{1000 \times 220^2 \times 35} = 0.072$	
	$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\} =$ (not greater than 0.95.d) = 201 mm	
	0.95d = 209 mm	
	$A_s\,(req) = M/0.87f_yz = \dfrac{121.6 \times 10^6}{0.87 \times 500 \times 201} = 1392\ mm^2$	**Provide**
	A_s (min) = 0.13% = 325 mm^2/m	**H16 @ 125**
		(1608)
	Reinforcement provided: **H16 @ 125** A_s (prov) = 1608 mm^2/m	**Top**
	A_s (prov) = 1608 mm^2	

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design

Slab strip E **Continuous slab strip .**



Ultimate Loads:

Wall load = (From wall load calcs) = 44.81 (Wall C)

P1 = 44.81 + 0 = 44.8 kN/m

Slab UDL, w = 1.4 x 8.58 + 1.6 x 1.50 = 14.4 kN/m^2

Calculate Span moments using Moment Distribution, Hardy Cross method.

Relative stiffness of spans:

With EI being constant along length of slab strip, the stiffness is based an end support conditions and length of spans between supports.

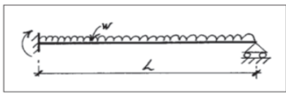
Span 1 = $0.75 \times \frac{1}{4.5} = 0.17$ Span 2 = $0.75 \times \frac{1}{5.8} = 0.13$

For a non-continuous support.

Distribution factors about support B:

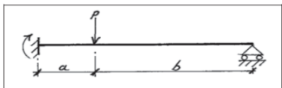
Span 1 = $\frac{0.17}{0.17 + 0.13} = 0.56$ Span 2 = $\frac{0.13}{0.17 + 0.13} = 0.44$

Fixed End Moments:

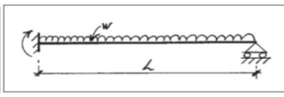


$\frac{wL^2}{8}$

FEM (BA) = $\frac{14.4 \times 4.5^2}{8}$ = 36.5 kNm



$\frac{Pab(2L-a)}{2L^2}$



$\frac{wL^2}{8}$

FEM (BC) = $\frac{44.81 \times 1.80 \times 4.00\ (2 \times 5.80 - 1.80)}{2 \times 5.80^2} + \frac{14.4 \times 5.8^2}{8}$ = 107.6 kNm

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design **Slab strip E**

Moment Distribution:

	A		B		C	
DF			0.56	0.44		
FEM		0.0	-36.5	107.6	0.0	
DIST			-40.0	-31.1		
FINAL		0.0	-76.5	76.5	0.0	kNm

Calculate support reactions:

Taking moments about support B: (Span 1)

$$RA \times 4.50 - w \times \frac{4.50^2}{2} = -76.5$$

$$RA = \frac{14.41 \times 4.50^2 /2 + -76.5}{4.50} = 15 \text{ kN}$$

Taking moments about support B: (Span 2)

$$RC \times 5.80 - P1 \times 1.80 - w \times \frac{5.80^2}{2} = -76.53$$

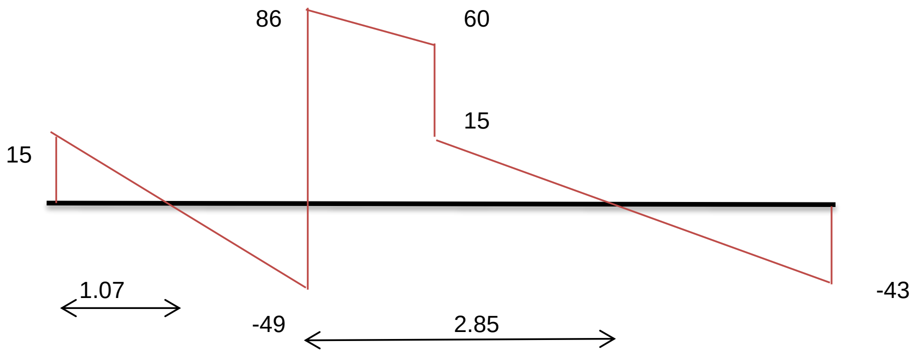
$$RC = \frac{44.81 \times 1.80 + 14.41 \times 5.80^2 /2 + -76.53}{5.80} = 43 \text{ kN}$$

Resolving forces vertically:

$$RB = P1 + w \times 10.3 - RA - RC$$

$$RB = 44.81 + 14.41 \times 10.3 - 15.42 - 42.51 = 135 \text{ kN}$$

Shear Force diagram:



LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design **Slab strip E**

Calculate maximum span moments:

Taking moments about points of zero shear

Span 1 (x = 1.07 m)

$$RA \times 1.07 - w \times \frac{1.07^2}{2} =$$

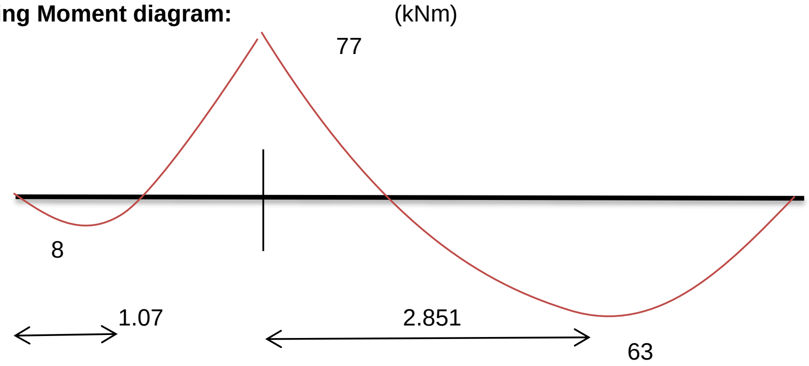
$$15 \times 1.07 - 14.41 \times \frac{1.07^2}{2} = 8 \text{ kNm}$$

Span 2 (x = 2.949 m[5.8 - 2.851])

$$RC \times 2.95 - w \times \frac{2.95^2}{2} =$$

$$42.51 \times 2.95 - 14.41 \times \frac{2.95^2}{2} = 63 \text{ kNm}$$

Bending Moment diagram: (kNm)



LOCATION	CALCULATIONS	OPTIONS
	Ground floor Slab Reinforcement design	
	Slab strip E **Reinforcement design for maximum span moment**	
	M = **63** **kNm** **(Sagging)** strip width = 1000 mm	
	Slab depth = 250 mm Cover (bottom) = 20 mm	
	Effective depth, d = 250 - 20 - 10 = 220 mm	
	Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2	
	$k = M/bd^2f_{cu}$ $k = \frac{62.7 \times 10^6}{1000 \times 220^2 \times 35} = 0.037$	
	$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\} =$ (not greater than 0.95.d) = 211 mm	
	0.95d = 209 mm	
	$A_s\text{ (req)} = M/0.87f_yz = \frac{62.7 \times 10^6}{0.87 \times 500 \times 209} = 689.5\ mm^2$	**Provide**
	A_s (min) = 0.13% = 325 mm^2/m	**H16 @ 150** **(1340)** **Bottom**
	Reinforcement provided: **H16 @ 150** A_s (prov) = 1340 mm^2/m	
	A_s (prov) = 1340 mm^2	
	Deflection Check: basic l/d = 26 For continuous strip.	**H12 @ 150** **(753)** **Top**
table 3.10	$M/b.d^2 = \frac{63 \times 10^6}{1000 \times 220^2} = 1.30$ $f_s = \frac{2.f_y.A_s\text{ req}}{3.A_s\text{ prov}} =$ 172 N/mm^2	
	Modification factor, Mod (T) = $0.55 + \frac{(477 - f_s)}{120.(0.9 + M/b.d^2)} = 1.71 \leq 2.00$ (tension reinforcement)	Hence:
table 3.11	Modification factor, Mod (C) = 1.08 $100A'_s$ prov/bd = 0.257 (compression reinforcement)	
	Allowable l/d = 26 x 1.71 x 1.08 = 48.0	l/d acceptable.
	Act. l/d = $\frac{5800}{220} = 26.4$	

LOCATION	CALCULATIONS	OPTIONS

Ground floor Slab Reinforcement design

Slab strip E **Reinforcement design for maximum support moment**

M = **77** **kNm** **(Hogging)** strip width = 1000 mm

Slab depth = 250 mm Cover (top) = 20 mm
Effective depth, d = 250 - 20 - 10 = 220 mm
Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2

$k = M/bd^2f_{cu}$ $k = \dfrac{76.5 \times 10^6}{1000 \times 220^2 \times 35} = 0.045$

$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\}$ = (not greater than 0.95.d) = 208 mm
0.95d = 209 mm

$A_s\ (req) = M/0.87f_yz = \dfrac{76.5 \times 10^6}{0.87 \times 500 \times 208} = 844.4\ mm^2$

A_s (min) = 0.13% = 325 mm^2/m

Reinforcement provided: **H16 @ 150** A_s (prov) = 1340 mm^2/m
A_s (prov) = 1340 mm^2

Options:
Provide
H16 @ 150
(1340)
Top

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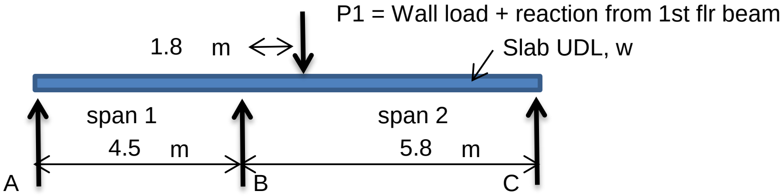
Sheet No: GFS21 | Project No: K697
By IN | Date Jan-16
Checked: GS | Date

10 Clorane Gardens, London NW3
New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design

Slab strip F **Continuous slab strip .**



Ultimate Loads:

Wall load = (From wall load calcs) = 56.93 (Wall D)

\+ reaction from 1st flr beam (spread by wall over 2m)= 115 /2 = 57.5

P1 = 56.93 + 57.5 = 114.4 kN/m

Slab UDL, w = 1.4 x 8.58 + 1.6 x 1.50 = 14.4 kN/m^2

Calculate Span moments using Moment Distribution, Hardy Cross method.

Relative stiffness of spans:

With EI being constant along length of slab strip, the stiffness is based an end support conditions and length of spans between supports.

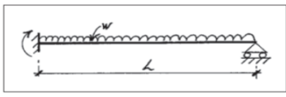
Span 1 = $0.75 \times \frac{1}{4.5} = 0.17$ Span 2 = $0.75 \times \frac{1}{5.8} = 0.13$

For a non-continuous support.

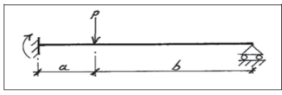
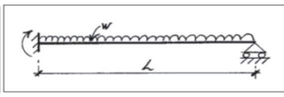
Distribution factors about support B:

Span 1 = $\frac{0.17}{0.17 + 0.13} = 0.56$ Span 2 = $\frac{0.13}{0.17 + 0.13} = 0.44$

Fixed End Moments:

 $\frac{wL^2}{8}$

FEM (BA) = $\frac{14.4 \times 4.5^2}{8} = 36.5$ kNm

 $\frac{Pab(2L-a)}{2L^2}$  $\frac{wL^2}{8}$

FEM (BC) = $\frac{114.4 \times 1.80 \times 4.00\ (2 \times 5.80 - 1.80)}{2 \times 5.80^2}$ +

$\frac{14.4 \times 5.8^2}{8} = 180.6$ kNm

10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design **Slab strip F**

Moment Distribution:

	A			B			C
DF			0.56		0.44		
FEM		0.0	-36.5		180.6	0.0	
DIST			-81.2		-63.0		
FINAL		0.0	-117.6		117.6	0.0	

kNm

Calculate support reactions:

Taking moments about support B: (Span 1)

$$RA \times 4.50 - w \times \frac{4.50^2}{2} = -117.6$$

$$RA = \frac{14.41 \times 4.50^2 /2 + -117.6}{4.50} = 6 \text{ kN}$$

Taking moments about support B: (Span 2)

$$RC \times 5.80 - P1 \times 1.80 - w \times \frac{5.80^2}{2} = -117.6$$

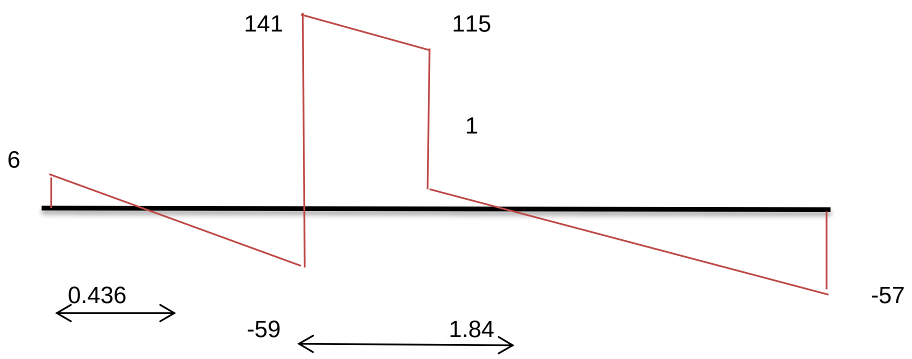
$$RC = \frac{114.4 \times 1.80 + 14.41 \times 5.80^2 /2 + -117.6}{5.80} = 57 \text{ kN}$$

Resolving forces vertically:

$$RB = P1 + w \times 10.3 - RA - RC$$

$$RB = 114.4 + 14.41 \times 10.3 - 6.285 - 57.02 = 200 \text{ kN}$$

Shear Force diagram:



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Sheet No:	GFS23	Project No:	K697
By	IN	Date	Jan-16
Checked:	GS	Date	

10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design **Slab strip F**

Calculate maximum span moments:

Taking moments about points of zero shear

Span 1 (x = 0.436 m)

$$RA \times 0.44 - w \times \frac{0.44^2}{2} =$$

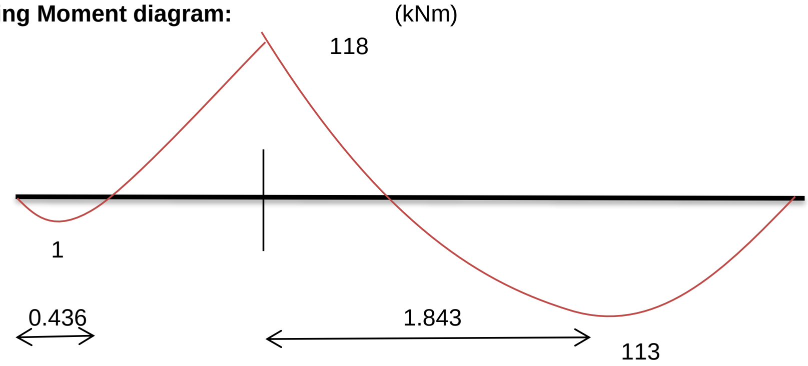
$$6 \times 0.44 - 14.41 \times \frac{0.44^2}{2} = 1 \text{ kNm}$$

Span 2 (x = 3.957 m[5.8 - 1.843])

$$RC \times 3.96 - w \times \frac{3.96^2}{2} =$$

$$57.02 \times 3.96 - 14.41 \times \frac{3.96^2}{2} = 113 \text{ kNm}$$

Bending Moment diagram: (kNm)



LOCATION	CALCULATIONS	OPTIONS

Ground floor Slab Reinforcement design
For Slab strip with highest moment.
Slab strip F **Reinforcement design for maximum span moment**

M = **113** **kNm** **(Sagging)** strip width = 1000 mm

Slab depth = 250 mm Cover (bottom) = 20 mm
Effective depth, d = 250 - 20 - 10 = 220 mm
Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2

$k = M/bd^2f_{cu}$ $k = \frac{112.8 \times 10^6}{1000 \times 220^2 \times 35} = 0.067$

$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\}$ = (not greater than 0.95.d) = 202 mm
0.95d = 209 mm

$A_s\ (req) = M/0.87f_yz = \frac{112.8 \times 10^6}{0.87 \times 500 \times 202} = 1282\ mm^2$ — **Provide**

A_s (min) = 0.13% = 325 mm^2/m — **H16 @ 125**
(1608)

Reinforcement provided: **H16 @ 125** A_s (prov) = 1608 mm^2/m — **Bottom**
A_s (prov) = 1608 mm^2

Deflection Check: basic l/d = 26 For continuous strip.

H12 @ 125
(905)
table 3.10 — $M/b.d^2 = \frac{113 \times 10^6}{1000 \times 220^2}$ **=** 2.33 $f_s = \frac{2.f_y.A_s\ req}{3.A_s\ prov} =$ 266 N/mm^2
Top

Modification factor, Mod (T) = $0.55 + \frac{(477 - f_s)}{120.(0.9 + M/b.d^2)}$ = 1.09 ≤ 2.00
(tension reinforcement) — Hence:
table 3.11 — Modification factor, Mod (C) = 1.09 $100A'_s$ prov/bd = 0.309
(compression reinforcement)
Allowable l/d = 26 x 1.09 x 1.09 = 31.1 — l/d acceptable.

Act. l/d = $\frac{5800}{220}$ = 26.4

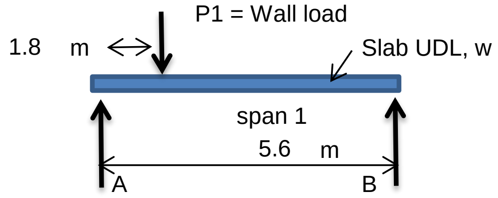
LOCATION	CALCULATIONS	OPTIONS
	Ground floor Slab Reinforcement design	
	Slab strip F **Reinforcement design for maximum support moment**	
	M = **118** **kNm** **(Hogging)** strip width = 1000 mm	
	Slab depth = 250 mm Cover (top) = 20 mm	
	Effective depth, d = 250 - 20 - 10 = 220 mm	
	Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2	
	$k = M/bd^2f_{cu}$ $k = \frac{117.6 \times 10^6}{1000 \times 220^2 \times 35} = 0.069$	
	$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\} =$ (not greater than 0.95.d) = 201 mm	
	0.95d = 209 mm	
	A_s (req) = $M/0.87f_yz$ $= \frac{117.6 \times 10^6}{0.87 \times 500 \times 201} = 1342$ mm^2	**Provide**
	A_s (min) = 0.13% = 325 mm^2/m	**H16 @ 125**
		(1608)
	Reinforcement provided: **H16 @ 125** A_s (prov) = 1608 mm^2/m	**Top**
	A_s (prov) = 1608 mm^2	

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design

Slab strip G

Simply supported span



Ultimate Loads:

P1 = Wall load = (From wall load calcs) = 56.93 (Wall D)

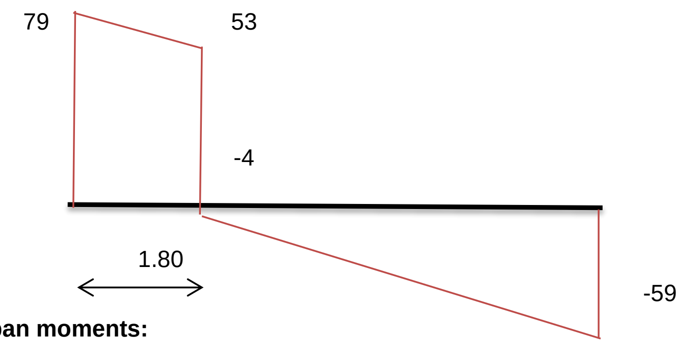
Slab UDL, w = 1.4 x 8.58 + 1.6 x 1.50 = 14.4 kN/m^2

Analysis:

$$RB = \frac{P1 \times 1.8 + w \times 5.6^2 / 2}{5.6} =$$

$$RB = \frac{56.9 \times 1.8 + 14.4 \times 5.6 / 2}{5.6} = 58.7 \text{ kN}$$

Shear Force diagram:



Calculate maximum span moments:

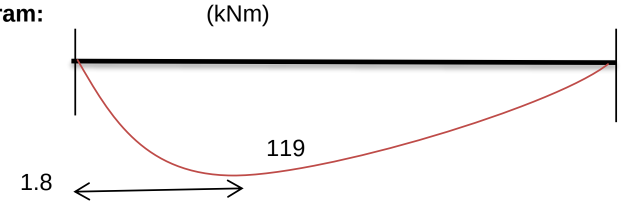
Taking moments about points of zero shear

Span 1 (x = 3.8 m[5.6 - 1.8])

$$RB \times 3.80 - w \times \frac{3.80^2}{2} =$$

$$58.7 \times 3.80 - 14.4 \times \frac{3.80^2}{2} = 119 \text{ kNm}$$

Bending Moment diagram: (kNm)



10 Clorane Gardens, London NW3
New basement and upper floor alterations

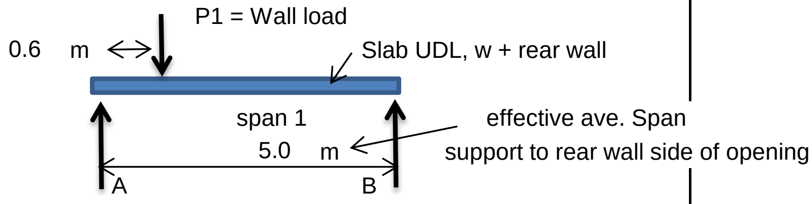
LOCATION	CALCULATIONS	OPTIONS
	Ground floor Slab Reinforcement design	
	Slab strip G **Reinforcement design for maximum span moment**	
	M = **119** **kNm** **(Sagging)** strip width = 1000 mm	
	Slab depth = 250 mm Cover (bottom) = 20 mm	
	Effective depth, d = 250 - 20 - 10 = 220 mm	
	Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2	
	$k = M/bd^2f_{cu}$ $k = \frac{118.8 \times 10^6}{1000 \times 220^2 \times 35} = 0.070$	
	$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\}$ = (not greater than 0.95.d) = 201 mm	
	0.95d = 209 mm	
	$A_s\text{ (req)} = M/0.87f_yz = \frac{118.8 \times 10^6}{0.87 \times 500 \times 201} = 1357\ mm^2$	**Provide**
	A_s (min) = 0.13% = 325 mm^2/m	**H16 @ 100**
		(2010)
	Reinforcement provided: **H16 @ 100** A_s (prov) = 2010 mm^2/m	**Bottom**
	A_s (prov) = 2010 mm^2	
	Deflection Check: basic l/d = 20 For simply supported strip.	
		H12 @ 100
table 3.10	$M/b.d^2 = \frac{119 \times 10^6}{1000 \times 220^2}$ **=** 2.46 $f_s = \frac{2.f_y.A_s\text{ req}}{3.A_s\text{ prov}} =$ 225 N/mm^2	**(1131)**
		Top
	Modification factor, Mod (T) = $0.55 + \frac{(477 - f_s)}{120.(0.9 + M/b.d^2)}$ = 1.18 ≤ 2.00	
	(tension reinforcement)	Hence:
table 3.11	Modification factor, Mod (C) = 1.11 100A'$_s$ prov/bd = 0.386	
	(compression reinforcement)	
	Allowable l/d = 20 x 1.18 x 1.11 = 26.2	l/d acceptable.
	Act. l/d = $\frac{5600}{220}$ = 25.5	

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design

Slab strip H

Simply supported span
supporting rear wall



Ultimate Loads:

P1 = Wall load = (From wall load calcs) = 56.93 (Wall D)

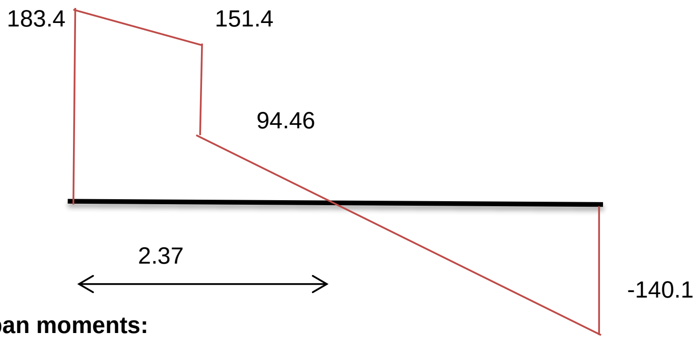
Slab UDL, w = 1.4 x 8.6 + 1.6 x 1.50 + 1.4 x 25.5 + 1.6 x 2.0
= 53.3 kN/m^2

Analysis:

$$RB = \frac{P1 \times 0.6 + w \times 5.0^2 /2}{5.0} =$$

$$RB = \frac{56.9 \times 0.6 + 53.3 \times 5.0 /2}{5.0} = 140.1 \text{ kN}$$

Shear Force diagram:



Calculate maximum span moments:

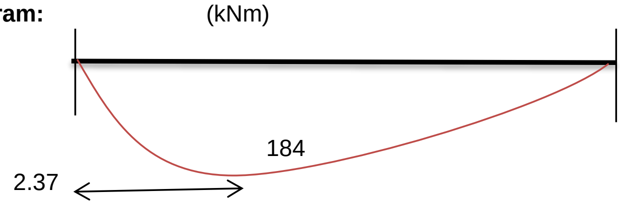
Taking moments about points of zero shear

Span 1 (x = 2.63 m[5.0 - 2.37])

$$RB \times 2.63 - w \times \frac{2.63^2}{2} =$$

$$140.1 \times 2.63 - 53.3 \times \frac{2.63^2}{2} = 184 \text{ kNm}$$

Bending Moment diagram: (kNm)



ALAN BAXTER PARTNERSHIP LLP
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Sheet No:	GFS29	Project No:	K697
By	IN	Date	Jan-16
Checked:	GS	Date	

10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Ground floor Slab Reinforcement design

Slab strip H **Reinforcement design for maximum span moment**

M = **184** **kNm** **(Sagging)** strip width = 1000 mm

Slab depth = 250 mm Cover (bottom) = 20 mm

Effective depth, d = 250 - 20 - 10 = 220 mm

Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2

$k = M/bd^2f_{cu}$ $k = \dfrac{184.1 \times 10^6}{1000 \times 220^2 \times 35}$ = 0.109

$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\}$ = (not greater than 0.95.d) = 189 mm

0.95d = 209 mm

A_s (req) = $M/0.87f_yz$ = $\dfrac{184.1 \times 10^6}{0.87 \times 500 \times 189}$ = 2238 mm^2 — **Provide**

A_s (min) = 0.13% = 325 mm^2/m — **H20 @ 100**

(3141)

Reinforcement provided: **H20 @ 100** A_s (prov) = 3141 mm^2/m — **Bottom**

A_s (prov) = 3141 mm^2

Deflection Check: basic l/d = 20 For simply supported strip.

H12 @ 100

table 3.10 — $M/b.d^2 = \dfrac{184 \times 10^6}{1000 \times 220^2}$ **=** 3.80 $f_s = \dfrac{2.f_y.A_s \text{ req}}{3.A_s \text{ prov}}$ = 238 N/mm^2 — **(1131)**

Top

Modification factor, Mod (T) = $0.55 + \dfrac{(477 - f_s)}{120.(0.9 + M/b.d^2)}$ = 0.97 ≤ 2.00

(tension reinforcement) — Hence:

table 3.11 — Modification factor, Mod (C) = 1.11 $100A'_s$ prov/bd = 0.386

(compression reinforcement)

Allowable l/d = 20 x 0.97 x 1.11 = 21.7 — l/d acceptable.

Act. l/d = $\dfrac{5000}{220}$ = 22.7

<u>Considered acceptable as some continuity into adjacent slab.</u>

Also area of windows in rear wall will reduce actual loading on slab.

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Sheet No:	GFS30	Project No:	K697
By	IN	Date	Jan-16
Checked:	GS	Date	

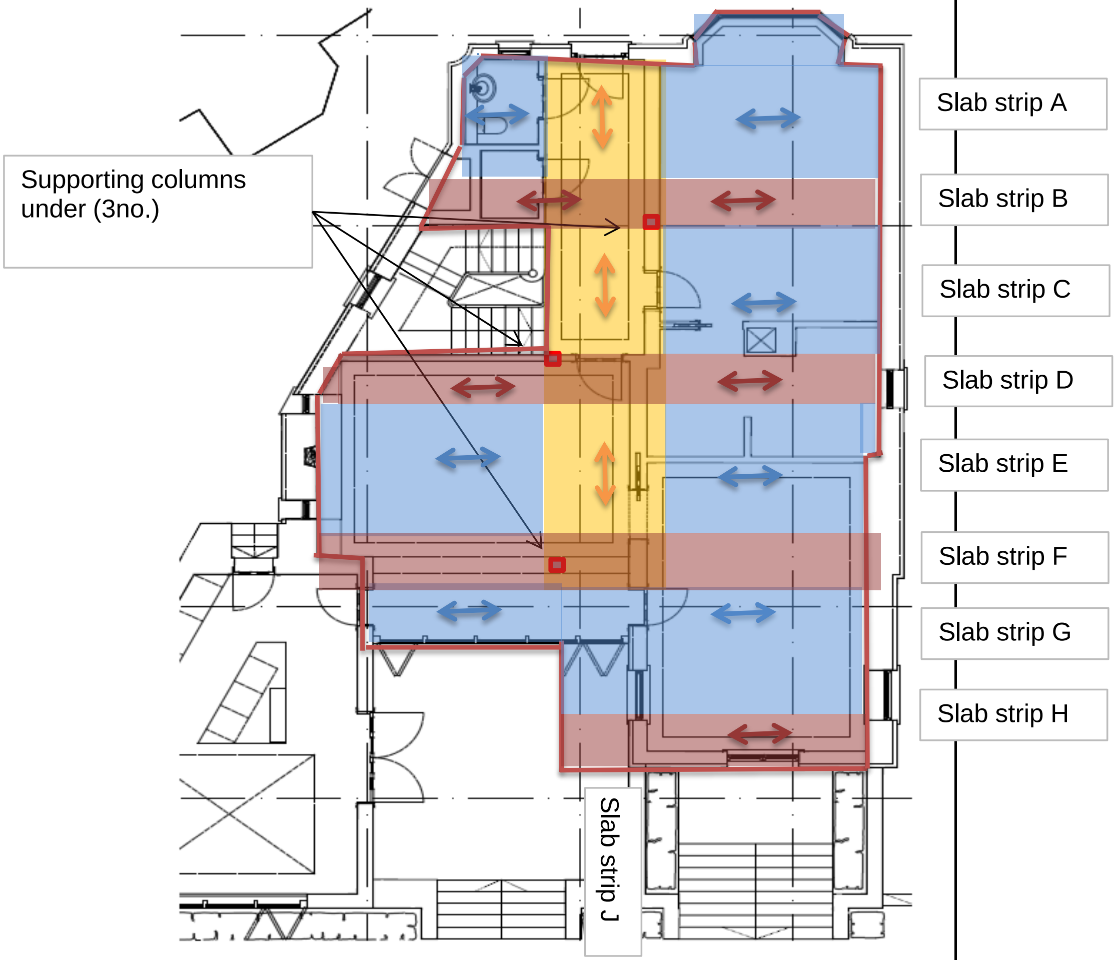
10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design

Summary of Bending moments - Slab strips A to H



Ground floor plan showing arrangement of slab strips.

Slab Strip	**Maximum moment (kNm)**		
	Span 1 (sagging)	**Support (hogging)**	**Span 2 (sagging)**
Slab Strip A	0	57	41
Slab Strip B	0	57	41
Slab Strip C	0	13	64
Slab Strip D	118	122	36
Slab Strip E	8	77	63
Slab Strip F	1	118	113
Slab Strip G	simply supported span		119
Slab Strip H	simply supported span		184

10 Clorane Gardens, London NW3

New basement and upper floor alterations

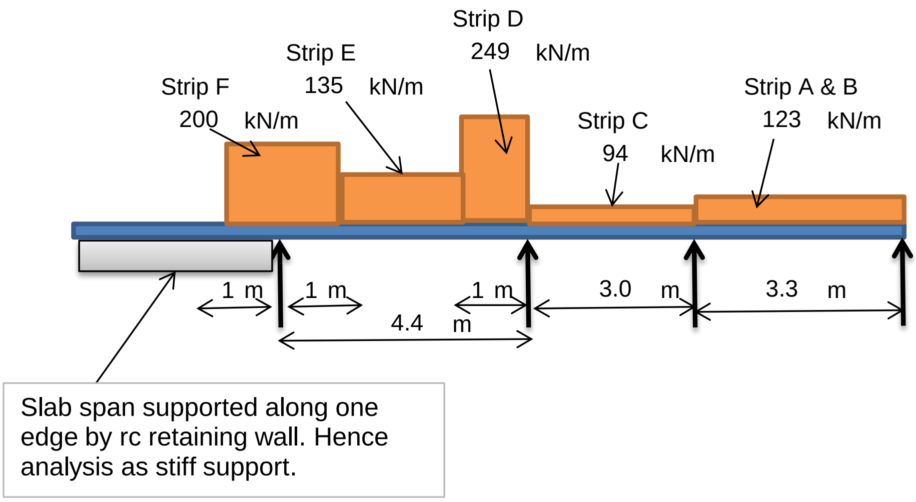
LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design

Slab strip J **Continuous strip through centre of house.**

Loading:

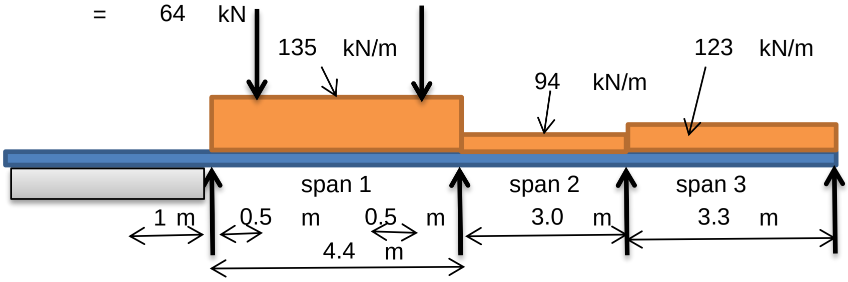
Slab strip load from central support reactions from slab strips A to H



Equivilent loads (for purpose of analysis)

P2 = 248.6 - 135.3 = 113 kN

P1 = 199.6 - 135.3 = 64 kN



10 Clorane Gardens, London NW3

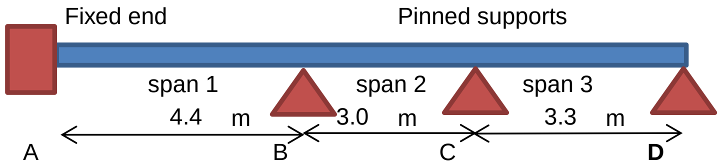
New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design

Slab strip J **Continuous strip through centre of house.**

Support Conditions:



Calculate Span moments using Moment Distribution, Hardy Cross method.

Relative stiffness of spans:

With EI being constant along length of slab strip, the stiffness is based an end support conditions and length of spans between supports.

Span 1 = $\frac{1}{4.4}$ = 0.23   Span 2 = $\frac{1}{3.0}$ **=** 0.33

Distribution factors about support B:

Span 1 = $\frac{0.23}{0.23 + 0.33}$ = 0.41   Span 2 = $\frac{0.33}{0.23 + 0.33}$ = 0.59

Span 2 = $\frac{1}{3.0}$ = 0.33   Span 3 = 0.75 x $\frac{1}{3.3}$ **=** 0.23

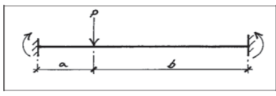
For a non-continuous support.

Distribution factors about support C:

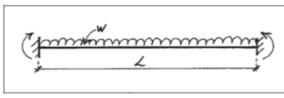
Span 2 = $\frac{0.33}{0.33 + 0.23}$ = 0.59   Span 3 = $\frac{0.23}{0.33 + 0.23}$ = 0.41

Fixed End Moments:

Span 1



$\frac{Pa^2b}{L^2}$



$\frac{wL^2}{12}$

FEM (AB) = $\frac{64.23 \times 0.50^2 \times 3.90}{2 \times 4.40^2} + \frac{113.3 \times 3.90^2 \times 0.50}{2 \times 4.40^2}$

$\frac{135.3 \times 4.4^2}{12}$ = 242 kNm

FEM (BA) = $\frac{64.23 \times 3.90^2 \times 0.50}{2 \times 4.40^2} + \frac{113.3 \times 0.50^2 \times 3.90}{2 \times 4.40^2}$

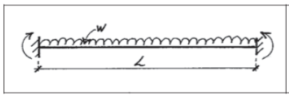
$\frac{135.3 \times 4.4^2}{12}$ = 234 kNm

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design **Slab strip J**

Fixed End Moments (cont'd):

<u>Span 2</u>

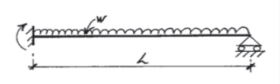


$\frac{wL^2}{12}$

$$FEM\ (BC) = \frac{93.7 \times 3.00^2}{12} = 70 \text{ kNm}$$

$$FEM\ (CB) = \frac{93.7 \times 3.00^2}{12} = 70 \text{ kNm}$$

<u>Span 3</u>



$\frac{wL^2}{8}$

$$FEM\ (CD) = \frac{123 \times 3.3^2}{8} = 168 \text{ kNm}$$

Moment Distribution:

	A		B		C	D	
DF		0.41	0.59	0.59	0.41		
FEM	242.2	-233.8	70.3	-70.3	167.6	0.0	
DIST		66.3	97.2	-57.9	-39.5		
CO	33.1		-28.9	48.6			
DIST		11.7	17.2	-28.9	-19.7		
CO	5.9		-14.5	8.6			
DIST		5.9	8.6	-5.1	-3.5		
CO	2.9		-2.6	4.3			
DIST		1.0	1.5	-2.6	-1.7		
CO	0.5		-1.3	0.8			
DIST		0.5	0.8	-0.5	-0.3		
CO	0.3		-0.2	0.4			
DIST		0.1	0.1	-0.2	-0.2		
CO	0.0		-0.1	0.1			
DIST		0.0	0.1	0.0	0.0		
CO	0.0		0.0	0.0			
FINAL	285.0	-148.2	148.2	-102.7	102.7	0.0	kNm

LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design **Slab strip J**

Calculate support reactions:

Taking moments about support B: (Span 1)

$$RA \times 4.40 - P1 \times 3.90 - P2 \times 0.50 - w \times \frac{4.40^2}{2} = -148.2$$

$$RA = \frac{64.23 \times 3.90 + 113.3 \times 0.50 + 135.3 \times 4.40^2 /2 \quad -148.2}{4.40}$$

= 333.8 kN

Taking moments about support C: (Span 3)

$$RD \times 3.30 - w \times \frac{3.30^2}{2} = -102.7$$

$$RD = \frac{123.1 \times 3.30^2 /2 \quad -102.7}{3.30} = 172 \text{ kN}$$

Taking moments about support B: (Span 2 & 3)

$$RD \times 6.30 + RC \times 3.00 - w2 \times \frac{3.00^2}{2} - w3 \times 3.30 \times 4.65 = -102.7$$

$$RC = \frac{123 \times 3.30 \times 4.65 + 93.7 \times 3.00^2 /2 \quad -102.7 - 172 \times 6.30}{3.00}$$

= 374.8 kN

Resolving forces vertically:

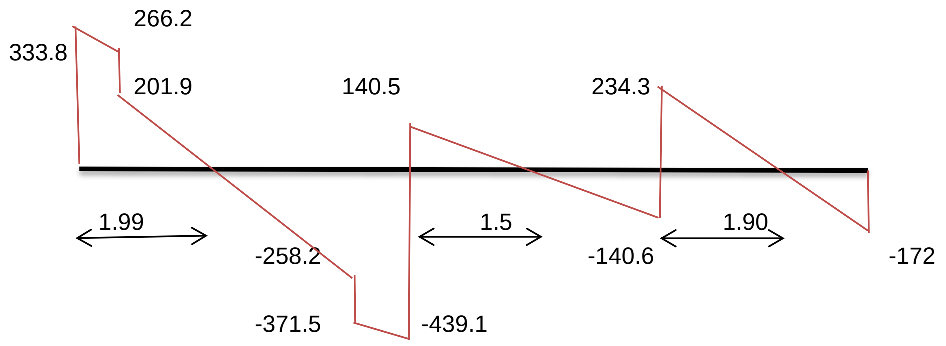
RB = P1 + P2 + w x L - RA - RC - RD

RB = 64.23 + 113.3 + 135.33 x 4.4 - 333.8 - 374.8 - 172

+ 93.7 x 3.0 + 123.1 x 3.3

RB = 579.7 kN

Shear Force diagram:



LOCATION	CALCULATIONS	OPTIONS

Ground Floor Slab Reinforcement design **Slab strip J**

Calculate maximum span moments:

Taking moments about points of zero shear

Span 1 (x = 1.99 m)

$$RA \times 1.99 - P1 \times 1.49 - w \times \frac{1.99^2}{2} =$$

$$333.8 \times 1.99 - 64.23 \times 1.49 - 135.3 \times \frac{1.99^2}{2} = 301 \text{ kNm}$$

Span 2 (x = 3.0 - 1.5 = 1.5 m) from supprt C

$$RD \times 4.80 + RC \times 1.50 - w3 \times 3.30 \times 3.15$$

$$- w2 \times \frac{1.50^2}{2} =$$

$$172 \times 4.80 + 374.82 \times 1.50 - 123.1 \times 3.30 \times 3.15$$

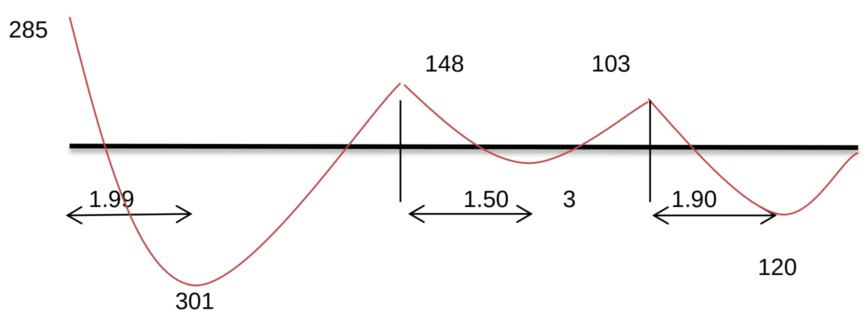
$$- 93.7 \times \frac{1.50^2}{2} = 3 \text{ kNm}$$

Span 3 (x = 3.3 - 1.90 = 1.397 m) from supprt D

$$RD \times 1.40 - w \times \frac{1.40^2}{2} =$$

$$172 \times 1.40 - 123.1 \times \frac{1.40^2}{2} = 120 \text{ kNm}$$

Bending Moment diagram:



LOCATION	CALCULATIONS	OPTIONS
	Ground floor Slab Reinforcement design	
	Slab strip J **Reinforcement design for maximum span 1 moment**	
	M = **301** **kNm** **(Sagging)** strip width = 2000 mm	
	Slab depth = 250 mm Cover (bottom) = 20 mm	
	Effective depth, d = 250 - 20 - 26 = 204 mm	
	Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2	
	$k = M/bd^2f_{cu}$ $k = \dfrac{300.7 \times 10^6}{2000 \times 204^2 \times 35} = 0.103$	
	$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\} =$ (not greater than 0.95.d) = 177 mm	
	0.95d = 194 mm	
	$A_s\,(req) = M/0.87f_yz = \dfrac{300.7 \times 10^6}{0.87 \times 500 \times 177} = 3904\ mm^2$	**Provide**
	A_s (min) = 0.13% = 325 mm^2/m	**14H20 @ 150** **(4398)** **Bottom** **B2**
	Reinforcement provided: **14H20 @ 150**	
	A_s (prov) = 4398 mm^2	
	Deflection Check: basic l/d = 26 For continuous strip.	**14 H16 @ 150** **(3216)** **Top** **T2**
table 3.10	$M/b.d^2 = \dfrac{301 \times 10^6}{2000 \times 204^2} = 3.61$ $f_s = \dfrac{2.f_y.A_s\,req}{3.A_s\,prov} =$ 296 N/mm^2	
	Modification factor, Mod (T) = $\dfrac{0.55 + (477 - f_s)}{120.(0.9 + M/b.d^2)} = 0.88 \leq 2.00$ (tension reinforcement)	Hence:
table 3.11	Modification factor, Mod (C) = 1.16 100A'$_s$ prov/bd = 0.591 (compression reinforcement)	
	Allowable l/d = 26 x 0.88 x 1.16 = 26.8	l/d acceptable.
	Act. l/d = $\dfrac{4400}{204}$ = 21.6	

LOCATION	CALCULATIONS	OPTIONS
	Ground floor Slab Reinforcement design	
	Slab strip J **Reinforcement design for maximum span 3 moment**	
	M = **120** **kNm** **(Sagging)** strip width = 2000 mm	
	Slab depth = 250 mm Cover (bottom) = 20 mm	
	Effective depth, d = 250 - 20 - 26 = 204 mm	
	Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2	
	$k = M/bd^2f_{cu}$ $k = \dfrac{120.2 \times 10^6}{2000 \times 204^2 \times 35} = 0.041$	
	$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\}$ = (not greater than 0.95.d) = 194 mm	
	0.95d = 194 mm	
	$A_s\ (req) = M/0.87f_yz = \dfrac{120.2 \times 10^6}{0.87 \times 500 \times 194} = 1425\ mm^2$	**Provide**
	A_s (min) = 0.13% = 325 mm^2/m	**14H16 @ 150** **(3216)** **Bottom** **B2**
	Reinforcement provided: **14H16 @ 150**	
	A_s (prov) = 3216 mm^2	
	Deflection Check: basic l/d = 26 For continuous strip.	**14 H16 @ 150** **(3216)** **Top** **B2**
table 3.10	$M/b.d^2 = \dfrac{120 \times 10^6}{2000 \times 204^2} = 1.44$ $f_s = \dfrac{2.f_y.A_s\ req}{3.A_s\ prov} = 148\ N/mm^2$	
	Modification factor, Mod (T) = $0.55 + \dfrac{(477 - f_s)}{120.(0.9 + M/b.d^2)}$ = 1.72 ≤ 2.00 (tension reinforcement)	Hence:
table 3.11	Modification factor, Mod (C) = 1.16 $100A'_s prov/bd$ = 0.591 (compression reinforcement)	
	Allowable l/d = 26 x 1.72 x 1.16 = 52.1	l/d acceptable.
	Act. l/d = $\dfrac{3300}{204}$ = 16.2	

LOCATION	CALCULATIONS	OPTIONS

Ground floor Slab Reinforcement design

Slab strip J **Reinforcement design for maximum support moment**

M = **285** **kNm** **(Hogging)** strip width = 2000 mm

Slab depth = 250 mm Cover (top) = 20 mm
Effective depth, d = 250 - 20 - 26 = 204 mm
Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2

$k = M/bd^2f_{cu}$ $k = \dfrac{285.0 \times 10^6}{2000 \times 204^2 \times 35} = 0.098$

$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\}$ = (not greater than 0.95.d) = 179 mm
0.95d = 194 mm

$A_s\text{ (req)} = M/0.87f_yz = \dfrac{285.0 \times 10^6}{0.87 \times 500 \times 179} = 3667\ mm^2$

A_s (min) = 0.13% = 325 mm^2/m

Reinforcement provided: **14H20 @ 150** A_s (prov) = 4398 mm^2

Provide
14H20 @ 150
(4398)
Top
T2

Slab strip J **Reinforcement design for support B moment**

M = **148** **kNm** **(Hogging)** strip width = 2000 mm

Slab depth = 250 mm Cover (top) = 20 mm
Effective depth, d = 250 - 20 - 16 = 214 mm
Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2

$k = M/bd^2f_{cu}$ $k = \dfrac{148.2 \times 10^6}{2000 \times 214^2 \times 35} = 0.046$

$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\}$ = (not greater than 0.95.d) = 202 mm
0.95d = 203 mm

$A_s\text{ (req)} = M/0.87f_yz = \dfrac{148.2 \times 10^6}{0.87 \times 500 \times 202} = 1684\ mm^2$

A_s (min) = 0.13% = 325 mm^2/m

Reinforcement provided: **14H16 @ 150** A_s (prov) = 4398 mm^2

Provide
14H16 @ 150
(3216)
Top
T2

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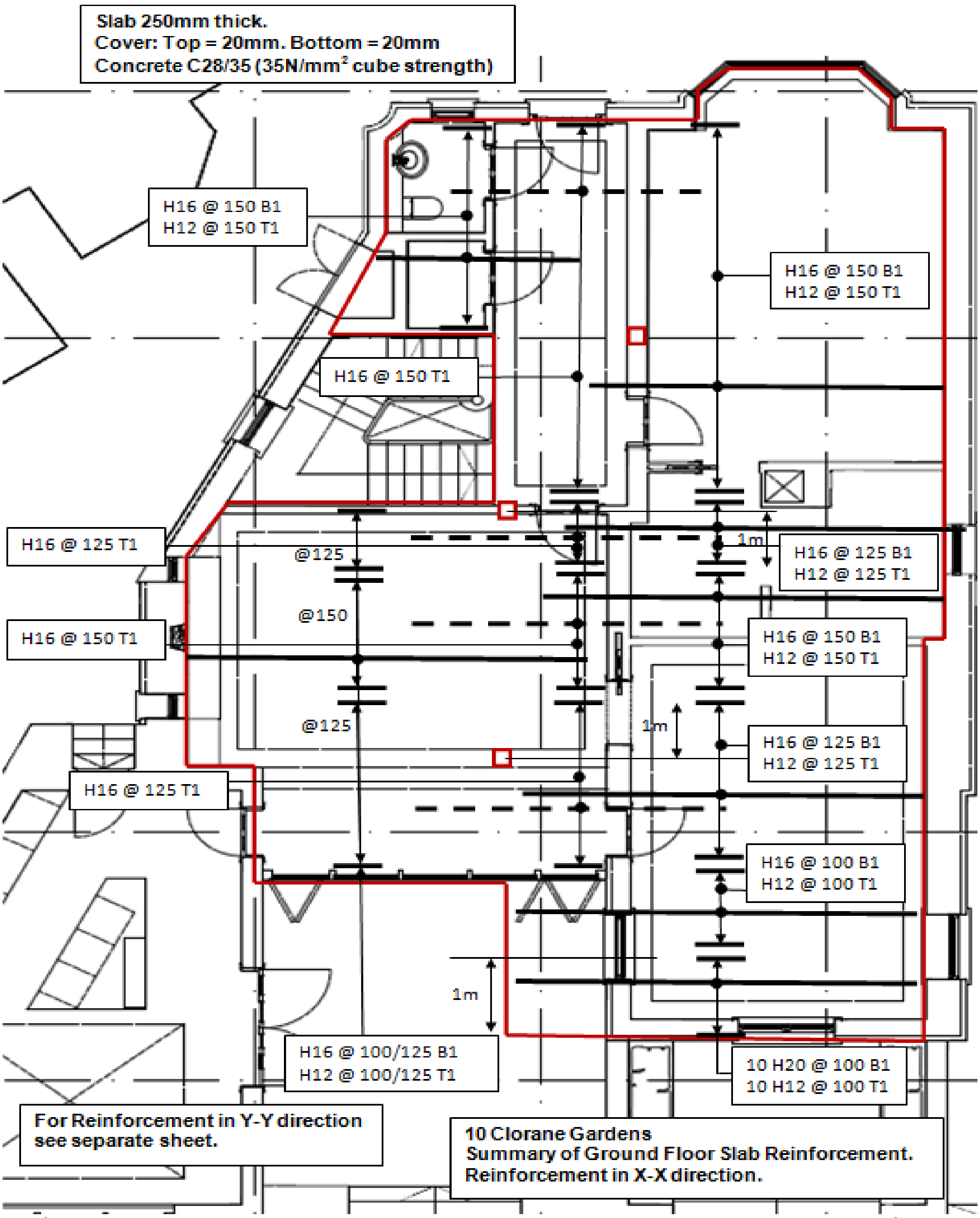
Sheet No:	GFS39	Project No:	K697
By	IN	Date	Jan-16
Checked:	GS	Date	

10 Clorane Gardens, London NW3

New basement and upper floor alterations

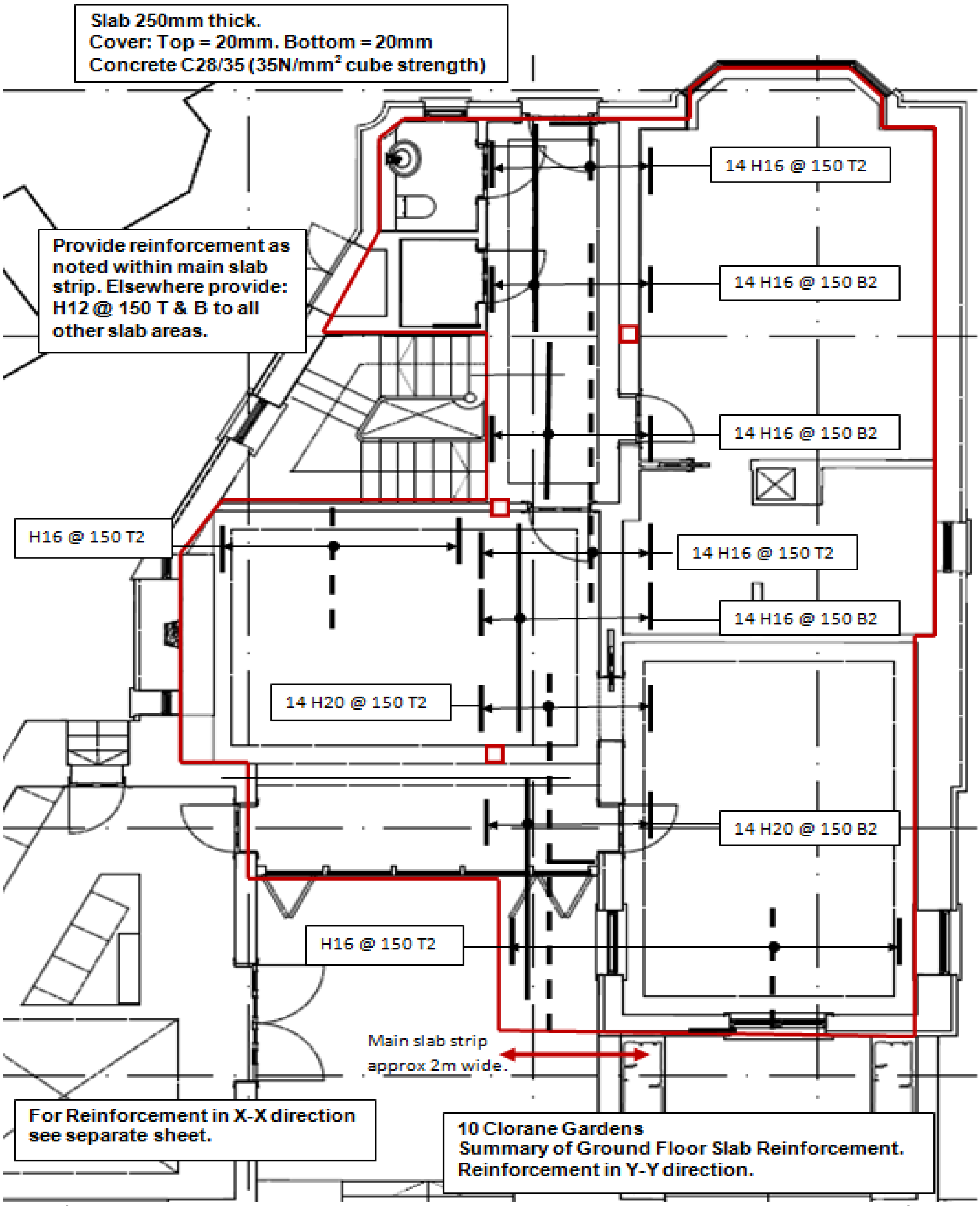
LOCATION	CALCULATIONS	OPTIONS
	Ground floor Slab Reinforcement design	
	Slab Reinforcement Summary - X-X direction reinforcement.	



LOCATION	CALCULATIONS	OPTIONS

Ground floor Slab Reinforcement design

Slab Reinforcement Summary - Y-Y direction reinforcement.



10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Column Loading Assessment

Loading on central column supporting internal loadbearing wall line through basement.

Loading : Based on supported areas

							Dead	**Live**	
Roof	(1.18	,	0.63)x	5	x	3.6	21.3	11.25	
Second	(0.78	,	1.50)x	5	x	3.6	14.0	27	
First	(0.78	,	1.50)x	5	x	3.6	14.0	27	
Wall	2.14		x	5.2	x	3.6	40.1		
Grd	(8.58	,	1.50)x	5	x	3.6	154.4	27	
Basement	(9.22	,	1.50)x	2	x	2	36.9	6	
Total							281	98	kN
							379		kN
Plus 10% design development contingency							295	103	kN
							417		kN
Ultimate 1.4x D + 1.6x L							578		kN

Compare loading to reaction from continuous ground floor slab strip
(reaction at support B, see calculation sheet GFS34) = 580 kN

hence loading assessment considered to be sufficiently accurate.

For pad foundation design also consider temporary loading on slab during construction:

Temporary Construction loads on central column (prior to installation of basement.)

Use 0.25 kN/m^2 imposed load to upper floors

							Dead	**Live**	
Roof	(1.18	,	0.63)x	5	x	3.6	21.3	11.25	
Second	(0.78	,	0.25)x	5	x	3.6	14.0	4.5	
First	(0.78	,	0.25)x	5	x	3.6	14.0	4.5	
Wall	2.14		x	5.2	x	3.6	40.1		
Grd	(6.00	,	0.25)x	5	x	3.6	108.0	4.5	
Total							197	25	kN
							222		kN
Ultimate 1.4x D + 1.6x L							316		

For ground floor, slab weight only no finishes installed at construction stage.

LOCATION	CALCULATIONS	OPTIONS

Wall Loading Assessment

Loading on perimeter retaining wall LHS front

						Dead		Live	
Roof	(1.18	, 0.63)x	2.2 x	1		2.6		1.4	
Second	(0.78	, 1.50)x	2.2 x	1		1.7		3.3	
First	(0.78	, 1.50)x	2.2 x	1		1.7		3.3	
Grd	(8.58	, 1.50)x	2.2 x	1		18.9		3.3	
Wall	4.04	x	5.4 x	1		21.8		0	
retain Wall	8.17	x	2.8 x	1		22.9		0	
basement	(9.22	, 1.50)x	1 x	1		9.2		1.5	
Total						78.8		12.8	kN/m
							91.6		kN/m
Plus 10% design development contingency						86.7		14.1	kN/m
Say						110.0		20.0	
							100.8		kN/m
							130.0		

Loading on perimeter retaining wall RHS front

						Dead		Live	
Roof	(1.18	, 0.63)x	2.2 x	1		2.6		1.4	
Second	(0.78	, 1.50)x	2.2 x	1		1.7		3.3	
First	(0.78	, 1.50)x	2.2 x	1		1.7		3.3	
Grd	(8.58	, 1.50)x	2.2 x	1		18.9		3.3	
Wall	4.04	x	5.4 x	1		21.8		0	
retain Wall	8.17	x	2.8 x	1		22.9		0	
basement	(9.22	, 1.50)x	1 x	1		9.2		1.5	
Total						78.8		12.8	kN/m
							91.6		kN/m
Plus 10% design development contingency						86.7		14.1	kN/m
Say						110.0		20.0	
							100.8		kN/m
							130.0		

Loading on rear wall , carried on GF slab

Floor span parallel with wall.					Dead	Live
Roof	(1.18	, 0.63)x	0.5 x	1	0.6	0.3
Second	(0.78	, 1.50)x	0.5 x	1	0.4	0.75
First	(0.78	, 1.50)x	0.5 x	1	0.4	0.75
Wall	4.04	x	5.4 x	1	21.8	0
Total load on ground floor slab					23.2	1.8

10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Wall Loading Assessment

Loading on perimeter retaining wall **LHS rear**

								Dead		Live	
Roof	(	1.18	,	0.63)x	2.2	x	1	2.6		1.4	
Second	(	0.78	,	1.50)x	2.2	x	1	1.7		3.3	
First	(	0.78	,	1.50)x	2.2	x	1	1.7		3.3	
Grd	(	8.58	,	1.50)x	2.7	x	1	23.2		4.1	
Carry wall	(	51.02	,	12.03)x	1.4	/	5.4	13.2		3.1	
component load of wall carried on grd flr slab											
Wall		4.04		x	5.4	x	1	21.8		0	
retain Wall		8.17		x	2.8	x	1	22.9		0	
basement	(	9.22	,	1.50)x	1	x	1	9.2		1.5	
Total								96.3		16.6	kN/m
									113.0		kN/m
Plus 10% design development contingency								106.0		18.3	kN/m
Say								130.0		20.0	
									124.3		kN/m
									150.0		

Loading on perimeter rear wall LHS, carried on GF slab

								Dead		Live	
Roof	(	1.18	,	0.63)x	2.2	x	1	2.6		1.4	
Second	(	0.78	,	1.50)x	2.2	x	1	1.7		3.3	
First	(	0.78	,	1.50)x	2.2	x	1	1.7		3.3	
Wall		4.04		x	5.4	x	1	21.8		0	
Total load on ground floor slab								27.9		8.0	
Grd	(	8.58	,	1.50)x	2.7	x	1	23.2		4.1	
Total								51.0		12.0	kN/m
									63.0		kN/m

Loading on rear retaining wall supporting ground floor slab with carried wall.

								Dead		Live	
Grd	(	8.58	,	1.50)x	2.7	x	1	23.2		4.1	
Carry wall	(	51.02	,	12.03)x	4.3	/	5.4	40.6		9.6	
component load of wall carried on grd flr slab											
retain Wall		8.17		x	2.8	x	1	22.9		0	
basement	(	9.22	,	1.50)x	1	x	1	9.2		1.5	
Total								95.9		15.1	kN/m
									111.0		kN/m
Plus 10% design development contingency								105.5		16.6	kN/m
Say								130.0		20.0	
									122.1		kN/m
									150.0		

10 Clorane Gardens, London NW3
New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Wall Loading Assessment
Loading on perimeter retaining wall **RHS rear**

						Dead		Live	
Roof	(1.18	, 0.63)x	3 x	1		3.6		1.9	
Second	(0.78	, 1.50)x	3 x	1		2.3		4.5	
First	(0.78	, 1.50)x	3 x	1		2.3		4.5	
Grd	(8.58	, 1.50)x	3 x	1		25.7		4.5	
Wall	4.04	x	5.4 x	1		21.8		0	
retain Wall	8.17	x	2.8 x	1		22.9		0	
basement	(9.22	, 1.50)x	1 x	1		9.2		1.5	
Total						87.9		16.9	kN/m
							104.8		kN/m
Plus 10% design development contingency						96.7		18.6	kN/m
Say						120.0		20.0	
							115.2		kN/m
							140.0		

Loading on pad bases to rear extension
Single storie extension supported on ground beam spanning on to pads

						Dead		Live	
Roof	(0.78	, 0.75)x	3.6 x	2.6		7.3		7.0	
Grd	(4.71	, 1.50)x	3.6 x	2.6		44.1		14.0	
Wall	2.84	x	4 x	3.2		36.4		0.0	
G Beam	6.48	x	6.6 x	1		42.8		0.0	
Total						130.5		21.1	kN
							151.6		kN
Plus 10% design development contingency						143.6		23.2	kN
Say						160.0		40.0	
							166.7		kN
							200.0		

Loading on retaining wall, no wall over

						Dead		Live	
Grd	(8.58	, 1.50)x	1 x	1		8.6		1.5	
retain Wall	8.17	x	2.8 x	1		22.9		0	
basement	(9.22	, 1.50)x	1 x	1		9.2		1.5	
Total						40.7		3.0	kN/m
							43.7		kN/m
Plus 10% design development contingency						44.7		3.3	kN/m
Say						50.0		5.0	
							48.0		kN/m
							55.0		

LOCATION	CALCULATIONS	OPTIONS

Pad Foundations below central columns

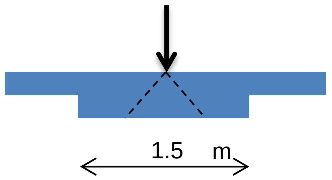
Columns to be supported on pad foundations at basement level.

Pad foundations to be constructed in excavations made from ground level as part of the underpinning works. Pad foundations support temporary construction loads prior to forming the basement slab. In the final condition the basement slab is placed over the pad foundations increaseing their depth and . Reinforcement should be provided to tie the pad foundation to the basement slab in the final condition.

Considering temporary construction loads only:

Load on Pad Foundation = 222 kN **Safe bearing pressure =** 150 kN/m^2

Required pad size = $\frac{222.2}{150}$ = 1.481 m^2 = **1.0 m x 1.5 m**



Pad foundation depth (without basement slab) = 400 mm

Bending moment in pad foundation, M Ultimate load = **316 kN**
(taking account of 45 degree spread through foundation)

$$= \frac{316}{2} \times \frac{1.50}{4} - \frac{316}{2} \times \frac{0.80}{4} = 27.7 \text{ kNm}$$

Pad Foundation Reinforcement Design

Pad depth = 400 mm Cover (bottom) = 35 mm
Effective depth, d = 400 - 35 - 10 = 355 mm
Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2

$k = M/bd^2f_{cu}$ $k = \frac{27.7 \times 10^6}{1500 \times 355^2 \times 35} = 0.004$

$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\}$ = (not greater than 0.95.d) = 353 mm
0.95d = 337 mm

A_s (req) = $M/0.87f_yz$ = $\frac{27.7 \times 10^6}{0.87 \times 500 \times 337}$ = 188.5 mm^2
= 188.5 mm^2/m

A_s (min) = 0.13% = 520 mm^2/m

Reinforcement provided: **H16 @ 150** A_s (prov) = 1340 mm^2/m

OPTIONS: **Provide** **H16 @ 150** **(1340)** **Bottom**

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Sheet No:	PF2	Project No:	K697
By	IN	Date	Jan-16
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10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

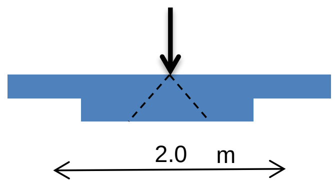
Pad Foundations below central columns

Considering final loading condition:

Load on Pad Foundation = 417 kN **Safe bearing pressure =** 150 kN/m^2

Required pad size = $\frac{416.9}{150}$ = 2.78 m^2 = **1.4 m x 2.0 m**

In final condition with basement slab constructed the basement slab acts as an enlarged pad base spreading the column loads. The thicker pad base below the basement slab acts to stiffen the base.



Basement slab depth (forms reinforced base)
= 300 mm

Bending moment in pad foundation, M Ultimate load = **578 kN**

(taking account of 45 degree spread through foundation)

$$= \frac{578}{2} \times \frac{2.00}{4} - \frac{578}{2} \times \frac{0.60}{4} = 101.1 \text{ kNm}$$

Pad Foundation Reinforcement Design

Pad depth = 300 mm Cover (bottom) = 35 mm

Effective depth, d = 300 - 35 - 10 = 255 mm

Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2

$k = M/bd^2f_{cu}$ $k = \frac{101.1 \times 10^6}{2000 \times 255^2 \times 35} = 0.022$

z = d{0.5 + √(0.25 - K/0.9)} = (not greater than 0.95.d) = 249 mm

0.95d = 242 mm

A_s (req) = $M/0.87f_yz$ = $\frac{101.1 \times 10^6}{0.87 \times 500 \times 242}$ = 959.5 mm^2

= 685.4 mm^2/m

A_s (min) = 0.13% = 390 mm^2/m

Reinforcement provided: H16 @ 150 A_s (prov) = 1340 mm^2/m

Provide

H16 @ 150

(1340)

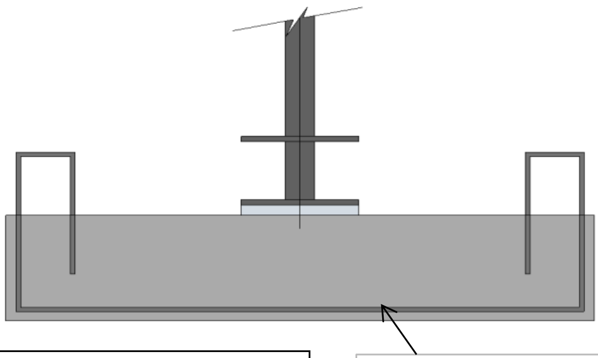
Bottom

LOCATION	CALCULATIONS	OPTIONS

Pad Foundations below central columns

Pad Foundation reinforcement summary.

First stage pad foundation (formed from ground level as part of underpinning works)



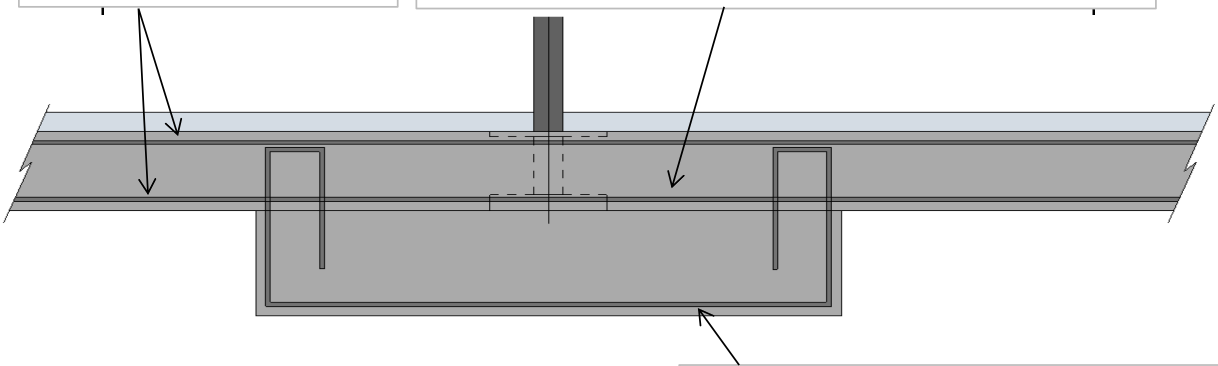
Pad bases. (400mm thk.)
Cover: Bottom & Sides = 35mm
Concrete C28/35 (35N/mm2 cube strength)

H16 bars at 150mm centres bottom.
Both directions.
Bars turned up to tie the pad foundation to the basement slab in the final condition.

Second stage pad foundation (integrated with basement slab)

Slab reinforcement.
(see seperate reinforcement summary)

H16 bars at 150mm centres in bottom of slab section.
Both Directions.
H16 bars to extend over area of effective base (2.0m x 1.4m) plus normal lap length requirements. (500mm for lap and curtailment to H12 bars).



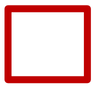
H16 bars at 150mm centres bottom.
Both directions.
Bars turned up to tie the pad foundation to the basement slab in the final condition.

Basement Slab. (300mm thk.)
Cover: Top = 25mm, Bottom = 35mm
Concrete C28/35 (35N/mm2 cube strength)

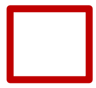
LOCATION	CALCULATIONS	OPTIONS

Steel Column Design - Columns supporting ground floor slab and loads over.
Column Between Basement and ground

Column supported on slab
At basement



Column supports ground floor slab
Allow notional eccentricities at ground.



using simplified approach: (columns in simple multi storey construction)

BBS5950 cl. 4.7.7

$$\frac{F}{P_c} + \frac{M_x}{M_{bs}} + \frac{M_y}{p_y Z_y}$$

<u>Try 120 x 120 x 8 SHS</u> **(grade S355)**

Effective length L_{exx} and L_{eyy} = 0.85 L $L_{exx} = L_{eyy} = 0.85 \times$ 3.2 = 2.7 m

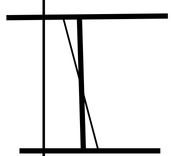
From BS5950 member capacity tables:

P_c (compressive strength) = P_{cy} = 1048 kN

M_{bs} (buckling resistance moment) = 52.7 kNm $p_y Z_y$ = 43.7 kNm

BS8110 3.8.2.4

Nominal eccentricity can be taken as 0.05 column width
(end plate in case of steel column)
Moment in column moment from notional eccentricity at ground.



e_x = 0.05 x 300 = 15 mm M_x = 578 x 0.015 = 8.67 kNm

e_y = 0.05 x 300 = 15 mm M_y = 578 x 0.015 = 8.67 kNm

F_c (compression force) = From column load drop = **578** kN

$$\frac{F}{P_c} + \frac{M_x}{M_{bs}} + \frac{M_y}{p_y Z_y} = \frac{578}{1048} + \frac{8.67}{52.7} + \frac{8.67}{43.7} = \mathbf{0.914}$$

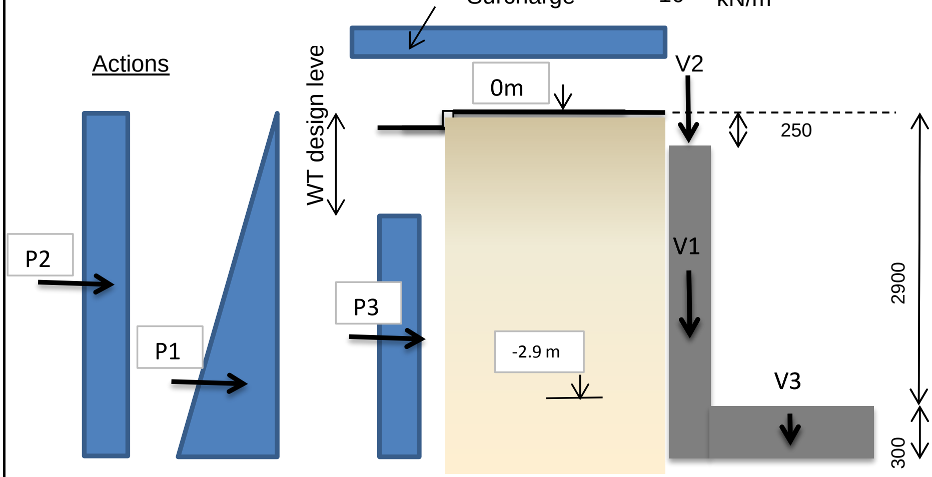
<1 hence OK

LOCATION	CALCULATIONS	OPTIONS

Basement Retaining Wall

For design consider front elevation which has max retained heights and maximum potential surcharge loads.

Surcharge = 10 kN/m^2



The basement retaining wall is to be designed as a propped cantilever with the ground floor RC slab acting to prop the retaining wall in its final condition.

A design check is to be made for the construction condition where the retaining wall will be required to act as a pure cantilever prior to the construction of the ground floor slab.

Vertical loads from the perimeter wall of the house are spread by the retaining wall on to the basement slab acting as a raft foundation.

Loading conditions:

	Final Condition		Construction condition	
		γ_f		γ_f
Surcharge (kN/m^2)	10	1.6	10	1.6
Ground water design level (below ground level, m)	1.0	1.2	3.5	1

Ground water 1m below ground level is considered to be a worst credible condition a partial safety factor of 1.2 is therefore applied.

Soil Perameters:

Granular soil density = 18 kN/m^3
The angle of shear resistance, Φ = 30 º
coefficient of friction between the soil and the concrete = 0.45
Bearing capacity of the soil = 150 kN/m^2

Sheet No:	RW2	Project No:	K697
By	IN	Date	Jan-16
Checked:	GS	Date	

10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Basement Retaining Wall

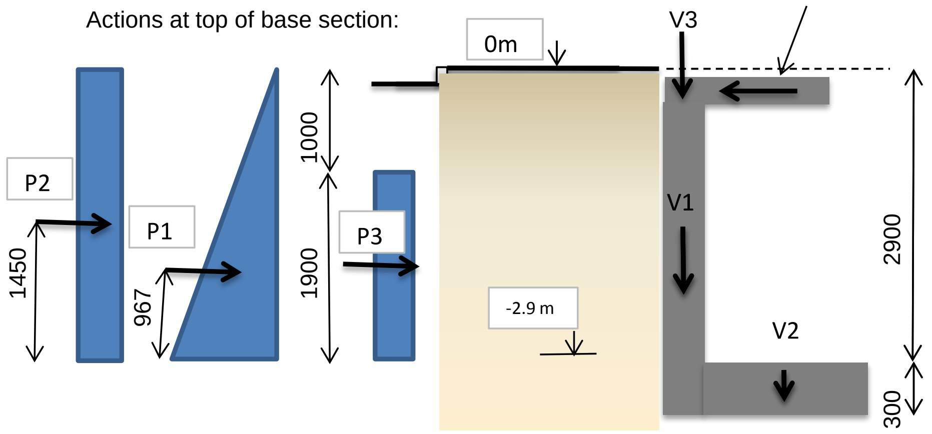
Pressure Coefficients:

Active Pressure, Ka = $\frac{1 - \sin 30}{1 + \sin 30}$ = 0.33

Passive Pressure, Kp = $\frac{1 + \sin 30}{1 - \sin 30}$ = 3.00

Calculation of Actions: **<u>For Final Condition (acting as propped cantilever)</u>**

Actions at top of base section:



From Soil:

P1 = $\frac{18 \text{ kN/m}^3 \times 0.33 \times 2.90}{2}$ = 8.7 kN/m

P1 (ultimate) x 1.4 = 12.2 kN/m

From surcharge;

P2 = 10 kN/m^2 x 0.33 x 2.90 = 9.7 kN/m

P2 (ultimate) x 1.6 = 15.5 kN/m

From ground water:

P3 = 10 kN/m^3 x 1.0 x 1.90 = 19 kN/m

P3 (ultimate) x 1.2 = 22.8 kN/m

V1, V2 & V3 are component parts of the concrete retaining wall and wall load over.

V1 = 24 kN/m^3 x 0.30 x 2.65 = 19.1 kN/m

(wall element) Ultimate = 26.7 kN/m

V2 = (9.22 , 1.50) x 1.00 = 10.7 kN/m

(base element, assume 1.0m base slab) Ultimate = 15.31 kN/m

V3 = 100.8 kN/m vertical load from external wall

Ultimate = 143.9 kN/m

LOCATION	CALCULATIONS	OPTIONS

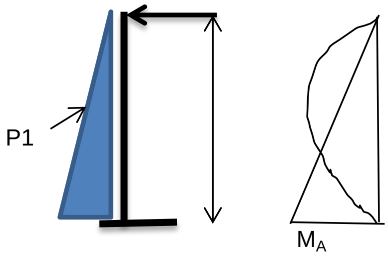
Basement Retaining Wall

Analysis: **<u>For Final Condition (acting as propped cantilever)</u>**

Calculate bending moments in retaining wall based on propped cantilever.

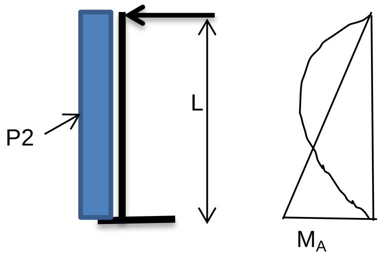
(summating rectangular and trianlular components of loading)

From standard bending moment table max bending moment at base of propped wall:



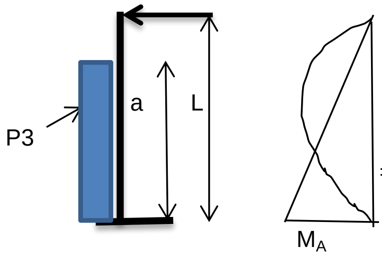
M_A = -2.P1.L/15

$= 2 \times 12.18 \times \dfrac{2.9}{15} = 4.7$ kNm



M_A = -P2.L/8

$= 15.47 \times \dfrac{2.9}{8} = 5.6$ kNm



M_A = -P3.a/8 (2-a/L)^2

$= 22.8 \times \dfrac{1.9}{8} \left(2- \dfrac{1.9}{2.9}\right)^2 = 9.8$ kNm

hence moment at base of propped wall

M = 4.7 + 5.6 + 9.8 = **20.1 kNm**

LOCATION	CALCULATIONS	OPTIONS

Basement Retaining Wall

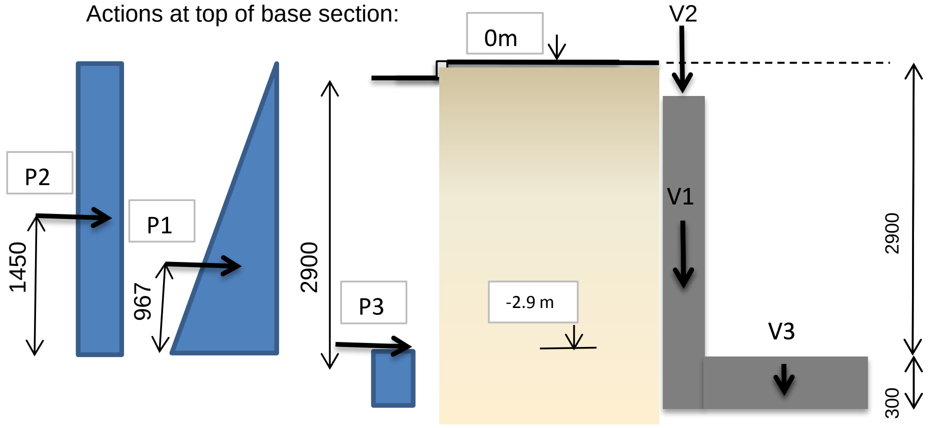
Pressure Coefficients:

Active Pressure, Ka = $\frac{1 - \sin 30}{1 + \sin 30}$ = 0.33

Passive Pressure, Kp = $\frac{1 + \sin 30}{1 - \sin 30}$ = 3.00

Calculation of Actions: __**For Construction Condition (acting as pure cantilever)**__

Actions at top of base section:



From Soil:

P1 = $\frac{18 \text{ kN/m}^3 \times 0.33 \times 2.90}{2}$ = 8.7 kN/m

P1 (ultimate) x 1.4 = 12.2 kN/m

From surcharge;

P2 = 10 kN/m^2 x 0.33 x 2.90 = 9.7 kN/m

P2 (ultimate) x 1.6 = 15.5 kN/m

From ground water:

P3 = 10 kN/m^3 x 1 x -0.60 = -6 kN/m

P3 (ultimate) x 1.0 = -6.0 kN/m

V1, V2 & V3 are component parts of the concrete retaining wall and wall load over.

V1 = 24 kN/m^3 x 0.30 x 2.65 = 19.1 kN/m

(wall element) Ultimate = 26.7 kN/m

V2 = (9.22 , 1.50) x 1.00 = 10.7 kN/m

(base element, assume 1.0m base slab) Ultimate = 15.31 kN/m

V3 = 100.8 kN/m vertical load from external wall

Ultimate = 143.9 kN/m

LOCATION	CALCULATIONS	OPTIONS

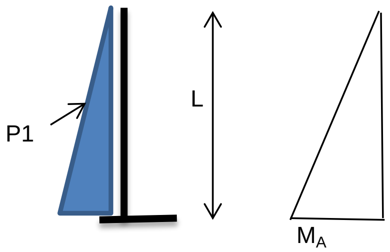
Basement Retaining Wall

Analysis: **<u>For Construction Condition (acting as pure cantilever)</u>**

Calculate bending moments in retaining wall based on pure cantilever.

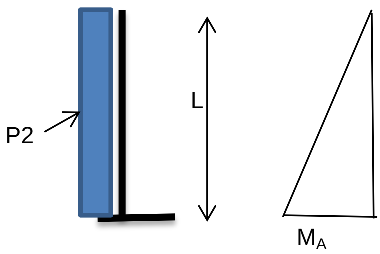
(summating rectangular and trianlular components of loading)

From standard bending moment table max bending moment at base cantilever wall:



M_A = -P1.L/3

$$= 12.18 \times \frac{2.9}{3} = 11.8 \text{ kNm}$$



M_A = -P2.L/2

$$= 15.47 \times \frac{2.9}{2} = 22.4 \text{ kNm}$$

hence moment at base of cantilevered wall

M = 11.8 + 22.4 = **34.2 kNm**

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Sheet No:	RW6	Project No:	K697
By	IN	Date	Jan-16
Checked:	GS	Date	

10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS
	Basement Retaining Wall **Wall reinforcement design:**	
	Take bending moments about top surface of base slab:	
	M (at top of base) = **34.2** **kNm**	
	(worst case being from construction condition) Final condition M = **20.1** **kNm**	
	wall thickness. = 300 mm Cover (outside face) = 35 mm	
	Effective depth, d = 300 - 35 - 10 = 255 mm	
	Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2	
	$k = M/bd^2f_{cu}$ $k = \dfrac{34.2 \times 10^6}{1000 \times 255^2 \times 35} = 0.015$	
	$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\}$ = (not greater than 0.95.d) = 251 mm	
	hence z = 0.95d = 242 mm	
	A_s (req) = $M/0.87f_yz$ = $\dfrac{34.2 \times 10^6}{0.87 \times 500 \times 242}$ = 324.5 mm^2/m	**Provide**
	A_s (min) = 0.13% = 390 mm^2/m	**H16 @ 150**
		(1340)
	Reinforcement provided: **H16 @ 150** A_s (prov) = 1340 mm^2/m	**Outside face**
	Shear Check: Shear force, V = P1 + P2 + P3 = 21.6 kN	
cl 3.4.5.2	Design shear stress, v = V /bv.d = 0.08 N/mm^2	
	$v_c = 0.79 \{ 100.A_s / (b_v.d) \}^{1/3} . (400 / d)^{1/4} / \gamma_m$	
BS8110		
table 3.8	$100.A_s / b_v.d$ = 0.53 400 / d = 1.57 **v_c = 0.571 N/mm^2**	
table 3.16	$v < v_c$ hence no shear reinforcement required	**Also**
		Provide
	Deflection Check: basic l/d = 7 For cantilever wall.	
		H 12 @150
table 3.10	$M/b.d^2 = \dfrac{34 \times 10^6}{1000 \times 255^2}$ **=** 0.53 $f_s = \dfrac{2.f_y.A_s \text{ req}}{3.A_s \text{ prov}}$ = 81 N/mm^2	**(754)**
		Inside face
	Modification factor, Mod (T) = $0.55 + \dfrac{(477 - f_s)}{120.(0.9 + M/b.d^2)}$ = 2.87	
	(tension reinforcement)	Hence:
table 3.11	Modification factor, Mod (C) = 1.09 $100A'_s$ prov/bd = 0.296	
	(compression reinforcement)	
	Allowable l/d = 7 x 2.87 x 1.09 = 21.9 Act. l/d = 11.4	l/d acceptable.

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Sheet No:	BS1	Project No:	K697
By	IN	Date	Jan-16
Checked:	GS	Date	

10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Basement Retaining Wall **Basement slab design**

Bearing Stress Check:

For bearing stress check use unfactored loads

Taking moments about the centre line of the base:

Taking 1.0 m width of slab as effective base.

Overturning moment: From soil and ground water.

M_{ot} = P1 x 0.967 + P2 x 1.45 + P3 x 0.95 =

= 8.7 x 0.967 + 9.667 x 1.45 + 19 x 0.95 = 40.5 kNm

Restoring moment: From load on retaining wall.

M_R = (V1+V3)x La = (19.08 + 100.8) x 0.3 = 36.0 kNm

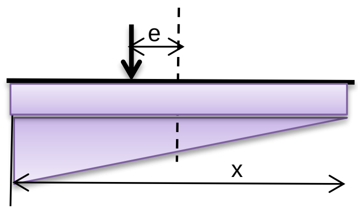
$M = M_{ot} - M_R =$ 40.5 - 36.0 = 4.5 kNm

Vertical actions on to base:

N = V1 + V2 + V3 = (19.08 + 10.72 + 100.8) = 130.56 kN

Bearing Pressure under base:

$e = \frac{M}{N} = \frac{4.5}{130.56} = 0.035$



e< b/6
hence:
x = 1.0 m

$$Pa = \frac{\text{load}}{\text{contact area}} + \frac{\text{bending moment}}{\text{contact base section modulus } (bd^2/6)}$$

$$Pa = \frac{130.56}{1 \times 1.0} \pm \frac{4.5 \times 6}{1 \times 1.0^{2}} = 103.4 \text{ kN/m}^2$$

103.4 < 150 kN/m^2

hence bearing pressure under retaining wall base is acceptable.

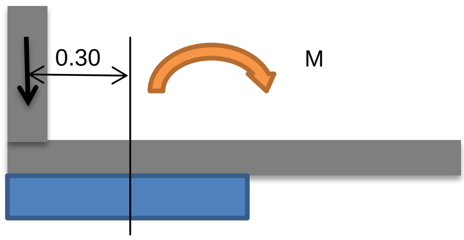
LOCATION	CALCULATIONS	OPTIONS

Basement Slab Reinforcement design

Top Reinforcement design **Ultimate Loads**

Design for moments associated with vertical loads only, Overturning moments on retaining wall will be beneficial and are therefore ignored.
For the purpose of top slab reinforcement design calculate the restoring moment in the slab required to spread the vertical load on the retaining wall on to a bearing strip around the perimeter of the slab.

V1 + V3



Assumed
Bearing strip width = 1.0 m

M = (V1 + V3) x 0.30 = (26.71 + 143.9) x 0.30 = **51.2 kNm**

Slab depth = 300 mm Cover (top) = 25 mm
Effective depth, d = 300 - 25 - 10 = 265 mm
Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2

$k = M/bd^2f_{cu}$ $k = \dfrac{51.2 \times 10^6}{1000 \times 265^2 \times 35} = 0.021$

$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\}$ = (not greater than 0.95.d) = 259 mm
hence z = 0.95d = 252 mm

A_s (req) = $M/0.87f_yz$ = $\dfrac{51.2 \times 10^6}{0.87 \times 500 \times 252}$ = 467.3 mm^2/m

A_s (min) = 0.13% = 390 mm^2/m

Reinforcement provided: **H12 @ 150** A_s (prov) = 754 mm^2/m

The slab is in direct bearing therefore deflection check not required.

Provide

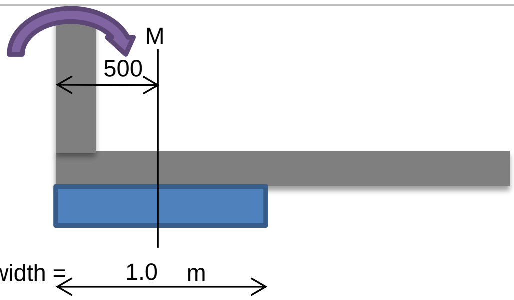
H12 @ 150
(754)
Top

LOCATION	CALCULATIONS	OPTIONS

Basement Slab Reinforcement design

Bottom Reinforcement design

Design for moments associated with horizontal retaining wall loads. Wall loads will act as restoring moments that will be benificial and are therefore ignored.
For the purpose of bottom slab reinforcement design the design moment will be the same as the design moment acting on the vertical retaining wall element. Reinforcement at the edge of the slab will be the same as that provided in the outside face of the wall. <u>The following design calculates the point this reinforcement can be curtailed.</u>



Assumed
Bearing strip width = 1.0 m

M = As retaining wall calculation (sht. RW6) = **34.2** **kNm**

Slab depth = 300 mm Cover (bottom) = 35 mm
Effective depth, d = 300 - 35 - 10 = 255 mm
Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2

$k = M/bd^2f_{cu}$ $k = \dfrac{34.2 \times 10^6}{1000 \times 255^2 \times 35} = 0.015$

$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\}$ = (not greater than 0.95.d) = 251 mm
hence z = 0.95d = 242 mm

$A_s\text{ (req)} = M/0.87f_yz = \dfrac{34.2 \times 10^6}{0.87 \times 500 \times 242} = 324.5\ mm^2/m$

A_s (min) = 0.13% = 390 mm^2/m

Reinforcement provided: **H12 @ 150** A_s (prov) = 754 mm^2/m

Increased reinforcement requirement in the wall is for deflection control only.
The slab is in direct bearing therefore deflection check not required.

Outside face wall reinforcement H16 @ 150 can be curtailed to H12 @150
a lap length from the slab edge.

Provide

H12 @ 150
(754)
Bottom

LOCATION	CALCULATIONS	OPTIONS

Basement Slab Reinforcement design

Design to Resist Uplift forces on basement slab from water pressure and Heave

Basement Heave

10 Clorane Gardens lies on a sloping site with ground levels to the rear approximatly 1m below ground level at the front of the house.

The excavation of the new basement to a formation depth of approximately 2.8m below ground level will entail the excavation of an average of a 1.8m thickness of soil, taking account of existing subfloor voids and variation in ground levels between the front and rear of the house. This excavation will result in a net unloading of around 32 kN/m^2.

This will result in a measure of short term heave and long term swelling of the underlying London Clay, which theoretically takes a number of years to complete. These movements will to a certain extent be mitigated by the continued load applied by the existing buildings.

The new basement slab is to be designed to withstand the potential heave forces and movements. About 50% of total movement would normally be expected to occur prior to construction of the slab (for a normal construction programme). If it is (reasonably) assumed that the relationship between heave movement and pressure is linear the maximum heave pressure for an infinitely stiff slab could therefore be about 16 kN/m^2 for the fully constrained condition. Heave pressure below a more flexible slab will be less due to stress dissipation as the slab deflects.

Hydrostatic Ground Water Pressure

Based on the worst case design loading of ground water 1.0m below ground (recommendation of BS 8102) the potential hydrostatic ground water pressure on the underside of the basement slab would be 10 kN/m^2 [(2.0m to basement slab formation, at the rear of the house – 1.0m) x 10 kN/m^3].

<u>It is noted that water pressure is not additional to any soil heave pressures but will be the minimum uplift</u>

The basement slab is therefore to be designed to resist an uplift force = **16 kN/m^2**

Less the weight of the completed basement slab = 9.22 kN/m^2

Total (Ultimate) uplift force acting on basement slab

= 1.4 x 16.0 - 1.0 x 9.2 = **13.2 kN/m^2**

γ_f for heave
(Worst credible condition)

γ_f (beneficial) for dead load

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Sheet No:	BS5	Project No:	K697
By	IN	Date	Jan-16
Checked:	GS	Date	

10 Clorane Gardens, London NW3

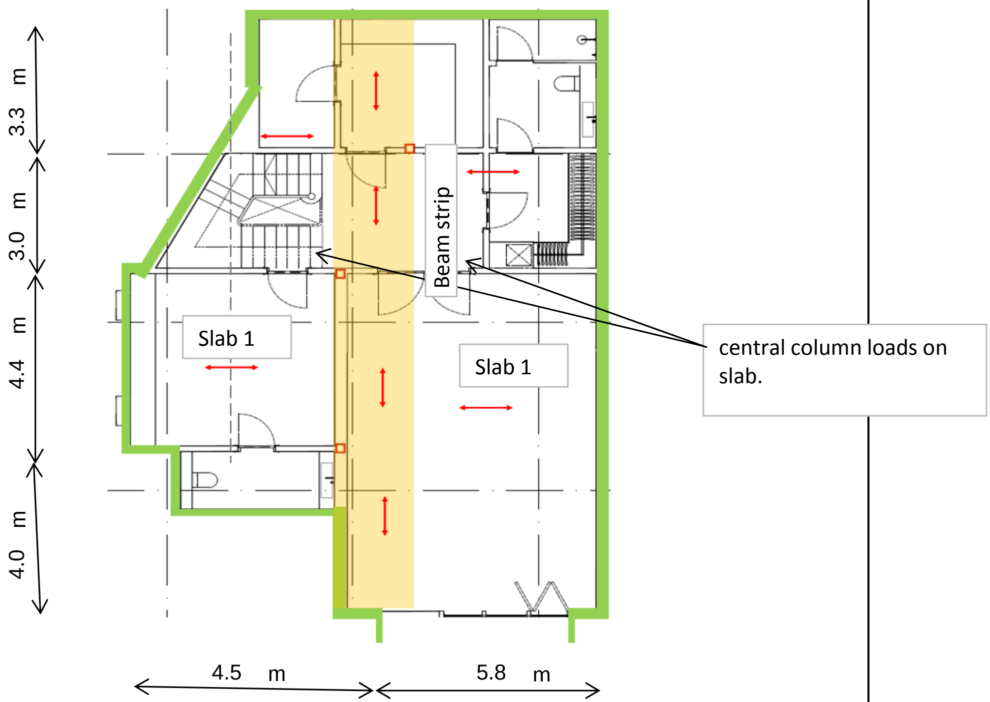
New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Basement Slab Reinforcement design

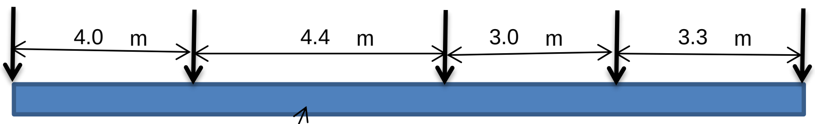
Design to Resist Uplift forces on basement slab from water pressure and Heave

Design arrangement of basement slab:



Basement slab designed on the basis of slabs spanning on to beam strip.

Design of beam strip:



Uplift force, w

w = 13.18 x (4.5 + 5.8) /2 x 1.25 = 84.8 kN/m
(loaded slab width)

M max (hogging) mid span = 0.07 w.L^2 = 0.07 x 84.8 x 4.4 ^{2} = 115 kNm

M max (saging) support = 0.125 w.L^2 = 0.125x 84.8 x 4.4 ^{2} = 205.3 kNm

V = w.L/2 = 84.8 x $\frac{4.4}{2}$ = 186.7 kN

LOCATION	CALCULATIONS	OPTIONS
	Basement Slab Reinforcement design	
	Slab (beam) strip Top reinforcement design	
	M = **115.0** **kNm** Beam strip width = 2000 mm	
	Slab depth = 300 mm Cover (top) = 25 mm	
	Effective depth, d = 300 - 25 - 22 = 253 mm	
	Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2	
	$k = M/bd^2f_{cu}$ $k = \frac{115.0 \times 10^6}{2000 \times 253^2 \times 35} = 0.026$	
	$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\}$ = (not greater than 0.95.d) = 246 mm	
	hence z = 0.95d = 240 mm	
	$A_s\ (req) = M/0.87f_yz = \frac{115.0 \times 10^6}{0.87 \times 500 \times 240} = 1100\ mm^2$	
	= 550 mm^2/m	**Provide**
	A_s (min) = 0.13% = 390 mm^2/m	**H12 @ 150** **(754)**
	Reinforcement provided: **H12 @ 150** A_s (prov) = 754 mm^2/m	**Top T2**
	1508 **mm^2 over** **2.0** **m wide strip.**	
	Deflection Check: basic l/d = 26 For continuous strip.	**H 12 @150**
table 3.10	$M/b.d^2 = \frac{115 \times 10^6}{2000 \times 253^2} = 0.90$ $f_s = \frac{2.f_y.A_s\ req}{3.A_s\ prov} = 243\ N/mm^2$	**(754)** **bottom B2**
	Modification factor, Mod (T) = $\frac{0.55 + (477 - f_s)}{120.(0.9 + M/b.d^2)}$ = 1.63 (tension reinforcement)	Hence:
table 3.11	Modification factor, Mod (C) = 1.07 100A'$_s$ prov/bd = 0.224 (compression reinforcement)	
	Allowable l/d = 26 x 1.63 x 1.07 = 45.4	l/d acceptable.
	Act. l/d = $\frac{4400}{253}$ = 17.4	

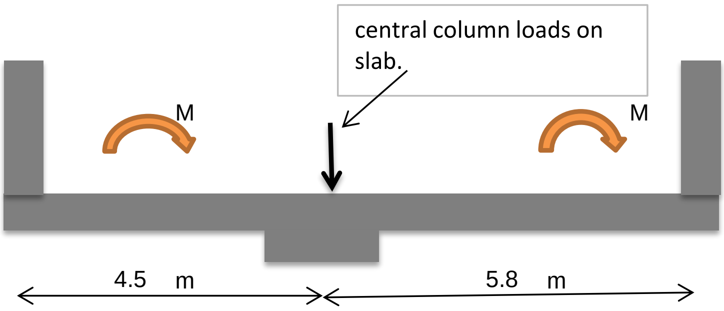
LOCATION	CALCULATIONS	OPTIONS
	Basement Slab Reinforcement design	
	Slab (beam) strip Bottom reinforcement design, Below central support.	
	M = **205.3** **kNm** Beam strip width = 2000 mm	
	Slab depth = 300 mm Cover (bottom) = 35 mm	
	Effective depth, d = 300 - 35 - 10 = 255 mm	
	Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2	
	$k = M/bd^2f_{cu}$ $k = \frac{205.3 \times 10^6}{2000 \times 255^2 \times 35} = 0.045$	
	$z = d\{0.5 + \sqrt{(0.25 - K/0.9)}\}$ = (not greater than 0.95.d) = 242 mm	
	0.95d = 242 mm	
	A_s (req) = $M/0.87f_yz$ = $\frac{205.3 \times 10^6}{0.87 \times 500 \times 242}$ = 1954 mm^2	
	= 977 mm^2/m	**Provide**
	A_s (min) = 0.13% = 390 mm^2/m	**H16 @ 150**
		(1340)
	Reinforcement provided: **H16 @ 150** A_s (prov) = 1340 mm^2/m	**Bottom**
	2680 mm^2 over 2.0 m wide strip.	
	The slab is in direct bearing under central columns therefore deflection check not required.	
	Shear Check: Shear force, V = w.L/2 = 186.7 kN	
cl 3.4.5.2	Design shear stress, v = V /bv.d = 0.37 N/mm^2	
	$v_c = 0.79 \{ 100.A_s / (b_v.d) \}^{1/3} . (400 / d)^{1/4} / \gamma_m$	
BS8110 table 3.8	$100.A_s / b_v.d$ = 0.53 400 / d = 1.57 **v_c = 0.571 N/mm^2**	
table 3.16	$v < v_c$ hence no shear reinforcement required	
	Note: **H16 @150 reinforcement required in bottom of slab under columns to act as spraed pad bases. Refer to pad foundation calculation.**	

LOCATION	CALCULATIONS	OPTIONS

Basement Slab Reinforcement design

Design to Resist Uplift forces on basement slab from water pressure and Heave
Top Reinforcement design

Design for moments associated with water pressure and heave only, For slab top reinforcement design overturning moments on retaining wall will be benificial and are therefore ignored.



M = $0.10\,w.L^2$ = 0.10 x 13.2 x 5.8^2 = **44.3 kNm**

Slab depth = 300 mm Cover (top) = 25 mm
Effective depth, d = 300 - 25 - 10 = 265 mm
Concrete strength, fcu = 35 N/mm^2 Reinforcement strength = 500 N/mm^2

$k = M/bd^2f_{cu}$ $k = \dfrac{44.3 \times 10^6}{1000 \times 265^2 \times 35}$ = 0.018

z = d{0.5 + √(0.25 - K/0.9)} = (not greater than 0.95.d) = 260 mm
hence z = 0.95d = 252 mm

A_s (req) = $M/0.87f_yz$ = $\dfrac{44.3 \times 10^6}{0.87 \times 500 \times 252}$ = 404.9 mm^2/m

A_s (min) = 0.13% = 390 mm^2/m

Reinforcement provided: H12 @ 150 A_s (prov) = 754 mm^2/m

Provide
H12 @ 150
(754)
Top

Deflection Check: basic l/d = 26 For continuous strip.

H 12 @150
(754)
bottom

table 3.10 — $M/b.d^2 = \dfrac{44 \times 10^6}{1000 \times 265^2}$ **=** 0.63 $f_s = \dfrac{2.f_y.A_s\ req}{3.A_s\ prov}$ = 179 N/mm^2

Modification factor, Mod (T) = $0.55 + \dfrac{(477 - f_s)}{120.(0.9 + M/b.d^2)}$ = 2.17 ≤ 2.00
(tension reinforcement)

Hence:

table 3.11 — Modification factor, Mod (C) = 1.12 100A'$_s$ prov/bd = 0.427
(compression reinforcement)

Allowable l/d = 26 x 2.00 x 1.12 = 58.5 Act. l/d = 21.9

l/d acceptable.

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Sheet No:	BS9	Project No:	K697
By	IN	Date	Jan-16
Checked:	GS	Date	

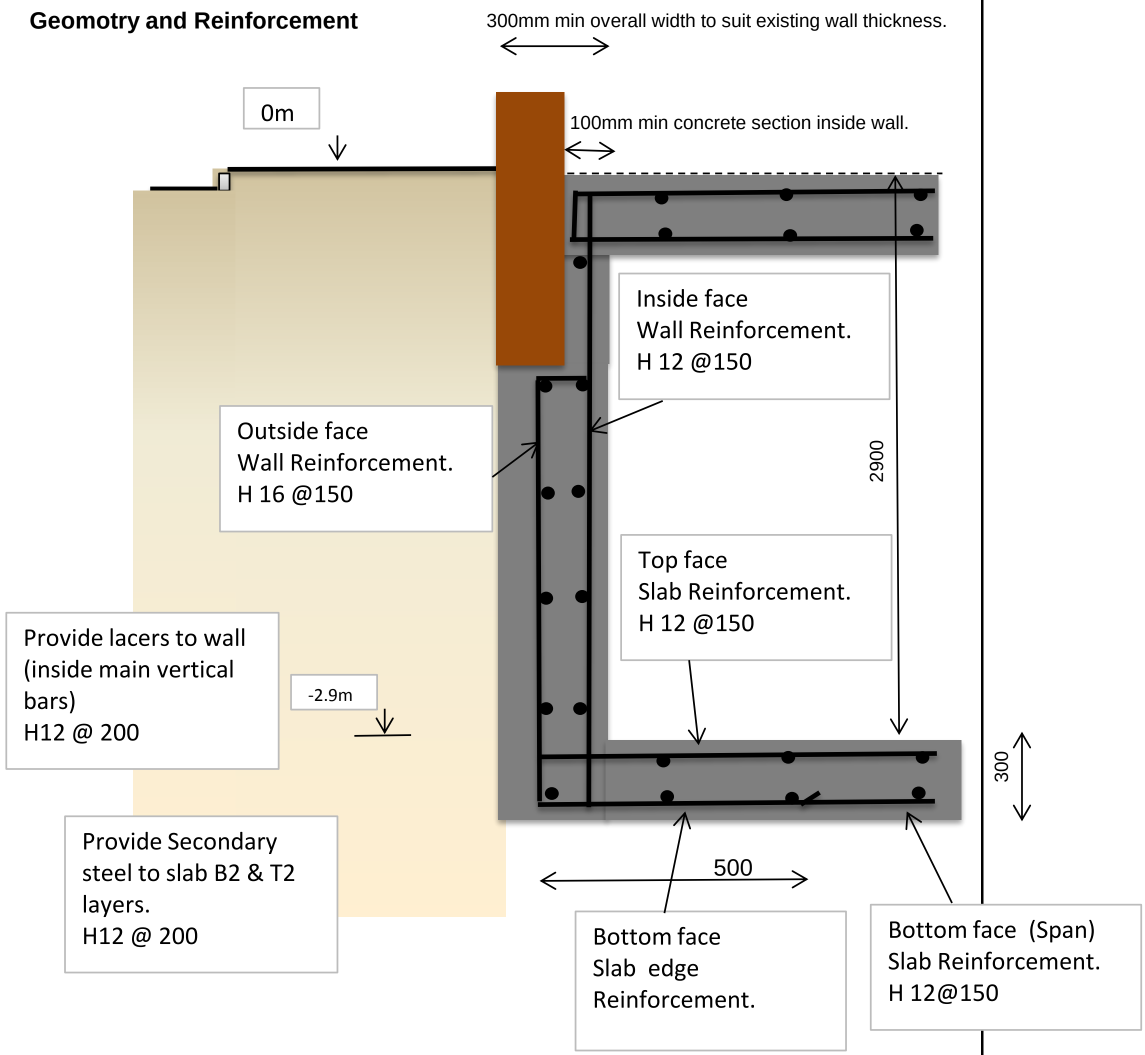
10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Basement Retaining Wall and slab reinforcement summary

Geomotry and Reinforcement



__Laps & Curtailment:__ Laps to be staggered.
Curtail H16 @150 bottom reinforcement to H12@150 500mm from slab edge
(curtail alternate bars at 500mm from slab edge, with alternate bars curtailed 1000mm from slab edge in order to ensure staggered laps)

Concrete Grade C28/35 (35 N/mm^2 cube strength)

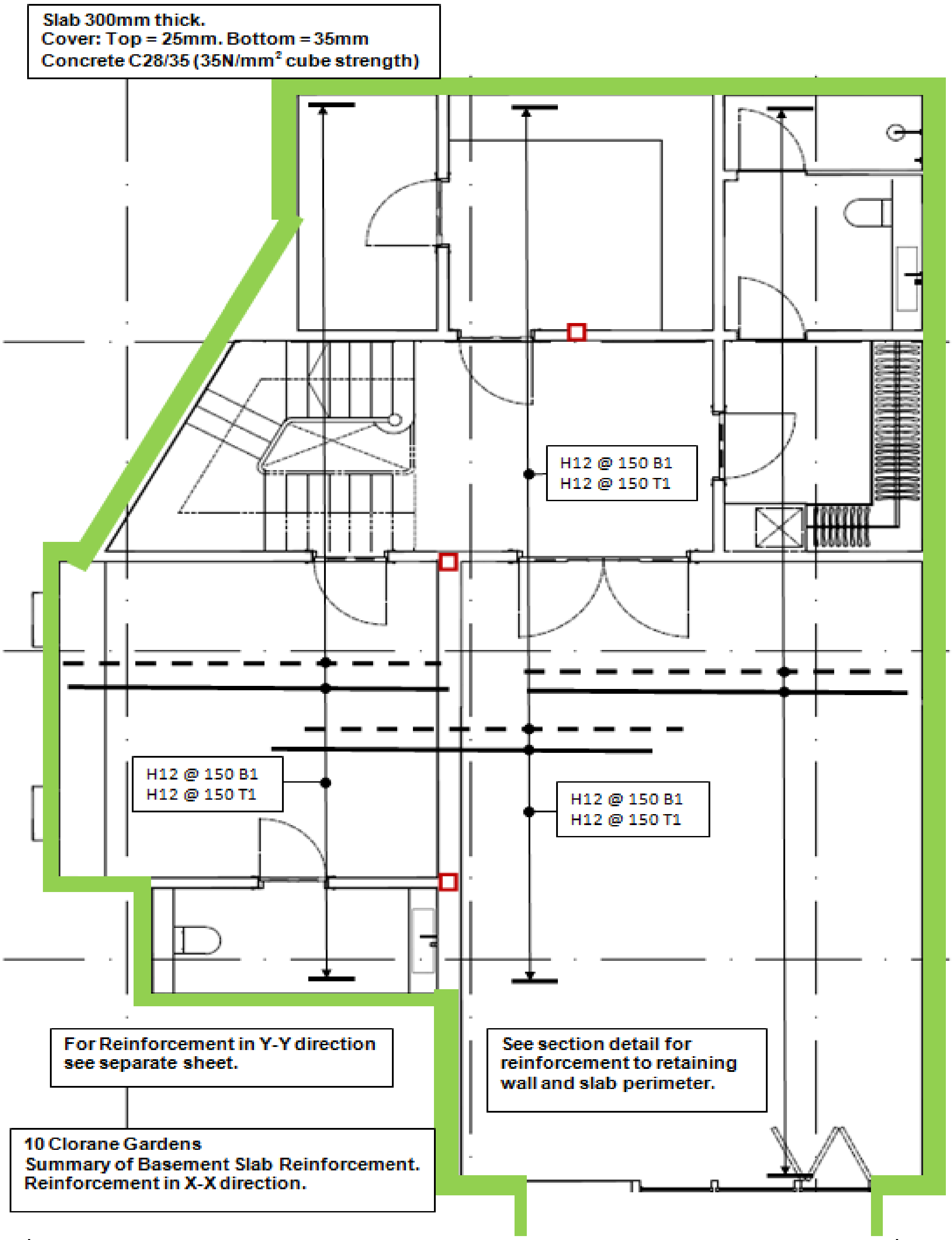
Concrete cover:

Wall (outside) = 35mm   Wall inside = 25mm
Slab (bottom) = 35mm   Slab (top) = 25mm

LOCATION	CALCULATIONS	OPTIONS

Basement Slab Reinforcement design

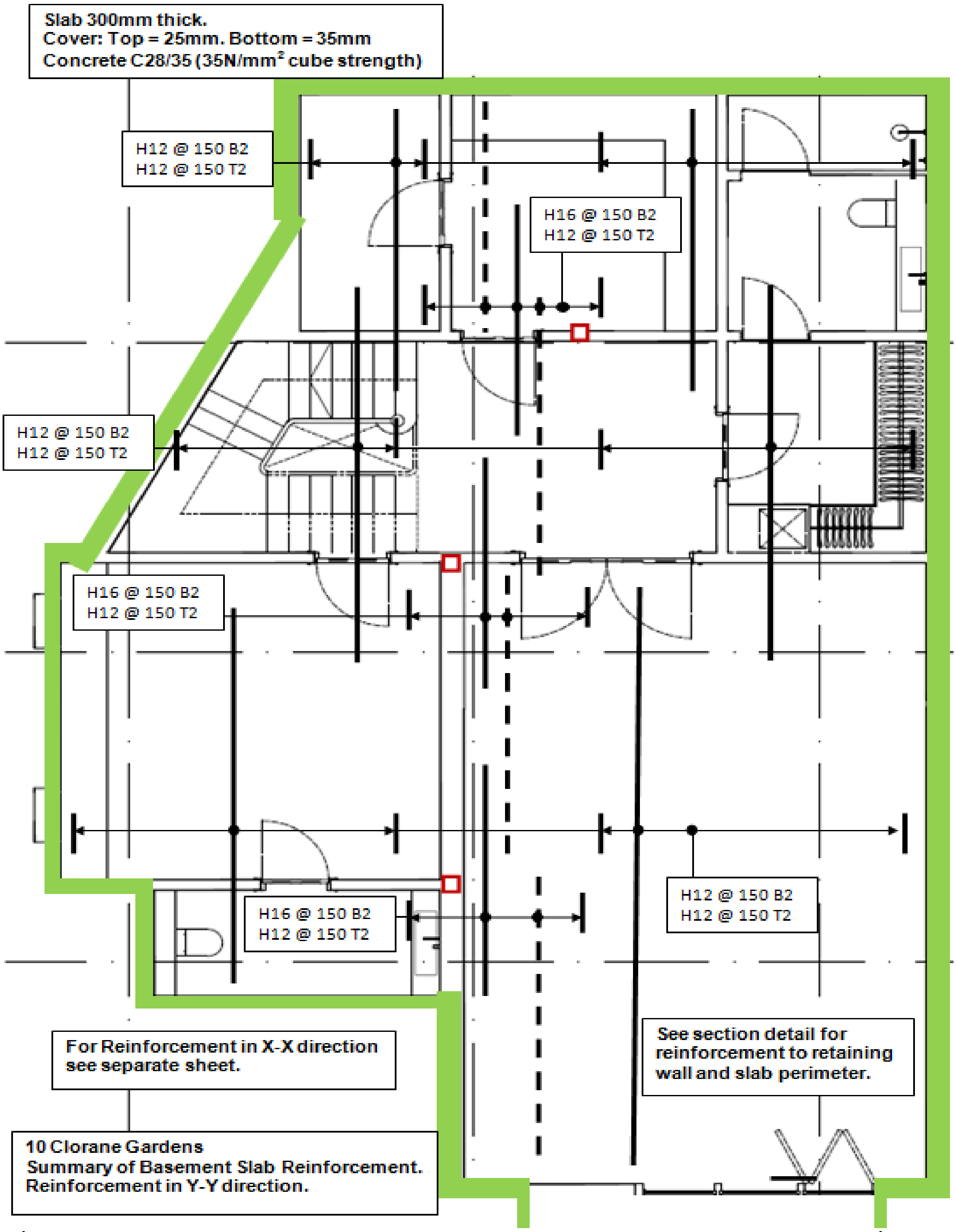
Slab Reinforcement Summary - X-X direction reinforcement.



LOCATION	CALCULATIONS	OPTIONS

Basement Slab Reinforcement design

Slab Reinforcement Summary - Y-Y direction reinforcement.



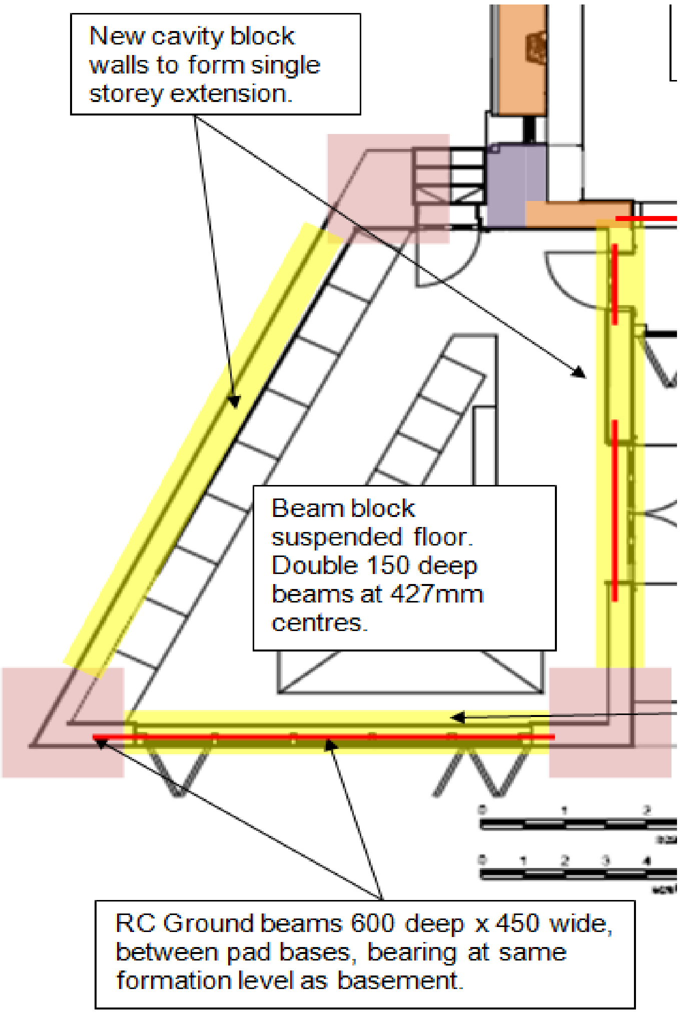
Sheet No:	RE1	Project No:	K697
By	IN	Date	Jan-16
Checked:	GS	Date	

10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Rear Ground Floor Extension



Pad Foundations below rear extension

Load on Pad Foundation = 167 kN **Safe bearing pressure =** 150 kN/m^2

Required pad size = $\frac{166.7}{150}$ = 1.111 m^2 = **1.2 m x 1.2 m**

Pad foundations to be excavated to level coincident with basement excavation to ensure a firm undisturbed bearing is achieved. Minimum mass concrete pad foundation depth to be 500mm.

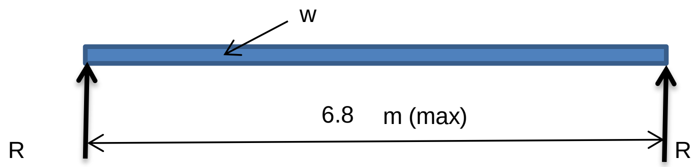
10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Ground Beams to Rear Extension

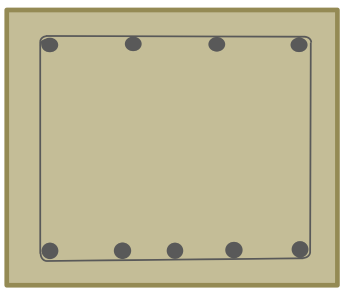
Loading:



UDL, w							**Dead**	**Live**	
Roof	(	0.78	,	0.75)x	1 x	2.6	2.0	2.0	
Grd	(	4.71	,	1.50)x	1 x	2.6	12.2	3.9	
Wall		2.84		x	1 x	3.2	9.1	0.0	
G Beam		6.48		x	1 x	1	6.5	0.0	
Total							29.8	5.9	kN/m
		Ultimate		=			51.1		kN/m

Analysis: R = w.l/2 = 51.1 x 6.80 /2 = 174 kN

M = $w.l^2/8$ = 51.1 x 6.80 ^{2}/8 = 296 kNm



b = 450 mm h= 600 mm

Cover bottom = 35 mm

d= 600 - 35 - 20 = 545 mm

C28/35 concrete, f_{cu} = 35 N/mm2

Reinforcement, f_y = 500 N/mm2

BS8110
cl 3.4.4.4

$K = M/bd^2f_{cu} = \dfrac{295.6 \times 10^6}{450 \times 545^2 \times 35} = 0.063$

z = d{0.5 + √(0.25 - K/0.9)} = (not greater than 0.95.d) = 504 mm

0.95d = 518 mm

A_s (req) = $M/0.87f_yz$ = $\dfrac{295.6 \times 10^6}{0.87 \times 500 \times 504}$ = 1349 mm^2

A_s (min) = 0.13% = 351 mm^2

Reinforcement provided: **5 H20** A_s (prov) = 1570 mm^2

Provide

5 H20

(1570)

Bottom

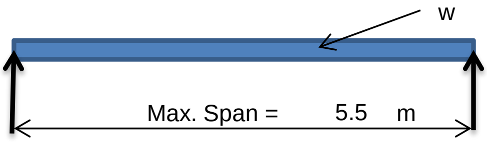
LOCATION	CALCULATIONS	OPTIONS
	Ground Beams to Rear Extension	
	Shear Check: Beam end reaction, R = 173.9 kN bv = 450 mm d= 545 mm	
	Shear force, V (at 2d from end of beam)= 51.14 x (6.8 /2 - 2 x 0.545)	
	= 118 kN	
cl 3.4.5.2	Design shear stress, v = V /bv.d = 0.482 N/mm^2 A_s (prov) = 1570 mm^2	
	$v_c = 0.79 \{ 100.A_s / (b_v.d) \}^{1/3} . (400 / d)^{1/4} / \gamma_m$	
BS8110 table 3.8	$100.A_s / b_v.d$ = 0.64 400 / d = 0.734 **v_c = 0.504 N/mm^2**	
3.4.5.10	v_c is enhanced is within 2d of support, hence check at 2d is worst case.	
table 3.7	$v < (v_c + 0.4)$ hence provide Minimum links for whole length of beam.	**Provide**
	Minimum links: $Asv = \frac{0.4.bvsv}{0.95.fyv}$ = 76 mm^2, 2 H 8 = 100 mm^2 link spacing 200mm	**<u>H 8 Links at 200mm centres (2 Legs)</u>**
	Deflection Check: basic l/d = 20 For simply supported strip.	**4 H12 (452) Top**
table 3.10	$M/b.d^2 = \frac{296 \times 10^6}{450 \times 545^2}$ = 2.21 $f_s = \frac{2.f_y.A_s \text{ req}}{3.A_s \text{ prov}}$ = 286 N/mm^2	
	Modification factor, Mod (T) = $0.55 + \frac{(477 - f_s)}{120.(0.9 + M/b.d^2)}$ = 1.06 ≤ 2.00 (tension reinforcement)	Hence:
table 3.11	Modification factor, Mod (C) = 1.06 $100A'_s$ prov/bd = 0.184 (compression reinforcement)	
	Allowable l/d = 20 x 1.06 x 1.06 = 22.4	l/d acceptable.
	Act. l/d = $\frac{6800}{545}$ = 12.5	

10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Rear Extension Floor Slabs - Beam Block Floor



Using "Milbank Floors" safe load tables.

Floor finish loads are within 1.8kN/m^2 allowance made in safe load tables.
Use 1.5 kN/m^2 Imposed live load (as applicable to domestic floor use)

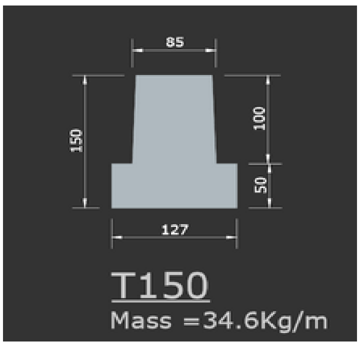
T150 Load Span Table

150mm deep T beam (based on 30 mins fire resistance) Medium density infill blocks 1450kg/m³			Maximum Clear Span* in metres below allows for characteristic live loads as stated + Self weight + 1.8 kN/m2 (75mm screed) finishes + 1.00 kN/m² partition allowance							
	**	Self	Imposed live load kN/m²							
Beam centres (mm)	Block spacing	weight (kN/m²)	0.75	1.50	2.00	2.50	3.00	4.00	5.00	7.50
525mm	W	1.84	3.990	3.730	3.590	3.460	3.340	3.130	2.960	2.630
412mm	A	1.95	4.470	4.190	4.030	3.880	3.750	3.520	3.330	2.960
300mm	N	2.15	5.170	4.850	4.670	4.510	4.360	4.100	3.880	3.460
652mm	DW	2.15	4.950	4.650	4.470	4.320	4.180	3.930	3.720	3.320
540mm	DA	2.31	5.380	5.060	4.870	4.710	4.560	4.290	4.070	3.630
427mm	DN	2.54	5.940	5.600	5.400	5.220	5.060	4.780	4.540	4.060
554mm	TN	2.75	6.290	5.940	5.730	5.550	5.380	5.090	4.830	4.340

* Clear span = Distance between supporting walls
** W=Wide(440mm) A=Alternate (440 + 215mm) N=Narrow (215mm).

Use Double 150mm deep T beams with Narrow (215mm) blocks.
427mm beam centres
(Where span reduces below 4.8m single T beams will be suitable.)

Note:
Final design and selection of beam block floor arrangement to be by beam block floor manufacturer.



Sheet No:	RE5	Project No:	K697
By	IN	Date	Jan-16
Checked:	GS	Date	

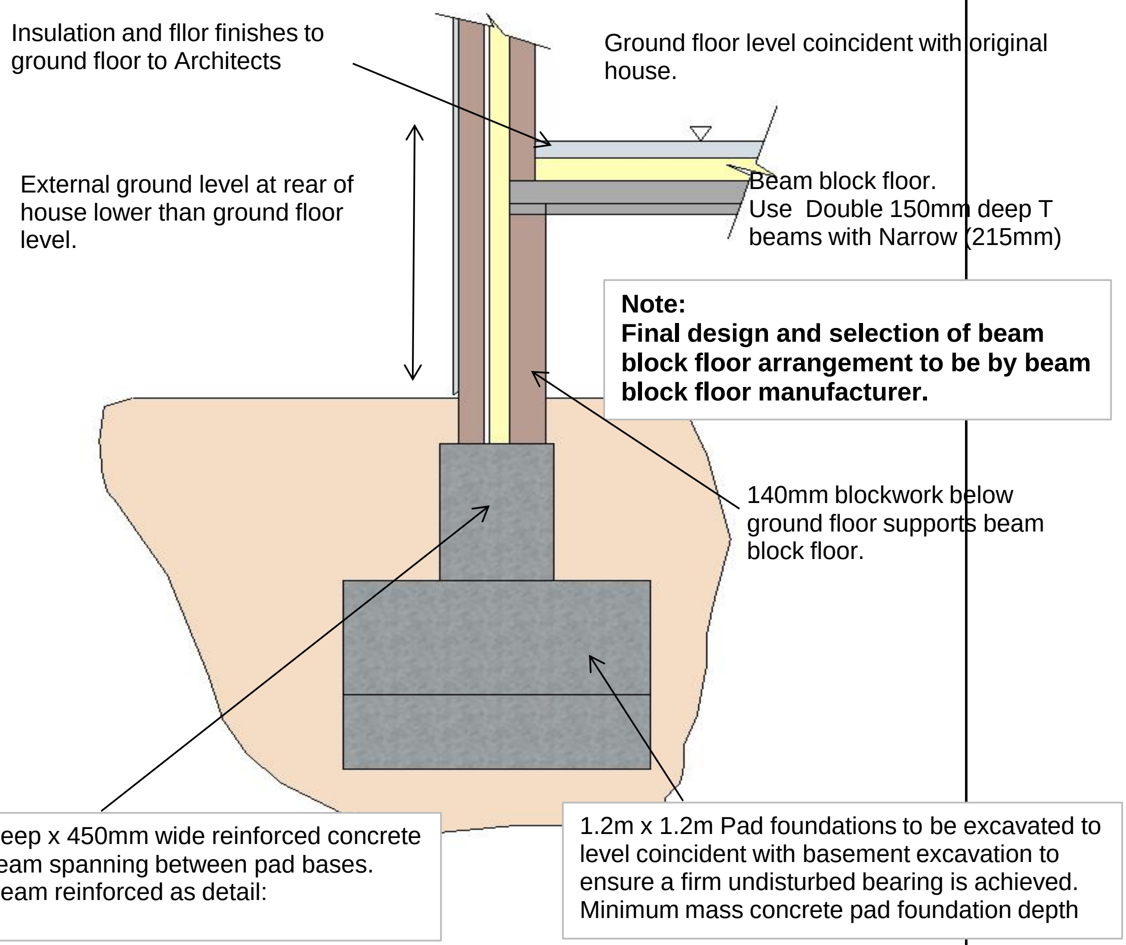
10 Clorane Gardens, London NW3

New basement and upper floor alterations

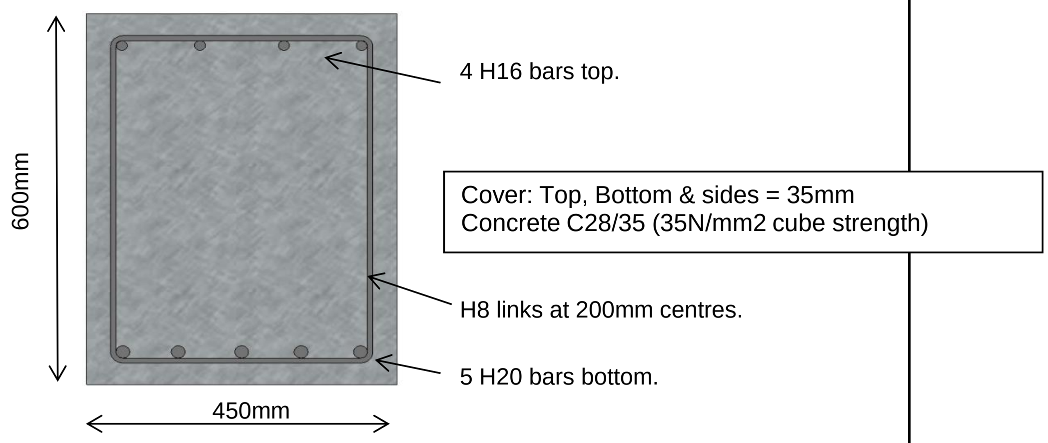
LOCATION	CALCULATIONS	OPTIONS

Rear Ground Floor Extension

Summary of Foundation and ground floor requirements to rear extension:



Ground beam reinforcement summary:



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Sheet No:	RE6	Project No:	K697
By	IN	Date	Jan-16
Checked:	GS	Date	

10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Lintel design over rear windows and bi-fold doors.

Maximum lintel span =

4.5 m

Wall Construction over lintel:

100/100/100 blockwork cavity wall, rendered externally

(cavity width to be confirmed by Architect, subject to insulation requirements)

Load on Outer leaf of lintel — Outer leaf of cavity wall supports wall over only.

w2 = (kN/m)				Dead	Live	Ult.	
wall	1.90	x	0.6	1.1		1.6	
	total			1.1	0.0	1.6	kN/m

Total safe working load on Outer leaf of lintel, s.w.l = udl x lintel length

= (1.1 + 0.0) x 4.5 = **5.1 kN**

Load on Inner leaf of lintel — Inner leaf of cavity wall supports roof edge

w2 = (kN/m)					Dead	Live	Ult.	
roof	(0.78	,	0.75) x	1.0	0.8	0.8	2.3	
wall	0.94	x	0.6		0.6		0.8	
	total				1.3	0.8	3.1	kN/m

Total working load on Inner leaf of lintel, w.l = udl x lintel length

= (1.3 + 0.8) x 4.5 = **9.4 kN**

Total working load on lintel, w.l = Inner leaf + Outer leaf load

= 5.1 + 9.4 = **15 kN**

Load ratio on lintel =

(Inner leaf : Outer leaf)

2 : 1 < 19:1 hence ok.

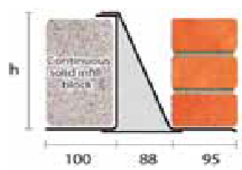
Lintel required:

Catnic 'Extra Heavy Duty'

cavity lintel CX90/100

or similar approved.

Extra Heavy Duty



Standard lengths are available in 150mm increments up to 3000mm, 300mm at lengths 3000mm to 4800mm (including 4575mm, but excluding 4500mm).

CX90/100

Standard lengths (mm)	900-2700	2850-3000	3300-3900	4200-4800
SWL 1:1/19:1 (kN)	60	55	50	32
Weight (kg/m)	16.9	16.9	20.5	20.5
Nominal height 'h' (mm)	232	232	232	232

Note: This is an assessment of the load on external wall lintels in order to provide an indicative guide to lintel requirements.
<u>Final lintel design and selection should be by the lintel manufacturer.</u>

<u>Lintel installation and bearing lengths to be strictly in accordance with manufacturers recommendations.</u>

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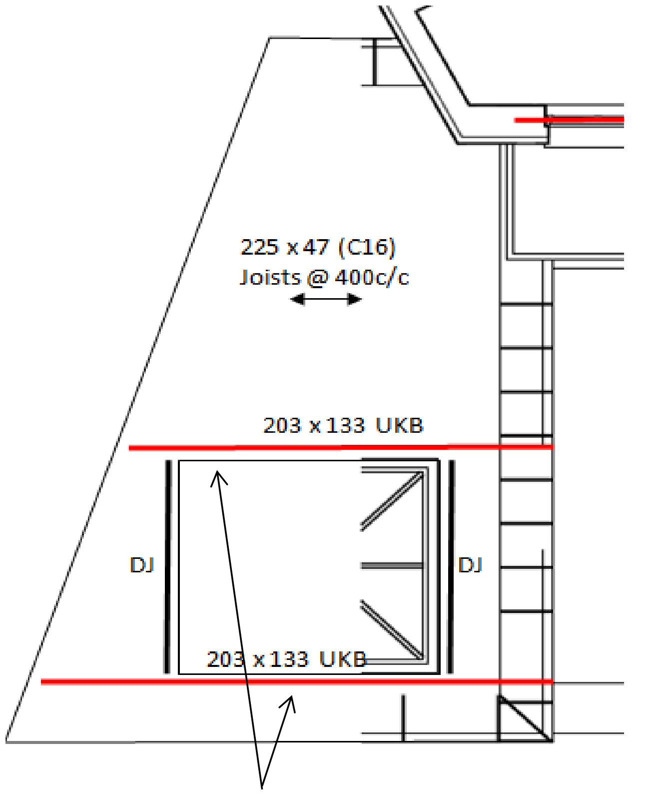
Sheet No:	RE7	Project No:	K697
By	IN	Date	Jan-16
Checked:	GS	Date	

10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Roof over rear extension



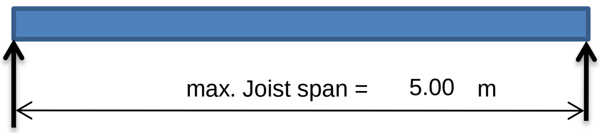
Roof layout.

Steel beams trimming lantern roof light.

LOCATION	CALCULATIONS	OPTIONS

Timber joists to flat roof over rear extension.

Loading: Dead= 0.78 kN/m2 Live= 0.75 kN/m2



Joists spacing 400 mm

Total loading per joist (unfactored for permissible stress design to BS5268)

w = (0.78 + 0.75) x 0.4 [joist spacing] = 0.61 kN/m

Analysis:
(timber design to permissible stresses, hence calculations based on unfactored loads)

Max. Bending moment, $M = wl^2/8$ = 0.61 x 5.00 $^2/8$ = 1.91 kNm

Max. Shear, $V = wl/2$ = 0.61 x 5.00 x 1/2 = 1.53 kN

Timber section design:

225 x 45 Joists at 400 mm centres. **Timber grade C16**

BS5268-2
cl. 1.6.4 — service class = 1 [Internal use] Flat Roof constructed as 'warm roof' with insulation over joists and roof deck.

table 8 — Grade stresses: Bending = 5.3 N/mm^2 Shear = 0.67 N/mm^2

Modulus of elasticity: 8800 N/mm^2 (mean) 5800 N/mm^2 (minimum)

cl.2.8
table 17 — Duration of loading = medium term hence: K_3 = 1.25

cl. 2.9 — Joists are load share system (spacing < 610mm)

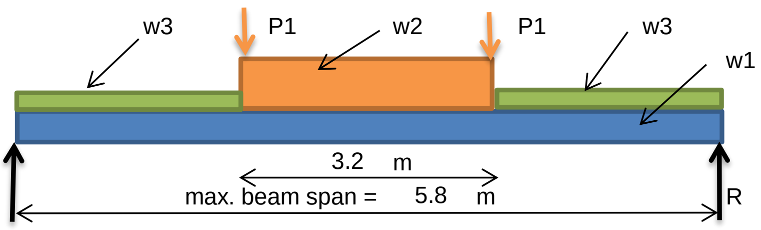
Load share modification factor, K_8 = 1.10 mean modulus of elasticity applies

LOCATION	CALCULATIONS	OPTIONS
	Timber joists to flat roof over rear extension.	
BS5268-2 2002	Depth of timber joist = 225 mm	
cl. 2.10.6	Depth modification factor, $K_7 = (300/h)^{0.11}$ = 1.03	
	Allowable bending stress in timber joist = 5.3 $\times K_3 \times K_8 \times K_7$	
	= 5.3 x 1.25 x 1.10 x 1.03 = **7.52** **N/mm^2**	
	For 225 x 45 joist:	
	Section modulus, $Z = bd^2/6$ = 45 x 225 $^2/6$ = 379.7 $\times 10^3\ mm^3$	
	Second momoment of area, $I = bd^3/12$ = 45 x 225 $^3/12$ = 42.71 $\times 10^6\ mm^4$	
	Applied bending stress in timber joist = M/Z = $\frac{1.91 \times 10^6}{379.7 \times 10^3}$ = **5.04** **N/mm^2**	
	< allowable, hence ok	
	Check Shear:	
	Allowing for up to 20mm notch to underside of joist in joist hanger support	
cl 2.10.4	notch factor $K_5 = h_e/h$ = $\frac{205}{225}$ = 0.91	
	Allowable shear stress = 0.67 $\times K_5$ = **0.61** **N/mm^2**	
	Applied shear stress at joist end = V/bd = $\frac{1.53 \times 10^3}{45 \times 225}$ = **0.15** **N/mm^2**	
	< allowable, hence ok	
	Check Deflection:	
cl 2.10.7	Allowable deflection = 0.003 x 5000 = 15 mm	
	Deflection = $5/384\ wl^4/EI$ = $\frac{5 \times 0.61 \times 5000^4}{384 \times 8800 \times 42.71 \times 10^6}$ = 13.2 mm	
	< allowable, hence ok	

LOCATION	CALCULATIONS	OPTIONS

Roof beams trimming lantern rooflight.

Loading:



Total loading on beam

Ultimate:

w1 = Roof loading to one side of joist [joist spacing]
w1 = (0.78 + 0.75) x 0.4 / 2 = 0.31 kN/m 0.46 kN/m

w2 = Glazed roof light + timber kerb
w2 = (0.80 + 0.75) x 2.60 / 2 = 2.02 kN/m 3.02 kN/m

w3 = Roof loading to side of beam each end of roof light.
w3 = (0.78 + 0.75) x 0.4 / 2 = 0.31 kN/m 0.46 kN/m

P1 = reaction from trimmer to roof light including timber kerb.
P1 = (0.78 + 0.75) x 0.6 x 2.6 / 2 = 1.19 kN 1.79 kN

Analysis:

R= w1 x 5.8 /2 + w2 x 3.2 /2 + w3 x 1.3 + P1

R= 0.46 x 5.8 /2 + 3.02 x 3.2 /2 + 0.46 x 1.3 + 1.79

= 8.5 kN

M= R x 5.8 /2 - w1 x 2.90 ^{2}/2 - w2 x 1.6 ^{2}/2

- w3 x 1.3 x 2.25 - P1 x 1.6

M= 8.54 x 5.8 /2 - 0.46 x 2.90 ^{2}/2 - 3.02 x 1.6 ^{2}/2

- 0.46 x 1.3 x 2.25 - 1.79 x 1.6

= **14.8 kNm**

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Sheet No:	RE11	Project No:	K697
By	IN	Date	Jan-16
Checked:	GS	Date	

10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

Roof beams trimming lantern rooflight.

From Analysis:

Applied moment, M = **14.8 kNm**

Try 203 x 133 x 25 UKB **(grade S275)** I = 2340 cm^4

Beam is restrained by timber roof deck, hence both flange fully restrained

BS5950 Table 13 — Take L_E = 2 m

From member capacity charts:

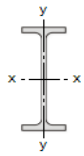
BS 5950-1: 2000
BS 4-1: 2005

Table 1.4.2.3

BENDING

Advance® UKB
Subject to Bending

MOMENT CAPACITY AND BUCKLING RESISTANCE
MOMENT FOR Advance 275



Section Designation	Section Classification	Moment Capacity M_{cx} kNm	Buckling Resistance Moment M_b (kNm) for Effective lengths L_E (m) 1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0
203 x 133 x 30	Plastic	86.4	86.4	82.6	74.1	66.1	58.9	52.6	47.3	39.1	33.2	28.9	25.6	23.0	20.9
203 x 133 x 25	Plastic	71.0	71.0	67.1	59.6	52.5	46.0	40.5	35.9	29.0	24.3	20.9	18.4	16.4	14.8

<u>Mb = 29 kNm</u> **Beam section adequate.**

Deflection check: Span / 360 = $\frac{5800}{360}$ = 16.1 mm

w (live) = 0.75 x 3.0 / 2 = 1.13 kN/m

Deflection (live) = $\frac{5 \times w \times L^4}{384\ E\ I}$ = $\frac{5\text{x}\ 1.13 \times 5800^4}{384 \times 205\text{x}10^3 \times 2340\ \text{x}10^4}$ = 3.5 mm

Deflection considered to be acceptable.

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Sheet No: BM1		Project No:	K697
By	IN	Date	Jan-16
Checked:	GS	Date	

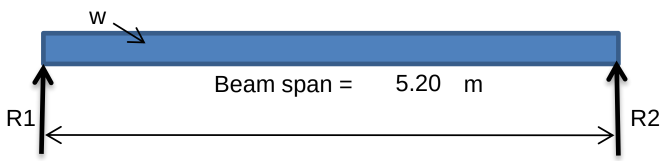
10 Clorane Gardens, London NW3

New basement and upper floor alterations

LOCATION	CALCULATIONS	OPTIONS

First Floor Beam supporting rear wall over opening.

Loading:



w (ultimate) = 39.43 kN/m

Loading on to beam, w							Dead	Live	Ultimate (1.4D +1.6L)	
Roof	(	1.18	,	0.63	)x	2.50	2.96	1.56	6.64	
2nd floor	(	0.78	,	1.50	)x	2.20	1.72	3.30	7.68	
1st floor	(	0.78	,	1.50	)x	2.20	1.72	3.30	7.68	
balcony	(	0.78	,	0.75	)x	1.00	0.78	0.75	2.29	
Rear wall		4.04	x	2.60			10.50	0.00	14.71	
Beam sw		0.30					0.30	0.00	0.42	
Total							17.98	8.91	39.43	kN/m

Analysis:

R1 = w.L/2 = 102.5 kN R2 = w.L/2 = 102.5 kN

Applied moment, M = w.l^2/8 = **133 kNm**

Try 203 x 203 x 46 UKC (grade S275) I = 4570 cm^4

BS5950 Table 13

Beam is restrained by first floor slab, hence compression flange restrained

Take L_E = 2 m From member capacity charts:

Imported with limited functionality from Tata Steel Interactive 'blue book' application version 4.3.0.44

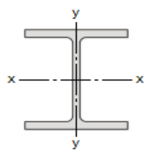
BS 5950-1: 2000
BS 4-1: 2005

Table 1.4.4.1

BENDING

Advance® UKC
Subject to Bending

MOMENT CAPACITY AND BUCKLING RESISTANCE
MOMENT FOR Advance 275



Section Designation	Section Classification	Moment Capacity M_{cx} kNm	Buckling Resistance Moment M_b (kNm) for Effective lengths L_E (m) 2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
203 x 203 x 60	Plastic	180	180	169	153	140	127	117	108	100	93.1	87.0	81.7	76.9	72.7
203 x 203 x 52	Plastic	156	156	144	130	117	106	96.1	87.9	80.9	74.9	69.7	65.2	61.2	57.7
203 x 203 x 46	Compact	137	137	125	111	99.2	88.7	79.9	72.5	66.3	61.1	56.6	52.7	49.3	46.4

Mb = 137 kNm **Beam section adequate.**

Deflection check: Span / 360 = $\frac{5200}{360}$ = 14.4 mm

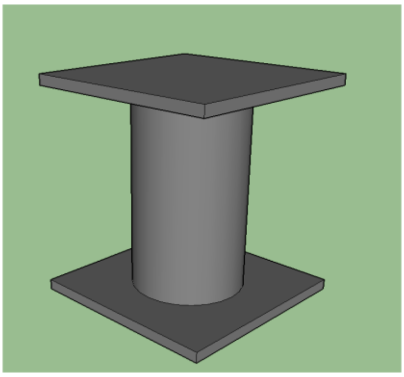
w (live) = 8.91 kN/m

Deflection (live) = $\frac{5 \times w \times L^4}{384\,E\,I}$ = $\frac{5x \quad 8.91 \quad x \quad 5200^4}{384 \times 205x10^3 \times \quad 4570 \quad x10^4}$ = 9.1 mm

LOCATION	CALCULATIONS	OPTIONS

Steel Stool Design.
Stools providing wall support for construction of ground floor slab.

Stool to comprise Steel CHS section with steel bearing plates top and bottom.
Overall height of stool = 250mm



using simplified approach:

BBS5950

$$\frac{F}{P_c} + \frac{M_x}{M_{bs}} + \frac{M_y}{p_y Z_y}$$

cl. 4.7.7

Try 114.3 x 5.0 CHS **(grade S355)**

Effective length L_{exx} and L_{eyy} = 0.85 L $L_{exx} = L_{eyy}$ = 0.85 x 0.23 = 0.20 m

From BS5950 member capacity tables:

P_c (compressive strength) = P_{cy} = 595 kN

M_c (buckling resistance moment) = 19.2 kNm p_yS= 21.2 kNm

Moment in column, moment from eccentricity of wall load on plate .

e_x = 0.5 x 200 = 100 mm M_x = 24 x 0.10 = 2.42 kNm

e_y = 0.5 x 200 = 100 mm M_y = 24 x 0.10 = 2.42 kNm

F_c (compression force) = From internal wall load = **24** kN
(30 kN/m x 800mm stool spacing)

$$\frac{F}{P_c} + \frac{M_x}{M_{bs}} + \frac{M_y}{p_yS} = \frac{24}{595} + \frac{2.42}{19.2} + \frac{2.42}{21.2} = \mathbf{0.281}$$

<1 hence OK

Provide 12mm thick plates top and bottom to form bearing with wall.

	CALCULATIONS	OPTIONS

General Notes and Construction Guidance.

Building Regulations submission:
Structural calculations have been prepared for Building Regulation purposes only. Sketches contained within are not considered to constitute working drawings. Any work undertaken prior to Building Regulation Plan Approval is done so entirely at the client/contractors own risk.
All details are indicative only and may require adjustment/alteration to suit site conditions.
Dimensions and ordering materials:
All setting out, and dimensions are to be confirmed by site measurement prior to any ordering of materials.
The spans noted in these calculations are scaled from drawings and should not be used to order materials. Proposed openings should be measured on site before ordering beam lengths. All beam lengths must include allowance for correct bearing lengths, at each end of the beam. All beams to be provided with 100mm minimum bearings where beam is perpendicular to supporting wall or beam.
Temporary works and support to structure:
The Contractor is responsible for maintaining the stability of the structure throughout the course of the works. The Contractor is to satisfy himself as to the condition of the structure prior to commencing any works. The Contractor is responsible for the design and installation of all temporary works.
To comply with current Health and Safety Regulations both for temporary and permanent works, specialist plant/equipment/lifting gear may be required to install/construct certain elements of the structure.
The existing structure to the existing house has been assumed to be in a sound stable condition, in a good state of repair, this is to be confirmed prior to commencing any works.
Foundations to basement columns.
Foundations to internal basement columns are to be installed in deep foundations from ground level in underpinned type excavations below existing loadbearing walls. Temporary sacrificial props are to be used as necessary to ensure the walls over remain stable at all times. refer to basement column installation drawing for further details.
Timber Joists to upper floors and flat roof:
All double/triple joists to be fixed together along the full joist length with either M10 bolts at 450mm centres or spiked together at 300mm c/c with 4mm x90mm long nails for 50mm wide joists and 5mm x 125mm long nails for 63/75mm wide joists.
If stone or heavy ceramic tiling is to be used on timber floors refer back to Engineer for further design checks.
Provide double joists under partitions parallel to spans. Provide double floor joists or timber spreaders to distribute loads under bath supports.
Consequential damage and cracking.
Significant Structural works of this nature may be quite disruptive and likely to cause cracking to brittle finishes within the rooms adjacent to the works particularly when there are several operations transferring loads from temporary works to new structure. Allowance should be made for repairs and redecoration in rooms affected.
Steel stool installation for temporary support to internal walls
A continuous slot is created at the base of existing internal load bearing walls, using steel stools installed in an underpinning type sequence . A new ground floor slab is then constructed providing the new support to internal walls.
Refer to Steel Stool Installation Sequence drawing for further details.