PK & Partners
Consulting Engineers

Structural Engineer's Supplementary Report
Basement Impact Assessment

49 Willow Road, London, NW3 1TS

PK & Partners Limited
Office 1, Izabella House
24-26 Regent Place
Birmingham
B1 3NJ

PHILIP KWAN BEng (Hons) CEng MIStructE
E: philip.kwan@pk-partners.co.uk

Ref: 2136 49 Willow Road - BIA Supplement
Date: March 2021
Revision: C

Registered in England   Registration Number 08026415

Contents

1 Introduction

1.1 A Structural Engineer's basement impact assessment was prepared by PK & Partners in August 2020 to support the planning application for the proposed lower ground floor extension at 49 Willow Road, London NW3.

1.2 It outlined the structural design philosophy and the anticipated construction methodology for the proposed construction. It considers the site, geology, groundwater and hydrology, environmental considerations, sustainability, structural stability, temporary works, construction access and the boundary aspects in relation to the proposed works. This report was prepared in accordance with 'Camden Planning Guidance - Basements – March 2018' and Camden Local Plan (2017) Policy A5 (Basements)'.

1.3 Planning application was submitted (number is 2020/3681/P) which was registered 23 September 2020).

1.4 A Basement Impact Assessment Audit has subsequently been completed by Campbell Reith for Camden Council and this report provides further clarifications and supplementary information in response to this audit.

1.5 This report should be read in conjunction with PK & Partners' Structural Engineer's Basement Impact Assessment (ref: 2136 49 Willow Road – BIA revision C all Architect's and Campbell Reith's Basement Impact Assessment Audit (ref: KBemb13398-54-061120-49 Willow Road_D1.doc)

2 Supplementary Information & Response

Campbell Reith's Basement Impact Assessment Audit Clause 5.7
'Further clarification of the use of corbelling and a heel in the underpin construction is required, and further details regarding the construction sequence are requested.'

Function of heel in underpins

2.1 The heel in the underpinning will be constructed in mass concrete and this would in line with the existing strip or corbelled footing to ensure that the bearing pressure in the short term does not exceed the existing applied pressure. The heel is not essential in the long term and does not form part of the structural design. It is constructed in mass concrete to allow the adjoining owner to remove in the event that basement is constructed in the adjoining site.

Construction Sequence adjacent garage

2.2 The basement wall at the rear boundary will be constructed in two stages as indicated in PK and Partners basement impact assessment and drawing 101. This drawing has been amended to include specific details in relation the rear boundary with the garage which can be found in appendix A. The general sequence of work is outlined as follow.

2.3 The existing perimeter masonry walls will be stabilised in the first instance with perimeter whalers and a diagonal brace (Figure 1 below).

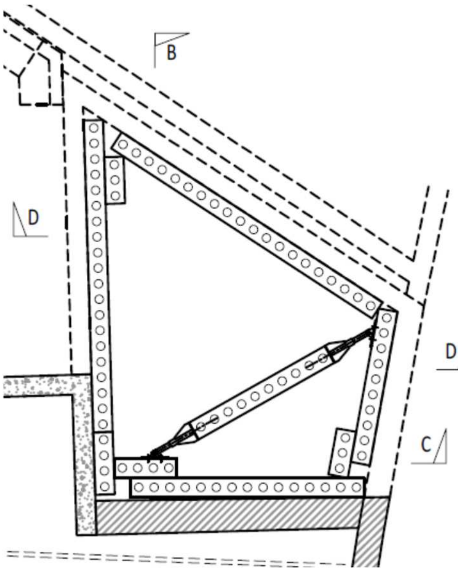


Figure 1 – Install perimeter whalers and brace

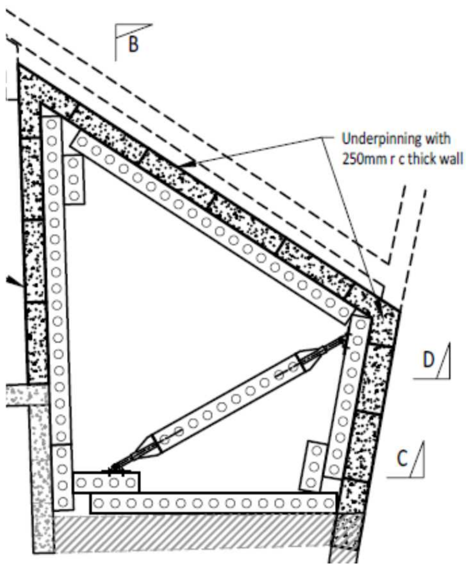


Figure 2: Carry out stage 1 underpinning

2.4 1st stage underpinning will then be undertaken in sequence to construction the wall down to approximately 1.1m below street level. Once the three sides are completed, the timber ground floor will be removed followed by the installation another layer of whalers and cross brace at this lower level (see figure 3). It is anticipated that the bulk excavation will be undertaken when stage 2 underpinning is complete.

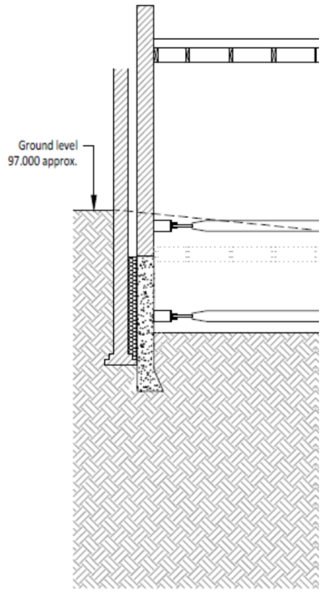


Figure 3 – Remove ground floor and install props

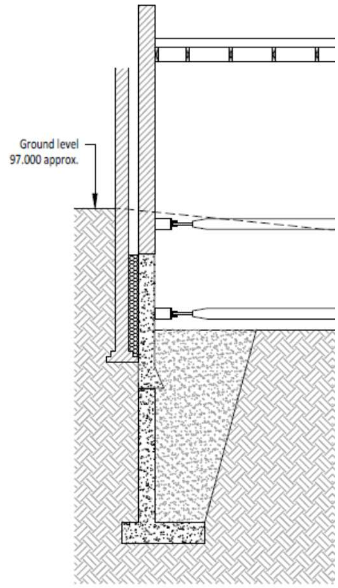


Figure 4: Carry out stage 2 underpinning

2.5 Undertake stage 2 underpinning and backfill between each pin to ensure excavation is supported at all times (see figure 4).

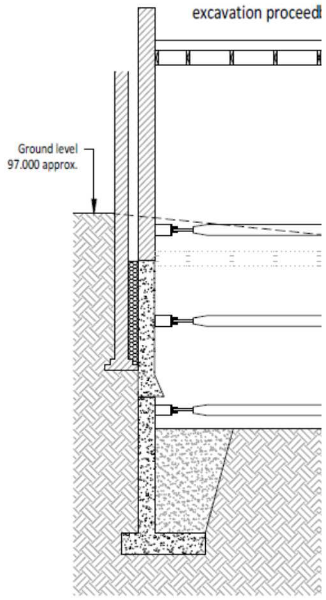


Figure 5 – Excavate in increments and install props

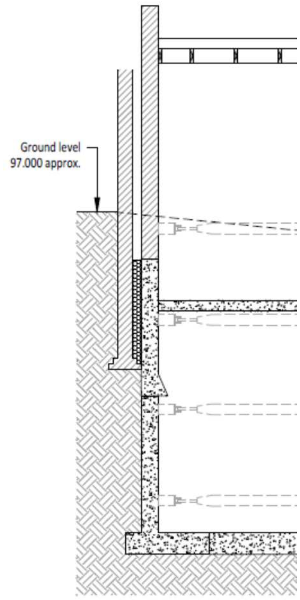


Figure 6: Construct slabs and remove props

2.6 Excavate the soil in increments and install props to ensure the excavation is supported at all times, construct lower ground floor and ground floor slabs. Allow reinforced concrete to cure and remove props when curing is complete (see figures 5 & 6).

Campbell Reith's Basement Impact Assessment Audit Clause 5.8
Structural calculations for the basement should demonstrate how surcharge loads from the boundary wall, the higher adjacent ground levels, and the garage have been considered in the design. Consideration of the impact of storing soil arisings adjacent to the basement excavation. is required.

Loadings and Surcharges at Rear Boundary Wall

2.7 Supplementary calculations are included in appendix B of this report and the design loads for the surcharges along the rear boundary wall are illustrated below:

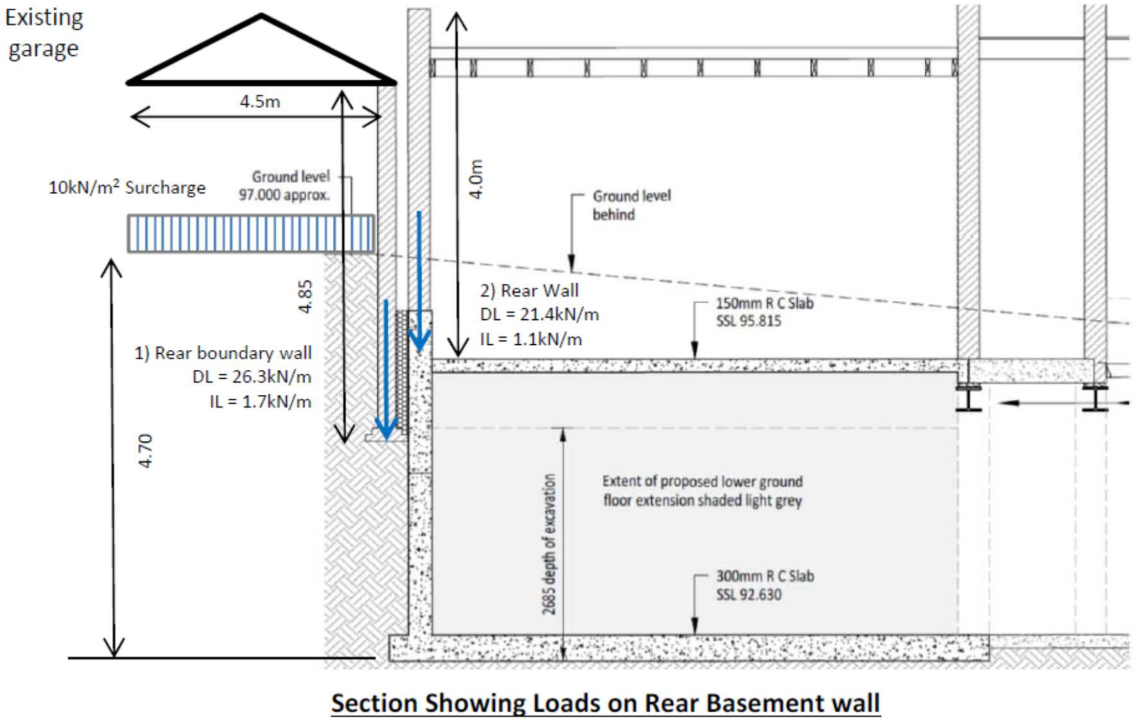


Figure 7 – Loadings and surcharges along rear boundary with adjacent garage.

2.8 The calculations did not indicate any significant issues and B12 reinforcement at 150mm centres in both directions and faces will form the basic grid excepting that B16 re-bars at 150mm centres will be provided to the internal wall face.

Impact of storage of arisings

2.9 Owing to the lack of space which severely limits access, it is anticipated that only two underpins can be constructed at any one time. Each underpin will comprise approximately $2.2m^3$ of soil and this represent a total of $4.4m^3$ of earth.

2.10 The yard is some $10m^2$ in area so there is sufficient space to store this quantity of arisings here. This volume represents a depth of 440mm of spoil over the area of the yard and a surcharge of approximately $8kN/m^2$. There adjoining garden is at the same level and the ground is higher in the adjacent garage so the surcharge from the spoil should not cause instability.

2.11 This volume will form the limit for the storage of spoil on site which will be removed regularly under a wait and load system.

2.12 Where there is an existing basement, temporary prop will be provided to ensure retaining walls are no compromised (see figure 8).

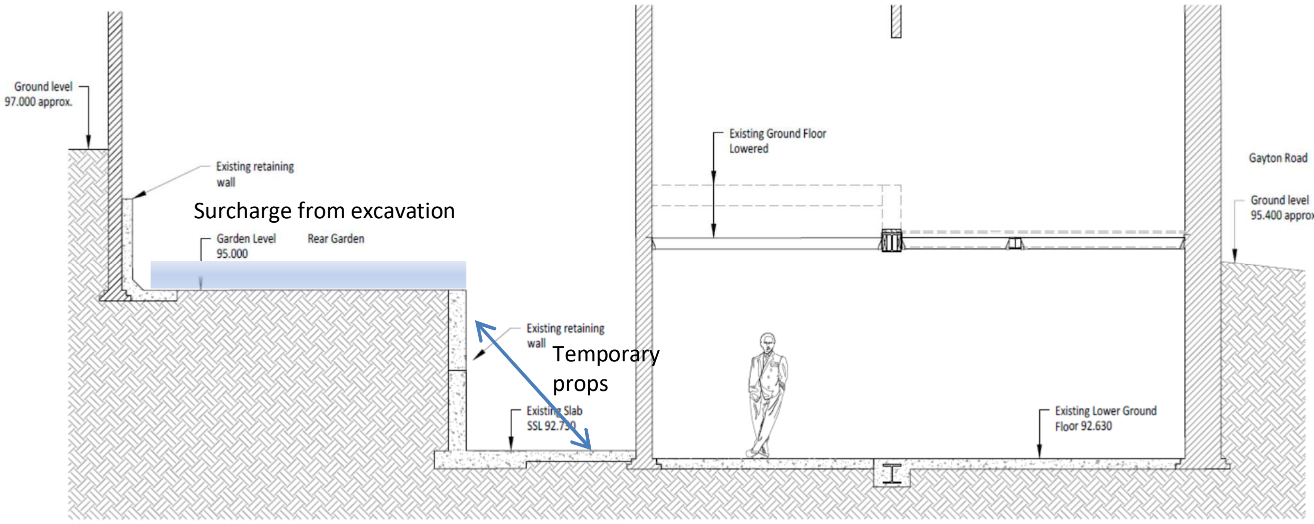


Figure 8 – Temporary propping to existing basement.

De-watering measures

2.13 It is anticipated that there may be some groundwater seepage during the underpinning process. Water ingress into any excavations will mitigated with a local sump pump as indicated in figure 9 below.

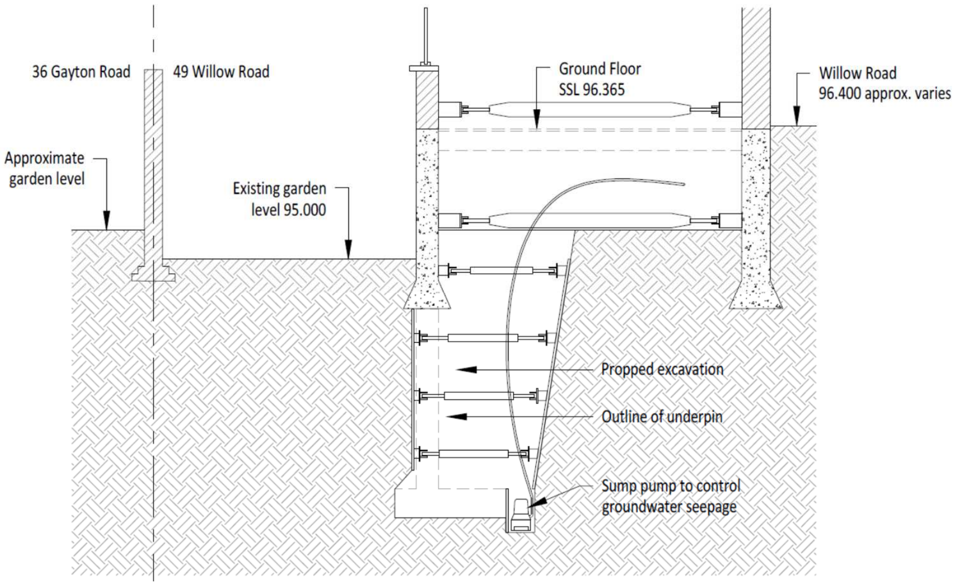


Figure 9 – Propped excavation showing sump to control groundwater.

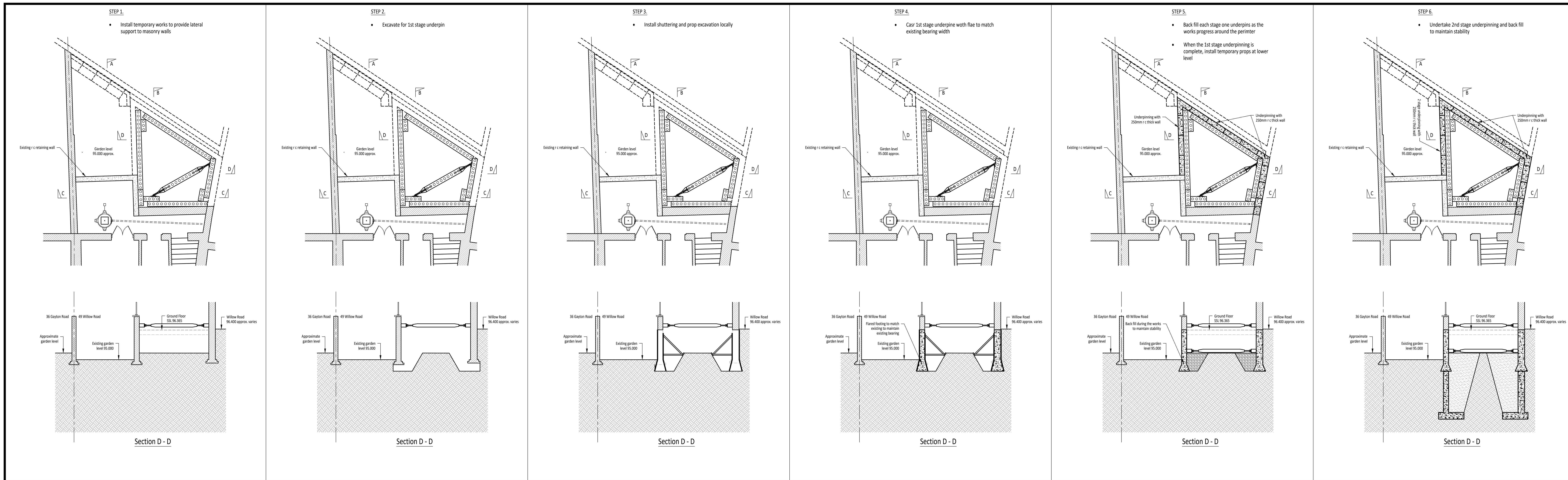
2.14 Ground movement trigger levels

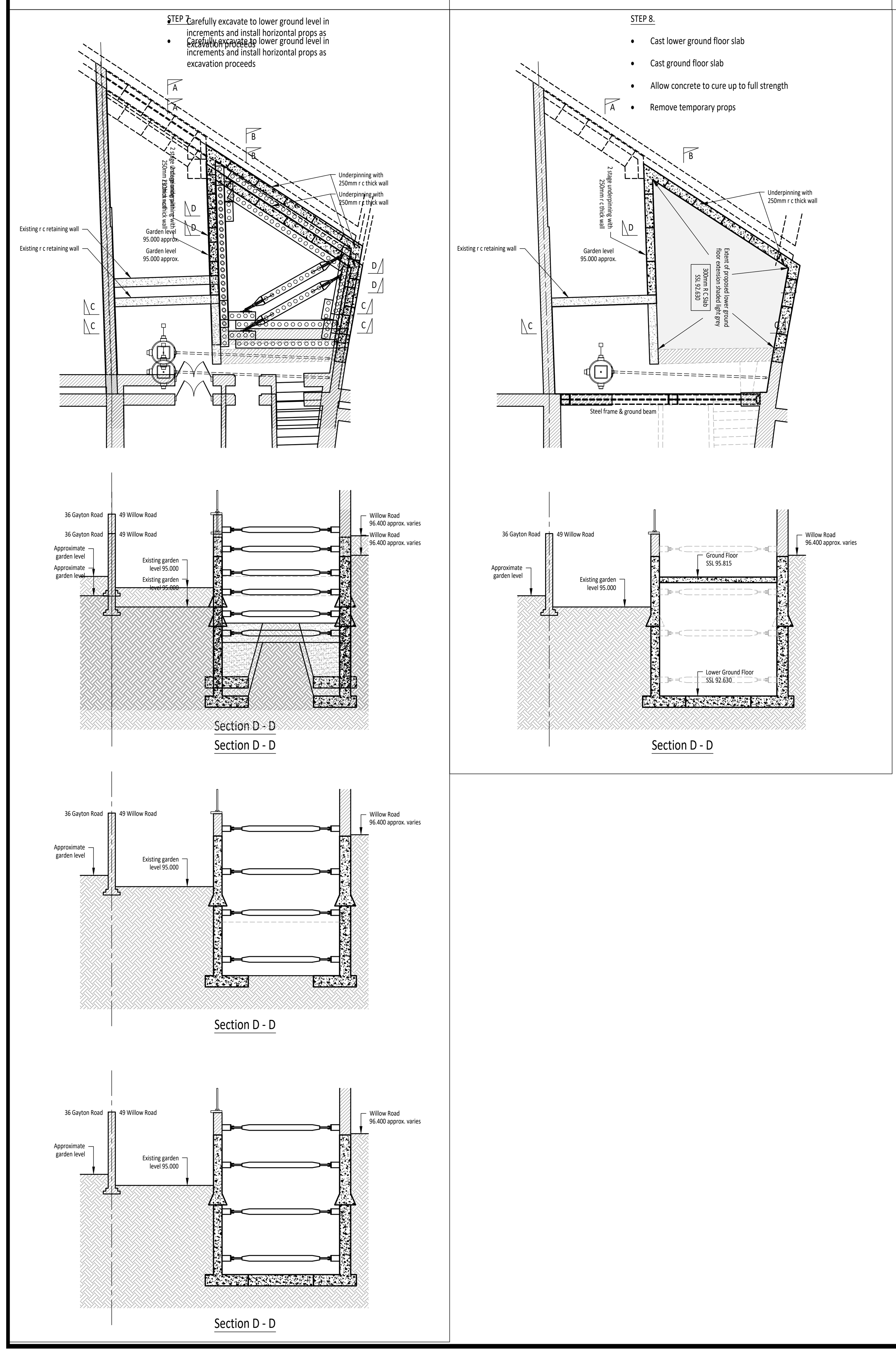
Movement	Category	Action
0-3mm	Green	No Action required
3-5mm	Amber	Carry out structural review and implement mitigation and/or remedial measure as required
>5mm	Red	Cease works with the exception of necessary works for safety and stability. Review monitoring data and revise method of works.
Tolerances: The measurements shall be accurate to +/- 0.50mm in any direction		

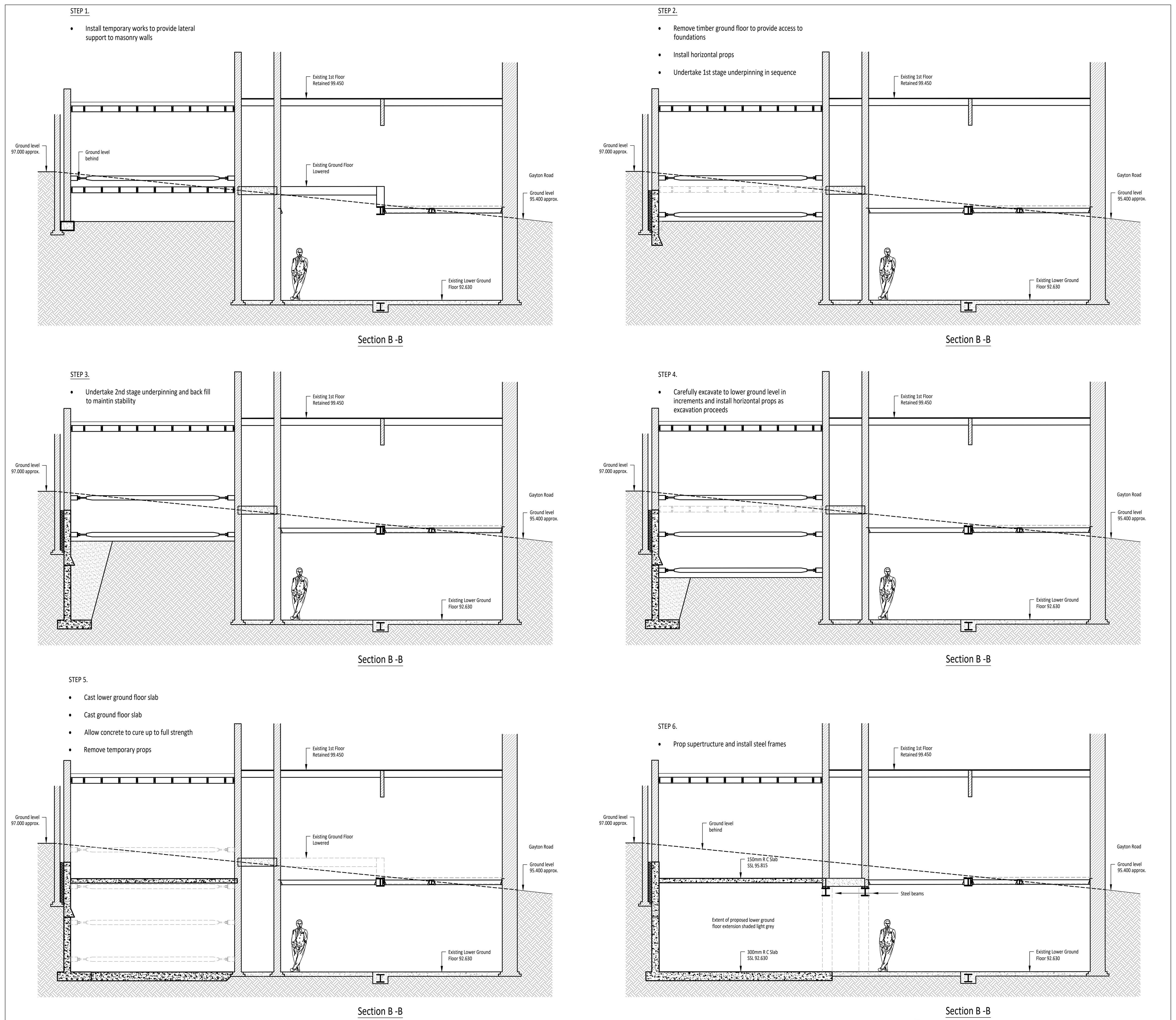
Author
Philip Kwan BEng (Hons) CEng MIStructE

APPENDIX A

Construction sequence drawing 2136-101E







NOTES

1. This drawing is to be read in conjunction with all other Architect's and Engineers' drawing.
2. All dimensions are in millimeters unless noted otherwise.
3. Work to figured dimensions only and do not scale from this drawing and refer to the Architect or Engineer if in doubt.
4. Refer to PK & Partners drawing number 2136-001 for general notes and specifications.
5. Under the CDM regulations 2015, exceptional risks in relation to the works are highlighted on this drawing and area annotated for the Contractor's attention.

REV.	BY	CHK'D	APP'D	DATE	DESCRIPTION
E	PK	PK	PK	09.03.21	Stage 1 underpinning back fill shown
D	PK	PK	PK	13.11.20	Cross section B-B sequence added
C	PK	PK	PK	11.08.20	Grd Fl level amended
B	PK	PK	PK	22.07.20	Issued for planning submission
A	PK	PK	PK	16.06.20	Issued for information & comments

PK & Partners
Consulting Engineers
London Birmingham
www.pk-partners.com m: 07788 921 371

Architect: CHARLTON BROWN ARCHITECTURE

Project: 49 WILLOW ROAD
LONDON
NW3 1TS

Drawing: SCHEMATIC LOWER GROUND
FLOOR EXTENSION
CONSTRUCTION SEQUENCE

DWG. No. 2136-101 REV. E

DRAWN : PK CHECKED : PK

SCALE : 1:100 @ A1 1:200 @ A3 @ A1

100mm

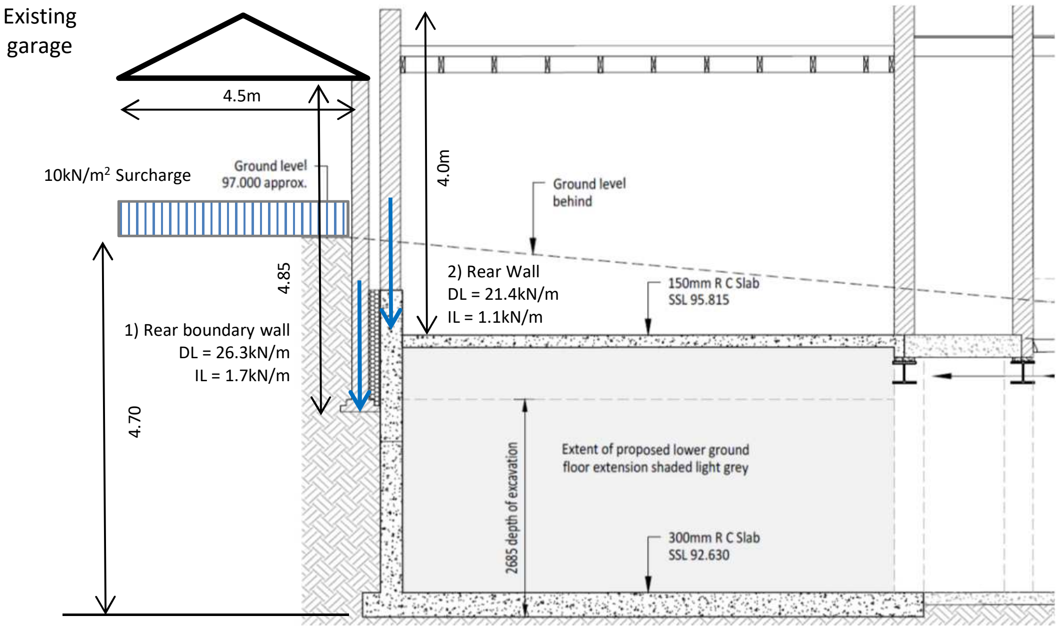
APPENDIX B

Supplementary Calculations Rear Boundary Wall with Garage

Project: **49 Willow Road NW3** Project No: **2136** PK & Partners

Consulting Engineers

Date: **Nov 2020** By: **PK** Sheet No: **Calcs-02-01**



Section Showing Loads on Rear Basement wall

1) Rear Basement Wall adjacent Garage

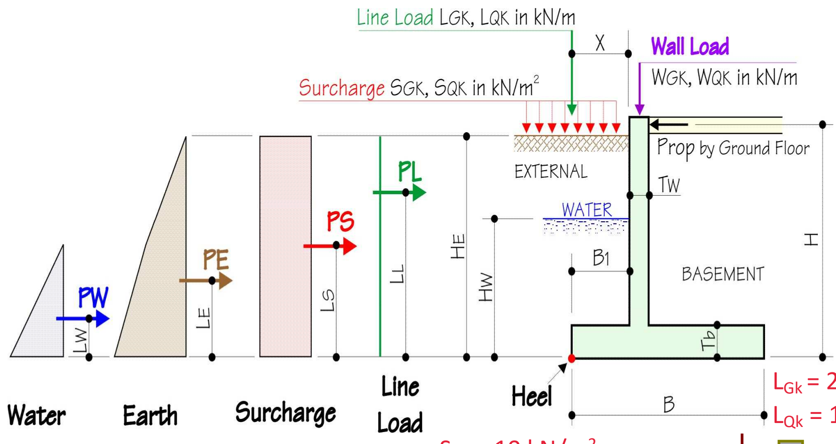
Loadings	Unit load kN/m^2		DL kN/m	LL kN/m
Garage foundation load				
Roof				
Single ply membrane, roof joists and plasterboard ceiling	0.80 kN/m^2		1.8	
Imposed load	0.75 kN/m^2			1.7
Loading width	2.25 m			
9" (230mm) masonry boundary wall	5.06 kN/m^2			
Wall height =	4.85 m		24.5	
		Total:	**26.3**	**1.7**

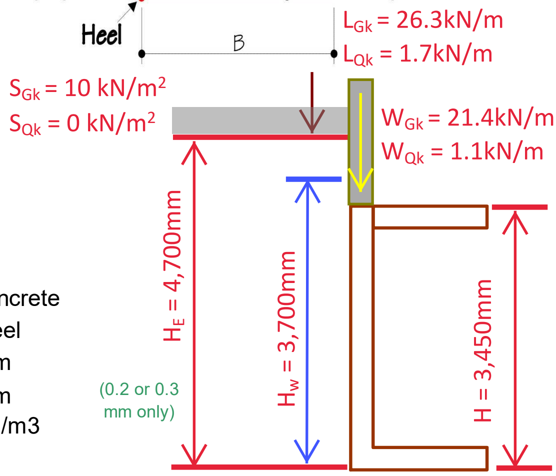
2) Rear wall load

Loadings	Unit load kN/m^2		DL kN/m	LL kN/m
Roof				
Single ply membrane, roof joists and plasterboard ceiling	0.80 kN/m^2		1.2	
Imposed load	0.75 kN/m^2			1.1
Loading width	1.50 m			
9" (230mm) masonry boundary wall	5.06 kN/m^2			
Wall height =	4.00 m		20.2	
		Total:	**21.4**	**1.1**

Project	49 Willow Road	REINFORCED CONCRETE COUNCIL	PK & Partners Limited		
Client	Dylan McNeil		Made by	Date	Page
Location	Rear Basement Wall		PK	12-Feb-2021	C2-02A
	Basement wall design to BS8110:1997, BS8002:1994. BS 8004:1986 etc.		Checked	Revision	Job No
	Originated from 'RCC61 Basement Wall.xls' v2.1	© 1999-20002 BCA for RCC	PK	A	2136

IDEALISED STRUCTURE and FORCE DIAGRAMS   DESIGN STATUS : VALID





Wall Geometry

DIMENSION (mm)

H =	3450	B =	1800	Tw =	300
Hw =	3700	Bl =	0	Tb =	300
He =	4700				

MATERIAL PROPERTIES

fcu =	35	N/mm²	γm =	1.50	concrete
fy =	460	N/mm²	γm =	1.05	steel

Cover to tension reinforcement (co) = 40 mm
Max. allowable design surface crack width (W) = 0.3 mm (0.2 or 0.3 mm only)
Concrete density = 24.0 kN/m3

SOIL PROPERTIES

Design angle of int'l friction of retained mat'l (Ø) =	25	degree	
Design cohesion of retained mat'l (C) =	0	kN/m2	(Only granular backfill considered, ie "C" = 0)
Density of retained mat'l (q) =	20	kN/m3	
Submerged Density of retained mat'l (qs) =	13.33	kN/m3	(default=2/3 of q), only apply when Hw >0
Design angle of int'l friction of base mat'l (Øb) =	24	degree	= 13.33
Design cohesion of base mat'l (Cb) =	10	kN/m2	
Density of base mat'l (qb) =	20	kN/m3	
Allowable gross ground bearing pressure (GBP) =	120	kN/m2	

ASSUMPTIONS
a) Wall friction is zero
b) Minimum active earth pressure = 0.25qH
c) Granular backfill
h) Design not intended for walls over 3.5 m high
i)Does **not** include check for temp or shrinkage

LOADINGS (unfactored)

Surcharge load -- live (SQK) =	10	kN/m2
Surcharge load -- dead (SGK) =	0.01	kN/m2
Line load -- live (LQK) =	1.7	kN/m
Line load -- dead (LGK) =	26.3	kN/m
Distance of line load from wall (X) =	300	mm
Wall load -- live (WQK) =	1.1	kN/m
Wall load -- Dead (WGK) =	21.4	kN/m

LATERAL FORCES

Ko = 0.58 default Ko = (1-SIN Ø) 0.58
Kac = 1.52 = $2Ko^{0.5}$

Force (kN)		Lever arm (m)		γ_f	Ultimate Force (kN)
PE =	101.18	LE =	1.654	1.40	141.66
PS(GK) =	0.03	LS =	2.35	1.40	0.04
PS(QK) =	27.14	LS =	2.35	1.60	43.42
PL(GK) =	15.19	LL =	4.45	1.40	21.26
PL(QK) =	0.98	LL =	4.45	1.60	1.57
PW =	68.45	LW =	1.23	1.40	95.83
Total	212.96				303.77

EXTERNAL STABILITY

STABILITY CHECK : OK

ANALYSIS - Assumptions & Notes

1) Wall idealised as a propped cantilever (i.e. pinned at top and fixed at base)
2) Wall is braced.
3) Maximum slenderness of wall is limited to 15, i.e [0.9*(He-Tb/2)/Tw < 15]
4) Maximum Ultimate axial load on wall is limited to 0.1fcu times the wall cross-sectional area
5) Design Span (Effective wall height) = He - (Tb/2)
6) -ve moment is hogging (i.e. tension at external face of wall)
   +ve moment is sagging (i.e. tension at internal face of wall)
7) " Wall MT. " is maximum +ve moment on the wall.
8) Estimated lateral deflections are used for checking the**P**Δ effect .

UNFACTORED LOADS AND FORCES

Lateral Force	Force (kN)	Lever arm to base (m)	Base MT. (kNm)	Wall MT. (kNm)	Reaction at Base (kN)	Reaction at Top (kN)	Estimated Elastic Deflection Δ (mm)
PE =	95.27	1.60	-34.98	21.40	59.63	35.63	1.0
PS(GK) =	0.03	2.28	-0.01	0.00	0.01	0.02	0.0
PS(QK) =	26.27	2.28	-5.77	2.73	9.91	16.36	0.1
PL(GK) =	15.19	4.30	6.89	-21.83	-6.68	21.87	0.8
PL(QK) =	0.98	4.30	0.45	-1.41	-0.43	1.41	0.0
PW =	63.01	1.18	-27.35	12.56	48.70	14.31	0.4
Total	200.74		-60.77	13.46	111.14	89.60	2.4

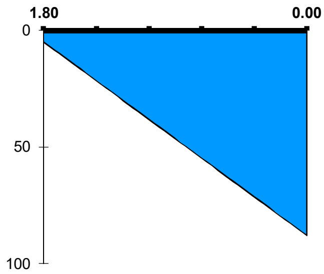
GROUND BEARING FAILURE

LOAD CASE: Wall Load **MIN**
Surcharge **MIN**

Taking moments about centre of base (anticlockwise "+")

Vertical FORCES (kN)		Lever arm (m	Moment (kNm)
Wall load =	21.4	0.75	16.04999979
Wall (sw) =	22.68	0.75	17.01
Base =	12.96	0.00	0.00
Earth =	0.00	0.90	0.00
Water =	0.00	0.90	0.00
Surcharge =	0.00	0.90	0.00
Line load =	26.30	0.00	0.00
∑ V =	83.34	∑ Mv =	33.06

BEARING PRESSURE
(kN/m²)



MOMENT due to LATERAL FORCES, Mo = -55.45 kNm

RESULTANT MOMENT, M = Mv + Mo = -22.39 kNm

ECCENTRICITY FROM BASE CENTRE, M / V = -0.27 m
MAXIMUM GROSS BEARING PRESSURE = 87.77 kN/m^2 < 120 OK

SLIDING AT BASE (using overall factor of safety instead of partial safety fa F.O.S = 1.50

SUM of LATERAL FORCES, **P** = 111.14 kN
BASE FRICTION, **F$_b$** = - (**V** TANØb + B.Cb) = -55.11 kN

Factor of Safety, F_b / P = 0.50 < 1.50 FAIL .. but

therefore, LATERAL RESISTANCE to be provided by BASEMENT SLAB = 111.61 kN

Project	49 Willow Road	**PK & Partners Limited**	
Client	Dylan McNeil	Made by: PK	Date: 12-Feb-2021	Page: C2-04A
Location	Rear Basement Wall		
	Basement wall design to BS8110:1997, BS8002:1994. BS 8004:198	Checked: PK	Revision: A	Job No: 2136
	Originated from 'RCC61 Basement Wall.xls' v2.1 © 1999-20002 BCA for RC		

STRUCTURAL DESIGNS (ultimate)

DESIGN CHECKS : OK

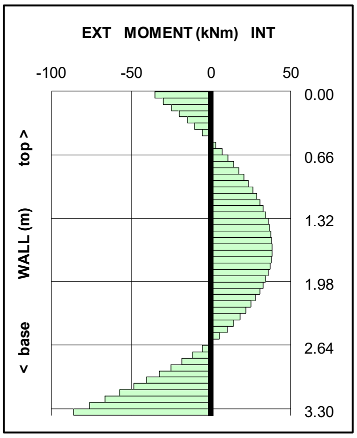
BS8110 reference

WALL (per metre length)

AXIAL LOAD CAPACITY (Limited to 0.1fcu) = 1050.00 kN > 31.72 OK 3.4.4.1

Lateral Force	Force (kN)	γ_f	Ultimate Force (kN)	Ult. Moment at base (kNm)	Ult. Shear at base (kN)	Ult. Shear at top (kN)
PE =	95.27	1.40	133.37	-48.98	83.48	49.89
PS(GK) =	0.03	1.40	0.04	-0.01	0.01	0.02
PS(QK) =	26.27	1.60	42.03	-9.23	15.85	26.18
PL(GK) =	15.19	1.40	21.26	9.64	-9.35	30.61
PL(QK) =	0.98	1.60	1.57	0.71	-0.69	2.26
PW =	63.01	1.40	88.22	-38.29	68.19	20.03
Total	200.74		286.49	-86.15	157.49	129.00

Design Bending Moments



On INTERNAL face due to lateral forces, M_{int} = 38.07 kNm

On EXTERNAL face due to lateral forces, M_{ext} = -86.15 kNm

Eccentricity of Axial Loads = 100 mm

LATERAL DEFLECTION " Δ " = 2.4 mm

Due to eccentricity of axial loads, M_{ecc} = 3.2 kNm

Due to **P**Δ effect, M_p = 0.08 kNm

Total Mmt on INTERNAL face ($M_{int}+0.5M_{ecc}+M_p$) = 39.7 kNm

Total Mmt on EXTERNAL face ($M_{ext}+0.5M_{ecc}$) = -87.7 kNm

		EXTERNAL FACE		INTERNAL FACE				
WALL REINFORCEMENT :	Min. As =	390		390		mm^2		Table 3.25
	ϕ =	16		12		mm		
	centres =	150	< 466	150	< 762	mm	OK	3.12.11.2.7(b)
	As =	1340	> 390	754	> 390	mm^2	OK	
MOMENT of RESISTANCE :	d =	252		254		mm		
	z =	233		241		mm		3.4.4.4
	As' =	0		0		mm^2		3.4.4.4
	M_{res} =	137.0	> 87.73	79.7	> 39.73	kNm	OK	

		BASE of WALL		TOP of WALL				
SHEAR RESISTANCE:	As =	1340	ϕ =	12	@150 mm 754	mm^2/m		
	100As/bd =	0.53%	=	0.30%				
	vc =	0.64		0.53		N/mm^2		Table 3.8
	V_{res} =	162.0	> 157.49	134.2	> 129.00	kN	OK	3.5.5.2

ACK WIDTH to BS8100/8007	X =	82.67	mm	εm =	0.00078			BS8007
Temp & shrinkage effects not included	Acr =	81.04	mm	**W =**	0.14	< 0.30 mm	OK	App. B.2

REINFORCEMENT SUMMARY for WALL

	Type	ϕ mm	centres mm	As mm^2	Min. As mm^2	
INTERNAL FACE	T	12	150	754	390	OK
EXTERNAL FACE	T	16	150	1340	390	OK
TRANSVERSE	T	10	150	524	390	OK

Project	49 Willow Road	REINFORCED CONCRETE COUNCIL	PK & Partners Limited		
Client	Dylan McNeil		Made by	Date	Page
Location	Rear Basement Wall		PK	12-Feb-2021	C2-05A
	Basement wall design to BS8110:1997, BS8002:1994. BS 8004:198		Checked	Revision	Job No
	Originated from 'RCC61 Basement Wall.xls' v2.1	© 1999-20002 BCA for RC	PK	A	2136

OUTER BASE (per metre length) BS8110 reference

γ_f = 1.50 (ASSUMED)

Ult. Shear = 37.85 kN (AT d from FACE of WALL)
Ult. MT. = 0.00 kNm TENSION - TOP FACE

BOTTOM REINFORCEMENT : Min. As = 390 mm^2 — Table 3.25
ϕ = 12 mm
centres = 150 mm < 762 OK
As = 754 mm^2 > 390 OK

MOMENT of RESISTANCE : d = 254 mm
Z = 241 mm — 3.4.4.4
As' = 0 mm^2
Mres = 79.71 kNm > 0.00 OK

SHEAR RESISTANCE: 100As/bd = 0.30%
vc = 0.53 N/mm^2 — Table 3.8
Vres = 134.20 kN > 37.85 OK — 3.5.5.2

CHECK CRACK WIDTH IN ACCORDANCE WITH BS8100/80 Temp & shrinkage effects not included
X = 65.43 mm ε_m = -0.00097 — BS8007
Acr = 81.98 mm W = -0.18 mm < 0.30 OK — App. B.2
NO CRACKING

INNER BASE (per metre length)
Ult. Shear = -56.04 kN (AT d from FACE of WALL)
Ult. MT. = 91.16 kNm TENSION - BOTTOM FACE

BOTTOM REINFORCEMENT : Min. As = 390 mm^2 — Table 3.25
ϕ = 16 mm
centres = 150 mm < 449 OK
As = 1340 mm^2 > 390 OK

MOMENT of RESISTANCE : d = 252 mm
Z = 233 mm
As' = 0 mm^2
Mres = 136.95 kNm < 91.16 OK — 3.4.4.4

SHEAR RESISTANCE: 100As/bd = 0.53%
vc = 0.64 N/mm^2 — Table 3.8
Vres = 162.03 kN > 56.04 OK — 3.5.5.2

CHECK CRACK WIDTH IN ACCORDANCE WITH BS8100/80 Temp & shrinkage effects not included
X = 82.67 mm ε_m = 0.000776 — BS8007
Acr = 81.04 mm W = 0.14 mm < 0.30 OK — App. B.2

REINFORCEMENT SUMMARY for BASE

	Type	ϕ mm	centres mm	As mm^2	Min. As mm^2	
TOP	T	12	150	754	390	OK
BOTTOM	T	16	150	754	390	OK
TRANSVERSE	T	12	150	754	390	OK