

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.

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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 $f_y = 460 \text{ N/mm}^2$

Structural Steel S275

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Project

1 Wadhvan Gardens

Job No. 1550

Sheet No. 101

Date. 10 Oct 15

Ref:

Loadings

By: SAJ Ckd: ✓

Roof Dead = 0.25 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
Fins = 1.2
300 slab = 2.2
CFS = 0.4
8.8
Live = 1.5

New Basement Slab (Ground Bering) Far bearing 1/24 + 1/24
Fins = 1.2 = 1.2
500 slab = 12 = (24-18) x 0.5 = 3.0
13.2 = 4.2
Live = 1.5 = 1.5

External Wall
330 BWH = 6.6
Fins = 0.3
6.9

Internal walls (originally ext)
330 BWH = 6.6
Fins = 0.6
7.2

113 BWH walls = 2.2
Fins = 0.6
2.8

Underpin 800 wide = (24-18) x 0.8 = 4.8 kN/m

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Project

1 Wadham Gardens

Job No. 1550

Sheet No. 02

Date. 10 Oct 15

Ref:

Loads / Ground Pressure

By: *SAH*

Ckd:

Main Flank Wall

kw/m

$$\begin{array}{l} \text{Roof DL} = 0.75 \times 3.8 = 3.0 \\ \text{LL} = 0.6 \times 2.5 = 1.5 \end{array}$$

$$\begin{array}{l} \text{ceiling DL} = 0.5 \times 0.75 = 0.4 \\ \text{LL} = 0.25 \times 0.75 = 0.2 \end{array}$$

$$\begin{array}{l} \text{Second DL} = 0.75 \times 2.4 = 1.8 \\ \text{LL} = 1.5 \times 2.4 = 3.6 \end{array}$$

$$\begin{array}{l} \text{First DL} = 1.8 \\ \text{LL} = 3.6 \end{array}$$

$$\begin{array}{l} \text{Ground DL} = 8.8 \times 2.5 = 22 \\ \text{LL} = 1.5 \times 2.5 = 4.0 \end{array}$$

$$\text{Masonry End-Ews} = 6.9 \times 7 = 48$$

$$\text{Underpin} = 4.8 \times 3 = 14$$

$$\text{Total} = 91 + 13 = 104$$

$$\text{Ground Pressure} = 104 / 0.8 = 130 \nabla 160 \text{ OK}$$

Main Flank Wall Chimney stack

Load of floors and roof taken on inside wall

Assume main stack on wider footing / underpin

$$\text{Total weight of stack} = 4.8 \times 15 = 72 \text{ kw/m}$$

$$\text{Ground Pressure} = 72 / 0.8 = 90 \text{ kw/m} \nabla 160 \text{ OK}$$

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

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/m ³

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/m ²
Coefficient of friction against sliding	[Cf]	= 0.4

Check for bearing

At left corner of footing	Pl	= (Tv/Ar) = 133.4 kN/m ²
At right corner of footing	Pr	= (Tv/Ar) = 133.4 kN/m ²
Soil pressure	Pmax	= Pl = 133.4 kN/m ²

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

Left corner of footing	Pl	= (Tv/Ar) -(Tm/Z) = 133.4 kN/m ²
Right corner of footing	Pr	= (Tv/Ar)+(Tm/Z) = 133.4 kN/m ²
Maximum soil pressure	Pmax	= Pr = 133.4 kN/m ²
Minimum soil pressure	Pmin	= Pl = 133.4 kN/m ²

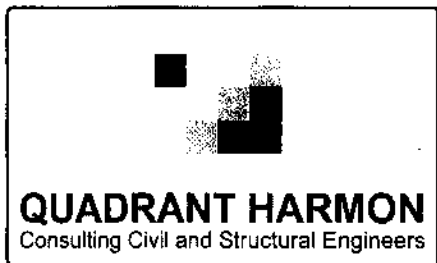
Max. pressure (Pmax) is less than the allowable pressure (SBC). Hence safe.

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



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

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	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/mm ²	
	Aggregate Size	20 mm	Aggregate Type Normal
	Reinforcement Data		
	Main	H	Links H
	Strength Type	H	H
	Bond Type	Deformed type 2	-
	Yield Stress N/mm ²	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. (mm ²)	982	982	982	982	1963			
% provided(100Asc/Ac)	-	-	-	-	2.18 %			
Area required (mm ²)	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/bh²	My/b²h	Moment capacity (kNm)	Utilisation ratio
1	394.0	4.38	-	56.1 0.0	2.08 X-Axis	0.00 Y-Axis	120.7 X-Axis 0.0 Y-Axis	0.46

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Project
1 Woodham Gardens

Job No. 1550

Sheet No. 02

Date. 10 Oct 15

Ref:

Flat Slabs

By: SCH Ckd: /

① Two way spanning 5000 spans


$$\begin{aligned} DL &= 8.8 \text{ kN/m} \\ LL &= 1.5 \text{ kN/m} \end{aligned}$$

② Two way spanning slabs 4500 spans

$$\begin{aligned} DL &= 8.8 \\ LL &= 1.5 \end{aligned}$$

Line Load See 03

$$\begin{aligned} DL &= 11 + 9 + 24 = 44 \text{ kN/m} \\ LL &= 16 \text{ kN/m} \end{aligned}$$

 <p>QUADRANT HARMON Consulting Civil and Structural Engineers</p>	1 Wadham Gardens Flat Slab 5m Span Middle Strip	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 strip on grid reference 1	

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Slab geometry

Span No	Span		Slab Type	Category	Lower support			Upper support			
	Length (m)	Span ref.			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
2	5.000	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		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		Trans span width		Loaded width	Trans support		Strip width		
				near	far	near	far		near	far	Mid near	Column	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)			Sagging moment(kNm)			Hogging shear(kN)	Sagging shear(kN)
		Mid near	Main	Mid far	Mid near	Main	Mid far		
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

 <p>QUADRANT HARMON Consulting Civil and Structural Engineers</p>	1 Wadham Gardens	Job No	1550
	Flat Slab 5m Span ^{Col} Middle Strip	Slab strip on grid reference 1	Job Ref
		Designed By	SOH
		Checked By	MC
		Date	10-10-2015
		Revision No	
		Calc No	08
		Page No	

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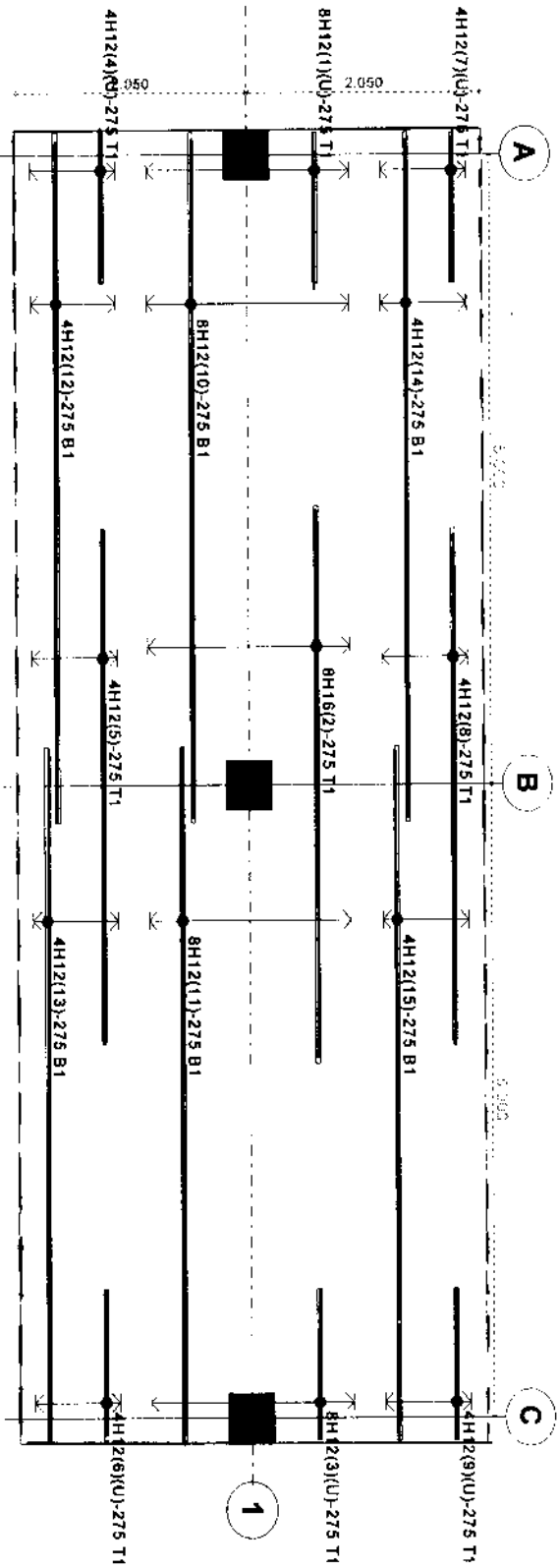
Elastic moment and shear values for span 1 (Contd)

Slice no.	Position (mm)	Hogging moment(kNm)			Sagging moment(kNm)			Hogging shear(kN)	Sagging shear(kN)
		Mid near	Main	Mid far	Mid near	Main	Mid far		
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)			Sagging moment(kNm)			Hogging shear(kN)	Sagging shear(kN)
		Mid near	Main	Mid far	Mid near	Main	Mid far		
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 Wadhwa Gardens

Flat Slab 5m Span ~~on grid reference 1~~

5

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	09
Calc No	
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 QUADRANT HARMON Consulting Civil and Structural Engineers	1 Wadham Gardens	Job No	1550
	Flat Slab 4.5m Span Col Strip	Slab strip on grid reference 1	Job Ref
		Designed By	SOH
		Checked By	MC
		Date	10-10-2015
		Revision No	
		Calc No	10
		Page No	

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Slab geometry

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

Support properties (mm)

Supp ref.	Type	Section		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

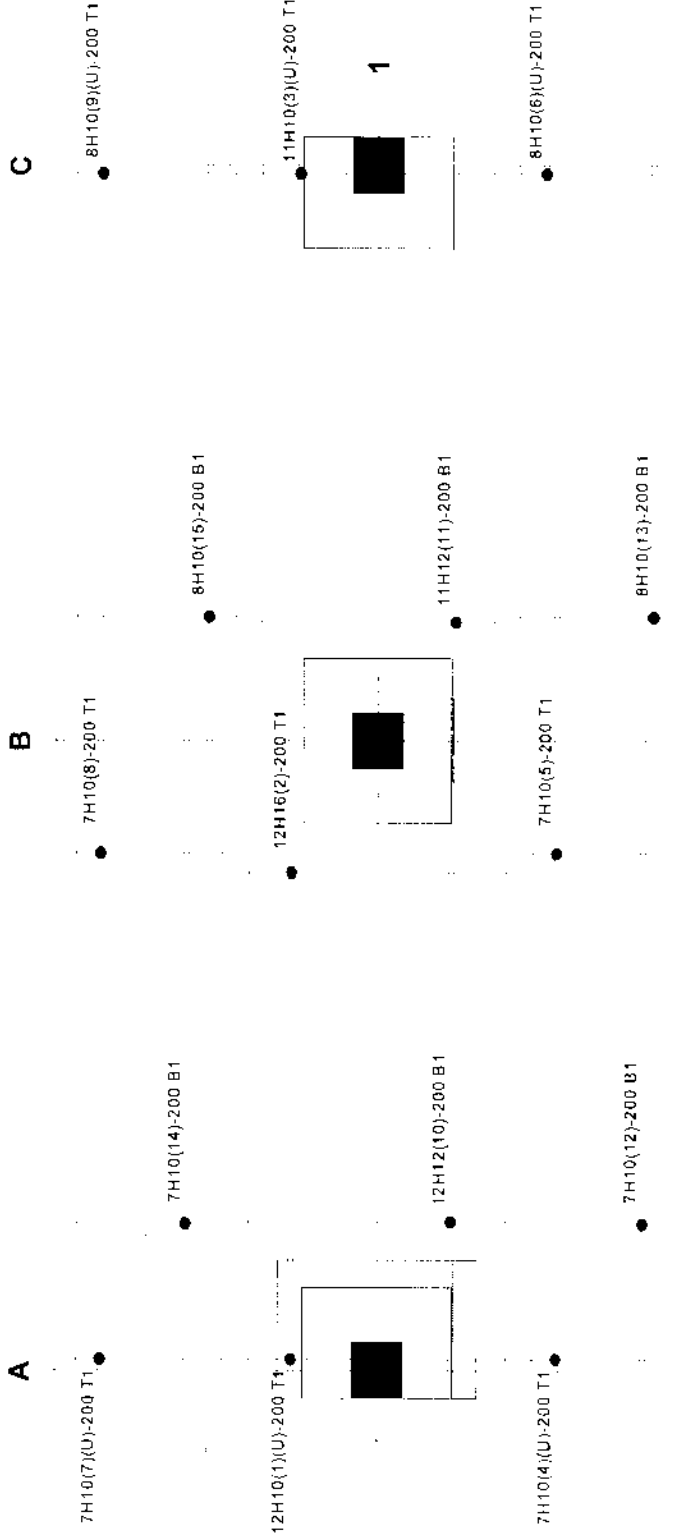
Span sections and profiles (mm)

Span ref.	Type	O/A depth	Vert offset	Design width		Trans span width		Loaded width	Trans support		Strip width		
				near	far	near	far		near	far	Mid near	Column	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	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.

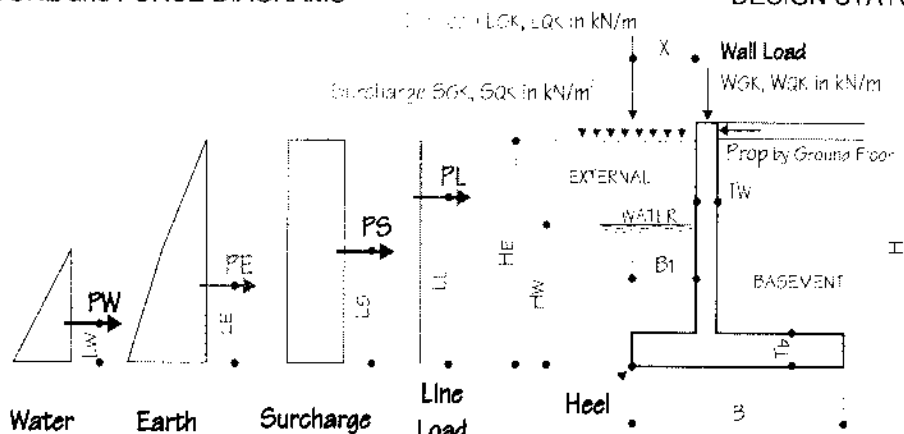
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<p>1 Wadham Gardens Flat Slab 4.5m Span Grid Strip</p>	<p>Job No 1550 Job Ref Flat Slab Tw Designed By SOH Checked By MC Date 10-10-2015 Revision No Calc No Page No 11</p>
<p>QUADRANT HARMON Consulting Civil and Structural Engineers</p>	<p>Slab strip on grid reference 1</p>

Project	1 Wadham Gardens	REINFORCED CONCRETE COUNCIL	REINFORCED CONCRETE COUNCIL	
Client	Amek Property Investment LLP		Made by	Date
Location	Flank Wall RC Underpinning Basement wall design to BS8110:1997, BS8002:1994, BS 8004:1986 etc.	SOH	26-Oct-2015	2
Originated from "RCC61 Basement Wall.xls" v2.1 © 1999-20002 BCA for RCC		Checked	Revision	Job No
		CM	-	1550

IDEALISED STRUCTURE and FORCE DIAGRAMS

DESIGN STATUS : NOT VALID

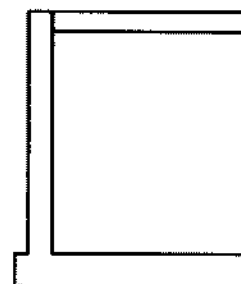


DIMENSION (mm)

H =	<u>4000</u>	B =	<u>3500</u>	Tw =	<u>350</u>
Hw =	<u>3000</u>	Bl =	<u>200</u>	Tb =	<u>500</u>
He =	<u>3500</u>				

MATERIAL PROPERTIES

fcu =	<u>35</u>	N/mm ²	γm =	<u>1.50</u>	concrete
fy =	<u>460</u>	N/mm ²	γm =	<u>1.05</u>	steel
Cover to tension reinforcement (co) =	<u>40</u>	mm			
Max. allowable design surface crack width (W) =	<u>0.3</u>	mm			(0.2 or 0.3 mm only)
Concrete density =	<u>24.0</u>	kN/m ³			



Wall Geometry

SOIL PROPERTIES

Design angle of int'l friction of retained mat'l (Ø) =	<u>21</u>	degree	
Design cohesion of retained mat'l (C) =	<u>0</u>	kN/m ²	(Only granular backfill considered, ie "C" = 0)
Density of retained mat'l (q) =	<u>20</u>	kN/m ³	
Submerged Density of retained mat'l (qs) =	<u>19.00</u>	kN/m ³	(default=2/3 of q), only apply when Hw > 0
Design angle of int'l friction of base mat'l (Øb) =	<u>20</u>	degree	= 13.33
Design cohesion of base mat'l (Cb) =	<u>0</u>	kN/m ²	
Density of base mat'l (qb) =	<u>20</u>	kN/m ³	
Allowable gross ground bearing pressure (GBP) =	<u>160</u>	kN/m ²	

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) =	<u>5</u>	kN/m ²
Surcharge load -- dead (SGK) =	<u>5</u>	kN/m ²
Line load -- live (LQK) =	<u>13</u>	kN/m
Line load -- dead (LGK) =	<u>77</u>	kN/m
Distance of line load from wall (X) =	<u>2000</u>	mm
Wall load -- live (WQK) =	<u>13</u>	kN/m
Wall load -- Dead (WGK) =	<u>77</u>	kN/m

LATERAL FORCES

Ko =	<u>0.64</u>	default Ko = (1-SIN Ø)	0.64
Kac =	<u>1.60</u>	= 2Ko ^{0.5}	

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

Project	1 Wadham Gardens	REINFORCED CONCRETE COUNCIL	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 [$0.9 \cdot (H_e - T_b/2) / T_w < 15$]
- 4) Maximum Ultimate axial load on wall is limited to 0.1f_{cu} times the wall cross-sectional area
- 5) Design Span (Effective wall height) = $H_e - (T_b/2)$
- 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 PA effect .

UNFACTORED LOADS AND FORCES

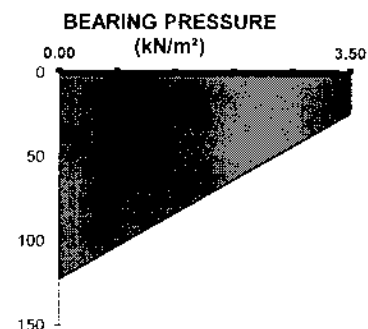
Lateral Force	Force (kN)	Lever arm to base (m)	Base MT. (kNm)	Wall MT. (kNm)	Reaction at Base (kN)	Reaction at Top (kN)	Estimated Elastic Deflection Δ (mm)
PE =	65.35	1.09	-32.79	13.91	55.10	10.24	0.3
PS(GK) =	10.43	1.63	-5.44	3.00	7.36	3.07	0.1
PS(QK) =	10.43	1.63	-5.44	3.00	7.36	3.07	0.0
PL(GK) =	49.41	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 M_v = 193.05



MOMENT due to LATERAL FORCES, $M_o = -92.28$ kNm

RESULTANT MOMENT, $M = M_v + M_o = 100.77$ 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 factors) F.O.S = 1.50

SUM of LATERAL FORCES, $P = 147.95$ kN

BASE FRICTION, $F_b = - (V \tan \phi_b + B \cdot C_b) = -93.14$ 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 8004:1984	Checked	Revision	Job No	
	Originated from 'RCC61 Basement Wall.xls' v2.1 © 1999-20002 BCA for RCC	CM	-	1550	

OUTER BASE (per metre length)

BS8110
reference

$\gamma_f = 1.50$ (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 mm²
 $\phi = 16$ mm
 centres = 225 mm < 766 OK
 As = 894 mm² > 650 OK

Table 3.25

MOMENT of RESISTANCE :
 d = 452 mm
 Z = 429 mm
 As' = 0 mm²
 Mres = 168.10 kNm > 1.06 OK

3.4.4.4

SHEAR RESISTANCE:
 100As/bd = 0.30%
 vc = 0.41 N/mm²
 Vres = 186.17 kN > 29.48 OK

Table 3.8
3.5.5.2

CHECK CRACK WIDTH IN ACCORDANCE WITH BS8100/80 Temp & shrinkage effects not included
 X = 97.65 mm $\epsilon_m = -0.00127$
 Acr = 114.31 mm W = -0.32 mm < 0.30 OK

BS8007
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 mm²
 $\phi = 16$ mm
 centres = 225 mm < 766 OK
 As = 894 mm² > 650 OK

Table 3.25

MOMENT of RESISTANCE :
 d = 452 mm
 Z = 429 mm
 As' = 0 mm²
 Mres = 168.10 kNm > 156.66 OK

3.4.4.4

SHEAR RESISTANCE:
 100As/bd = 0.20%
 vc = 0.41 N/mm²
 Vres = 186.17 kN > 54.08 OK


Table 3.8
3.5.5.2

CHECK CRACK WIDTH IN ACCORDANCE WITH BS8100/80 Temp & shrinkage effects not included
 X = 97.65 mm $\epsilon_m = 0.000304$
 Acr = 114.31 mm W = 0.08 mm < 0.30 OK

BS8007
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
	CADS RC Slab Designer V1 26 (Build 148) Copyright © 2014 - Computer And Design Services Ltd	

Slab geometry

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

Support properties (mm)

Supp ref.	Type	Section		Height
		Width	Length	
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		Trans span width		Loaded width	Trans support		Strip width		
				near	far	near	far		near	far	Mid near	Column	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

A

4H16(7)(U)-275 T1

4H16(14)-275 B1

8H16(1)(U)-275 T1

8H25(2)-275 T1

B

4H16(8)-275 T1

4H16(15)-275 B1

8H20(10)-275 B1

8H20(1)-275 B1

C

4H16(9)(U)-275 T1

8H16(3)(U)-275 T1

4H16(4)(U)-275 T1

4H16(12)-275 B1

4H16(6)-275 T1

4H16(13)-275 B1

4H16(6)(U)-275 T1

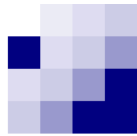
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QUADRANT HARMON
Consulting Civil and Structural Engineers

1 Wadhams 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 - 2005
Revision No	
Calc No	16
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QUADRANT HARMON
Consulting Civil and Structural Engineers

1 Wadham Gardens
Temporary Propping
Worst Case

Job No 1550
Job Ref
Designed By SOH
Checked By FD
Date 16 - 11 - 2018
Revision No
Calc No
Page No 17

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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

<i>Degree of Freedom</i>		<i>End 1</i>	<i>End 2</i>
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				

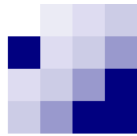
Effective Length Factors

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



QUADRANT HARMON
Consulting Civil and Structural Engineers

1 Wadham Gardens
Temporary Propping
Worst Case

Job No 1550
Job Ref
Designed By SOH
Checked By FD
Date 16 - 11 - 2018
Revision No
Calc No
Page No 18

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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	Comb 2								
	ULS	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

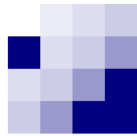
Design Criterion	Utilization Ratio	Load Combination	Position	Status
Local capacity / strength	0.073	1	0	OK
Lateral buckling	0.413	1	0	OK
Torsional buckling				n/a
Deflection	0.115	2	3804	OK

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

Cmb	Axial		Shear			Bending		Combined		Torsion	Status		
	Fz		Fvx		Fvy	Mx		My		Mt			
	mm	U	mm	U	mm	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		Utilization Ratio	Status
		Start(mm)	End(mm)		
1	1	0	9000	0.413	OK



QUADRANT HARMON
Consulting Civil and Structural Engineers

1 Wadham Gardens
Temporary Propping
Worst Case

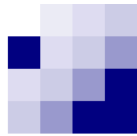
Job No 1550
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Deflection Checks for Member Calculatio Sheet 19-06 Nov 2018

Critical Combination 2 (OK)

Comb.	Normal					Lateral					Utilization ratio
	Pos'n mm	Allowable		Actual		Pos'n mm	Allowable		Actual		
		Deflect. mm	L/defl. ratio	Deflect. mm	L/defl. ratio		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



QUADRANT HARMON
Consulting Civil and Structural Engineers

1 Wadham Gardens
Waling Beam Typical Span 5m

Job No 1551
Job Ref
Designed By SOH
Checked By FD
Date 16 - 11 - 2018
Revision No
Calc No
Page No 20

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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

<i>Degree of Freedom</i>		<i>End 1</i>	<i>End 2</i>
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				

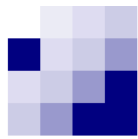
Effective Length Factors

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

 QUADRANT HARMON Consulting Civil and Structural Engineers	1 Wadham Gardens	Job No	1551
	Waling Beam Typical Span 5m	Job Ref	
		Designed By	SOH
		Checked By	FD
		Date	16 - 11 - 2018
		Revision No	
		Calc No	
		Page No	21

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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		Shear			Bending			Combined		Torsion		Status	
	Fz		Fvx		Fvy	Mx		My		Mt				
	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 Number	Length		Utilization Ratio	Status
		Start(mm)	End(mm)		
1	1	0	5000	0.120	OK

Deflection Checks for Member Waling Beam 16-Nov 2018

Critical Combination 2 (OK)

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



Geo-Environmental
1 Wadham Gardens

GEO-ENVIRONMENTAL SERVICES LTD

Job No.	Sheet No.	Rev.
GE10977	22	
Drg. Ref.		
Made by JT	Date	Checked

Preliminary Pile Working Loads

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/m ³]	[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]



Geo-Environmental
1 Wadham Gardens

GEO-ENVIRONMENTAL SERVICES LTD

Job No. Sheet No. Rev.

GE10977

23

Drg. Ref.

Preliminary Pile Working Loads

Made by
JT

Date

Checked

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.

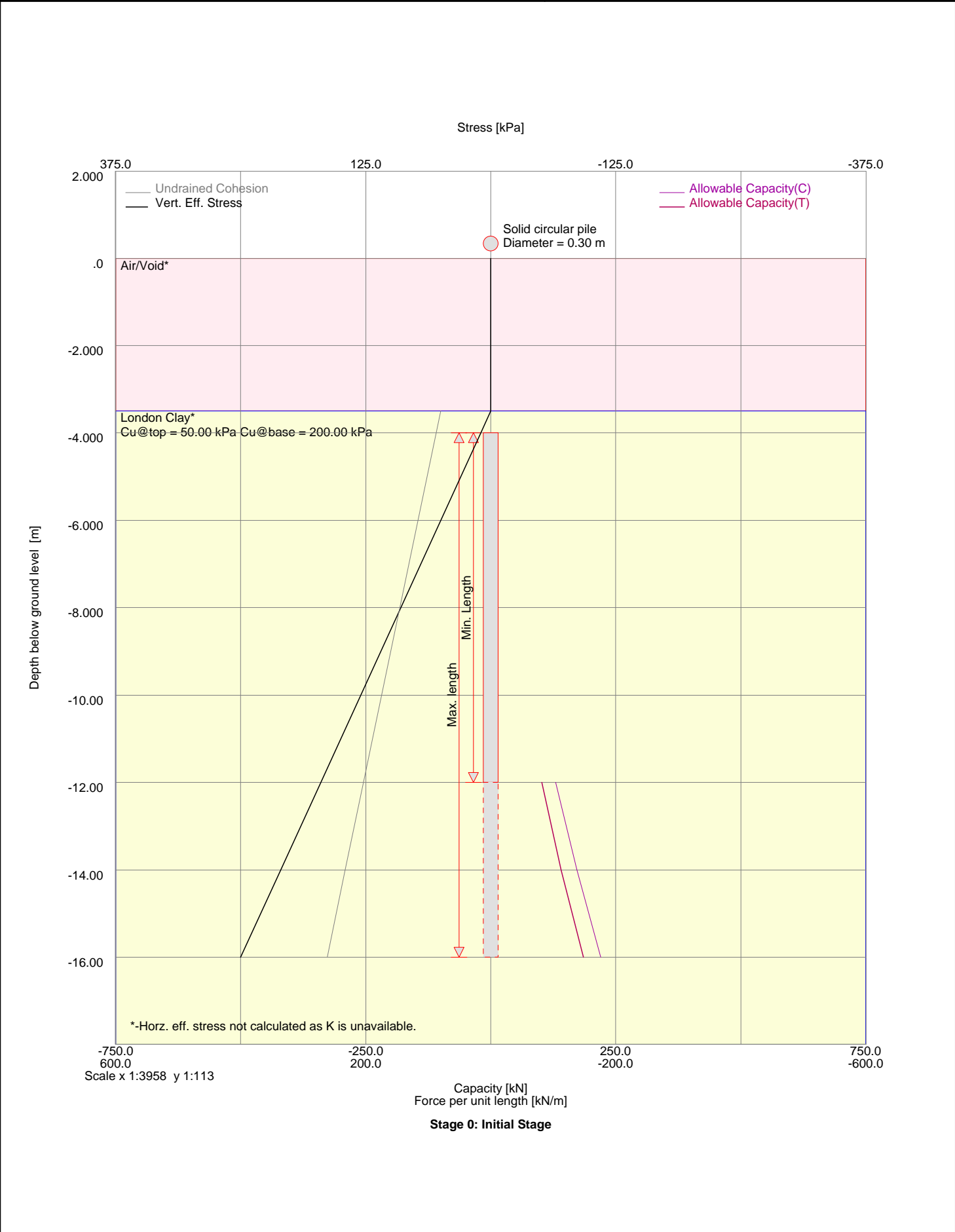
Results - Tension

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]





Geo-Environmental
1 Wadham Gardens

GEO-ENVIRONMENTAL SERVICES LTD

Job No.

Sheet No.

Rev.

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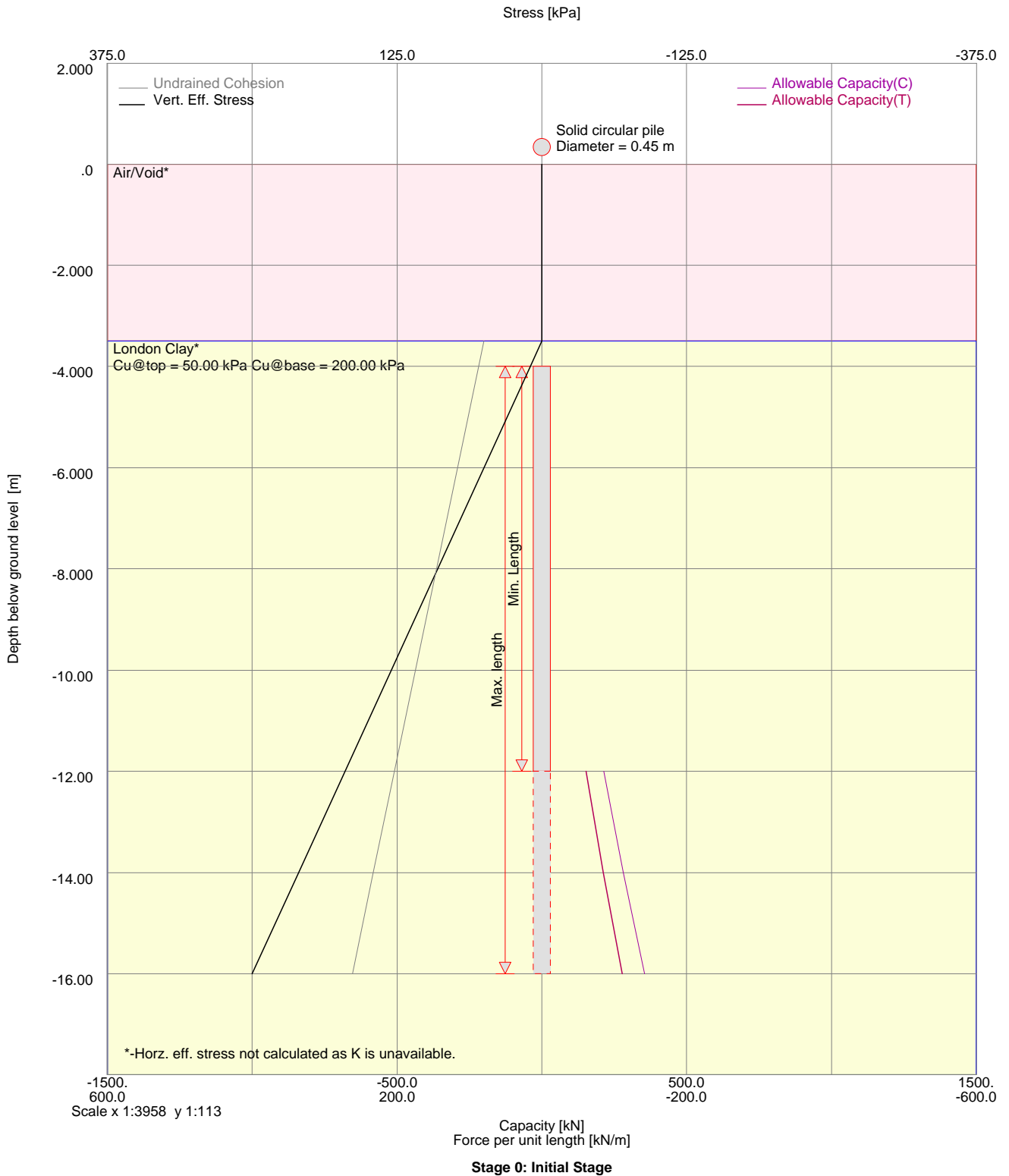
Drg. Ref.

Made by
JT

Date

Checked

Preliminary Pile Working Loads



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Project

1 Wadham Gardens

Job No. 1560

Sheet No. 26

Date. Nov 18

Ref:

Piles uplift force

By: *GH* Ckd: *[Signature]*

$$\text{Area of slab (worst case)} \approx 2.5 \times 1.5 = 4 \text{ m}^2$$

$$\text{Uplift Force} = 40 \times 4 = 160 \text{ kN}$$

$$\text{Weight of slab} = 7.2 \times 4 = \frac{29}{131 \text{ kN}}$$

From Calculation sheets

Pile ϕ 300 Capacity Tension = 141 kN
for 14 m length.

~~Pile capacity Tension =~~