CampbellReith
consulting engineers

8 Oakhill Avenue
London
NW3 7RE

Basement Impact Assessment
Audit

For

London Borough of Camden

Project Number: 13398-37
Revision: F1

February 2021

Campbell Reith Hill LLP
15 Bermondsey Square
London
SE1 3UN

T: +44 (0)20 7340 1700
E: london@campbellreith.com
W: www.campbellreith.com

Document History and Status

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Author	J Brown, BSc MSc FGS
Project Partner	E M Brown, BSc MSc CGeol FGS
Project Number	13398-37
Project Name	8 Oakhill Avenue
Planning Reference	2020/1698/P

Contents

Appendix

1.0 NON-TECHNICAL SUMMARY

1.1. CampbellReith was instructed by London Borough of Camden, (LBC) to carry out an audit on the Basement Impact Assessment submitted as part of the Planning Submission documentation for 8 Oakhill Avenue (planning reference 2020/1698/P). The basement is considered to fall within Category B as defined by the Terms of Reference.

1.2. The Audit reviewed the Basement Impact Assessment for potential impact on land stability and local ground and surface water conditions arising from basement development in accordance with LBC's policies and technical procedures.

1.3. CampbellReith was able to access LBC's Planning Portal and gain access to the latest revision of submitted documentation and reviewed it against an agreed audit check list. Additional discussions were undertaken and a revised Basement Impact Assessment (BIA) and Construction Method Statement (CMS) has been provided.

1.4. The Site Investigation & Ground Movement Assessment Report (BIA) and CMS have been prepared by consultants using individuals who possess suitable qualifications.

1.5. A utilities search has been undertaken.

1.6. The BIA has confirmed that the proposed basement will be founded within the Claygate Member. Bearing pressures are low and as such the basement is not considered to be at risk of bearing capacity failure. Should bearing pressures or founding depths increase, further consideration will be required.

1.7. The BIA identified that groundwater could be encountered during basement excavation if significant sand channels are encountered within the Claygate Member, during excavation for the basement. The BIA recommends that groundwater monitoring will be continued with trial excavations undertaken to assess groundwater inflows prior to excavation work. The CMS advises a contingency plan should be in place by the chosen contractor to address significant or prolonged inflows.

1.8. The CMS discusses underpinning during construction with suitable temporary propping arrangements. The basement will be constructed with a reinforced concrete raft slab. Structural calculations are provided.

1.9. A Ground Movement Assessment is provided which predicts damage to neighbouring properties no worse than Burland category 1.

1.10. Ground movements have been determined during underpinning installation, excavation, basement slab construction, and for the long term, total ground movements. The method to determine ground movements has been clarified.

1.11. The site is located on a slope, however, the BIA notes that there will be no changes to slope gradients resulting from the basement proposals. Comment has been provided on how impacts to slope stability will be mitigated.

1.12. A movement monitoring strategy during excavation and construction is indicated and will be formalised during the Party Wall Award.

1.13. It is accepted that the development will not impact on the wider hydrology of the area and is not in an area subject to flooding.

1.14. Given the extent of the basement and the discussion on groundwater observations in the Claygate Member, the development is not anticipated to impact significantly on groundwater flows.

1.15. It can be confirmed that the BIA complies with the requirements of CPG: Basements.

2.0 INTRODUCTION

2.1. CampbellReith was instructed by London Borough of Camden (LBC) on 3 August 2020 to carry out a Category B audit on the Basement Impact Assessment (BIA) submitted as part of the Planning Submission documentation for 8 Oakhill Avenue, NW3 7RE (planning reference 2020/1698/P).

2.2. The audit was carried out in accordance with the Terms of Reference set by LBC. It reviewed the Basement Impact Assessment for potential impact on land stability and local ground and surface water conditions arising from basement development.

2.3. A BIA is required for all planning applications with basements in Camden in general accordance with policies and technical procedures contained within

- Camden Local Plan 2017 - Policy A5 Basements.
- Camden Planning Guidance: Basements. March 2018
- Guidance for Subterranean Development (GSD). Issue 01. November 2010. Ove Arup & Partners.

2.4. The BIA should demonstrate that schemes:

a) maintain the structural stability of the building and neighbouring properties;

b) avoid adversely affecting drainage and run off or causing other damage to the water environment;

c) avoid cumulative impacts upon structural stability or the water environment in the local area;

and evaluate the impacts of the proposed basement considering the issues of hydrology, hydrogeology and land stability via the process described by the GSD and to make recommendations for the detailed design.

2.5. LBC's Audit Instruction described the planning proposal as *"The formation of a basement level construction."*

2.6. The Audit Instruction confirmed 8 Oakhill Avenue does not involve, and is not neighbour to, listed buildings.

2.7. CampbellReith accessed LBC's Planning Portal on 21st August 2020 and gained access to the following relevant documents for audit purposes:

- Construction Method Statement, Price and Myers , Ref 28373, Rev 1 dated February 2020;
- Site Investigation & Ground Movement Assessment Report, Geotechnical & Environmental Associates (GEA), Ref J19232 dated March 2020 (Inc. BIA, Desk Study and Ground Investigation Report);
- Design and Access Statement, Carver Farshi, Ref 1901_DAS-Basement dated April 2020;
- Planning Application Drawings consisting of:

  Location Plan, ref 1903_PL_010 dated April 2020;

  Site Survey, ref PL12174-01 dated May 2020;

  Existing Plans, Carver Farshi, ref 1903_EX_100, 1903_EX_101, 1903_EX_102, 1903_EX_103, 1903_EX_200 and 1903_EX_201 dated April 2020;

  Proposed Plans, Carver Farshi, ref 1903_EX_020*, 1903_PL_100, 1903_PL_101 and 1903_PL_300 dated April 2020.
- Planning Consultation Responses.

2.8. Updated information was accessed by CampbellReith from the LBC's Planning Portal on 19th November 2020 and gained access to the following relevant, updated documents for audit purposes:

- Construction Method Statement, Price and Myers , Ref 28373, Rev 2 dated September 2020;
- Site Investigation & Ground Movement Assessment Report, Geotechnical & Environmental Associates (hereafter referred to as the BIA), Ref J19232 dated September 2020 (inc. BIA, Desk Study, Utility Services search and Ground Investigation Report);
- Planning Consultation Responses.

2.9. The following additional documents were provided to CampbellReith in February 2021 in response to the initial audit reports and the queries summarised in Appendix 2:

- Site Investigation & Ground Movement Assessment Report, Geotechnical & Environmental Associates (hereafter referred to as the BIA), Ref J19232 dated February 2021.
- GEA Email responses dated 02/12/2020.
- Structural Calculations by Price & Myers, ref. 28373, dated September 2020.

3.0 BASEMENT IMPACT ASSESSMENT AUDIT CHECK LIST

Item	Yes/No/NA	Comment
Are BIA Author(s) credentials satisfactory?	Yes	Section 1.3.2 GEA Site Investigation and Ground Movement Assessment (BIA) report.
Is data required by Cl.233 of the GSD presented?	No	Programme should be produced prior to works commencing.
Does the description of the proposed development include all aspects of temporary and permanent works which might impact upon geology, hydrogeology and hydrology?	Yes	GEA BIA Report.
Are suitable plan/maps included?	Yes	
Do the plans/maps show the whole of the relevant area of study and do they show it in sufficient detail?	Yes	Carver Farshi plans. GEA BIA Report.
Land Stability Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	Section 3.1.2 GEA BIA report.
Hydrogeology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	Section 3.1.1 GEA BIA report.
Hydrology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	Section 3.1.3 GEA BIA report.
Is a conceptual model presented?	Yes	Section 5 GEA BIA report.

Item	Yes/No/NA	Comment
Land Stability Scoping Provided? Is scoping consistent with screening outcome?	Yes	Section 4 GEA BIA Report.
Hydrogeology Scoping Provided? Is scoping consistent with screening outcome?	Yes	Section 4 GEA BIA Report.
Hydrology Scoping Provided? Is scoping consistent with screening outcome?	Yes	Section 4 GEA BIA Report.
Is factual ground investigation data provided?	Yes	Appendix A GEA BIA Report.
Is monitoring data presented?	Yes	Section 5.4 GEA BIA Report.
Is the ground investigation informed by a desk study?	Yes	Section 2 GEA BIA Report.
Has a site walkover been undertaken?	Yes	
Is the presence/absence of adjacent or nearby basements confirmed?	No	Assumed to be absent for ground movement calculations and this is accepted.
Is a geotechnical interpretation presented?	Yes	Section 8 and 10 of the GEA BIA report.
Does the geotechnical interpretation include information on retaining wall design?	Yes	Section 8.1.1 GEA BIA report.
Are reports on other investigations required by screening and scoping presented?	N/A	
Are the baseline conditions described, based on the GSD?	Yes	Section 9 of the GEA BIA report. A Utilities search has been provided in Appendix A of the GEA BIA report

Item	Yes/No/NA	Comment
Do the base line conditions consider adjacent or nearby basements?	Yes	In respect of ground movement only - Section 9 of the GEA BIA report.
Is an Impact Assessment provided?	Yes	Section 3 and 4 of the GEA BIA report.
Are estimates of ground movement and structural impact presented?	Yes	Section 10 of the GEA BIA report.
Is the Impact Assessment appropriate to the matters identified by screening and scoping?	Yes	
Has the need for mitigation been considered and are appropriate mitigation methods incorporated in the scheme?	Yes	Section 13 of the GEA BIA report.
Has the need for monitoring during construction been considered?	Yes	Section 11.2 of the GEA BIA report.
Have the residual (after mitigation) impacts been clearly identified?	Yes	Section 13 of the GEA BIA report.
Has the scheme demonstrated that the structural stability of the building and neighbouring properties and infrastructure will be maintained?	Yes	Section 12 of the GEA BIA report.
Has the scheme avoided adversely affecting drainage and run-off or causing other damage to the water environment?	Yes	Section 8 of the GEA BIA report.
Has the scheme avoided cumulative impacts upon structural stability or the water environment in the local area?	Yes	Section 8 of the GEA BIA report.
Does report state that damage to surrounding buildings will be no worse than Burland Category 1?	Yes	Section 9 of the GEA BIA report.
Are non-technical summaries provided?	Yes	Section 13.3 of the GEA BIA report.

4.0 DISCUSSION

4.1. The Basement Impact Assessment, included as part of the Site Investigation & Ground Movement Assessment (BIA) Report, has been carried out by engineering consultants Geotechnical & Environmental Associates (GEA). The individuals concerned in its production have suitable qualifications. The Construction Method Statement (CMS) has been carried out by Price & Myers. The author is a chartered structural engineer.

4.2. The LBC Instruction to proceed with the audit identified that the basement proposal does not involve a listed building, nor is it adjacent to listed buildings.

4.3. The property comprises a detached 3 storey building with no existing below ground structures. The front garden slopes steeply down to the south east, away from the building to an existing brickwork retaining wall that fronts the public pavement. Steps lead down from a rear patio to the rear garden, separated by a low retaining wall. The garden continues to slope downwards towards the north western boundary.

4.4. Historic maps show the site to be undeveloped with a stream located approximately 30m to the north of site, later culverted or covered in 1895.

4.5. A utilities search has been provided.

4.6. The Price and Myers drawings show an existing single storey rear extension to be removed and replaced with a similarly sized extension that is indicated to be piled. It is understood that this is not part of the current application.

4.7. The BIA and CMS are now consistent in describing the proposed basement as a new reinforced concrete box structure consisting of a single storey construction formed by lowering a part of the northern corner of the existing lower ground floor area by just over 2.5 metres and excavating to a basement formation level approximately 3.5 metres below the existing internal ground floor slab level. The basement will be constructed with a reinforced concrete raft slab founding within the Claygate Member.

4.8. The basement construction sequence is indicated in the Price & Myers 'Construction Sequence'. The existing external walls are to be laterally propped prior to the removal of the existing ground floor. A reduced dig will be undertaken to provide a level working surface. Basement retaining walls are to be formed using sequential mass concrete pins constructed in a hit and miss sequence with an internal reinforced concrete liner wall. For the other walls sequential reinforced concrete pins (similar to the underpinning but not below an existing wall) will be constructed. Following completion of the underpinning, the bulk excavation will commence with lateral props installed across the basement excavation. The reinforced concrete ground bearing

basement slab will be designed to resist heave pressures. The ground floor slab will be cast to form an integral reinforced concrete box.

4.9. Structural calculations have been provided.

4.10. Screening and scoping assessments are presented, supported by desk study information. The relevant figures/maps from the Arup GSD and other guidance documents are referenced within the BIA to support responses to the screening questions and a ground investigation was undertaken.

4.11. The formation level for the basement is anticipated to be at 3.50m bgl (6.50m TBM). The BIA has identified that Made Ground was encountered up to 1.40m bgl (8.90m TBM). The Claygate Member was encountered to 7.50m bgl (1.40m TBM) and the London Clay was proven to a depth of 15.00m bgl (-6.10m TBM). The BIA describes the Claygate Member as firm to stiff, locally soft, sandy clay.

4.12. Groundwater was encountered as seepages in WS1 and WS3 between 1.00 and 1.60m bgl (8.30 and 7.40m TBM) and in WS2 at 4.90m bgl (5.90m TBM). Groundwater strikes were encountered in BH1 at 5.40m bgl (3.50m TBM) rising to 5.30m bgl (3.60m TBM) and at 10.00m bgl (-1.10m TBM) rising to 9.80m bgl (-0.90m TBM).

4.13. Groundwater was monitored in BH1, WS2 and WS3. The BIA states that due to a faulty installation in WS3, the groundwater monitoring recorded in this installation is not representative of the groundwater conditions. Groundwater was monitored between 3.65 and 4.90m bgl (6.40m and 4.00m TBM). The BIA states that groundwater within the Claygate Member could be encountered during basement construction provided permeable sand layers are present. In the absence of these sand layers the Claygate Member clay strata could not support a water table. The BIA also states any groundwater encountered during excavation is likely to be perched and that potential inflows are unlikely to be significant and so adequately dealt with through pumping from sumps. However, for surety, groundwater monitoring should be continued and trial excavations undertaken to assess the extent of inflows within the proposed basement excavations. The CMS states that it would be prudent for the chosen contractor to have a contingency plan in place to deal with more significant and prolonged inflows as a precautionary measure, and this is accepted.

4.14. The BIA provides a design bearing resistance for the Claygate Member of 115kPa. Whilst the undrained shear strength profile provided in Appendix 1 of the BIA is not considered moderately conservative, the maximum bearing pressures quoted in the BIA are significantly less than the design bearing resistance, giving an adequate factor of safety against bearing capacity failure. If bearing pressures increase, or if the depth of the foundations increases, further consideration will need to be given to demonstrating an adequate bearing stratum.

4.15. The presence of neighbouring basements and the depth of neighbouring foundations have not been investigated however, for the damage assessment it is accepted that it is conservative to assume that neighbouring basements are not present and the properties have shallow footings.

4.16. An updated ground movement assessment has been provided. The GMA has been undertaken within and surrounding the excavation using X-Disp and P-Disp with P-Disp ground movement imported into X-Disp. Ground movements have been determined during underpinning installation (Stage 1), excavation (Stage 2), basement slab construction (Stage 3), and for the long term condition (Stage 4). GEA have clarified that the damage category has been determined at each stage

4.17. Whilst the stiffness values are not considered moderately conservative, the settlements carried through to the damage assessment are within the range to be expected for a development of this nature. The assessment has determined that ground movements will not affect the structural integrity of neighbouring buildings with a Burland damage category of not more than 1 (very slight) predicted.

4.18. The site is located on a slope. GEA note the land to the rear of the site has a slope angle of greater than 7° however the site is an angle less than 7°. GEA note that the proposed basement is located in the middle of the site and that slope angles on and around the site are not being altered. The construction sequence and design of the retaining walls must consider any loads resulting from the changes in level around the site.

4.19. Monitoring of ground movements is suggested by the BIA and is included as part of the CMS, which will be agreed under the Party Wall Agreement.

4.20. The area of new basement does not increase the extent of impermeable surfacing and will not impact on current rainwater discharges to the below ground surface water drainage system. The development is not in an area prone to flooding. It is therefore accepted that there are no significant impacts to surface water flows.

4.21. The development is remote from the Hampstead Heath Pond chain or other pond catchment areas. The site is close to a tributary of the “lost” River Westbourne and a spring line. The basement will be founding within the Claygate Member, a Secondary A Aquifer. The basement is proposed to extend beneath part of the existing detached building and so the development proposal is not anticipated to impact significantly on groundwater flows.

5.0 CONCLUSIONS

5.1. The Site Investigation and Ground Movement Assessment report (BIA) and the Construction Method Statement (CMS) have been carried out by individuals who possess suitable qualifications.

5.2. A utilities search has been undertaken.

5.3. A single storey basement is proposed and the CMS discusses underpinning during construction with suitable temporary propping arrangements. The basement will be constructed with a reinforced concrete raft slab.

5.4. Although the undrained shear strength profile provided for the Claygate Member is not considered moderately conservative, the bearing pressures are significantly less that the quoted allowable bearing capacities. It is accepted that there is an adequate factor of safety against bearing capacity failure.

5.5. The BIA has identified that ground water could be encountered during basement excavation if significant sand channels are encountered during excavation. Groundwater monitoring is to be continued with trial excavations undertaken to assess groundwater inflows prior to excavation work. The CMS advises a contingency plan should be in place by the chosen contractor to address significant or prolonged inflows if encountered.

5.6. A Ground Movement Assessment is provided. GEA have clarified that movements have been appropriately determined with a damage category determined at each stage

5.7. Ground movements have been determined during underpinning installation, excavation, basement slab construction, and for the long term, total ground movements. A Burland damage scale category of not more than 1 (very slight) has been determined which is accepted.

5.8. The site is located on a slope less than 7°. GEA note the land to the rear of the site has a slope angle of greater than 7° however the proposed basement is located in the middle of the site at a level approximately similar to the house and back garden. The site is detached with low vertical retaining walls and as such do not anticipated slope instability.

5.9. Structural calculations are provided.

5.10. A movement monitoring strategy during excavation and construction is indicated and will be formalised during the Party Wall Award.

5.11. It is accepted that the development will not impact on the wider hydrology of the area and is not in an area subject to flooding.

5.12. The basement is proposed to extend beneath part of the existing detached building and, given the discussion on groundwater within the Claygate Member above, the development is not anticipated to impact significantly on groundwater flows.

5.13. Based on the revised submission, the BIA complies with the requirements of CPG: Basements.

Appendix 1: Residents' Consultation Comments

Residents' Consultation Comments

Surname	Address	Date	Issue raised	Response
Harding	-	01/05/2020	BIA missing.	Included as part of the Site Investigation & Ground Movement Assessment reference J19232 issue 5 as final, dated February 2021.

Appendix 2: Audit Query Tracker

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Audit Query Tracker

Query No	Subject	Query	Status	Date closed out
1	BIA	A utilities search has not been undertaken and is required.	Closed	24/11/2020
2	BIA	The BIA and Construction Method Statement are contradictory in regard to the basement proposals. This should be clarified and the documents updated to accurately reflect the proposed scheme.	Closed	24/11/2020
3	Stability	The strength, stiffness and bearing capacity of the bearing stratum requires confirmation.	Closed	04/02/2021
4	Stability	Queries are raised with respect to the methodologies adopted for the building damage assessment. GMA should be updated once these have been clarified.	Closed	04/02/2021
5	Stability	Structural calculations are not provided and are required.	Closed	04/02/2021
6	Stability	The site is located on a slope and comment should be provided on how slope stability concerns will be mitigated.	Closed	04/02/2021
7	Subterranean flows	Groundwater queries should be clarified before the impact on subterranean flows can be confirmed. Mitigation measures to be described where necessary.	Closed	09/02/2021

Appendix 3: Supplementary Supporting Documents

Structural Calculations by Price & Myers, ref. 28373, dated September 2020

GEA Email responses dated 02/12/2020

PRICE & MYERS

Job No.	28373	Page	01	Rev	
Date	Sept 2020	Eng	AS	Chd	CA
Job	8 Oakhill Avenue				

No. 8

OAKHILL AVENUE

LONDON

STRUCTURAL CALCULATIONS

PRICE & MYERS

Job No.	28373	Page	02	Rev	
Date	Sept 2020	Eng	AS	Chd	CA
Job	8 Oakhill Avenue				

BASEMENT DESIGN

Design Loads

	DL	LL
• Roof		
- Slates, timber battens & felt	0.55	-
- Timber rafters & insulation	0.2	-
- Ceiling & services	0.15	-
- Snow	-	0.6
	0.9	0.6

• Typical floor		
- boards / ply	0.15	-
- joists	0.20	-
- Ceiling & services	0.15	-
- Domestic	-	1.5
	0.75	1.5

• Flat roof (Green)		
- Green extensive	1.78	
- boards & ply	0.2	
- joists	0.2	
- Ceiling & services	0.15	
- Snow	-	0.6
	2.33	0.6

PRICE & MYERS

Job No. 28373 Page 04 Rev

Date Sept 2020 Eng AS Chd CA

Job 8 Oakhill Avenue

Design Loads

	DL	LL
• Ground floor slab over basement		
- Assume 200 thk RC slab	5	-
- Assume 75 screed	1.875	-
- Assume 25 tiles	0.63	-
- Ceiling & services	0.3	-
- Domestic + partition	-	2.5
	7.81	2.5

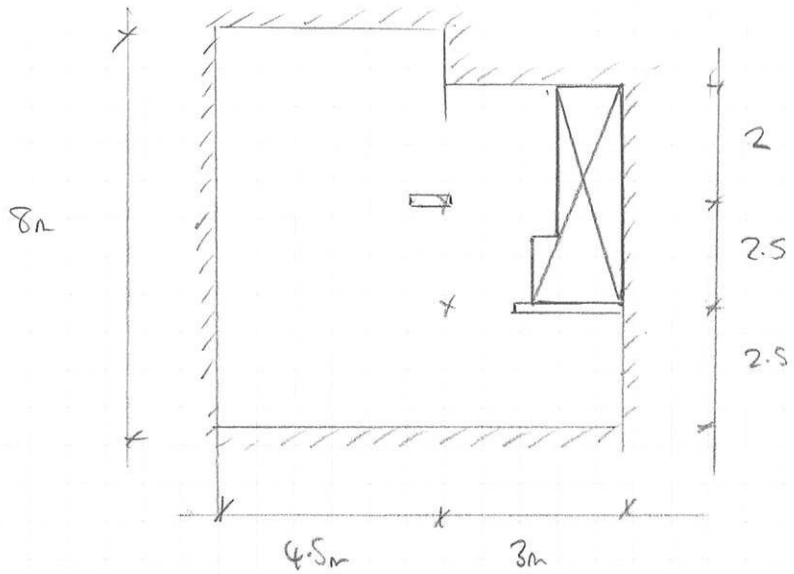
• 350 THK WALL		
- 350 wall	7	-
- Plaster	0.15	-
	7.15	-

• 230 THK WALL		
- 230 Brk	4.6	-
- Plaster both sides	0.3	-
	4.9	-
• 100 THK wall		
- 100 Brk	2	-
- Plaster both sides	0.3	-
	2.3	-

PRICE & MYERS

Job No.	28373	Page	05	Rev	
Date	Sept 2020	Eng	AS	Chd	CA
Job	8 Oakhill Avenue				

GROUND FLOOR SLAB OVER BASEMENT



Design loads $w_d = 7.81$ $w_l = 2.5$

Use 200 RC Slab
with A393 MESH T&B

Refer to spreadsheet

Project	8 Oakhill Avenue			REINFORCED CONCRETE COUNCIL	
Client	N/A			Made by: AS	Date: 28-Jan-20	Page: 06
Location	Ground Floor Slab	from grids 1	to 2	Checked: -	Revision: -	Job No: 28373

FLAT SLAB ANALYSIS & DESIGN to BS 8110:1997

MATERIALS

fcu	32	N/mm²	h agg	20	mm
fyl	460	N/mm²	γs	1.05	steel
fyv	460	N/mm²	γc	1.50	concrete

COVERS

	mm	TO LAYER
Top cover	25	1
Btm cover	25	1

SPANS

	L (m)
SPAN 1	4.500
SPAN 2	3.000
SPAN 3	
SPAN 4	
SPAN 5	
SPAN 6	

GEOMETRY

Bay type	EDGE	
Slab depth, h	200	mm
Edge Panel width, b	1000	mm
Edge distance	300	mm to C/L
End distance	300	from supt 1
End distance	300	from supt 3

PERIMETER LOADS *characteristic*

kN/m outside supports 1 & 3

kN/m along bay edge

LOADING PATTERN

	min	max
DEAD	1.0	1.4
IMPOSED		1.6

SUPPORTS

	ABOVE (m)	H (mm)	B (mm)	End Cond	BELOW (m)	H (mm)	B (mm)	End Cond
Support 1					1	200	800	E
Support 2					1	200	800	E
Support 3					1	200	800	E
Support 4								
Support 5								
Support 6								
Support 7								

LOADING

UDLs (kN/m²) PLs (kN/m) Position (m)

	Dead Load	Imposed Load	Position from left	Loaded Length
Span 1				
UDL	7.81	2.50	~~~~~	~~~~~
PL 1				~~~~~
PL 2				~~~~~
Part UDL				
Span 2				
UDL	7.81	2.50	~~~~~	~~~~~
PL 1				~~~~~
PL 2				~~~~~
Part UDL				
Span 3				
UDL			~~~~~	~~~~~
PL 1				~~~~~
PL 2				~~~~~
Part UDL				

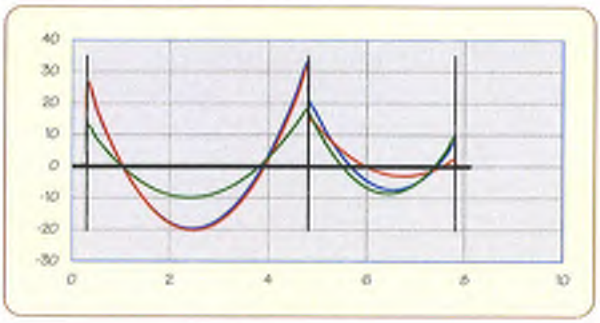
	Dead Load	Imposed Load	Position from left	Loaded Length
Span 4				
UDL			~~~~~	~~~~~
PL 1				~~~~~
PL 2				~~~~~
Part UDL				
Span 5				
UDL			~~~~~	~~~~~
PL 1				~~~~~
PL 2				~~~~~
Part UDL				
Span 6				
UDL			~~~~~	~~~~~
PL 1				~~~~~
PL 2				~~~~~
Part UDL				

LOADING DIAGRAM

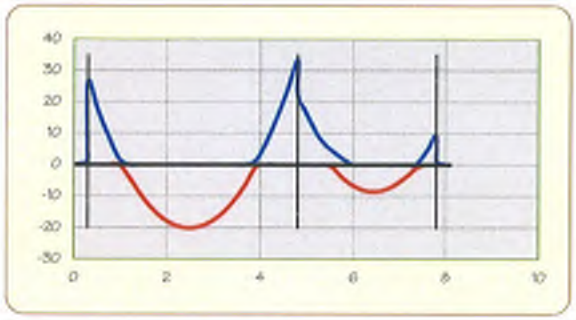
Project	8 Oakhill Avenue	REINFORCED CONCRETE COUNCIL		
Client	N/A	Made by: AS	Date: 28-Jan-20	Page: 07
Location	Ground Floor Slab, from grids 1 to 2	Checked: -	Revision: -	Job No: 28373
	FLAT SLAB ANALYSIS & DESIGN to BS 8110:1997			

Originated from RCC55.xls v2.2 on CD © 1999-2003 BCA for RCC

BENDING MOMENT DIAGRAMS (kNm)



Elastic Moments

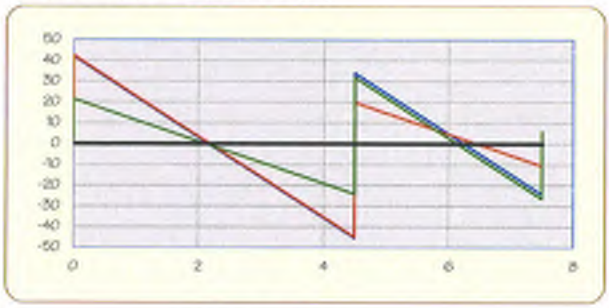


Redistributed Envelope

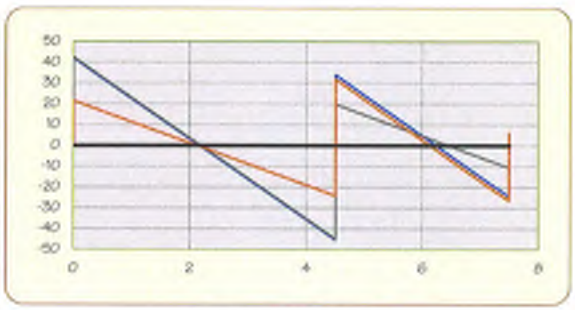
SUPPORT No	1	2	3				
Elastic M	26.2	33.3	9.4	~	~	~	~
Redistributed M	26.2	33.3	9.4	~	~	~	~
ßb	1.000	1.000	1.000	~	~	~	~
Redistribution							
End support reinf. Ø mm	12		12				

SPAN No	1	2				
Elastic M	20.1	8.5	~	~	~	~
Redistributed M	20.1	8.5	~	~	~	~
ßb	1.000	1.000	~	~	~	~

SHEARS FORCE DIAGRAMS (kN)



Elastic Shears



Redistributed Shears

SPAN No	1		2			
Elastic V	42.4	45.4	34.0	26.4	~	~
Redistributed V	42.4	45.4	34.0	26.4	~	~

SPAN No						
Elastic V	~	~	~	~	~	~
Redistributed V	~	~	~	~	~	~

REACTIONS (kN)

SUPPORT	1	2	3
ALL SPANS LOADED	47.8	79.3	30.1
ODD SPANS LOADED	48.3	64.8	13.6
EVEN SPANS LOADED	24.6	56.0	32.2
Veff for punching	60.3	111.3	40.2
Characteristic Dead	25.0	41.5	15.7
Characteristic Imposed	8.3	13.3	6.3

COLUMN MOMENTS (kNm)		1	2	3
ALL SPANS LOADED	Above			
	Below	24.9	-10.9	-7.0
ODD SPANS LOADED	Above			
	Below	25.8	-15.4	-1.7
EVEN SPANS LOADED	Above			
	Below	12.1	-1.2	-8.9

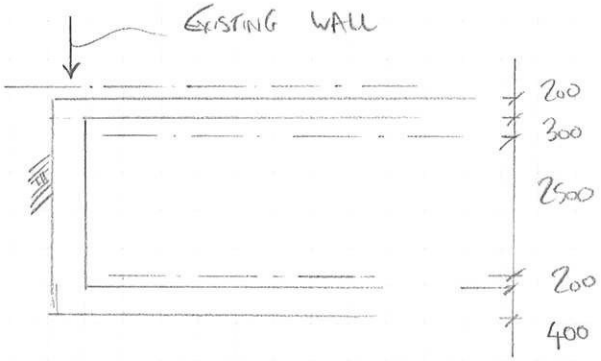
Project	8 Oakhill Avenue	REINFORCED CONCRETE COUNCIL		
Client	N/A	Made by: AS	Date: Jan-2020	Page: 08
Location	Ground Floor Slab, from grids 1 to 2	Checked: -	Revision: -	Job No: 28373
	FLAT SLAB ANALYSIS & DESIGN to BS 8110:1997			

Originated from RCC33.xls v2.2 on CD © 1998-2005 BCA for RCC

SPAN 1			LEFT	CENTRE	RIGHT
ACTIONS	βb		1.000	1.000	1.000
	Be		900		800
	Total M	kNm	22.1	20.1	28.9
	Mt max	kNm	123.4		109.7
MIDDLE STRIP	Width	mm	500	500	500
	M	kNm	0.3	9.1	7.2
	d	mm	169.0	169.0	169.0
	As	mm²/m	10	258	205
	As deflection	mm²/m		258	205
			Provide T12 @ 400 T1	Provide T12 @ 400 B1	Provide T12 @ 400 T1
	As prov	mm²/m	283	283	283
	Top steel			Provide T12 @ 400 T1	
	Deflection		L/d = 4,500 /169.0 = 26.627 < 26.0 x 1.622 x 1.053 x 0.9 = 39.968		OK
COLUMN STRIP	Width	mm	800	800	800
	M	kNm	22.1	11.1	21.6
	d	mm	169.0	169.0	169.0
	As	mm²/m	393	197	385
	As deflection	mm²/m		197	385
			Provide T12 @ 275 T1	Provide T12 @ 400 B1	Provide T12 @ 200:400 T1
	As prov	mm²/m	411	283	424
	Top steel			Provide T12 @ 400 T1	
	Deflection		L/d = 4,500 /169.0 = 26.627 < 26.0 x 2.000 x 1.053 x 0.9 = 49.272		OK
CHECKS	% As		ok	ok	ok
	Singly reinforced		ok	ok	ok
	max S		ok	ok	ok

SPAN 2			LEFT	CENTRE	RIGHT
ACTIONS	βb		1.000	1.000	1.000
	Be		800		900
	Total M	kNm	28.9	8.5	6.8
	Mt max	kNm	109.7		123.4
MIDDLE STRIP	Width	mm	500	500	500
	M	kNm	7.2	3.8	0.3
	d	mm	169.0	169.0	169.0
	As	mm²/m	205	109	10
	As deflection	mm²/m	205	109	
			Provide T12 @ 400 T1	Provide T12 @ 400 B1	Provide T12 @ 400 T1
	As prov	mm²/m	283	283	283
	Top steel			Provide T12 @ 400 T1	
	Deflection		L/d = 3,000 /169.0 = 17.751 < 26.0 x 2.000 x 1.053 x 0.9 = 49.272		OK
COLUMN STRIP	Width	mm	800	800	800
	M	kNm	21.6	4.7	6.8
	d	mm	169.0	169.0	169.0
	As	mm²/m	385	83	122
	As deflection	mm²/m	385	83	
			Provide T12 @ 200:400 T1	Provide T12 @ 400 B1	Provide T12 @ 425 T1
	As prov	mm²/m	424	283	266
	Top steel			Provide T12 @ 400 T1	
	Deflection		L/d = 3,000 /169.0 = 17.751 < 26.0 x 2.000 x 1.053 x 0.9 = 49.272		OK
CHECKS	% As		ok	ok	ok
	Singly reinforced		ok	ok	ok
	max S		ok	ok	ok

RETAINING WALL



Height = 3300 mm

Design loads

- Ground floor slab $w_{dl} = 7.81\ kN/m^2$, $w_{ll} = 2.5\ kN/m^2$

EXISTING BUILDING

element	width (m) / height	dl (kN/m²)	ll	DL (kN/m)	LL
Roof	3.7	0.9	0.6	3.33	2.22
Second	3.92/2 = 1.96	0.75	1.5	1.5	2.95
First	"	"	"	1.5	2.95
Ground	1m normal (assumed ground bearing) slab	3.75	1.5	3.75	1.5
Wall	6 + 1m bgl = 7	7.15	-	50	-
				60.1	9.62

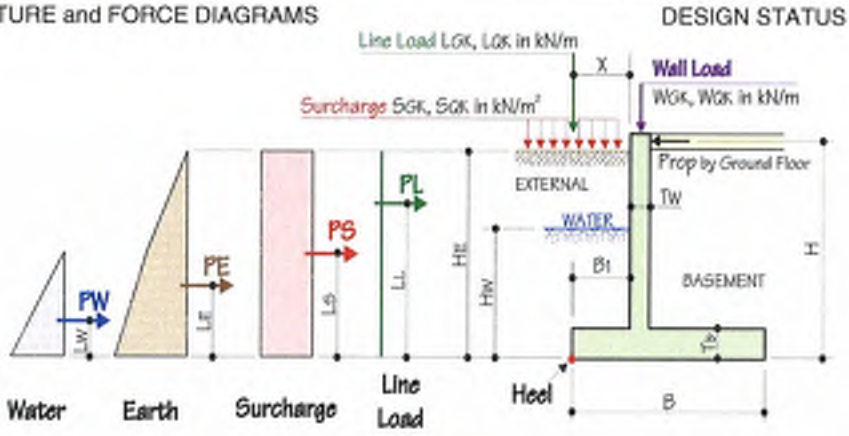
Project	Oakhill Avenue	REINFORCED CONCRETE COUNCIL		
Client		Made by: AS	Date: 28-Jan-2020	Page: 10
Location	Basement Retaining Wall	Checked	Revision: -	Job No: 28373

Basement wall design to BS8110:1997, BS8002:1994, BS 8004:1986 etc.

Originated from 'RCC81 Basement Wall.xls' v2.1 © 1999-2002 BCA for RCC

IDEALISED STRUCTURE and FORCE DIAGRAMS

DESIGN STATUS : VALID



DIMENSION (mm)

H =	3300	B =	5000	Tw =	250
Hw =	2300	B1 =	0	Tb =	400
He =	3300				

MATERIAL PROPERTIES

fcu =	35	N/mm²	γm =	1.50	concrete
fy =	460	N/mm²	γm =	1.05	steel
Cover to tension reinforcement (co) =				75	mm
Max. allowable design surface crack width (W) =				0.2	mm (0.2 or 0.3 mm only)
Concrete density =				24.0	kN/m3

Wall Geometry

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
Density of retained mat'l (q) =	19	kN/m3
Submerged Density of retained mat'l (qs) =	12.67	kN/m3
Design angle of int'l friction of base mat'l (Øb) =	25	degree
Design cohesion of base mat'l (Cb) =	0	kN/m2
Density of base mat'l (qb) =	19	kN/m3
Allowable gross ground bearing pressure (GBP) =	125	kN/m2

(Only granular backfill considered, ie "C" = 0)

(default=2/3 of q), only apply when Hw >0 = 12.67

LOADINGS (unfactored)

Surcharge load -- live (SQK) =	10	kN/m2
Surcharge load -- dead (SGK) =	0	kN/m2
Line load -- live (LQK) =	0	kN/m
Line load -- dead (LGK) =	0	kN/m
Distance of line load from wall (X) =	0	mm
Wall load -- live (WQK) =	60	kN/m
Wall load -- Dead (WGK) =	10	kN/m

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 effe

LATERAL FORCES

Ko = 0.40 default Ko = (1-SIN Ø) = 0.58

Kac = 1.26 = $2Ko^{0.5}$

Force (kN)		Lever arm (m)		γ_f	Ultimate Force (kN)
PE =	34.68	LE =	1.164	1.40	48.55
PS(GK) =	0.00	LS =	1.65	1.40	0.00
PS(QK) =	13.20	LS =	1.65	1.60	21.12
PL(GK) =	0.00	LL =	3.30	1.50	0.00
PL(QK) =	0.00	LL =	3.30	1.60	0.00
PW =	26.45	LW =	0.77	1.40	37.03
Total	74.33				106.70

Project	Oakhill Avenue	REINFORCED CONCRETE COUNCIL		
Client	0	Made by	Date	Page 11
Location	Basement Retaining Wall	AS	28-Jan-2020	
	Basement wall design to BS8110:1997, BS8002:1994. BS 8004:19	Checked	Revision	Job No
	Originated from 'RCC01 Basement Wall.xls' v2.1 © 1999-20002 RCA for RCC		-	28373

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

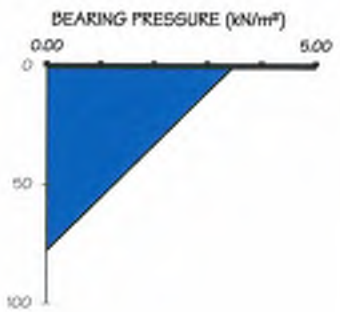
Lateral Force	Force (kN)	Lever arm to base (m)	Base MT. (kNm)	Wall MT. (kNm)	Reaction at Base (kN)	Reaction at Top (kN)	Estimated Elastic Deflection Δ (mm)
PE =	30.93	1.09	-12.90	6.50	24.18	6.75	0.3
PS(GK) =	0.00	1.55	0.00	#DIV/0!	0.00	0.00	0.0
PS(QK) =	12.40	1.55	-4.81	2.70	7.75	4.65	0.1
PL(GK) =	0.00	3.10	0.00	0.00	0.00	0.00	0.0
PL(QK) =	0.00	3.10	0.00	0.00	0.00	0.00	0.0
PW =	22.05	0.70	-8.66	3.15	19.86	2.19	0.1
Total	65.38		-26.36	#DIV/0!	51.80	13.59	0.5

GROUND BEARING FAILURE

LOAD CASE: Wall Load MAX
Surcharge MAX

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

Vertical FORCES (kN)		Lever arm (m	Moment (kNm)
Wall load =	70	2.37	166.2499993
Wall (sw) =	17.40	2.37	41.32
Base =	48.00	0.00	0.00
Earth =	0.00	2.50	0.00
Water =	0.00	2.50	0.00
Surcharge =	0.00	2.50	0.00
Line load =	0.00	2.50	0.00
Σ V =	135.40		Σ Mv = 207.58



MOMENT due to LATERAL FORCES, Mo = -26.36 kNm

RESULTANT MOMENT, M = Mv + Mo = 181.21 kNm

ECCENTRICITY FROM BASE CENTRE, M / V = 1.34 m

MAXIMUM GROSS BEARING PRESSURE = 77.71 kN/m² < 125 OK

SLIDING AT BASE

(using overall factor of safety instead of partial safety fact F.O.S = 1.00

SUM of LATERAL FORCES, P = 51.80 kN

BASE FRICTION, F_b = - (V TANØb + B.Cb) = -63.14 kN

Factor of Safety, F_b / P = 1.22 > 1.00 OK

Project	Oakhill Avenue	REINFORCED CONCRETE COUNCIL		
Client	0			
Location	Basement Retaining Wall	Made by: AS	Date: 28-Jan-2020	Page: 12
	Basement wall design to BS8110:1997, BS8002:1994. BS 8004:1986	Checked: 0	Revision: -	Job No: 28373
	Originated from 'RCC81 Basement Walls.xls' v2.1 © 1999-2002 BCA for RCC			

OUTER BASE (per metre length)

BS8110 reference

γ_f = 1.50 (ASSUMED)

Ult. Shear = 34.27 kN (AT *d* from FACE of WALL)

Ult. MT. = 0.00 kNm TENSION - TOP FACE

BOTTOM REINFORCEMENT :

Min. As =	520	mm^2			Table 3.25
ϕ =	16	mm			
centres =	150	mm	< 725	OK	
As =	1340	mm^2	> 520	OK	

MOMENT of RESISTANCE :

d =	317	mm			
Z =	298	mm			3.4.4.4
As' =	0	mm^2			
Mres =	175.12	kNm	> 0.00	OK	

SHEAR RESISTANCE:

100As/bd =	0.80%				
vc =	0.56	N/mm^2			Table 3.8
Vres =	178.29	kN	> 34.27	OK	3.5.5.2

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

X =	94.72	mm	εm =	-0.0008				BS8007
Acr =	103.87	mm	W =	-0.20	mm	< 0.20	OK	App. B.2

NO CRACKING

INNER BASE (per metre length)

Ult. Shear = -79.77 kN (AT *d* from FACE of WALL)

Ult. MT. = 39.54 kNm TENSION - BOTTOM FACE

BOTTOM REINFORCEMENT :

Min. As =	520	mm^2			Table 3.25
ϕ =	16	mm			
centres =	150	mm	< 725	OK	
As =	1340	mm^2	> 520	OK	

MOMENT of RESISTANCE :

d =	317	mm			
Z =	298	mm			
As' =	0	mm^2			
Mres =	175.12	kNm	> 39.54	OK	3.4.4.4

SHEAR RESISTANCE:

100As/bd =	0.42%				
vc =	0.56	N/mm^2			Table 3.8
Vres =	178.29	kN	> 79.77	OK	3.5.5.2

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

X =	94.72	mm	εm =	-0.0003				BS8007
Acr =	103.87	mm	W =	-0.08	mm	< 0.20	OK	App. B.2

NO CRACKING

REINFORCEMENT SUMMARY for BASE

	Type	ϕ mm	centres mm	As mm^2	Min. As mm^2	
TOP	T	16	150	1340	520	OK
BOTTOM	T	16	150	1340	520	OK
TRANSVERSE	T	16	150	1340	520	OK

PRICE & MYERS

Job No.	28373	Page	13	Rev	
Date	Sept 2020	Eng	AS	Chd	CA
Job	8 Oakhill Avenue				

GROUND FLOOR – CENTRAL COLUMN ADJACENT TO BASEMENT STAIRS

Elenet	Area	dL	LL	DL	LL
Roof	-				
Second	5.5/2 × 7/2 = 9.63	0.75	1.5	7.22	14.5
First	9.63	"	"	7.22	14.5
Self weight steel work	(5.5/2 + 7/2) × 2 + 6	1	–	12.3	–
				26.74	29

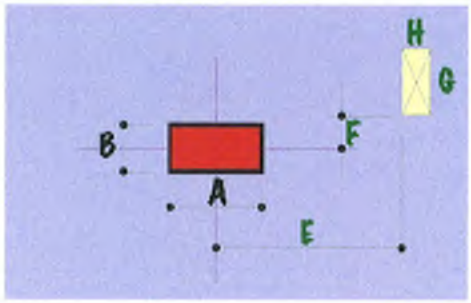
Project	Oakhill Avenue	REINFORCED CONCRETE COUNCIL	PRICE & MYERS
Client	-		Made by: AS | Date: 28-Jan-2020 | Page: 14
Location	Basement Central Column	INTERNAL COLUMN	Checked: | Revision: - | Job No: 28373
	PUNCHING SHEAR to BS8110:1997		
	Originated from RCCTSuite v2.2 on CD	© 1999-2003 BCA for RCC	

MATERIALS

fcu	N/mm²	40	
fyv	N/mm²	460	
link Ø	mm	10	

STATUS
VALID DESIGN

Legend



DIMENSIONS

A	mm	200	E	mm	0
B	mm	800	F	mm	0
G	mm	0	H	mm	0

LOADING

Vt	kN	113	Veff =	kN	113.0
ult UDL	kN/m²	78.80			

SLAB

h	mm	200	dx	mm	152.5	Asx	mm²/m 393
			dy	mm	127.5	Asy	mm²/m 393
			ave d	mm	140	ave As	% 0.283

RESULTS

Veff = 113.0 kN

At col. face, v max = 0.359 N/mm²

vc = 0.6309 N/mm² (Table 3.8)

At 1.5d perimeter, v = 0.1036 N/mm²

At 0d perimeter, v = 0.0308 N/mm²

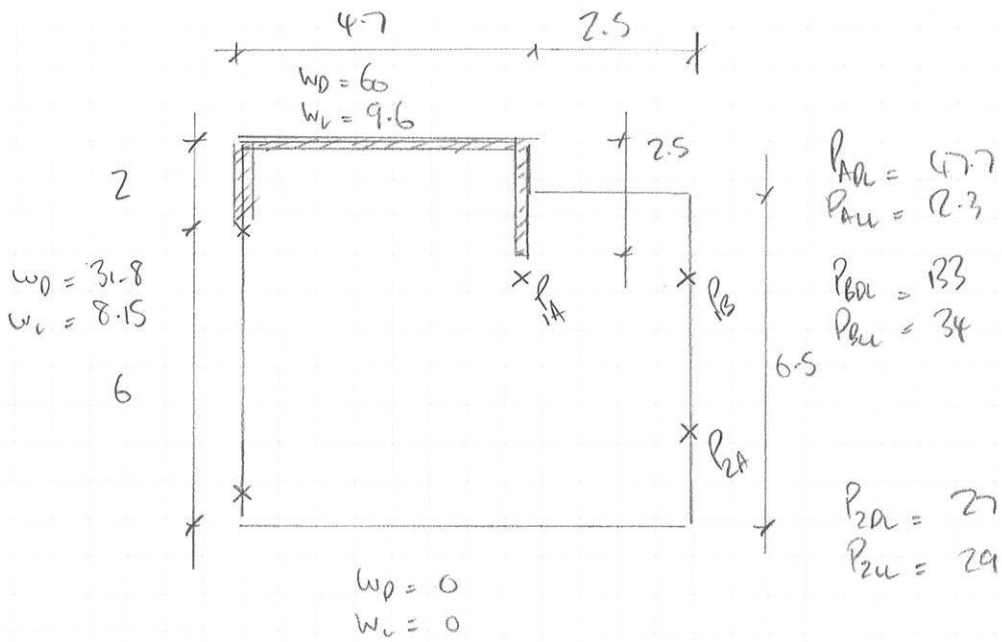
PROVIDE LINKS 0

Links not required

Plan

BASEMENT BUOYANCY

Basement excavation relative to external ground level = 3.3m



Superimposed loads on to basement not including basement & ground floor slab

ΣDL = $60 \times (4.7 + 2 + 2.5)$ = 950.5 kN

$31.8 \times (6)$	
47.7	
133	
27	

ΣLL = $9.6 \times (4.7 + 2 + 2.5)$ = 22.5 kN

$8.15 \times (6)$
12.3
34
29

Water uplift = $3.3 - 1.0 = 2m \times 10\ kN/m^3 = 20\ kN/m^2$

$\times$ Basement Area = $20 \times 53.9 = 1078$ kN

PRICE & MYERS

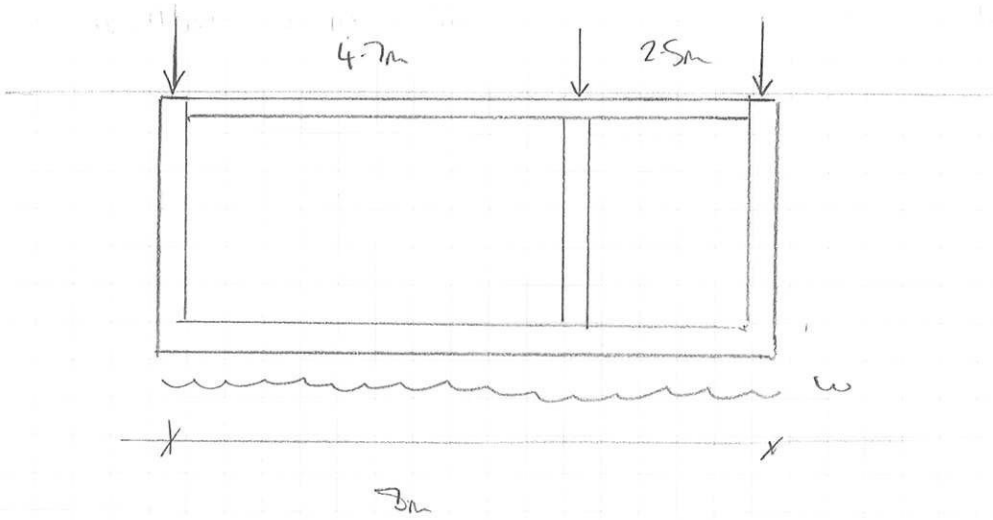
Job No.	28373	Page	16	Rev	
Date	Sept 2020	Eng	AS	Chd	CA
Job	8 Oakhill Avenue				

Resistance to uplift

Ground slab	$(4.7 \times 8) + (2.5 \times 6.5) = 53.9\ m^2$	7.81	2.5	421	134.8
Basement Slab	$53.9\ m^2$	12.81	2.5	421	134.8
Basement walls	$(4.7 + 2.5 + 1.5 + 6.5 + 7.2 + 8) \times 3 = 91.2$	7.5	-	684	-
				1526	270

1078 << 1526 (+950.5) ∴ OKAY

BASEMENT SLAB



$\Sigma DL = 1526 + 950 = 2476$

$\Sigma LL = 270 + 212 = 482$

$w_{DL} = \frac{2476}{53.9} = 46 \text{ kN/m}^2$

$w_{LL} = \frac{482}{53.9} = 9 \text{ kN/m}^2$

} Loads approximated as UDL spread across basement footprint

Check basement slab as flat slab, see spreadsheet over.

Use 400 THK

with H16's @ 200 CTRS / 100 CTRS over column hogging locations

Project	8 Oakhill Avenue		REINFORCED CONCRETE COUNCIL		
Client	N/A		Made by: AS	Date: 28-Jan-20	Page: 18
Location	Basement Floor Slab from grids 1 to 2		Checked: -	Revision: -	Job No: 28373
	FLAT SLAB ANALYSIS & DESIGN to BS 8110:1997				
	Originated from RCC35.xls v2.2 on CD	© 1999-2003 BCA for RCC			

MATERIALS

fcu	32	N/mm²	h agg	20	mm
fyl	460	N/mm²	γs	1.05	steel
fyv	460	N/mm²	γc	1.50	concrete

COVERS

	mm	TO LAYER
Top cover	75	1
Btm cover	50	1

SPANS

	L (m)
SPAN 1	4.700
SPAN 2	2.700
SPAN 3	
SPAN 4	
SPAN 5	
SPAN 6	

GEOMETRY

Bay type	EDGE	
Slab depth, h	400	mm
Edge Panel width, b	1000	mm
Edge distance	300	mm to C/L
End distance	300	from supt 1
End distance	300	from supt 3

PERIMETER LOADS *characteristic*

kN/m outside supports 1 & 3

kN/m along bay edge

LOADING PATTERN

	min	max
DEAD	1.0	1.4
IMPOSED		1.6

SUPPORTS

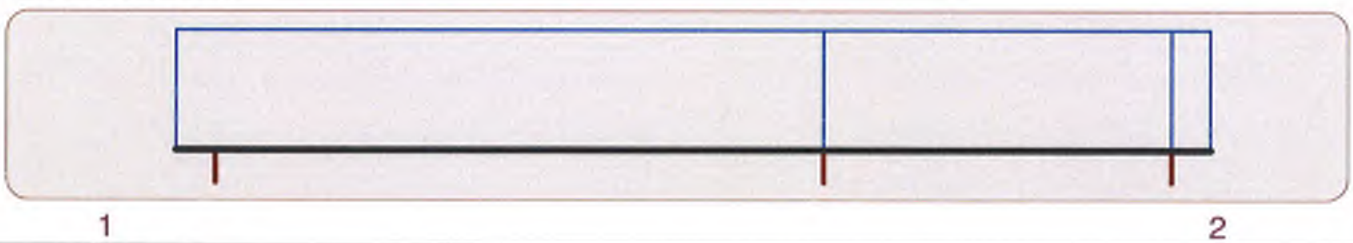
	ABOVE (m)	H (mm)	B (mm)	End Cond	BELOW (m)	H (mm)	B (mm)	End Cond
Support 1					1	200	800	E
Support 2					1	200	800	E
Support 3					1	200	800	E
Support 4								
Support 5								
Support 6								
Support 7								

LOADING *UDLs (kN/m²) PLs (kN/m) Position (m)*

	Dead Load	Imposed Load	Position from left	Loaded Length
Span 1				
UDL	46.00	9.00	~~~~~	~~~~~
PL 1				~~~~~
PL 2				~~~~~
Part UDL				
Span 2				
UDL	46.00	9.00	~~~~~	~~~~~
PL 1				~~~~~
PL 2				~~~~~
Part UDL				
Span 3				
UDL			~~~~~	~~~~~
PL 1				~~~~~
PL 2				~~~~~
Part UDL				

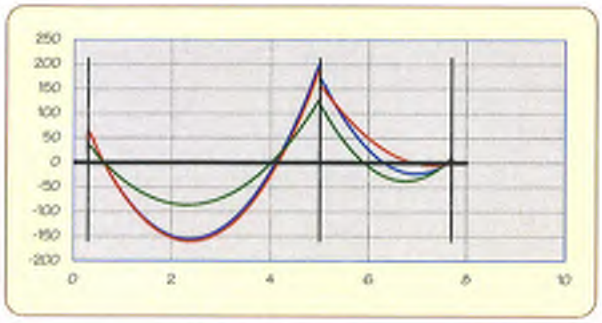
	Dead Load	Imposed Load	Position from left	Loaded Length
Span 4				
UDL			~~~~~	~~~~~
PL 1				~~~~~
PL 2				~~~~~
Part UDL				
Span 5				
UDL			~~~~~	~~~~~
PL 1				~~~~~
PL 2				~~~~~
Part UDL				
Span 6				
UDL			~~~~~	~~~~~
PL 1				~~~~~
PL 2				~~~~~
Part UDL				

LOADING DIAGRAM

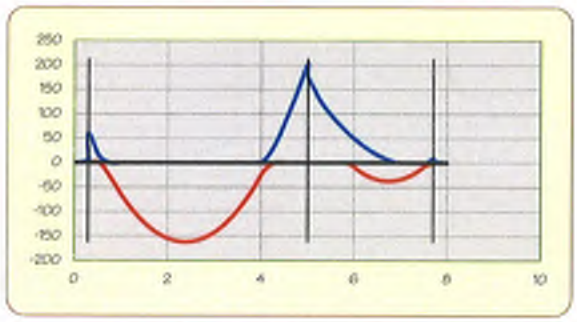


Project	8 Oakhill Avenue	REINFORCED CONCRETE COUNCIL		
Client	N/A	Made by: AS	Date: 28-Jan-20	Page: 19
Location	Basement Floor Slab, from grids 1 to 2	Checked: -	Revision: -	Job No: 28373
	FLAT SLAB ANALYSIS & DESIGN to BS 8110:1997			

BENDING MOMENT DIAGRAMS (kNm)



Elastic Moments

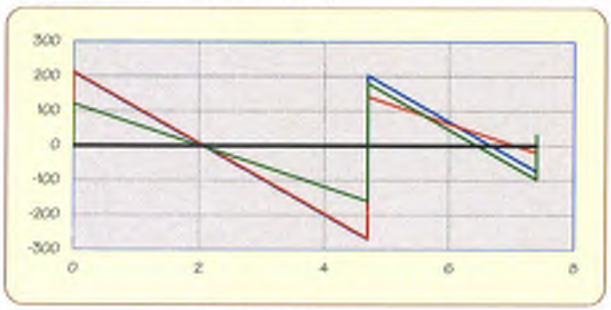


Redistributed Envelope

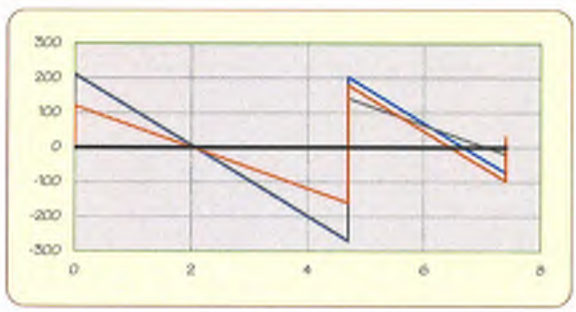
SUPPORT No	1	2	3				
Elastic M	62.8	201.9	9.3	~	~	~	~
Redistributed M	59.6	201.9	8.9	~	~	~	~
βb	0.950	1.000	0.950	~	~	~	~
Redistribution	5.0%		5.0%				
End support reinf. Ø mm	12		12				

SPAN No	1	2				
Elastic M	159.8	36.8	~	~	~	~
Redistributed M	161.5	37.1	~	~	~	~
βb	1.011	1.008	~	~	~	~

SHEARS FORCE DIAGRAMS (kN)



Elastic Shears



Redistributed Shears

SPAN No	1		2			
Elastic V	213.5	270.4	202.5	97.2	~	~
Redistributed V	212.9	271.0	202.5	97.0	~	~

SPAN No						
Elastic V	~	~	~	~	~	~
Redistributed V	~	~	~	~	~	~

REACTIONS (kN)

SUPPORT	1	2	3
ALL SPANS LOADED	241.2	473.5	104.9
ODD SPANS LOADED	243.6	409.9	38.1
EVEN SPANS LOADED	138.6	339.9	127.7
Veff for punching	304.5	613.5	159.7
Characteristic Dead	141.1	276.1	61.2
Characteristic Imposed	28.8	54.4	26.3

COLUMN MOMENTS (kNm)		1	2	3
ALL SPANS LOADED	Above			
	Below	57.6	-24.0	0.0
ODD SPANS LOADED	Above			
	Below	60.1	-29.2	6.6
EVEN SPANS LOADED	Above			
	Below	31.2	-8.7	-6.6

Project	Oakhill Avenue	REINFORCED CONCRETE COUNCIL	PRICE & MYERS		
Client	-		Made by: AS	Date: 28-Jan-2020	Page: 20
Location	Basement Central Column	INTERNAL	Checked:	Revision: -	Job No: 28373
	PUNCHING SHEAR to BS8110:1997	COLUMN			
	Originated from RCC13.xls v2.2 on CD	© 1999-2003 BCA for RCC			

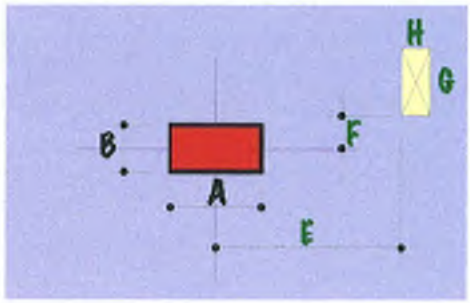
MATERIALS

fcu	N/mm²	40	
fyv	N/mm²	460	
link Ø	mm	10	

STATUS

VALID DESIGN

Legend



DIMENSIONS

A	mm	200	E	mm	0
B	mm	800	F	mm	0
G	mm	0	H	mm	0

LOADING

Vt	kN	700	Veff =	kN	700.0
ult UDL	kN/m²	78.80			

SLAB

h	mm	400	dx	mm	352.5	Asx	mm²/m 1508
			dy	mm	327.5	Asy	mm²/m 1508
			ave d	mm	340	ave As	% 0.444

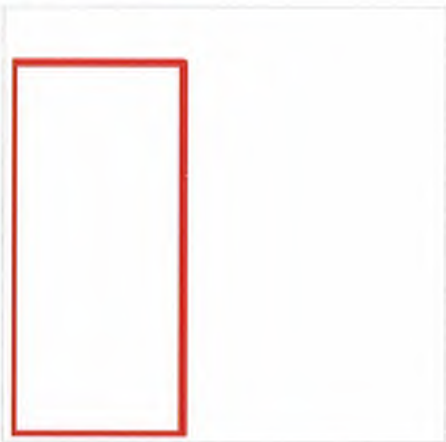
RESULTS

Veff =	700.0	kN	vc =	0.5874	N/mm² (Table 3.8)
At col. face, v max =	1.011	N/mm²	At 1.5d perimeter, v =	0.2540	N/mm²
			At 0d perimeter, v =	0.1385	N/mm²

PROVIDE LINKS 0

Links not required

Plan



Reference from Section 4.0 of Campbell Reith Audit Report D1	Reference from Section 4.0 of Campbell Reith Audit Report D2	Campbell Reith Comment	GEA Comment / Response
4.5	4.5	A utility search is not provided and it is required	Before the commence of the sitework, we carried out a utility search, which we can include in our report.
4.12	4.11	The BIA has identified that Made Ground was encountered up to 1.50m bgl. The Claygate Member was encountered to 7.50m bgl and the London Clay was proven to a depth of 15.00m bgl. Ground water was struck between 1.00 and 9.80m bgl and monitored between 0.70 and 4.90m bgl. The BIA describes the Claygate Member as firm to stiff clay, however, reference to the exploratory hole records indicates it to be soft to firm to at least 3.00m bgl with a triaxial test result at 5m bgl also indicating it to be soft to firm. The formation level for the basement is anticipated to be at 3.50m bgl, consequently the strength of the bearing stratum requires confirmation.	In Borehole No 1 groundwater was struck at 5.40 m (3.48 m TBM) and after 20 mins rose to 5.30 m (3.58 m TBM). Then the water was sealed out by the casing and groundwater struck again at 10.00 m (-1.12 m TBM), which rose to 9.80 m (-0.92 m TBM). In WS1, the Claygate Member is described as soft, but this is considered to be due to the presence of water. The strata was initially soft and with depth became firm to stiff. As discussed in Section 5.4 of our report, the depths related to WS3 are not accurate due to faulty installation of the cover cap.
4.13	4.12	The GMA provides a design bearing resistance of the Claygate Member of 125kPa. Noting the comments above about soil strength, this should be justified.	Based on the results of the triaxial testing at depths of 3.00 m and 5.00 m, an average cohesion of 58 kPa was used in order to calculate the bearing pressure. Using Skempton's equation and assuming a strip foundation of 1 m width, 3.50 m depth and a Nc value of 7.5, the bearing capacity was calculated to be 125Kpa.
4.15	4.14	A ground movement assessment has been undertaken within and surrounding the excavation using X-Disp and P-Disp with P-Disp ground movement imported into X-Disp. The assessment has determined that ground movements will not affect the structural integrity of neighbouring buildings with a Burland damage scale category of not more than 1 (very slight) determined. However, it is considered that this is likely to underestimate vertical movements as it does not include settlement resulting from the ground yielding into the excavation, nor construction related settlement such as the shrinking of the drypack. Additionally the stiffness values adopted for the Claygate member are at the upper range of what might be expected and are not moderately conservative as required by the planning guidance.	It is unclear how the conclusion that the analysis does not include movements as a result of installation effects and deflection of the walls during excavation has been arrived at, given that the report clearly outlines how the X-Disp analysis has been undertaken adopting the CIRIA curves for the 'installation of a planar diaphragm wall' and 'excavation of a stiff wall in clay', which, in the absence of specific curves for underpinning, are well established and accepted methods of determining the likely vertical and horizontal movements for a basement constructed using underpinning techniques. Additionally, as vertical movements on the underpinning have also been imported from P-Disp, the analysis actually includes additional vertical movements than would be calculated by using X-Disp alone. The stiffness values adopted are based on the strength profile identified during the investigation, which typically comprised firm becoming stiff soils of the Claygate Member and underlying London Clay as further discussed in the responses above. The relationship used to estimate the stiffness values is consistent with that adopted on many recent projects in Camden and is considered entirely suitable for projects of this size and nature, where the degree of loading / unloading and resultant strains are relatively small.
4.16	4.15	Ground movements have been determined during underpinning installation (Stage 1), excavation (Stage 2), basement slab construction (Stage 3), and for the long term (Stage 4) total ground movements. It should be clarified whether these movements are cumulative and what ground movements have been adopted to derive the damage category.	The movements at each stage are cumulative (the progression of which is clearly shown by the output contour plots included in the appendix for each stage of the analysis) with the final stage representing the total (short- + long-term) movements that will occur as a result of all the stages; these movements should not therefore be added together in an attempt to reach a total. For example, during the first stage approximately 1.5 mm of horizontal deflection is predicted around the main excavation, as a result if installation the proposed underpinning. This increases during Stage 2, to a value of between 4 mm and 5 mm, due to an additional 2.5 mm to 3.5 mm of deflection from excavation movements. As no further excavation takes place during Stage 3, the horizontal movements remain unchanged during this stage and thus represent the total horizontal that will occur, as outlined by the results reported in Stage 4. The progression of the vertical movements is more complicated due to the interplay between downward settlement as a result of installation effects, wall deflection during installation and loading of the proposed underpinning and raft foundations, set against the upward (heave) movements from the bulk excavations; there is therefore a small amount of recovery of some of the previous short-term settlement on the underpinning between Stages 1 and 2, before increasing again following loading of the proposed raft foundation. Damage assessments have been carried out at each stage, to allow the most critical stage for any given structure to be identified and the tabular results for each assessment are included in the appendix. As per Section 11.2, the majority of the results for each of the nearby structures for each stage fall within Category 0, with a single elevation of No 6 Oakhill Avenue falling into Category 1, the results of which are highlighted within the report to demonstrate how the damage category for this

			structure progresses through the development and identify the most critical stage.
4.17	4.16	The site is located on a slope and a comment should be provided on how impacts to slope stability will be mitigated.	Although the Camden Geological, Hydrogeological and Hydrological Study Slope Angle Map shows that the area of land to the rear of the site, which is currently occupied by houses fronting onto Heath Drive, has a slope angle greater than 7°, the overall slope angle of the site itself is less than 7°. Based on the drawings provided by Price & Myers, the proposed basement is located at the middle of the site at a level approximately similar with the existing house and the back garden. The site is detached with low vertical retaining walls and therefore it is not likely there is a slope instability.
4.20	4.19	The development is remote from the Hampstead Heath Pond chain or other pond catchment areas. The site is close to a tributary of the "lost" River Westbourne and a spring line. The basement will be founding within the Claygate Member, a Secondary A Aquifer. The BIA states that the Claygate Member does not support significant volumes of water. However there are discrepancies in the details of groundwater monitoring installations and a third round of monitoring is absent from the report and should be provided. Further discussion should also be provided for the groundwater observations observed in BH1. Clarification is required to confirm whether the basement will impact on subterranean flows.	The latest report we issued to Price & Myers on 6th March 2020 included the third round of groundwater monitoring. During the third monitoring visit, Borehole No 1 was not accessible and based on the two previous visits, groundwater was found to be at depths between 3.80 m (5.08 m TBM) and 4.90 m (3.98 m TBM). During drilling Borehole No 1, groundwater struck at 5.40 m (3.48 m TBM) and after 20 mins rose to 5.30 m (3.58 m TBM). Then the borehole was sealed and groundwater struck again at 10.00 m (-1.12 m TBM), which rose to 9.80 m (-0.92 m TBM). Based on the monitoring results we don't consider that the basement construction will affect the subterranean flow, since groundwater was found below the formation level of the basement. Any groundwater encountered during the excavation is likely to be restricted to shallow inflows of perched water from within the made ground.

London

15 Bermondsey Square
London
SE1 3UN

T: +44 (0)20 7340 1700
E: london@campbellreith.com

Birmingham

Chantry House
High Street, Coleshill
Birmingham B46 3BP

T: +44 (0)1675 467 484
E: birmingham@campbellreith.com

Surrey

Raven House
29 Linkfield Lane, Redhill
Surrey RH1 1SS

T: +44 (0)1737 784 500
E: surrey@campbellreith.com

Manchester

No. 1 Marsden Street
Manchester
M2 1HW

T: +44 (0)161 819 3060
E: manchester@campbellreith.com

Bristol

Wessex House
Pixash Lane, Keynsham
Bristol BS31 1TP

T: +44 (0)117 916 1066
E: bristol@campbellreith.com