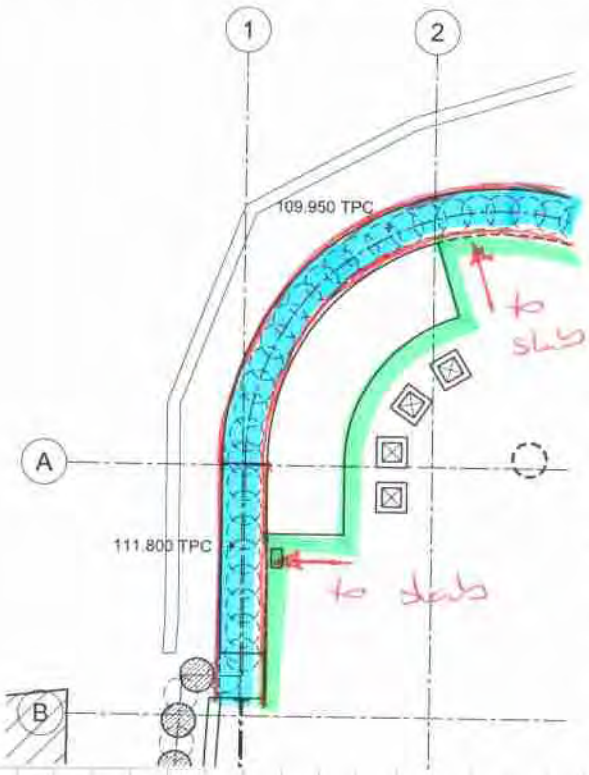
Project	5 Cannon Lane, London, NW3 1EL					Lucking & Clark Structural Engineers Lucking & Clark LLP 19-21 Hatton Garden London EC1N 8NR Telephone 020 7405 4054 Fax 020 7405 4056
Title	Basement – Permanent Works Design					
Project No. 24310	Sheet No. 1-27	By PJW	Date Feb 2011	Checked By	Date	

CALCULATIONS

5) grand beam GB 5 :



UDL = 50 kN/m (u)

SPAN = 5300 mm

* for simplification ignore arching effect (conservative approach) *

$M = 50 \times 5.3^2/8 = 176$ kNm (u)

$V = 50 \times 5.3/2 = 133$ kN (u)

• Bending:

$K = 0.033 \Rightarrow z/d = 0.95$

$A_s = 836\ mm^2 \Rightarrow$ 5H16 - to inside face

3H16 - to outside face

• Shear:

$v = 0.44\ N/mm^2 \quad v_c = 0.51\ N/mm^2$

$A_{sv}/s_v = 0.4 \times 600 / 0.95 \times 460 = 0.55$

Links H10 - 250 c/c's

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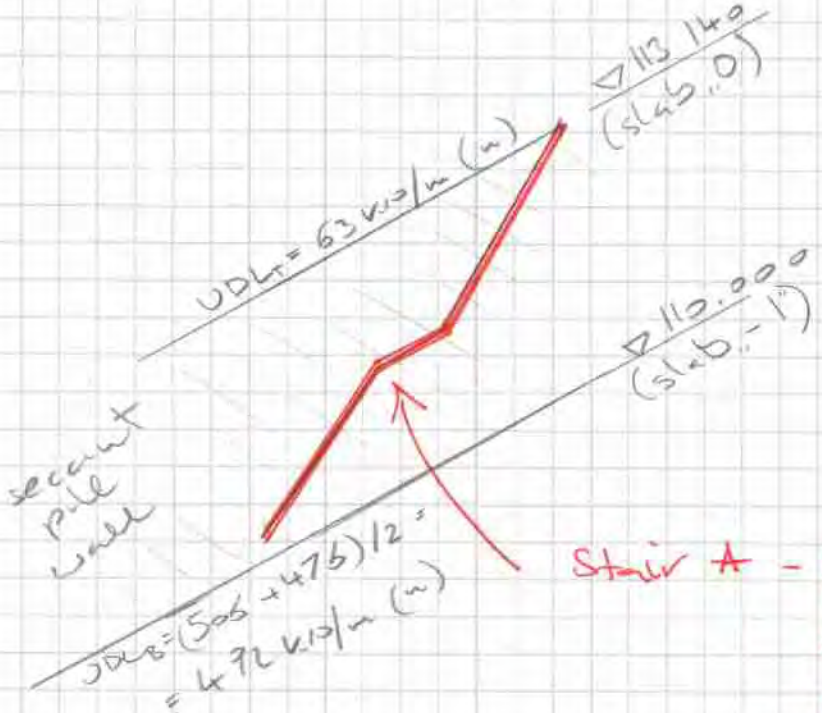
Project No. 24310	Sheet No. 1.23	By PJW	Date Feb 2011	Checked By	Date	

CALCULATIONS

Stair A - Acting as lateral restrain to secant pile wall

* Stairs are assumed to take average soil pressure between levels 113.140 & 110.000. This is assumed to be uniformly distributed along full length of stairs.



$UDL_s = (UDL_T + UDL_B)/2$

$UDL_s = 275$ kN/m (m)

Stair A - for section on stairs see following sheet (length of stair is 6700 mm)

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Project No. 24310	Sheet No. 1.29	By PJW	Date Feb 2011	Checked By	Date	

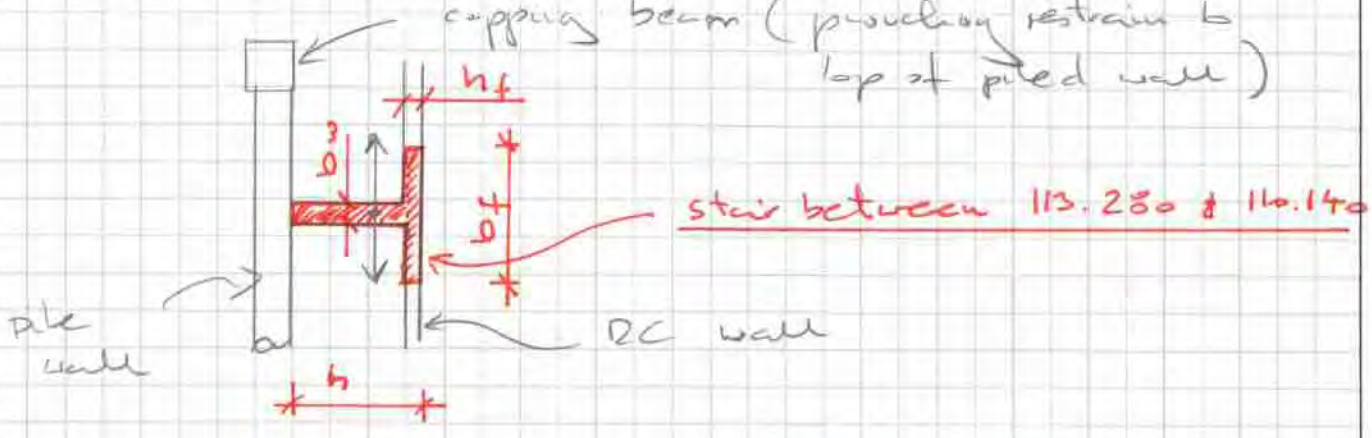
CALCULATIONS

RC Stair A - design for lateral forces

$M = 278 \times 6.7^2/8 = 1560$ kN m (u)

$V = 278 \times 6.7 = 1863$ kN - total lateral load → stairs

$V_T = 1/3 \times 1863 = 621$ kN $\quad V_B = 2/3 \times 1863 = 1242$ kN (u)



$b_f = b_w + L/5 = 200 + 6700/5 = 1540$ mm

$h_f = 150$ mm

$b_w = 250$ mm

$h = 1550$ mm

$d = 1550 - 150/2 = 1475$ mm

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Title	Perm. Walls					
Project No. 24310	Sheet No. 1.30	By PJW	Date Feb 2011	Checked By	Date	

CALCULATIONS

- **Bending:**

$$A_s = \left(M + 0.1 \times f_{cu} b_w d \times (0.45d - h_f)\right) \Big/ \left(0.95 \times f_y \times (d - 0.5h_f)\right)$$

$A_s = 3633\ mm^2$ over 1500 mm width of flange hidden in the wall

Provide 13 H20 at 125 centres

$(A_s^{prov} = 4082\ mm^2)$

- **Shear:**

$V_B = 1242\ kN$ (u) – critical as $V_T = 621\ kN$

$v = 1242 \times 10^3 / 250 \times 1475 = 3.4\ N/mm^2$

$100 A_s / b_v d = 100 \times 2 \times 314 / 250 \times 1475 = 0.17$

$(400/d)^{1/4} = 0.72 \Rightarrow$ use 1.0

$v_c = 0.35 \times \sqrt[3]{40/25} = 0.40\ N/mm^2$

$A_{sv}/s_v \geq 250 \times (3.4 - 0.40) / 0.95 \times 450 = 1.72$

Provide H12 - 125 → for 0.25 of span either end

H12 - 200 → for central 0.5 of span

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Project No. 24310	Sheet No. 1.31	By PJW	Date Feb 2011	Checked By	Date	

CALCULATIONS

Stair B - RC curved staircase between Levels -2" & -1" (Basement to Ground)

Design methodology:

* staircase to be dowelled to male piles along one edge and to RC wall along other edge.

* vertical loads acting on the stairs will be transferred to piles & RC wall via dowels - stair to span max 1800 mm

* in permanent condition the stair will be acting as a strut to secant pile wall

* thrust from piles acting on the stair as average thrust between levels -3" & -1"

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Project No. 24310	Sheet No. 1.32	By PJW	Date Feb 2011	Checked By	Date

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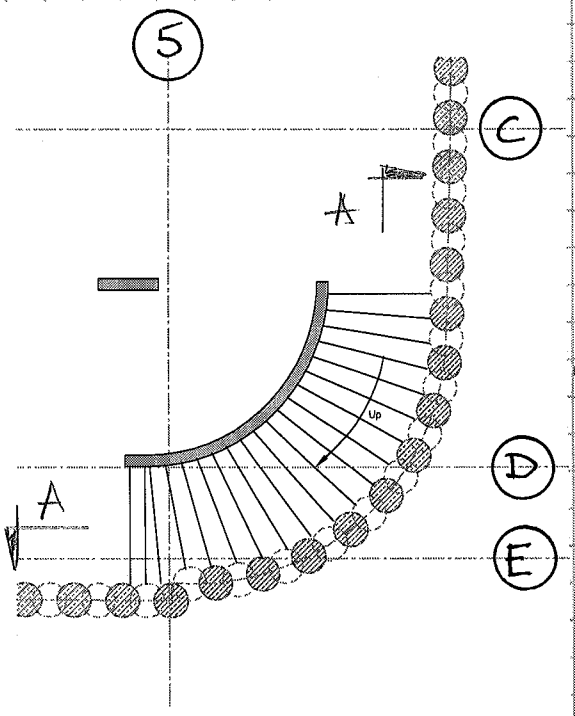
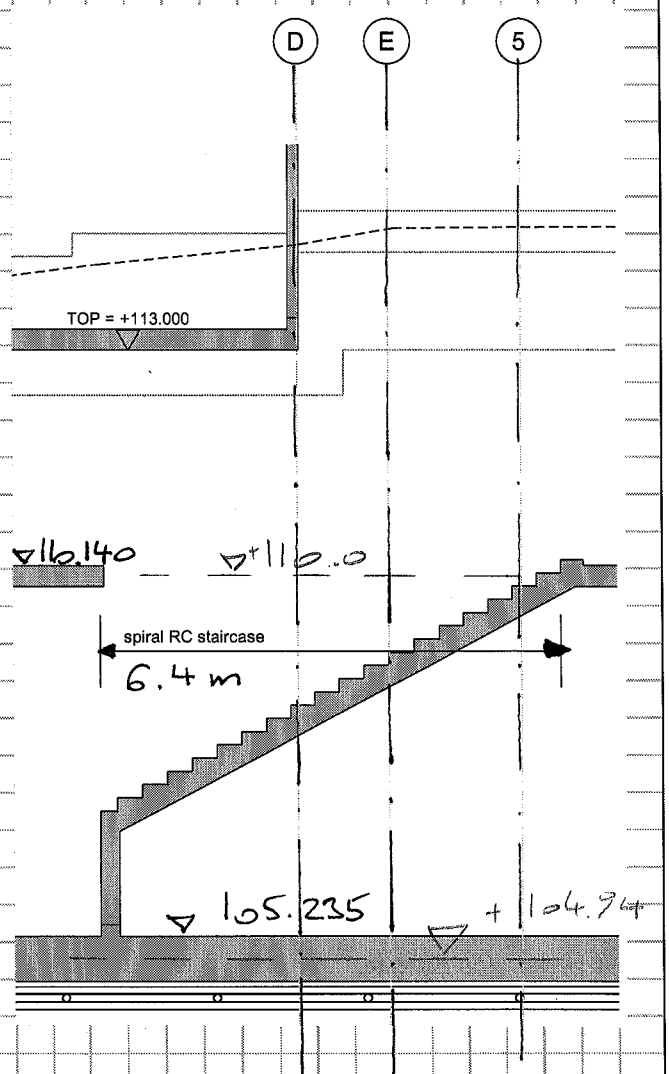
CALCULATIONS



Stair Plan

1: 100



Developed Section

A - A

1: 100

THRUST FROM PILES ($\gamma_F = 1.2$)

▽+ 110.100 192.5 kN/m (s) or 231 kN/m (u)

▽+ 104.935 336.1 kN/m (s) or 403.3 kN/m (u)

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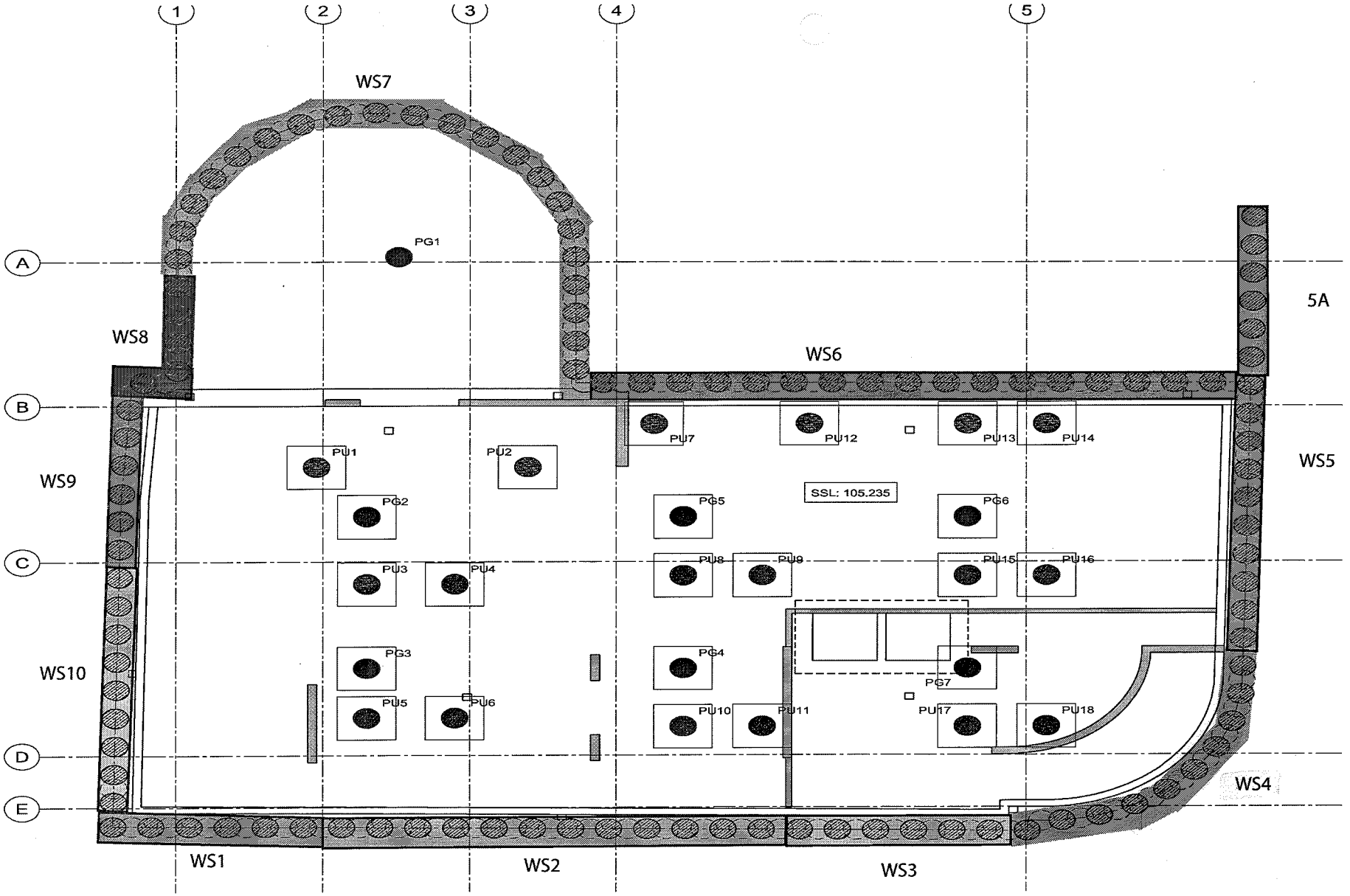

Sheet No.: 1.33

SITE PLAN
FIGURE 1

Plan at Sub basement level

LUCKING AND CLARK

Location: **HAMPSTEAD - 5 Cannon Lane**

TABLE 1 - Details of Retaining Wall Sections

Sheet:	5
Rev:	A
Made by:	DRI
Date:	05/05/11

Wall Section	Notes	Assumed Piling Level	Cut-off Level	Surcharges Description	Surcharges General	Surcharges 'Ground' surcharge	Temporary Props Upper Ground Floor Level	Temporary Props Ground Floor Level	Temporary Props Sub or Basement Level	Permanent Props Upper Ground Floor Level	Permanent Props Ground Floor Level	Permanent Props Sub or Basement Level slab	Initial excavation	Second excavation (if not max)	Planned excavation level	Temporary excavation level with overdig (unplanned)	notes
		mAOD	mAOD		kN/m²	kN/m²	mAOD	mAOD	mAOD	mAOD	mAOD	mAOD	mAOD	mAOD	mAOD	mAOD	
1	as 2	113.85	113.325	adjacent to road	10.0	4	113.143	110.003	N/A	113.143	110.003	104.935	112.9	109.7	104.235	103.735	temp prop at UGF used
2		113.85	113.325	adjacent to road	10.0	5	113.143	110.003	N/A	113.143	110.003	104.935	112.9	109.7	104.235	103.735	as top down sequence
3	3A as 2 3B	113.85	113.775 (adjust)	adjacent to road & stairs	10.0	14	113.14 temp	110.003	N/A	VARIES 110.003		104.935	112.9	109.7	104.235	103.735	temp prop at UGF used. RC stairs UGF-GF to act as prop in perm case
4	4A as 3B 4B	113.85	113.775 (adjust)	adjacent to road and brick wall & stairs	10.0	14	113.143	110.00 temp	N/A	VARIES 104.935		104.935	112.9	109.7	104.235	103.735	temp prop at UGF & GF used. RC stairs GF-SBF to act as prop in perm case. Surcharge from brick wall as 30kN/m run at 112.3mAOD offset 0.2m over 0.4m width
5		113.00	112.575	adjacent to road and brick wall	10.0	-	113.143	110.003	N/A	113.143	110.003	104.935	112.9	109.7	104.235	103.735	Surcharge from brick wall as 15kN/m run at 113.0mAOD offset 0.2m over 0.4m width
5A		113.00	112.475	adjacent to road and brick wall. RW as permanent wall	10.0	-	N/A	N/A	N/A	N/A	prop at 109.965 from slab	N/A	-	-	110,0 (perm)	109.500	Permanent support wall adjacent to garden. Permanent prop taken from slab at 110.065mAOD
6		109.95	109.425	adjacent to garden	5.0	-	N/A	Top Down	N/A	N/A	110.003	104.935	109.7	-	104.235	103.735	Initial reduce dig to lower piling level?
7		109.95	109.425	adjacent to garden	5.0	-	N/A	Top Down	N/A	N/A	110.003	106.690	109.7	-	106.140	105.640	Initial reduce dig to lower piling level?
8		109.95	adjust	adjacent to garden & boundary wall.	5.0	18 offset 1m	N/A	110.003	N/A	N/A	110.003	106.690	109.7	-	106.140	105.640	Initial reduce dig to lower piling level? Surcharge from boundary wall as 10kN/m run at 111.0mAOD. Offset 0.2m over 0.4m width
9		113.00	112.175	adjacent to alleyway for 4 Cannon Lane and adjoining wall & basement at 110.0mAOD	5.0	N/A	113.143	110.003	N/A	113.143	110.003	104.935	109.7	-	104.235	103.735	Surcharge from adjoining wall as 75kN/m run at 110.0(TBC). Offset 1.1m over 0.4m width. Next door basement taken at 110.0mAOD
10		113.00	112.475	adjacent to 4 Cannon Lane & basement at 110.0mAOD	5.0	N/A	113.143	110.003	N/A	N/A	110.003	104.935	109.7	-	104.235	103.735	Surcharge from adjoining wall as 75kN/m run at 110.0(TBC). Offset 1.1m over 0.4m width. Temp prop at UGF used

Sheet 1 of 1, 2nd

Run ID. Hampstead section 4B - SLS run 03 | Sheet No.
Hampstead - 5 Cannon Lane | Date:27-04-2011
Wall section 4B - SLS case - 450mm dia at 650mm c/c 03 | Checked :

Summary of results (continued)

Strut forces at each stage (horizontal components)

Stage no.	--- Strut no. 1 --- at elev. 110.10		--- Strut no. 3 --- at elev. 104.94		--- Strut no. 4 --- at elev. 113.14	
	kN/m run	kN/strut	kN/m run	kN/strut	kN/m run	kN/strut
7	---	---	---	---	51.5	51.5
10	160.8	482.3	---	---	17.8	17.8
12	118.2	354.5	---	---	22.4	22.4
13	118.6	355.7	---	---	22.4	22.4
15	192.5	577.4	167.8	167.8	5.6	5.6
16	---	---	352.6	352.6	97.5	97.5
18	---	---	336.1	336.1	98.4	98.4

Stage no.	--- Strut no. 5 --- at elev. 106.90	
	kN/m run	kN/strut
12	185.7	557.2
13	184.9	554.7

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Title	Basement – Permanent Works Design				
Project No. 24310	Sheet No. 1.36	By PJW	Date Feb 2011	Checked By	Date

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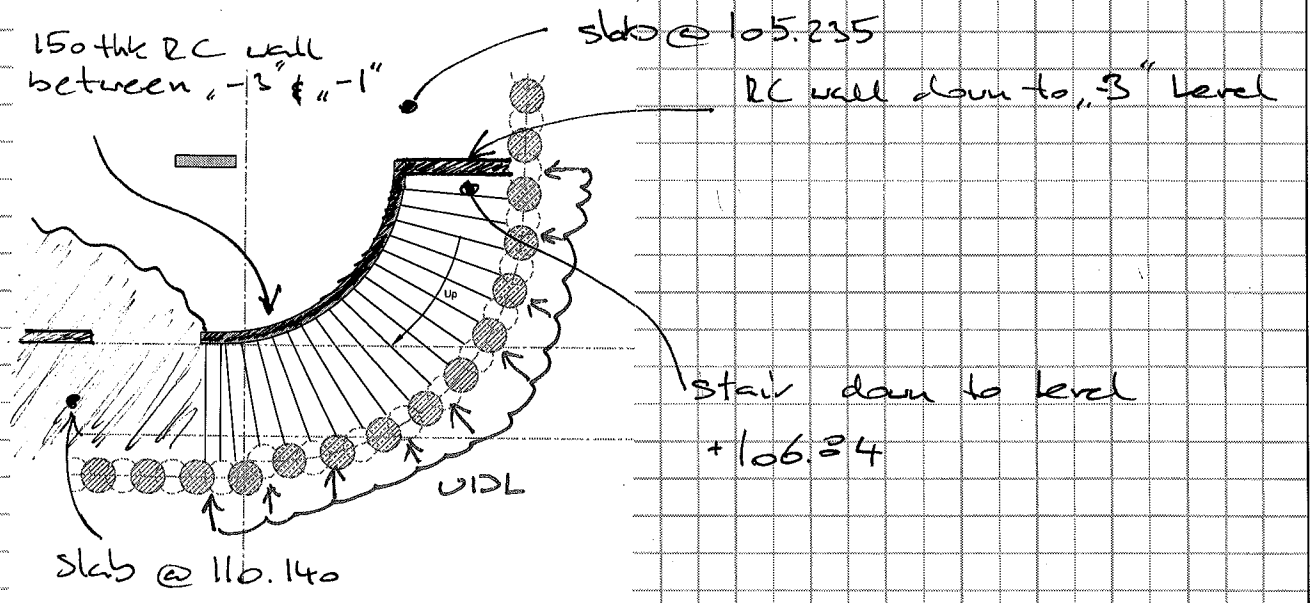
CALCULATIONS



UDL = (193 + 335)/2 = 265 kN/m (↓)

317.2 kN/m (↑)

LENGTH = 6400

For analysis results see the following sheet

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Project				
Title				
Made By PJW	Date	Project No.	Sheet No. 1 37	Checked By

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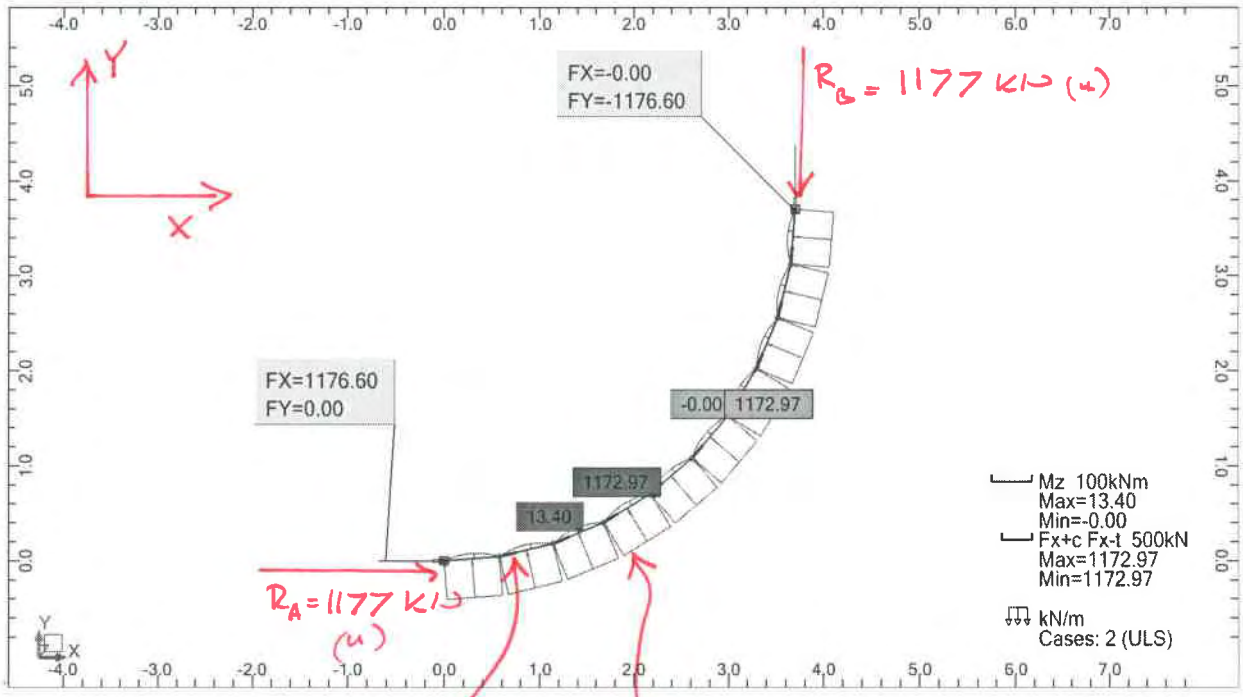
Software Analysis Output

Structure - FX,MZ,Reaction forces(kN), Cases: 2 (ULS)



318 kN/m

modelled as arc divided in 10 separate sections pinned together (350 × 1200)

- Max bending moment in each section (span):

  M = 13.4 kNm (u) ← negligible

- Max compression in single section:

  N = 1173 kN (u) – compression

design force

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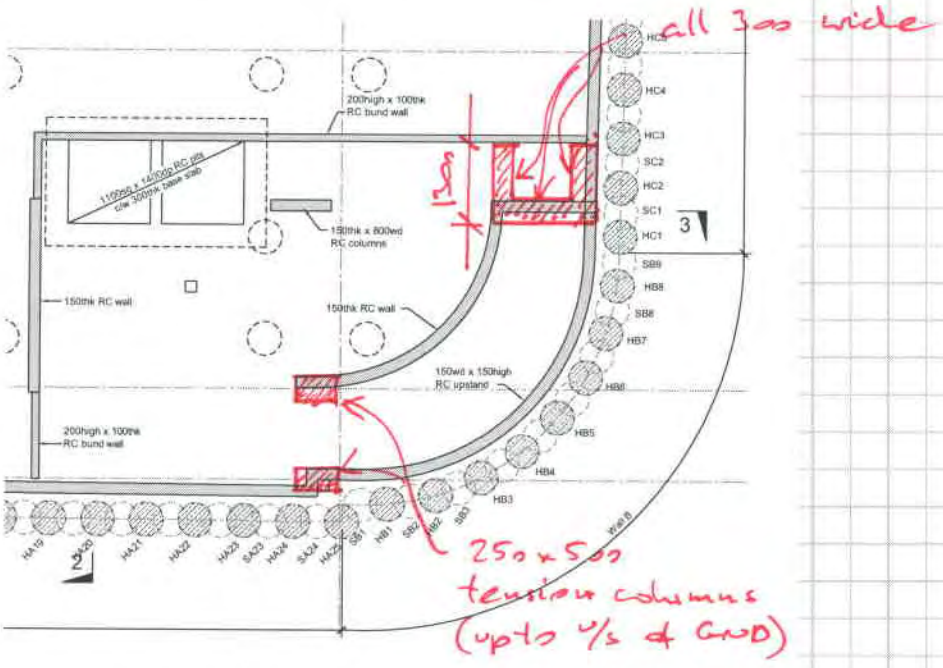
Project No. 24310	Sheet No. 1.38	By PJW	Date Feb 2011	Checked By	Date	

CALCULATIONS



Part Plan @ -2 level

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Title	Basement – Permanent Works Design					
Project No. 24310	Sheet No. 1.39	By PJW	Date Feb 2011	Checked By	Date	

CALCULATIONS

Staircase section to be designed for compression force N = 1173 kN (u)

* Stair section size : 1200 × 350
  " h " " b "

* Assume min reinforcement of 0.4% of concrete cross section area

$A_{sc}^{req} = 1200 \times 350 \times 0.14 \times 0.01 = 588\ mm^2$

Provide $A_{sc}^{prov} = 1356\ mm^2$ (4H12 – 200 T&B)

* Max. column capacity (short braced column)

$N_{comp} = 0.35 \times 35 \times 350 \times 1200 + 0.7 \times 1356 \times 460 =$

$= 5532\ kN > 1173\ kN$ OK

NOTE:

Column is designed as short braced column because it is connected to RC wall & RC piers using M16 dowels @ max. 600 cts.

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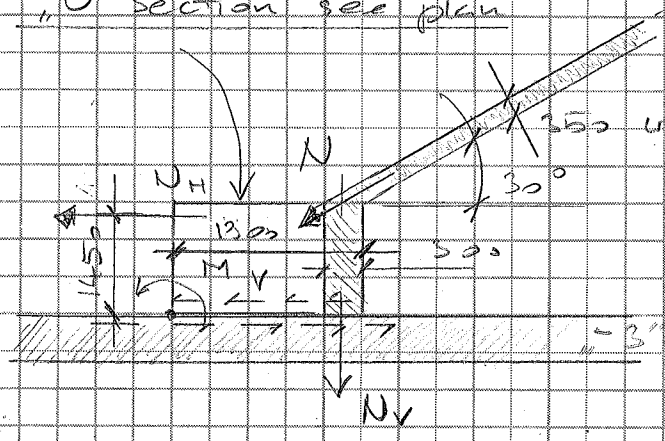
Project No. 24310	Sheet No. 1.39	By PJW	Date Feb 2011	Checked By	Date	

CALCULATIONS

- Due to their nature the compression load will be transferred to Sub Basement (-3) & Ground Slab (-1) @ an angle of 30°.

A) connection to „-3" slab :

„U" section see plan



$N_H = 1177 \times \cos 30° = 1019$ kN (u)

$N_V = 1177 \times \sin 30° = 589$ kN (u)

$M = 1.45 \times 1019 - 589 \times 1.0 = 886$ kNm (u)

$V = N_H = 1019$ kN (u)

- bending check :

$M = 886$ kNm ← on 2No. 300×1300 RC beams

$M' = 886/2 = 443$ kN ← on single 300×1300 beam

$d = 1300 - 35 - 10 - 16/2 = 1247$ mm

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Project No. 24310	Sheet No. 1.40	By PJW	Date Feb 2011	Checked By	Date	

CALCULATIONS

$K = 0.027 \Rightarrow z/d = 0.95$

$A_s = 856\ mm^2$ – for single 300×1300 beam

Provide 4H20 (1256 mm^2)

- Shear check:

$V = N_H = 1019\ kN\ (u)$ – on 2No. 300×300 beams

$V' = V/2 = 510\ kN\ (u)$ – on single 300×1300

$v = 510\times10^3 / 300\times1247 = 1.36\ N/mm^2$

$v_c = 0.34\ N/mm^2$

$A_{sv}/s_v = (1.36-0.34)\times300/(0.95\times460) =$

$= 0.7 \Rightarrow$ H10-100 (1.6)

Provide H10-100 links

Rev	By	Date	Checked	Date	Rev	By	Date	Checked	Date

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Title	Basement – Permanent Works Design				
Project No. 24310	Sheet No. 1.41	By PJW	Date Feb 2011	Checked By	Date

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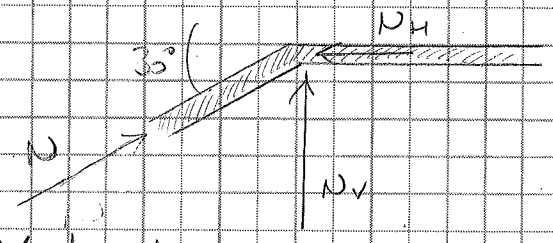
CALCULATIONS

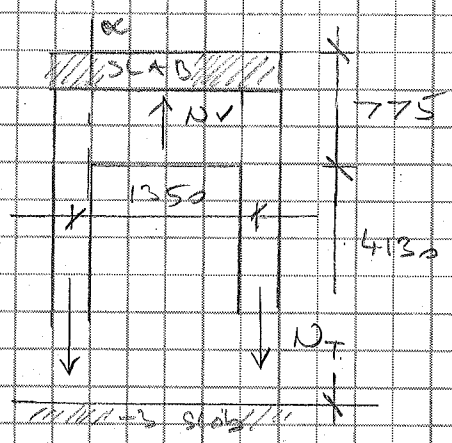
B) connection to "-1" slab:



• Vertical

• $N_V = 529$ kN acting upwards

provide two tension members to sides of slab/floor



$N_T = N_V/2 = 295$ kN

Try 8 No. H20 ($A_s = 2512$ mm²)

$\sigma_T = 295 \times 10^3 / 2512 = 117$ N/mm²

$\varepsilon = 117 / 205 \times 10^3 = 0.0006 \Rightarrow \Delta L = 0.0006 \times 4130 =$
$= 2.4$ mm

Horizontal

• $N_H = 1019$ kN – into slab

Check crushing of concrete

$0.6 \times 35 = 21$ N/mm²

$\sigma_c = 1019 \times 10^3 / 200 \times 1200 =$
$= 3.4$ N/mm² < 21 N/mm²

OK

Rev	By	Date	Checked	Date	Rev	By	Date	Checked	Date

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Title	Basement – Permanent Works Design				
Project No. 24310	Sheet No. 1.42	By PJW	Date Feb 2011	Checked By	Date

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CALCULATIONS

- shear in a plane (Lined / column point)

$v = 295 \times 10^3 / 250 \times 775 = 1.5 \ N/mm^2$

$A_{sv}/s_v = (1.5 - 0.34) \times 250 / 0.95 \times 460 = 0.7$

$\Downarrow$

$H10 - 150 \ (1.05 - A_{sv}/s_v)$

- limited bending:

$M = 295 \times 10^3 \times 1250/4 = 99 \ kNm$ (+)

section used: $b = 250$ & $h = 775$

$d = 775 - 35 - 10 - 16/2 = 722 \ mm$

- bending check:

$K = 0.022 \Rightarrow z/d = 0.95$

$A_s^+ = 330 \ mm^2 \rightarrow 2H16 \ (402 \ mm^2)$

provide 2H16 in top (club)

Rev	By	Date	Checked	Date	Rev	By	Date	Checked	Date

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Title	Basement – Permanent Works Design				
Project No. 24310	Sheet No. 1.43	By PJW	Date Feb 2011	Checked By	Date

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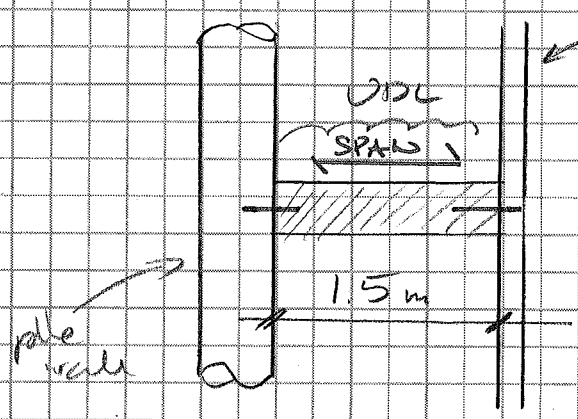
CALCULATIONS

RC stairs - vertical Loads

* Stair to span between pile wall & internal 150 thk wall *



UDL = 0.325 x 24 +
+ 1.5 + 0.5 =
= 9.5 kN/m (s)
14.0 kN/m (u)

$M = 14 \times 1.5^2/8 = 4.0$ kNm/m (u)

$V = 14 \times 1.5/2 = 10.5$ kN/m (u)

- Bending:

$d = 220 - 35 - 10 - 12/2 = 149$ mm

$K = 0.003 \Rightarrow z/d = 0.95$

$A_s = 65$ mm²/m → Use links for tension reinforcement (393 mm²/m)

Rev	By	Date	Checked	Date	Rev	By	Date	Checked	Date

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Title	Basement – Permanent Works Design				
Project No. 24310	Sheet No. 1.44	By PJW	Date Feb 2011	Checked By	Date

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CALCULATIONS

• Dowels :

$R = 14 \times 1.5/2 = 10.5$ kN/m (u)

7.4 kN/m (s)

TRY H12 12-HAC dowels @ 500 c/c's

$V_{rec} = 13.1$ kN with 150 edge distance

$V_{prov} = 13.1 \times 0.71 \times 1000/500 = 18.6$ kN/m (s)

USE H12 12-HAC dowels

@ 500 centres

Rev	By	Date	Checked	Date	Rev	By	Date	Checked	Date