Quadrant Harmon Consulting Ltd

Structural Calculations

For

Basement
At

1 Wadham Gardens

London

NW3 3DN

Development

For

Amek Property Investment LLP

Quadrant Harmon Consulting Ltd

Design Statement

The building is mainly a traditionally constructed two storey house, using loadbearing walls which support suspended timber floors and the pitched roof. Subsequent alterations have created rooms in the loft space and the building has a newer single storey side extension

Existing foundations are corbelled out brickwork for the original building and concrete strip foundations for the newer extensions.

The proposed basement will be formed by underpinning the entire perimeter walls with reinforced concrete underpinning which will act to transfer the main loads to the lower level and also to retain the adjacent ground. The base of the underpinning will be monolithic with the basement slab and in the permanent situation will be propped by the new reinforced concrete ground floor slab. The basement slab is to be designed for upward pressures due to heave.

Internal walls will be supported from the suspended ground floor slab with loads transferred to columns basement to ground floor.

It is proposed that the works are executed using the top down method and the proposed sequences for works are shown on drawings 1550/GN02 and 1550/GN03.

In order to minimise inward deflections during excavations, the sequences referred to above and shown on the drawings require temporary propping and this will be achieved by the new ground floor slab propping the top of the retaining wall. Temporary propping will also be required to prevent sliding at basement level. This will be removed on completion of the basement slab.

These calculations have been prepared for the main structural elements of the new basement. Refer to sheets 01 to 26 attached.

Quadrant Harmon Consulting Ltd

British Standards and Design Data

1). Building Regulations 2000: Approved Documents: DETR
2). BS 8110-1:1997 Structural Use of Concrete
3). BS 5950-1:1990 Structural Use of Steelwork in Building
4). BS 5628-1:1992 Structural Use of Unreinforced Masonry
5). BS 6399-1:1996 Loading for Buildings (Dead and Imposed Loads)
6). BS 6399-2:1997 Loading for Buildings (Wind Loads)
7). BS 6399-3:1988 Loading for Buildings (Imposed Roofs)
8). BS 8110-2:1985 Structural Use of Concrete, Part 2 (Code of Practice for Special Circumstances, especially section 3 "Excessive Cracking and Assessment of Crack widths")
9). BS 8007:1987 Design of Concrete Structures for Retaining Aqueous Liquids

Fire Resistance Requirement
1 hour for all elements of structure

Subsoil Conditions
See site Investigation report for detailed soil conditions.

Foundation Type
Pad and retaining wall foundations (underpinning) supporting the main vertical loads and earth pressures, however the basement slab is to form a raft foundation, monolithic with internal pads and the retaining wall and reinforced to accommodate the small amount of heave envisaged. Retaining Wall 350 wide and 500 deep basement raft slab

Material Data

Concrete Grade 35 with 20 mm max. aggregate
Steel Reinforcement. Characteristic Strength f_y = 460 N/mm^2
Structural Steel S275

Quadrant Harmon
Consulting Civil & Structural Engineers
Tel: 0207 637 2770 Fax: 0207 436 7823

Project: 1 Wadham Gardens

Job No. 1550
Sheet No. 101
Date. 10 Oct 15
By: SAA Ckd: ✓

Ref: Loadings

Roof
Dead = 0.75 Ceiling = 0.5
Live = 0.6 Live = 0.25

Second
Dead = 0.7
Live = 1.5

First
Dead = 0.7
Live = 1.5

New Ground
Dead
Finis = 1.2
300 Slab = 7.2
C&S = 0.4
8.8
Live = 1.5

New Basement Slab (Ground Bearing)
Finis = 1.2
500 Slab = 12 = (24-18)×0.5
13.2
Live = 1.5

For bearing pressure
= 1.2
= 3.0
4.2
= 1.5

External Wall
330 Brick = 6.6
Finis = 0.3
6.9

Internal Walls (originally ext)
330 Brick = 6.6
Finis = 0.6
7.2

113 Brick Walls = 2.2
Finis = 0.6
2.8

Underpin 800 wide = (24 − 18) × 0.8 = 4.8 kN/m

Quadrant Harmon Consulting Civil & Structural Engineers Tel: 0207 637 2770 Fax: 0207 436 7823	Project 1 Wadham Gardens	Job No. 1550
		Sheet No. 02
		Date. 10 Oct 15
Ref: Loads / Ground Pressure		By: SDH Ckd:

Main Flank Wall kN/m

Roof	DL	= 0.75 x 3.8	= 3.0	
	LL	= 0.6 x 2.5		= 1.5
ceiling	DL	≈ 0.5 x 0.75	= 0.4	
	LL	≈ 0.25 x 0.75		= 0.2
Second	DL	= 0.75 x 2.4	= 1.8	
	LL	= 1.5 x 2.4		= 3.6
First	DL	=	= 1.8	
	LL			= 3.6
Ground	DL	= 8.8 x 2.5	= 22	
	LL	= 1.5 x 2.5		= 4.0
			29	13
Masonry Grd-Ews		= 6.9 x 7	= 48	
			77	
Underpin		= 4.8 x 3	= 14	
			91	13

Total = 91 + 13 = 104

Ground Pressure = 104/0.8 = 130 ≯ 160 OK

Main Flank Wall Chimney stack

Load of Floors and roof taken on inside wall

Assume Main steel on wider footing / underpin

Total weight of steel ≥ 4.8 x 15 = 72 kN/m

Ground Pressure = 72/0.8 = 90 kN/m² ≯ 160 OK

For retaining wall design take live load for neighbours property as Dead = 77 Live = 13

Quadrant Harmon Consultancy Ltd
Morley House
320 Regent Street,

London
Tel:020 7637 2770 Fax:020 7436 7823

Proj: 1 Wadham Gardens
Ref : 1550
Sheet: 04

Date: 10/10/15

Internal Columns Base Idealisation check on bearing,sliding, and overturning under 2D loading.

Input details

Size of pedestal/column below natural ground level

Length of pedestal/column	[A]	= 0.3 m
Width of pedestal/column	[B]	= 0.3 m
Eccentricity of column	[E]	= 0 m

Base dimensions

Length of pad base	[L]	= 1.8 m
Width of pad base	[B]	= 1.8 m
Thickness of pad base	[T]	= 0.5 m
Density of concrete	[Gc]	= 23.6 kN/m³

Loads

Vertical load	[V]	= 394 kN
Horizontal load	[F]	= 0 kN
Moment	[M]	= 0 kNm

Factors of safety

Against overturning	[FOSM]	= 2
Against sliding excluding backfill	[FOSSE]	= 1.5

Bearing soil property

Allowable soil pressure	[SBC]	= 160 kN/m²
Coefficient of friction against sliding	[Cf]	= 0.4

Check for bearing

At left corner of footing	Pl	= (Tvl/Ar) = 133.4 kN/m²
At right corner of footing	Pr	= (Tvl/Ar) = 133.4 kN/m²
Soil pressure	Pmax	= Pl = 133.4 kN/m²

As "e" is less than L/6,soil pressure at:-

Left corner of footing	Pl	= (Tvl/Ar) -(Tm/Z) = 133.4 kN/m²
Right corner of footing	Pr	= (Tvl/Ar)+(Tm/Z) = 133.4 kN/m²
Maximum soil pressure	Pmax	= Pr = 133.4 kN/m²
Minimum soil pressure	Pmin	= Pl = 133.4 kN/m²

Max. pressure (Pmax) is less than the allowable pressure (SBC). Hence safe.
There is no horizontal force. Hence there is no sliding

Check for overturning

Overturning moment [OTM]	OTM	= (F*T)+ M = 0 kNm

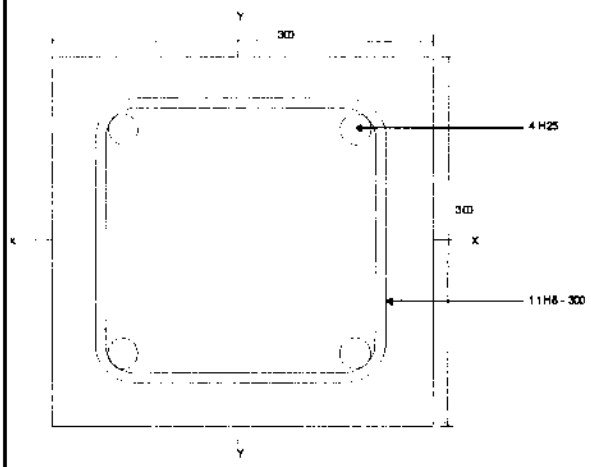
There is no overturning

QUADRANT HARMON
Consulting Civil and Structural Engineers

1 Wadham Gardens

Column Basement to Ground

Job No	1550
Job Ref	
Designed By	SOH
Checked By	CM
Date	10 - 10 - 2015
Revision No	
Calc No	05
Page No	



Section Geometry	X - Axis	Y - Axis	
Overall Rigidity	Braced	Braced	
Depth(h) / Width(b)mm	300	300	
Clear Height m	3.30	3.30	
Effective Height m	2.48	2.48	
Slenderness Ratio	8.25	8.25	
Cover mm	35	35	
Top End Fixity	1. Fixed	1. Fixed	
Bottom End Fixity	1. Fixed	1. Fixed	
Concrete Data			
Strength Class	C28/35 N/mm²		
Aggregate Size	20 mm	Aggregate Type	Normal
Reinforcement Data	Main	Links	
Strength Type	H	H	
Bond Type	Deformed type 2	-	
Yield Stress N/mm²	500	500	
Max Steel %	6%	-	
Link Type	-	Lateral	
Partial Safety Factors			
Concrete flexure	1.50	Concrete shear	1.25
Reinforcement strength	1.15	Reinforcement	1.40

Design code : BS8110 Amendment 3 **Detailing code :** BS8666-2005 **Shape code filename** BS8666-2005.scc

Load set	Axial load	Top X moment	Top Y moment	Bottom X moment	Bottom Y moment
1	394.0	39.0	20.0	39.0	20.0

Bar details	Far X-face	Near X-face	Far Y-face	Near Y-face	Total
Main bar	2 H25	2 H25	2 H25	2 H25	4 H25
Area provided. (mm²)	982	982	982	982	1963
% provided(100Asc/Ac)	-	-	-	-	2.18 %
Area required (mm²)	180	180	180	180	360
Link bars (no. of legs)	11 x (2) H8 300		11 x (2) H8 300		11 x (4) H8 300

Load set	Axial load N(kN)	N/bh	Axial load capacity (kN)	Design moment (kNm) Mx	My	Mx/bh² X-Axis	My/b²h Y-Axis	Moment capacity (kNm) X-Axis	Y-Axis	Utilisation ratio
1	394.0	4.38	-	56.1	0.0	2.08	0.00	120.7	0.0	0.46

Quadrant Harmon
Consulting Civil & Structural Engineers
Tel: 0207 637 2770 Fax: 0207 436 7823

Project: Wadham Gardens

Job No. 1550
Sheet No. 06
Date. 10 Oct 15
By: SGH Ckd:

Ref: Flat Slab

(1) Two way spanning 5000 spans

DL = 8.8 kN/m²
LL = 1.5 kN/m²

(2) Two way spanning slab 4500 spans

DL = 8.8
LL = 1.5

Line Load See 03

DL = 11 + 9 + 24 = 44 kN/m
LL = = 16 kN/m

QUADRANT HARMON Consulting Civil and Structural Engineers	1 Wadham Gardens Col Flat Slab 5m Span ~~Middle~~ Strip Slab strip on grid reference 1	Job No 1550 Job Ref Flat Slab Tw Designed By SOH Checked By MC Date 10 -10- 2015 Revision No Calc No 67 Page No

Slab geometry

Span				Lower support				Upper support			
Span No	Length (m)	Span ref.	Slab Type	Category	Support ref.	Height (mm)	Remote End	Category	Support ref.	Height (mm)	Remote End
1	5.000	P1	Flat (Solid)	Point Supp.	S1	3000	Pinned	Point Supp.	S1(U)	3000	Pinned
				Point Supp.	S2	3000	Pinned	Point Supp.	S2(U)	3000	Pinned
2	5.000	P2	Flat (Solid)								
				Point Supp.	S3	3000	Pinned	Point Supp.	S3(U)	3000	Pinned

Support properties (mm)

Supp ref.	Type	Section Size		Height
		Width	Length	
S1	Rec. Col.	400	400	3000
S1(U)	Rec. Col.	400	400	3000
S2	Rec. Col.	400	400	3000
S2(U)	Rec. Col.	400	400	3000
S3	Rec. Col.	400	400	3000
S3(U)	Rec. Col.	400	400	3000

Span sections and profiles (mm)

Span ref.	Type	O/A depth	Vert offset	Design width near	Design width far	Trans span width near	Trans span width far	Loaded width	Trans support near	Trans support far	Strip width Mid near	Strip width Column	Strip width Mid far
P1	Flat (Solid)	300	0	2050	2050	2050	2050	4100	None	None	1025	2050	1025
P2	Flat (Solid)	300	0	2050	2050	2050	2050	4100	None	None	1025	2050	1025

Load combinations

Category	Comb1	
	Min	Max
Dead	1.00	1.40
Imposed	0.00	1.60

Elastic moment and shear values for span 1

Slice no.	Position (mm)	Hogging moment(kNm) Mid near	Hogging moment(kNm) Main	Hogging moment(kNm) Mid far	Sagging moment(kNm) Mid near	Sagging moment(kNm) Main	Sagging moment(kNm) Mid far	Hogging shear(kN)	Sagging shear(kN)
0	0	6.72	40.32	6.72	0.00	0.00	0.00	134.41	0.00
1	250	2.75	16.53	2.75	0.00	0.00	0.00	119.32	0.00
2	500	0.00	0.00	0.00	1.69	4.14	1.69	0.00	104.24
3	750	0.00	0.00	0.00	6.82	16.67	6.82	0.00	89.15
4	1000	0.00	0.00	0.00	11.36	27.76	11.36	0.00	74.06

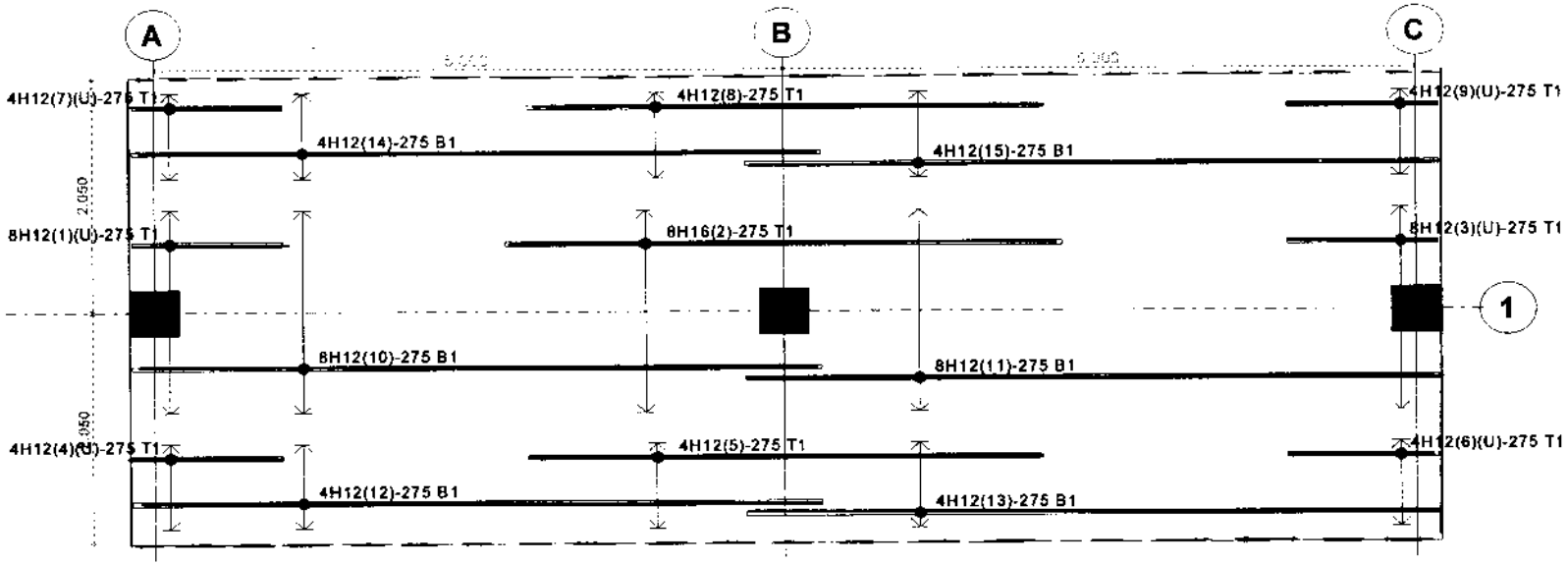
Elastic moment and shear values for span 1 (Contd)

Slice no.	Position (mm)	Hogging moment(kNm) Mid near	Main	Mid far	Sagging moment(kNm) Mid near	Main	Mid far	Hogging shear(kN)	Sagging shear(kN)
5	1250	0.00	0.00	0.00	15.10	36.91	15.10	0.00	58.97
6	1500	0.00	0.00	0.00	17.99	43.98	17.99	0.00	43.88
7	1750	0.00	0.00	0.00	20.04	48.98	20.04	0.00	28.80
8	2000	0.00	0.00	0.00	21.23	51.90	21.23	0.00	13.71
9	2250	0.00	0.00	0.00	21.58	52.75	21.58	0.00	9.68
10	2500	0.00	0.00	0.00	21.08	51.52	21.08	0.00	22.01
11	2750	0.00	0.00	0.00	19.73	48.22	19.73	0.00	37.10
12	3000	0.00	0.00	0.00	17.53	42.84	17.53	0.00	52.19
13	3250	0.00	0.00	0.00	14.48	35.39	14.48	0.00	67.28
14	3500	0.00	0.00	0.00	10.58	25.86	10.58	0.00	82.36
15	3750	1.34	8.01	1.34	5.84	14.26	5.84	63.80	97.45
16	4000	3.47	20.82	3.47	0.24	0.59	0.24	112.54	107.00
17	4250	5.89	35.32	5.89	0.00	0.00	0.00	127.63	0.00
18	4500	10.06	60.39	10.06	0.00	0.00	0.00	142.72	0.00
19	4750	14.76	88.56	14.76	0.00	0.00	0.00	157.80	0.00
20	5000	19.93	119.56	19.93	0.00	0.00	0.00	172.89	0.00

Elastic moment and shear values for span 2

Slice no.	Position (mm)	Hogging moment(kNm) Mid near	Main	Mid far	Sagging moment(kNm) Mid near	Main	Mid far	Hogging shear(kN)	Sagging shear(kN)
0	0	19.93	119.56	19.93	0.00	0.00	0.00	172.89	0.00
1	250	14.76	88.56	14.76	0.00	0.00	0.00	157.80	0.00
2	500	10.06	60.39	10.06	0.00	0.00	0.00	142.72	0.00
3	750	5.89	35.32	5.89	0.00	0.00	0.00	127.63	0.00
4	1000	3.47	20.82	3.47	0.24	0.59	0.24	112.54	107.00
5	1250	1.34	8.01	1.34	5.84	14.26	5.84	63.80	97.45
6	1500	0.00	0.00	0.00	10.58	25.86	10.58	0.00	82.36
7	1750	0.00	0.00	0.00	14.48	35.39	14.48	0.00	67.28
8	2000	0.00	0.00	0.00	17.53	42.84	17.53	0.00	52.19
9	2250	0.00	0.00	0.00	19.73	48.22	19.73	0.00	37.10
10	2500	0.00	0.00	0.00	21.08	51.52	21.08	0.00	22.01
11	2750	0.00	0.00	0.00	21.58	52.75	21.58	0.00	9.68
12	3000	0.00	0.00	0.00	21.23	51.90	21.23	0.00	13.71
13	3250	0.00	0.00	0.00	20.04	48.98	20.04	0.00	28.80
14	3500	0.00	0.00	0.00	17.99	43.98	17.99	0.00	43.88
15	3750	0.00	0.00	0.00	15.10	36.91	15.10	0.00	58.97
16	4000	0.00	0.00	0.00	11.36	27.76	11.36	0.00	74.06
17	4250	0.00	0.00	0.00	6.82	16.67	6.82	0.00	89.15
18	4500	0.00	0.00	0.00	1.69	4.14	1.69	0.00	104.24
19	4750	2.75	16.53	2.75	0.00	0.00	0.00	119.32	0.00
20	5000	6.72	40.32	6.72	0.00	0.00	0.00	134.41	0.00

Reinforcement details



QUADRANT HARMON
Consulting Civil and Structural Engineers

1 Wadham Gardens

Flat Slab 5m Span ~~Middle Strip~~

Slab strip on grid reference 1

Job No	1550
Job Ref	Flat Slab Tw
Designed By	SOH
Checked By	MC
Date	10 -10- 2015
Revision No	
Calc No	09
Page No	

QUADRANT HARMON Consulting Civil and Structural Engineers	1 Wadham Gardens Flat Slab 4.5m Span ~~Calc Strip~~ Slab strip on grid reference 1	Job No 1550 Job Ref Flat Slab Tw Designed By SOH Checked By MC Date 10 -10- 2015 Revision No Calc No 10 Page No

Slab geometry

Span				Lower support				Upper support			
Span No	Length (m)	Span ref.	Slab Type	Category	Support ref.	Height (mm)	Remote End	Category	Support ref.	Height (mm)	Remote End
1	4.500	P1	Flat (Solid)	Point Supp.	S1	3000	Pinned	Point Supp.	S1(U)	3000	Pinned
2	4.100	P2	Flat (Solid)	Point Supp.	S2	3000	Pinned	Point Supp.	S2(U)	3000	Pinned
				Point Supp.	S3	3000	Pinned	Point Supp.	S3(U)	3000	Pinned

Support properties (mm)

Supp ref.	Type	Section Size Width	Section Size Length	Height
S1	Rec. Col.	400	400	3000
S1(U)	Rec. Col.	400	400	3000
S2	Rec. Col.	400	400	3000
S2(U)	Rec. Col.	400	400	3000
S3	Rec. Col.	400	400	3000
S3(U)	Rec. Col.	400	400	3000

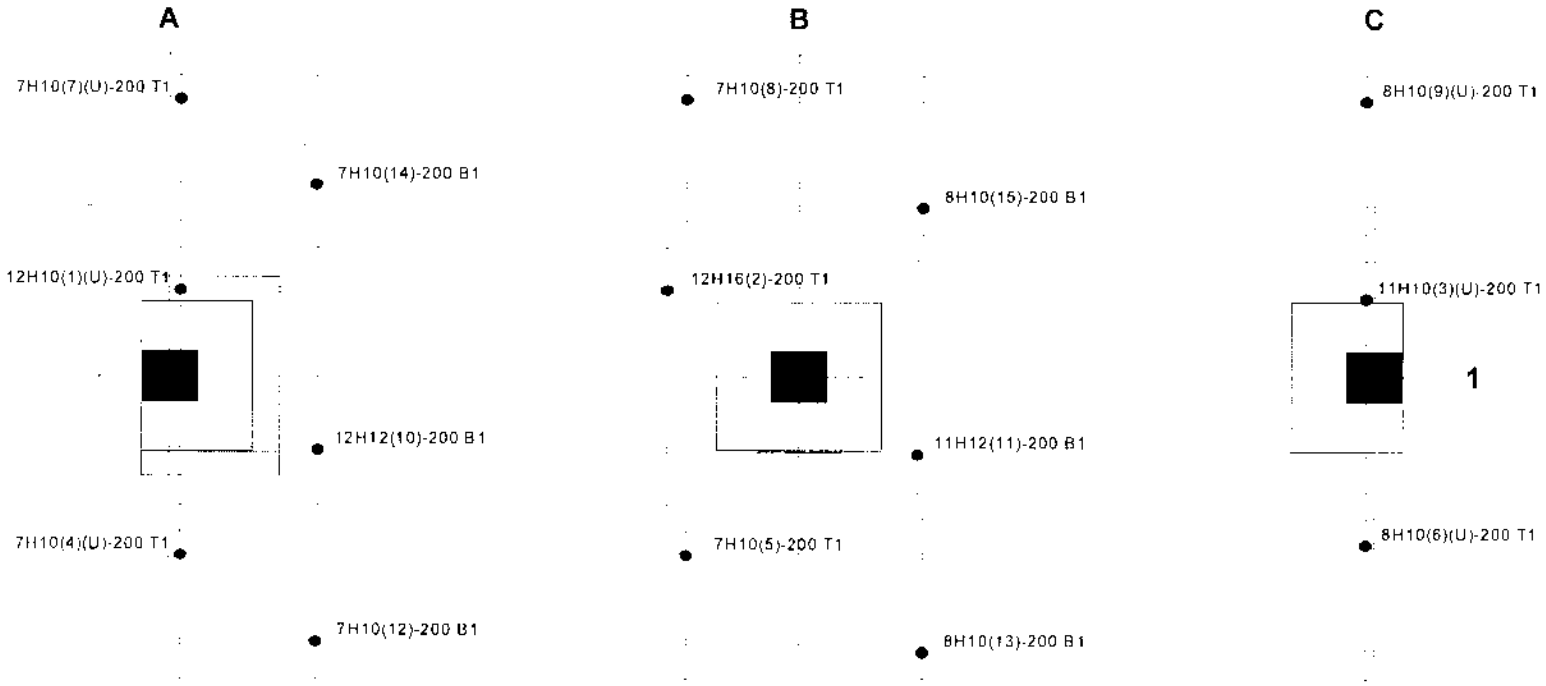
Span sections and profiles (mm)

Span ref.	Type	O/A depth	Vert offset	Design width near	Design width far	Trans span width near	Trans span width far	Loaded width	Trans support near	Trans support far	Strip width Mid near	Strip width Column	Strip width Mid far
P1	Flat (Solid)	300	0	2500	2500	2500	2500	5000	None	None	1375	2250	1375
P2	Flat (Solid)	300	0	2500	2500	2500	2500	5000	None	None	1475	2050	1475

Load combinations

Category	Comb1 Min	Comb1 Max
Dead	1.00	1.40
Imposed	0.00	1.60

Reinforcement details



Shaded zones require links for shear reinforcement - refer to Reinforcement design results for required density of links.

QUADRANT HARMON
Consulting Civil and Structural Engineers

1 Wadham Gardens

Flat Slab 4.5m Span ~~Col Strip~~

Slab strip on grid reference 1

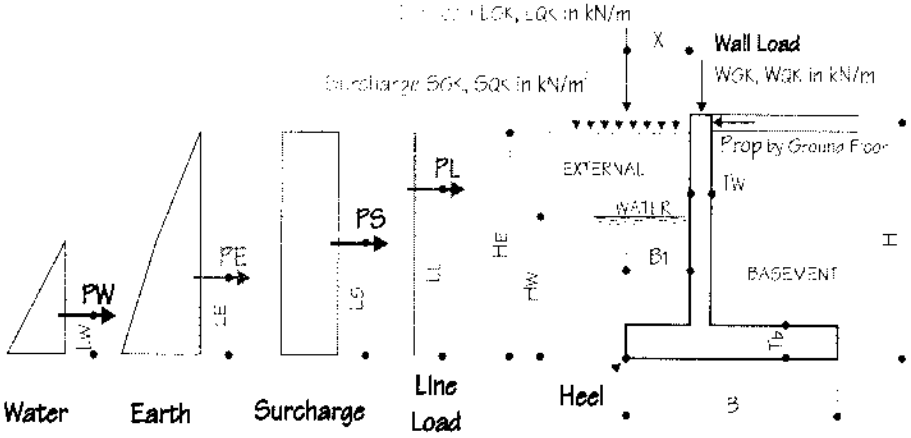
Job No	1550
Job Ref	Flat Slab Tw
Designed By	SOH
Checked By	MC
Date	10 -10- 2015
Revision No	
Calc No	11
Page No	

Project	1 Wadham Gardens	REINFORCED CONCRETE COUNCIL	
Client	Amek Property Investment LLP	Made by: SOH	Date: 26-Oct-2015	Page: 2
Location	Flank Wall RC Underpinning	Checked: CM	Revision: -	Job No: 1550
	Basement wall design to BS8110:1997, BS8002:1994, BS 8004:1986 etc.			

Originated from 'RCC61 Basement Wall.xls' v2.1

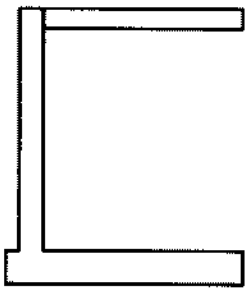
IDEALISED STRUCTURE and FORCE DIAGRAMS

DESIGN STATUS : NOT VALID



DIMENSION (mm)

H =	4000	B =	3500	Tw =	350
Hw =	3000	Bl =	200	Tb =	500
He =	3500				



Wall Geometry

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) =	21	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) =	19.00	kN/m3	(default=2/3 of q), only apply when Hw >0
Design angle of int'l friction of base mat'l (Øb) =	20	degree	= 13.33
Design cohesion of base mat'l (Cb) =	0	kN/m2	ASSUMPTIONS
Density of base mat'l (qb) =	20	kN/m3	a) Wall friction is zero
Allowable gross ground bearing pressure (GBP) =	160	kN/m2	b) Minimum active earth pressure = 0.25qH
LOADINGS (unfactored)			c) Granular backfill
Surcharge load -- live (SQK) =	5	kN/m2	h) Design not intended for walls over 3.5 m high
Surcharge load -- dead (SGK) =	5	kN/m2	i)Does **not** include check for temp or shrinkage
Line load -- live (LQK) =	13	kN/m	
Line load -- dead (LGK) =	77	kN/m	
Distance of line load from wall (X) =	2000	mm	
Wall load -- live (WQK) =	13	kN/m	
Wall load -- Dead (WGK) =	77	kN/m	

LATERAL FORCES

Ko = 0.64 default Ko = (1-SIN Ø) 0.64

Kac = 1.60 = $2Ko^{0.5}$

Force (kN)		Lever arm (m)		γ_f	Ultimate Force (kN)
PE =	75.71	LE =	1.173	1.40	106.00
PS(GK) =	11.23	LS =	1.75	1.40	15.72
PS(QK) =	11.23	LS =	1.75	1.60	17.97
PL(GK) =	49.41	LL =	1.82	1.40	69.17
PL(QK) =	8.34	LL =	1.82	1.60	13.35
PW =	45.00	LW =	1.00	1.40	63.00
Total	200.92				285.20

Project	1 Wadham Gardens	REINFORCED CONCRETE COUNCIL		
Client	Amek Property Investment LLP	Made by	Date	Page
Location	Flank Wall RC Underpinning	SOH	26-Oct-2015	13
	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	CM	-	1550

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 PΔ effect .

UNFACTORED LOADS AND FORCES

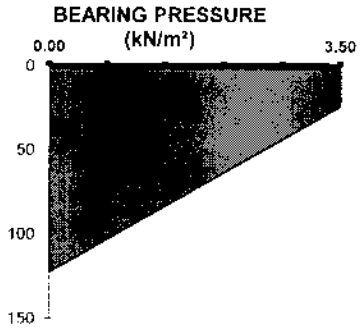
Lateral Force	Force (kN)	Lever arm to base (m)	Base MT. (kNm)	Wall MT. (kNm)	Reaction at Base (kN)	Reaction at Top (kN)	Estimated Elastic Deflection Δ (mm)
PE =	65.35	1.09	-32.79	13.91	55.10	10.24	0.3
PS(GK) =	10.43	1.63	-5.44	3.00	7.36	3.07	0.1
PS(QK) =	10.43	1.63	-5.44	3.00	7.36	3.07	0.0
PL(GK) =	49.41	1.57	-35.65	24.40	38.21	11.20	0.4
PL(QK) =	8.34	1.57	-6.02	4.12	6.45	1.89	0.0
PW =	37.81	0.92	-18.39	7.03	33.47	4.34	0.1
Total	181.76		-103.74	55.45	147.95	33.81	1.0

GROUND BEARING FAILURE

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

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

Vertical FORCES (kN)		Lever arm (m	Moment (kNm)
Wall load =	90	1.38	123.75
Wall (sw) =	29.40	1.38	40.43
Base =	42.00	0.00	0.00
Earth =	11.50	1.65	18.98
Water =	5.00	1.65	8.25
Surcharge =	1.00	1.65	1.65
Line load =	77.00	0.00	0.00
Σ V =	255.90		Σ Mv = 193.05



MOMENT due to LATERAL FORCES, Mo = -92.28 kNm

RESULTANT MOMENT, M = Mv + Mo = 100.77 kNm

ECCENTRICITY FROM BASE CENTRE, M / V = 0.39 m

MAXIMUM GROSS BEARING PRESSURE = 122.47 kN/m² < 160 OK

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

SUM of LATERAL FORCES, **P** = 147.95 kN

BASE FRICTION, F_b = - (**V** TANØb + B.Cb) = -93.14 kN

Factor of Safety, F_b / P = 0.63 < 1.50 FAIL .. but

therefore, LATERAL RESISTANCE to be provided by BASEMENT SLAB = 128.79 kN

Project	1 Wadham Gardens	REINFORCED CONCRETE COUNCIL		
Client	Amek Property Investment LLP	Made by	Date	Page
Location	Flank Wall RC Underpinning	SOH	26-Oct-2015	14
	Basement wall design to BS8110:1997, BS8002:1994. BS 8004:198	Checked	Revision	Job No
	Onginated from 'RCC61 Basement Wall.xls' v2.1 © 1999-20002 BCA for RC	CM	-	1550

OUTER BASE (per metre length) — BS8110 reference

γ_f = 1.50 (ASSUMED)

Ult. Shear = 29.48 kN (AT d from FACE of WALL)

Ult. MT. = 1.06 kNm TENSION - BOTTOM FACE

BOTTOM REINFORCEMENT :	Min. As =	650	mm^2			Table 3.25
	ϕ =	16	mm			
	centres =	225	mm	< 766	OK	
	As =	894	mm^2	> 650	OK	
MOMENT of RESISTANCE :	d =	452	mm			
	Z =	429	mm			3.4.4.4
	As' =	0	mm^2			
	Mres =	168.10	kNm	> 1.06	OK	
SHEAR RESISTANCE:	100As/bd =	0.30%				
	vc =	0.41	N/mm^2			Table 3.8
	Vres =	186.17	kN	> 29.48	OK	3.5.5.2

CHECK CRACK WIDTH IN ACCORDANCE WITH BS8100/80 Temp & shrinkage effects not included

X = 97.65 mm ε_m = -0.00127 — BS8007

Acr = 114.31 mm W = -0.32 mm < 0.30 OK — App. B.2

NO CRACKING

INNER BASE (per metre length)

Ult. Shear = -54.08 kN (AT d from FACE of WALL)

Ult. MT. = 156.66 kNm TENSION - BOTTOM FACE

BOTTOM REINFORCEMENT :	Min. As =	650	mm^2			Table 3.25
	ϕ =	16	mm			
	centres =	225	mm	< 766	OK	
	As =	894	mm^2	> 650	OK	
MOMENT of RESISTANCE :	d =	452	mm			
	Z =	429	mm			
	As' =	0	mm^2			
	Mres =	168.10	kNm	> 156.66	OK	3.4.4 4
SHEAR RESISTANCE:	100As/bd =	0.20%				
	vc =	0.41	N/mm^2			Table 3.8
	Vres =	186.17	kN	> 54.08	OK	3.5.5 2

CHECK CRACK WIDTH IN ACCORDANCE WITH BS8100/80 Temp & shrinkage effects not included

X = 97.65 mm ε_m = 0.000304 — BS8007

Acr = 114.31 mm W = 0.08 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	16	225	894	650	OK
BOTTOM	T	16	225	894	650	OK
TRANSVERSE	T	16	225	894	650	OK

QUADRANT HARMON Consulting Civil and Structural Engineers	1 Wadham Gardens London Basement Slab Upward Pressure NOTE: BARS ANNOTATED TOP ARE BOTTOM BARS AND VICE VERSA Slab strip on grid reference 1	Job No 1550 Job Ref Designed By SOH Checked By CM Date 30 - 9 - 2015 Revision No Calc No 15 Page No

Slab geometry

Span				Lower support				Upper support			
Span No	Length (m)	Span ref.	Slab Type	Category	Support ref.	Height (mm)	Remote End	Category	Support ref.	Height (mm)	Remote End
				Line Supp.	S1	-	-	None	-	-	-
1	5.000	P1	Flat (Solid)								
				Point Supp.	S2	-	-	Point Supp.	S2(U)	3000	Pinned
2	5.000	P2	Flat (Solid)								
				Line Supp.	S3	-	-	None	-	-	-

Support properties (mm)

Supp ref.	Type	Section Size Width	Size Length	Height
S1	Conc. Wall	350	-	-
S2	Conc. Base	1000	512	-
S2(U)	Rec. Col.	400	400	3000
S3	Conc. Wall	350	-	-

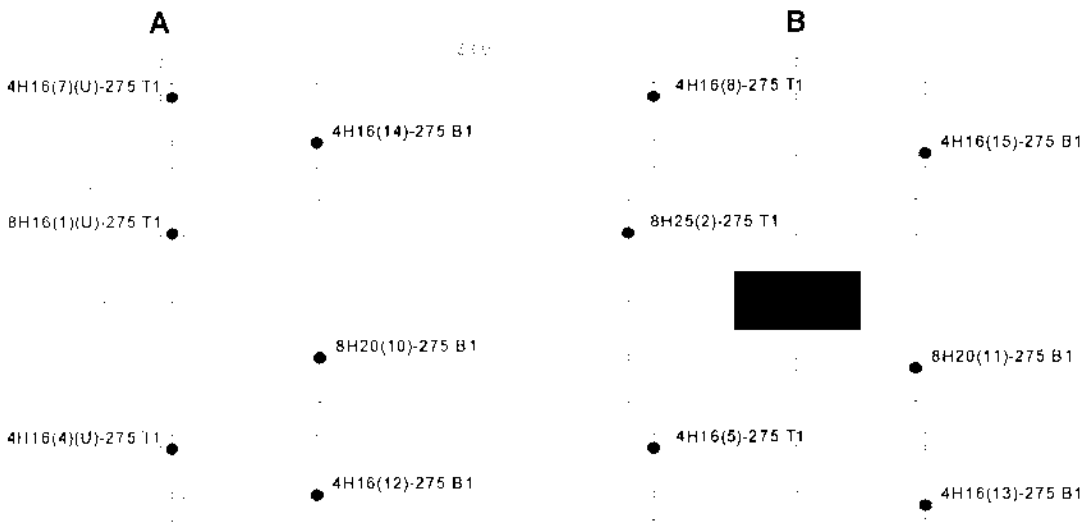
Span sections and profiles (mm)

Span ref.	Type	O/A depth	Vert offset	Design width near	Design width far	Trans span width near	Trans span width far	Loaded width	Trans support near	Trans support far	Strip width Mid near	Strip width Column	Strip width Mid far
P1	Flat (Solid)	500	0	2050	2050	2050	2050	4100	None	None	1025	2050	1025
P2	Flat (Solid)	500	0	2050	2050	2050	2050	4100	None	None	1025	2050	1025

Loads on slab strip (in kN & m units)

Load reference	Load type	Start posn.	Start value	End posn.	End value	Category	Area loads%	Other loads%
Span 1 (Length 5.0m)							100.00	100.00
Pressure	AL		50.000			Dead		
Span 2 (Length 5.0m)							100.00	100.00
Pressure	AL		50.000			Dead		

Reinforcement details



QUADRANT HARMON
Consulting Civil and Structural Engineers

1 Wadham Gardens
London
Basement Slab Upward Pressure
NOTE:
BARS ANNOTATED TOP ARE BOTTOM BARS AND VICE VERSA

Slab strip on grid reference 1

Job No	1550
Job Ref	
Designed By	SOH
Checked By	CM
Date	30 - 9 - 2015
Revision No	
Calc No	16
Page No	

Calculations for strength, stability and stiffness of steel members to BS 5950 Part 1
Member Details

Member profile	Uniform	
Member length	9000	mm
Member type	Beam	
Member slope	-0.0	deg
Section - reference	203x203 UC46	
- type	Rolled I-section	
- axis	Major	
Steel - grade	grade S275	
- ult. tensile strength	410	N/mm2
- yield stress	275	N/mm2
- design strength	275	N/mm2
- Youngs E. modulus	205000	N/mm2

Support Conditions

Degree of Freedom		*End 1*	*End 2*
Displacement	- normal	fixed	fixed
	- lateral	fixed	fixed
	- axial	fixed	free
Rotation	- normal	free	free
	- lateral	free	free
	- axial	fixed	fixed

Lateral Restraints

No.	*Type*	*Connection*	*Offset mm*	*Start mm*	*Length mm*	*Spacing mm*
1	End 1	Both flanges				
2	End 2	Both flanges				

Effective Length Factors
Major axis effective length factor on full member length = 1.00
Minor axis effective length factors on division length and member depth

Division Number	*Position*		*Moment*				*Axial Compression*	
	Start	*End*	*Sagging*		*Hogging*		*Length*	*Depth*
	mm	*mm*	*Length*	*Depth*	*Length*	*Depth*		
1	0	9000	1.00	0.00	1.00	0.00	1.00	0.00

Note: * indicates Destabilising Loads

Stiffness Criteria (Length/Deflection Ratios)

Member type	Normal			Lateral		
	Length	Ratio	Defl.	Length	Ratio	Defl.
	mm	L/Defl.	mm	mm	L/Defl.	mm
Column	9000	300.00	30.00	9000	300.00	30.00

Load Details (Units: kN and m)

No.	*Name*	*Load No.*	*Type*	*Start Pos. mm*	*Loaded Length mm*	*Start Value*	*End Value*	*Load Description*
2	Imposed	1	PA	9000		62.00		
		2	MN	0		6.20		

Load Combinations

Load Case	*Safety Factors*										
	Comb 1 ULS	*Comb 2 SLS*									
1	1.00	0.00									
2	1.60	1.00									
3	0.00	0.00									

Summary of Critical Results for Member (203x203 UC46) - File name: Calculatio Sheet 19-06 Nov 2018

Design Criterion	*Utilization Ratio*	*Load Combination*	*Position*	*Status*
Local capacity / strength	0.073	1	0	OK
Lateral buckling	0.413	1	0	OK
Torsional buckling				n/a
Deflection	0.115	2	3804	OK

Critical Capacity Positions, Utilization Ratios and Status for Member Calculatio Sheet 19-06 Nov 2018

Cmb	*Axial Fz*		*Shear Fvx*		*Shear Fvy*		*Bending Mx*		*Bending My*		*Combined*		*Torsion Mt*		*Status*
	mm	*U*	*mm*	*U*	*mm*	*U*	*mm*	*U*	*mm*	*U*	*mm*	*U*	*mm*	*U*	
1	0	0.061	0	0.005	n/a		0	0.073	n/a		0	0.073	n/a		OK

Critical Lateral Buckling Lengths for Member Calculatio Sheet 19-06 Nov 2018 (Units: kN and kNm)

Comb No.	*Buckling Number*	*Length Start(mm)*	*Length End(mm)*	*Utilization Ratio*	*Status*
1	1	0	9000	0.413	OK

Deflection Checks for Member Calculatio Sheet 19-06 Nov 2018 **Critical Combination 2 (OK)**

Comb.	Normal					Lateral					Utilization ratio
	Pos'n	Allowable		Actual		Pos'n	Allowable		Actual		
	mm	Deflect. mm	L/defl. ratio	Deflect. mm	L/defl. ratio	mm	Deflect. mm	L/defl. ratio	Deflect. mm	L/defl. ratio	
2	3804	30.0	300.0	3.4	2617.2	0	30.0	300.0	0.0	>10000	0.115

Calculations for strength, stability and stiffness of steel members to BS 5950 Part 1
Member Details

Member profile	Uniform	
Member length	5000	mm
Member type	Beam	
Member slope	-0.0	deg
Section - reference	305x305 UC97	
- type	Rolled I-section	
- axis	Major	
Steel - grade	grade S275	
- ult. tensile strength	410	N/mm2
- yield stress	275	N/mm2
- design strength	275	N/mm2
- Youngs E. modulus	205000	N/mm2

Support Conditions

Degree of Freedom		*End 1*	*End 2*
Displacement	- normal	fixed	fixed
	- lateral	fixed	fixed
	- axial	fixed	free
Rotation	- normal	free	free
	- lateral	free	free
	- axial	fixed	fixed

Lateral Restraints

No.	*Type*	*Connection*	*Offset mm*	*Start mm*	*Length mm*	*Spacing mm*
1	End 1	Both flanges				
2	End 2	Both flanges				

Effective Length Factors
Major axis effective length factor on full member length = 1.00
Minor axis effective length factors on division length and member depth

Division Number	*Position*		*Moment*				*Axial Compression*	
	Start	*End*	*Sagging*		*Hogging*		*Length*	*Depth*
	mm	*mm*	*Length*	*Depth*	*Length*	*Depth*		
1	0	5000	1.00	0.00	1.00	0.00	1.00	0.00

Note: * indicates Destabilising Loads

Stiffness Criteria (Length/Deflection Ratios)

Member type	Normal			Lateral		
	Length	Ratio	Defl.	Length	Ratio	Defl.
	mm	L/Defl.	mm	mm	L/Defl.	mm
Plaster finish beam	5000	360.00	13.89	5000	360.00	13.89

Load Details (Units: kN and m)

No.	*Name*	*Load No.*	*Type*	*Start Pos. mm*	*Loaded Length mm*	*Start Value*	*End Value*	*Load Description*
2	Imposed	1	UN			10.50		

Load Combinations

Load Case	*Safety Factors*										
	Comb 1 ULS	*Comb 2 SLS*									
1	1.00	0.00									
2	1.60	1.00									
3	0.00	0.00									

Critical Capacity Positions, Utilization Ratios and Status for Member Waling Beam 16-Nov 2018

Cmb	*Axial Fz*		*Shear Fvx*		*Shear Fvy*		*Bending Mx*		*Bending My*		*Combined*		*Torsion Mt*		*Status*
	mm	*U*	*mm*	*U*	*mm*	*U*	*mm*	*U*	*mm*	*U*	*mm*	*U*	*mm*	*U*	
1	n/a		0	0.084	n/a		2500	0.120	n/a		2500	0.120	n/a		OK

Critical Lateral Buckling Lengths for Member Waling Beam 16-Nov 2018
(Units: kN and kNm)

Comb No.	*Buckling Length Number*	*Start(mm)*	*End(mm)*	*Utilization Ratio*	*Status*
1	1	0	5000	0.120	OK

Deflection Checks for Member Waling Beam 16-Nov 2018 **Critical Combination 2 (OK)**

Comb.	*Normal*					*Lateral*					*Utilization ratio*
	Pos'n	*Allowable*		*Actual*		*Pos'n*	*Allowable*		*Actual*		
		Deflect.	*L/defl.*	*Deflect.*	*L/defl.*		*Deflect.*	*L/defl.*	*Deflect.*	*L/defl.*	
	mm	*mm*	*ratio*	*mm*	*ratio*	*mm*	*mm*	*ratio*	*mm*	*ratio*	
2	2500	13.9	360.0	1.9	2675.0	0	13.9	360.0	0.0	>10000	0.135

Notes

Assumed Cu vs Depth profile of 50kPa at 1m increasing at 8z, where z = depth below 1m in metres. This correlates well with a design line developed for a previous project within c.60m of the subject site.

STAGE SPECIFIC DATA

Stage 0 : Initial Stage

Stage specific warnings

1 - Stage 0 - The bottom most layer in Soil Profile 1 is assigned "Total stress" material. For this layer the cohesion is assumed to be constant at "Cu-Top", i.e cohesion specified at the top of this layer. The user specified value of cohesion at the bottom of this layer, "Cu-Bottom" is ignored. (Material Properties)

2 Stage 0 - Soil profile 1: Soil Profile 1 has no associated groundwater profile. Please review "Soil Profile - Groundwater Map" table as necessary.

CAPACITY RESULTS

Stress Profiles

Soil Profile 1: Soil Profile 1

Depth	Density	Undrained Cohesion	Nq	Total vertical stress	Porewater pressure	Effective vertical stress	Effective horizontal stress*	Cumulative skin friction per unit perimeter
[m]	[kN/m³]	[kPa]		[kPa]	[kPa]	[kPa]	[kPa]	[kN/m]
0.0	0.0	0.0	0.0	0.0	0.0	0.0	NA	0.0
3.5000	0.0	0.0	0.0	0.0	0.0	0.0	NA	0.0
3.5000	20.000	50.000	N.A.	0.0	0.0	0.0	NA	0.0
4.0000	20.000	54.545	N.A.	10.000	0.0	10.000	NA	0.0
12.000	20.000	127.27	N.A.	170.00	0.0	170.00	NA	0.0
14.000	20.000	145.45	N.A.	210.00	0.0	210.00	NA	0.0
16.000	20.000	163.64	N.A.	250.00	0.0	250.00	NA	0.0

* Effective horizontal stress not calculated for "Total Stress" materials and for Beta Method.

Cross-section 1 results:

Results - Compression

Soil Profile 1: Soil Profile 1

Depth	Pile length	Ultimate base capacity (Q_b)	Cumulative external Friction (Q_s)	Negative skin friction (Q_{nsf})	Ultimate capacity	Allowable capacity	Limiting criterion #
[m]	[m]	[kN]	[kN]	[kN]	[kN]	[kN]	
12.000	8.0000	80.967	308.45	0.0	389.41	129.80	2
14.000	10.000	92.534	424.12	0.0	516.65	172.22	2
16.000	12.000	104.10	555.21	0.0	659.31	219.77	2

Limiting criteria :
1: Global factor of safety
2: Shaft and base factors of safety
3: Shaft factor of safety
4: Pile material limiting stress [Compression]

Depth	Pile length	Ultimate base capacity (Q_b)	Cumulative external Friction (Q_s)	Negative skin friction (Q_{nsf})	Ultimate capacity	Allowable capacity	Limiting criterion #

Nq Calculation Details

Soil Profile 1: Soil Profile 1

There are no pile toe levels in any drained material(with Berezantzev/Bolton option) in the given soil profile.

Results - Tension

Soil Profile 1: Soil Profile 1

Depth	Pile length	Cumulative external Friction (Q_s)	Ultimate capacity	Allowable capacity	Limiting criterion #
[m]	[m]	[kN]	[kN]	[kN]	
12.000	8.0000	308.45	308.45	102.82	1
14.000	10.000	424.12	424.12	141.37	1
16.000	12.000	555.21	555.21	185.07	1

Limiting criteria :
1: Factor of safety on shaft
2: Pile material limiting stress [Tension]

Cross-section 2 results:

Results - Compression

Soil Profile 1: Soil Profile 1

Depth	Pile length	Ultimate base capacity (Q_b)	Cumulative external Friction (Q_s)	Negative skin friction (Q_{nsf})	Ultimate capacity	Allowable capacity	Limiting criterion #
[m]	[m]	[kN]	[kN]	[kN]	[kN]	[kN]	
12.000	8.0000	182.18	462.67	0.0	644.85	214.95	2
14.000	10.000	208.20	636.17	0.0	844.37	281.46	2
16.000	12.000	234.23	832.81	0.0	1067.0	355.68	2

Limiting criteria :
1: Global factor of safety
2: Shaft and base factors of safety
3: Shaft factor of safety
4: Pile material limiting stress [Compression]

Nq Calculation Details

Soil Profile 1: Soil Profile 1

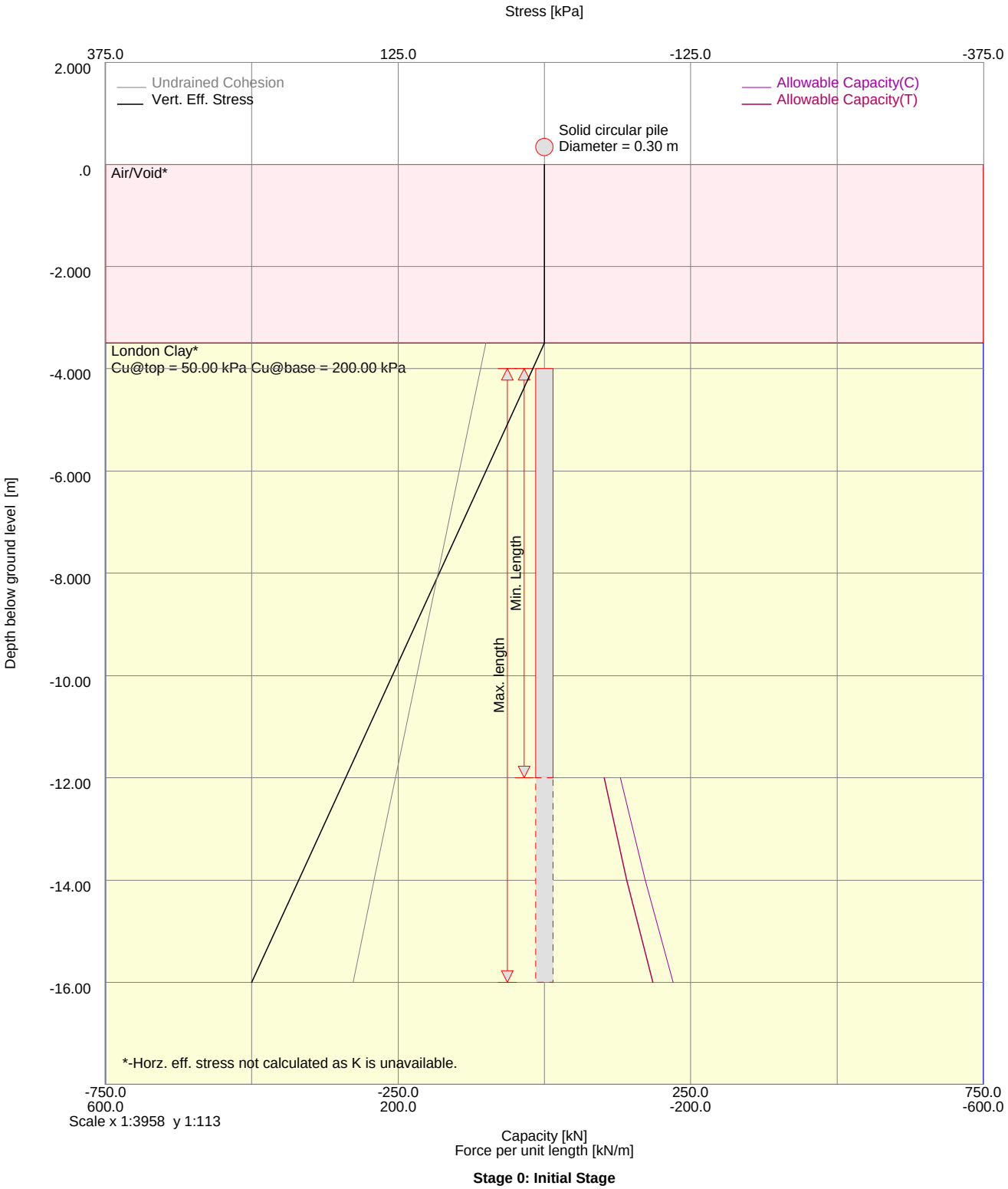
There are no pile toe levels in any drained material(with Berezantzev/Bolton option) in the given soil profile.

Results - Tension

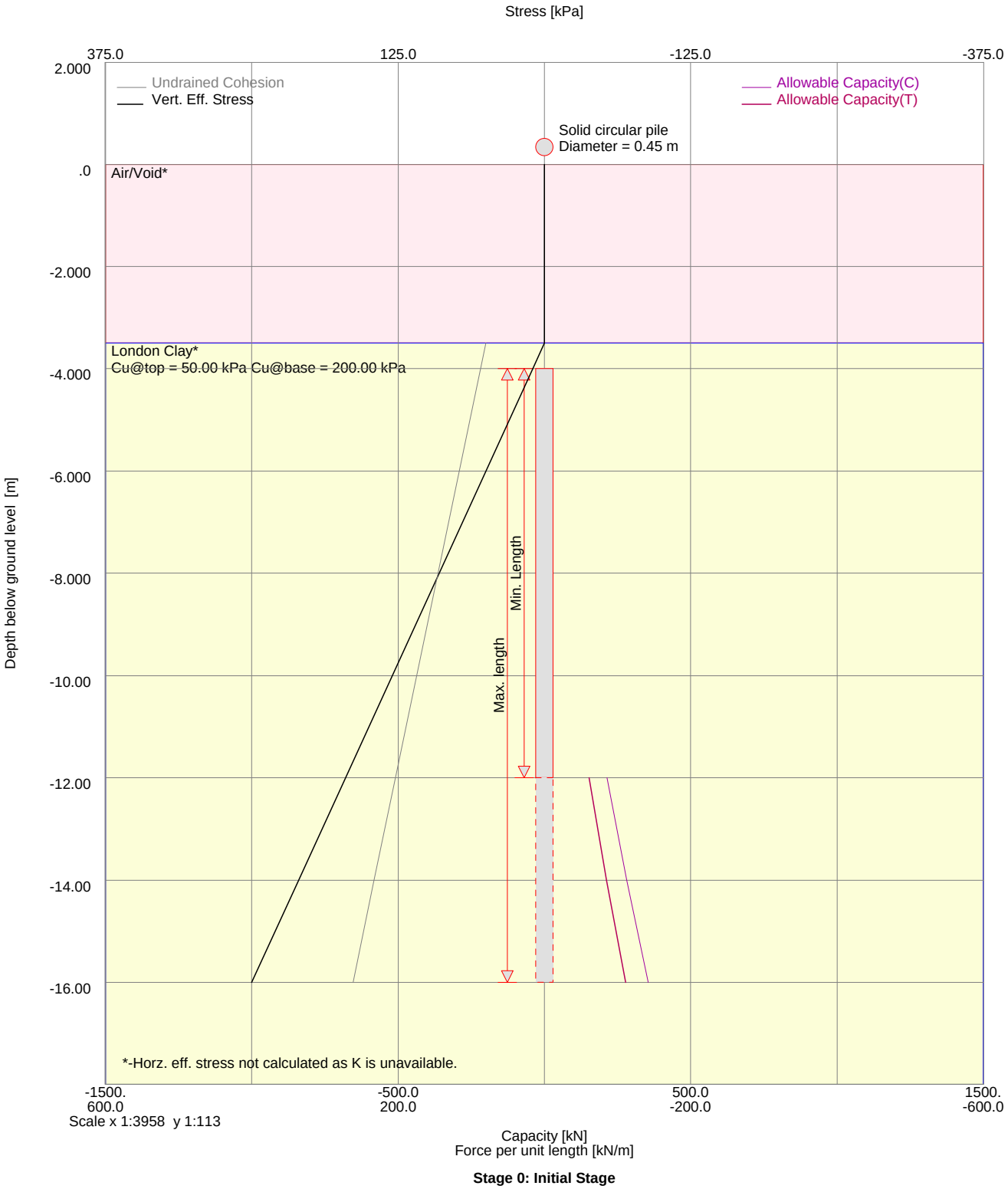
Soil Profile 1: Soil Profile 1

Depth	Pile length	Cumulative external Friction (Q_s)	Ultimate capacity	Allowable capacity	Limiting criterion #
[m]	[m]	[kN]	[kN]	[kN]	
12.000	8.0000	462.67	462.67	154.22	1
14.000	10.000	636.17	636.17	212.06	1
16.000	12.000	832.81	832.81	277.60	1

Limiting criteria :
1: Factor of safety on shaft
2: Pile material limiting stress [Tension]



Stage 0: Initial Stage



Stage 0: Initial Stage

Quadrant Harmon
Consulting Civil & Structural Engineers
Tel: 0207 637 2770 Fax: 0207 436 7823

Project: 1 Wadham Gardens

Job No. 1550
Sheet No. 26
Date. Nov 18

Ref: Piles uplift Force

By: [illegible] Ckd:

Area of Slab (worst case) = 2.5 × 1.5 = 4 m²

Uplift Force = 40 × 4 = 160 kN

Weight of Slab = 7.2 × 4 = 29

131 kN

From Calculation Sheets

Pile Ø 300 Capacity Tension = 141 kN

for 14 m length.