RIDGE

5010022
EA BOVENEY LOCK HOUSE – WALL REMOVAL
ENVIRONMENT AGENCY
1 November 2019

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ENVIRONMENT AGENCY

1 November 2019

Prepared for

Environment Agency
Kings Meadow House,
Kings Meadow Road,
Reading,
RG1 8DQ

Prepared by

Ridge and Partners LLP
The Cowyards,
Blenheim Park,
Oxford Road,
Woodstock,
OX20 1QR
Tel: 01993 815 098

Contact

Jesse Morris
Structural Engineer
JWMorris@Ridge.co.uk

VERSION CONTROL

VERSION	DATE	DESCRIPTION	CREATED BY	REVIEWED BY
1.0	31.10.2019	Initial Issue	JM	JFB/TW

CONTENTS

1. INTRODUCTION

This report has been prepared at the request of the Environment Agency to comment on the proposed wall removal in the Boveney Lock House, Dorney, Winsor, SL4 6QQ. The wall, marked on a Drawing No. 5008885-RDG-XX-00-PL-B-0001, separates the kitchen from a lobby area.

Boveney Lock House is owned and managed by the Environment Agency.

This report is based on findings from a site survey carried out on 16/10/19 by Jesse Morris, Structural Engineer for Ridge and Partners LLP, the following aspects were inspected:

- Confirmation of the structural form of the building
- Lifting of carpet & floorboards in bedroom 3 to determine joist size and spacing
- Trial pit on external wall foundation to determine form, size and bearing strata
- Removal of brick to determine external wall build-up
- Confirmation of dimensions
- Further information gathered to complete required calculations

Any conclusions contained in this report are based upon visual inspection of the property. We have not carried out any specialist testing or inspected other parts of the construction which are covered, unexposed or inaccessible, including the foundations, and we are therefore unable to report that any such part is free from defect. Therefore, no responsibility can be accepted for any hidden, latent or inherent defect which a more detailed examination might reveal.

This report is limited to those items outlined above and is for the sole use of the client and no responsibility is accepted or implied for any other parties.

2. STRUCTURAL DESCRIPTION

- Boveney Lock House is a two storey, three-bedroom detached house, from historical construction drawings it is estimated that the structure was erected circa 1900 and an extension was constructed in 1970.

- The building is located on Boveney Lock Island on the River Thames. The front elevation faces roughly north. The property's address is:

  Boveney Lock House,
  Boveney Lock,
  Dorney,
  Windsor,
  SL4 6QQ

- The structural form of the building is load bearing masonry and a timber roof structure clad with tiles, the extension has a concrete ground bearing slab.

- Drawings of the original structure and extension can be found in Appendix A.

3. OBSERVATIONS

Refer to survey notes in Appendix B

- The structural form of the building was confirmed by visual inspection as to be load bearing masonry as expected and detailed in the historic drawings supplied by the Environment Agency.

- Floor joists in bedroom 3 were found to be 50x230mm sections (width: 50mm, depth 230mm) at approximately 365mm centres, this spacing was found to be greater than the 12' (305mm) spacing indicated in the drawings. No stamp or marks could be seen indicating the strength grade of the timber.

- The trial pit revealed the foundations were concrete mass fill foundations, protruding 90mm from the wall base (total width approx. 450mm) and had a depth of 640mm. a drainage pipe was also uncovered running beneath the foundation.

- Removal of one of the bricks in the extension wall allowed the external wall build-up of the extension to be confirmed, this was found to be 270mm thick brick and block masonry wall (102.5mm brick, 70mm void, 100mm block), as per the historical drawings supplied. Although the drawings show that the wall to be removed has the same build-up as the external cavity wall, onsite this was found to be a single skin brick wall.

- Room dimensions and joist spans (existing and new) were confirmed as approximately 3.4m (Kitchen) & 1m (Store & Lobby) existing.

4. CONCLUSIONS

Structural calculations can be found in Appendix C.

- The joists were checked over the new span, the calculation was carried out conservatively assuming timber grade C16 as the grade could not be determined on site. The critical check was found to be deflection of the floor joists, the analysis found that the increase in span results in deflections of 14.9mm, <L/250 as per BS EN 1995-1-1:2004 Table NA.5.

- A load takedown has been completed to assess the percentage increase in the foundation load on the East elevation of the extension, the increase was found to be approximately 6% which is deemed acceptable.

- Finally, the external masonry wall has been checked for lateral loads to assess the effect of removing the support provided from the internal wall that is to be removed. This was found to pass with a utilisation ratio of 0.842 (84.2%).

5. RECOMMENDATIONS

- The existing first floor joists above the ground floor kitchen area are suitable for the increased span upon removal of the highlighted wall (Appendix A), therefore safe removal of the wall is possible without significant risk to tenants, public or the structure itself.

- No further structural works are deemed necessary.

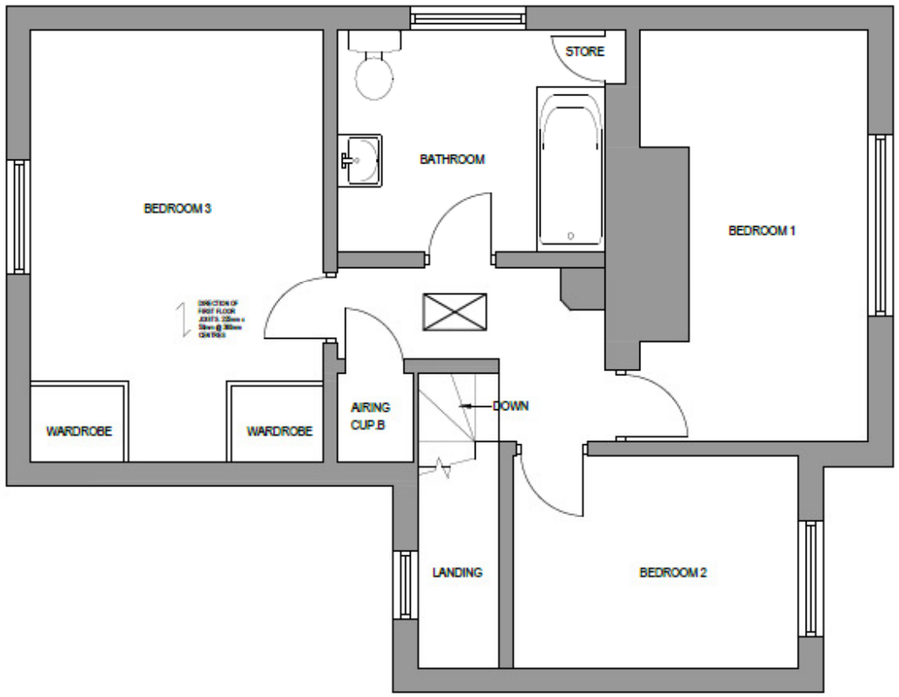
Report Prepared By:

Jesse Morris, BEng, MSc
Structural Engineer
For Ridge and Partners LLP

Report Reviewed by:

Julian Bayley, BSc (Hons)
Structural Engineer
For Ridge and Partners LLP

APPENDIX A: FLOOR PLANS & DRAWINGS



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REV	DESCRIPTION	DATE	BY	CHKD
-	-	00/00/15	XX	XX

ORIGINATOR:

RIDGE

BEAUMONT HOUSE
59 HIGH STREET
THEALE
READING, RG7 5AL

TEL: 0118 932 3088
WWW.RIDGE.CO.UK

CLIENT:
ENVIRONMENT AGENCY

CONTRACTOR CLIENT:

PROJECT:
BOVENEY LOCK HOUSE

TITLE:
FIRST FLOOR PLAN

DRAWN BY:	PH	SCALE: 1:50 @ A3	
CHECKED BY:	SB	DATE:	17/04/2019

STATUS:
INFORMATION

DRAWING No:

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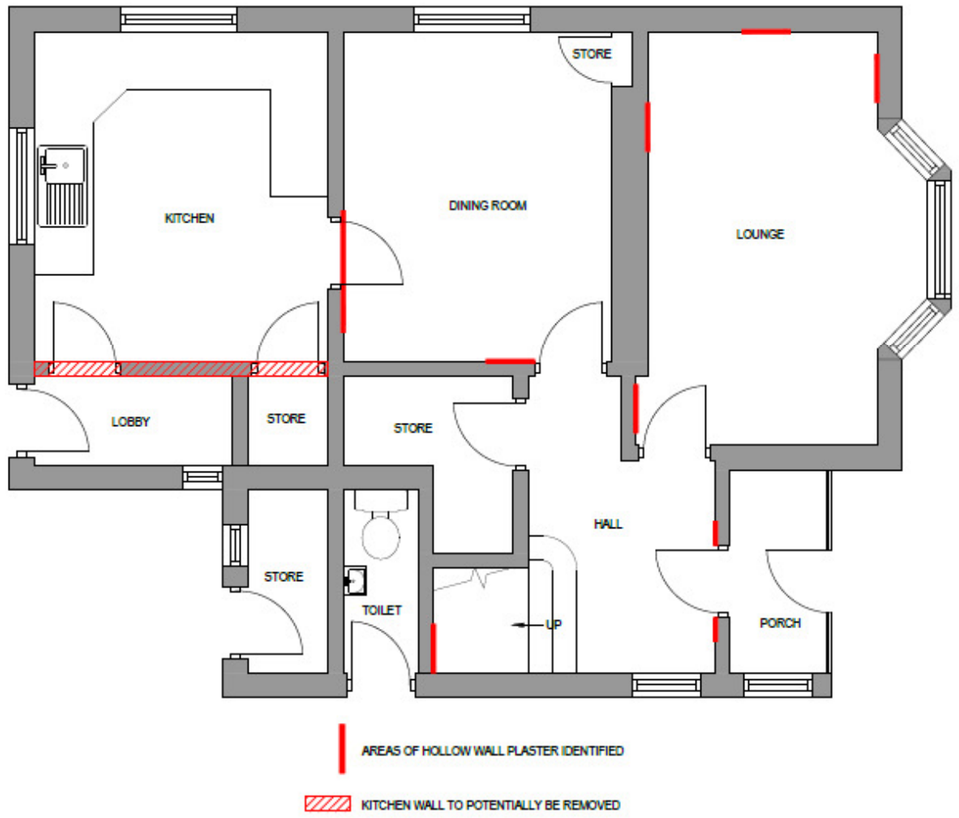

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DRAWING NOTES:

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REV	DESCRIPTION	DATE	BY	CHKD
-	-	00/00/15	XX	XX

ORIGINATOR:

RIDGE

PROPERTY & CONSTRUCTION SOLUTIONS

BEAUMONT HOUSE
59 HIGH STREET
THEALE
READING, RG7 5AL

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WWW.RIDGE.CO.UK

CLIENT:
ENVIRONMENT AGENCY

CONTRACTOR CLIENT:

PROJECT:
BOVENEY LOCK HOUSE

TITLE:
GROUND FLOOR PLAN

DRAWN BY:	PH	SCALE: 1:50 @	A3
CHECKED BY:	SB	DATE:	17/04/2019

STATUS:
INFORMATION

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5008885	RDG	XX	00	PL	B	0001	-

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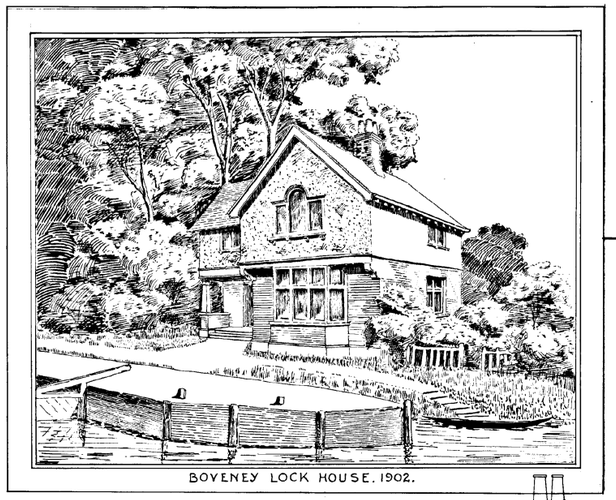
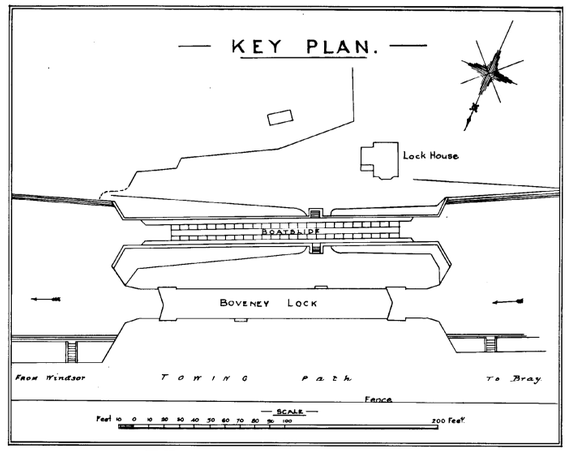
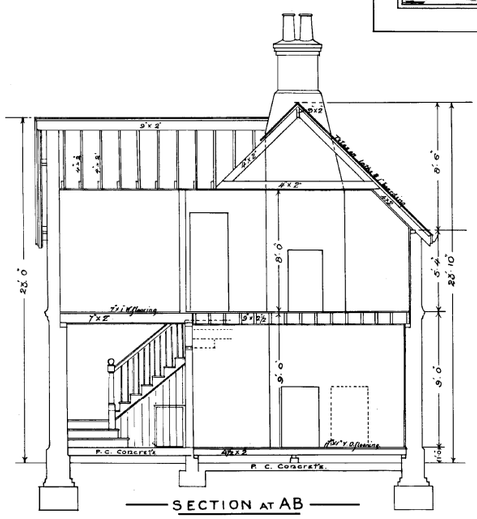
SCALE 1:50 m

BOVENEY
LOCK HOUSE
June 1902



BOVENEY LOCK HOUSE. 1902.





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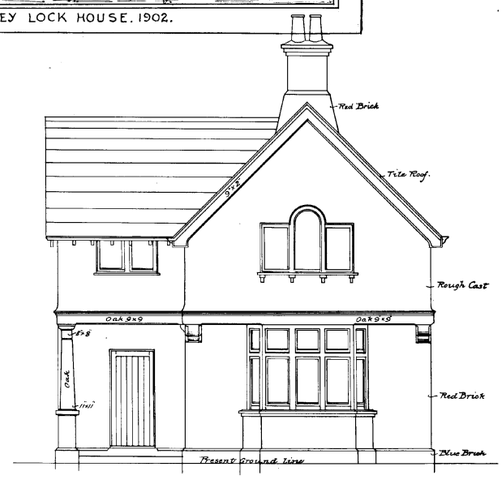

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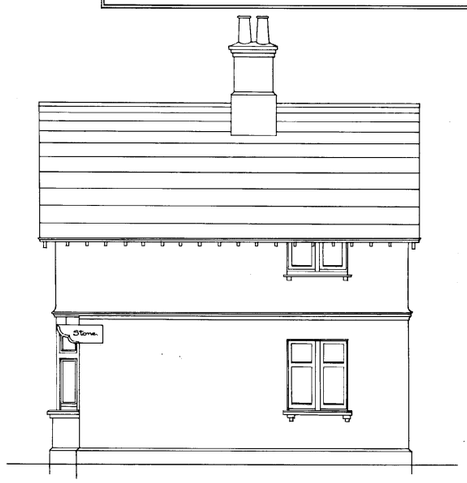
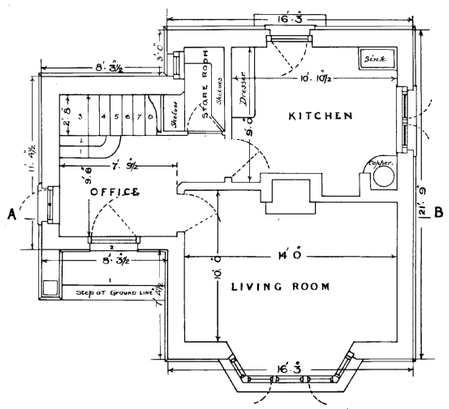


SIDE ELEVATION

SIDE ELEVATION



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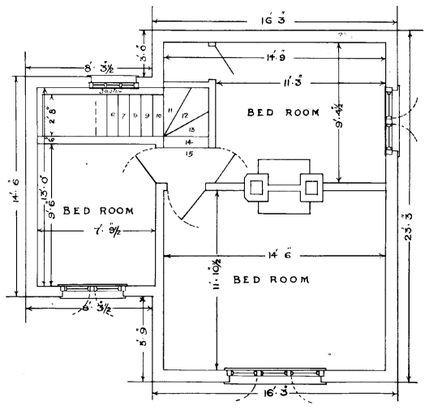

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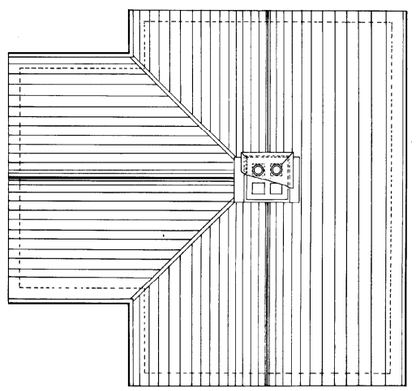

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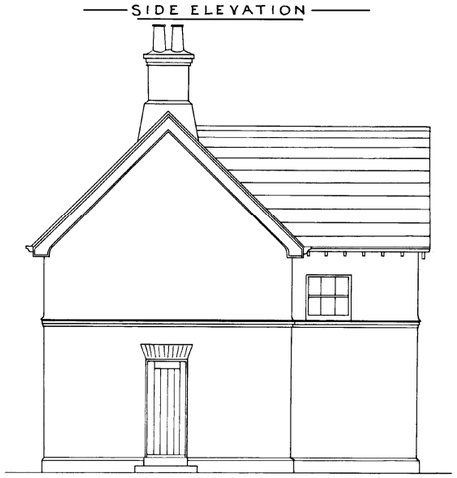

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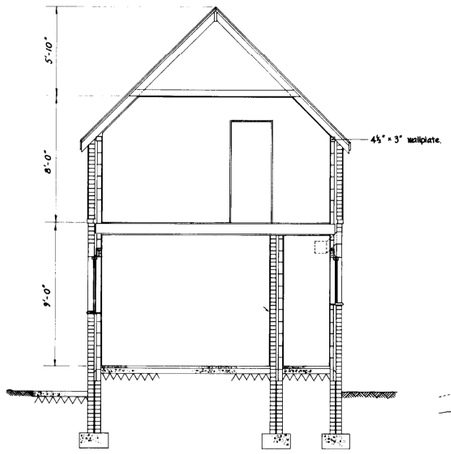

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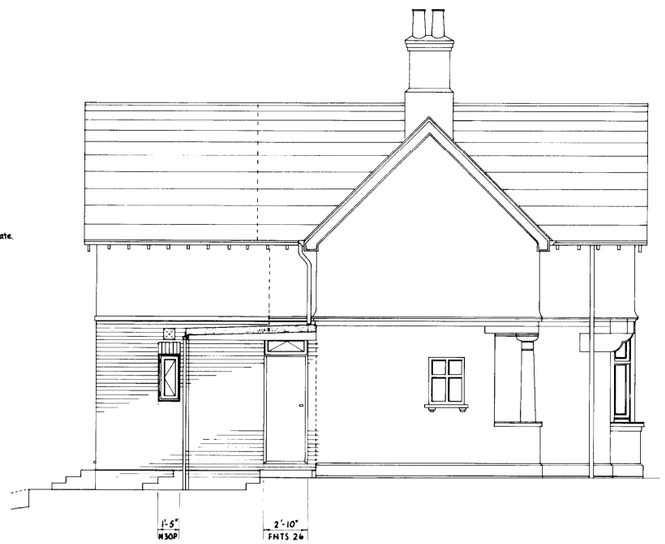

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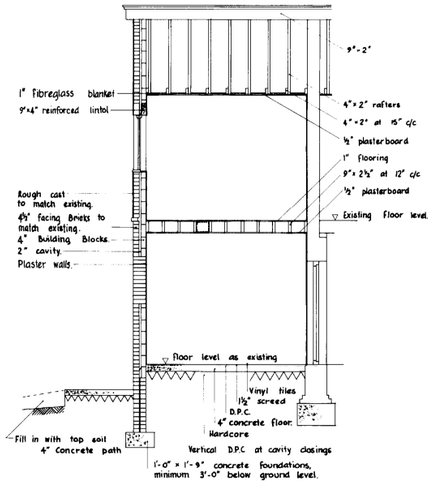

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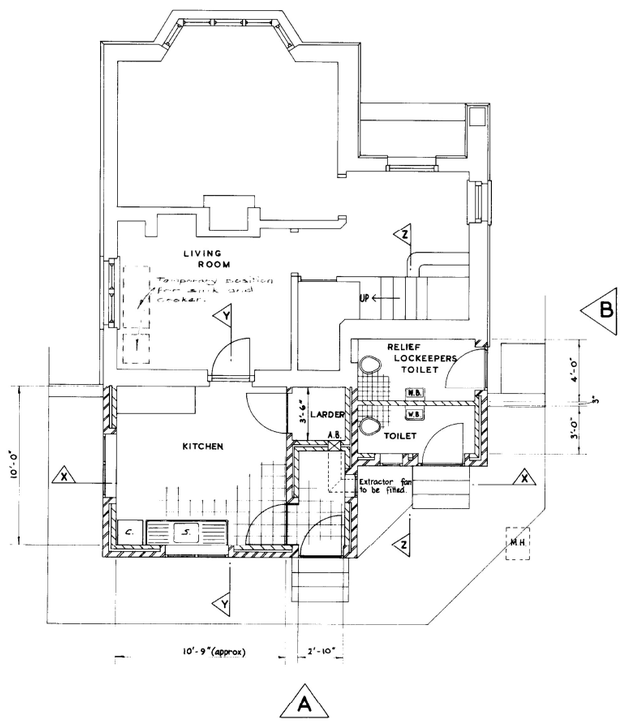

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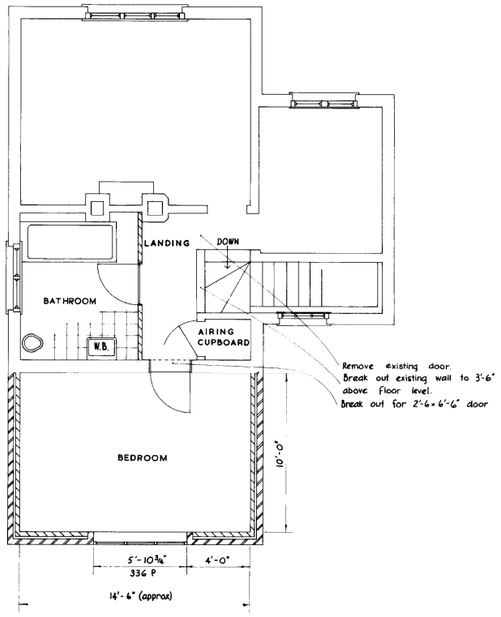

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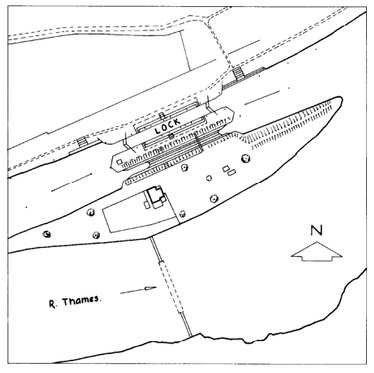

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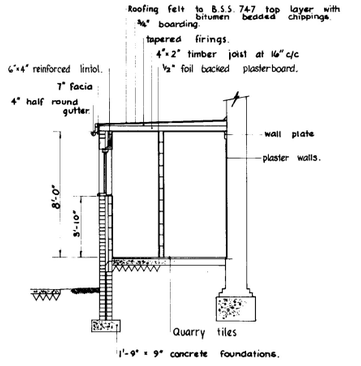


SECTION Z-Z

Note :-
The codes for B.S.S. windows and doors refer to those shown in Boulton and Paul standard joinery catalogue S.F.B.(31) U.D.C. 69. 028.2.

THAMES CONSERVANCY

BOVENEY LOCK HOUSE.

PROPOSED GROUND & FIRST FLOOR EXTENSION

Original frame size 960 x 667 mm 0 10 0mm

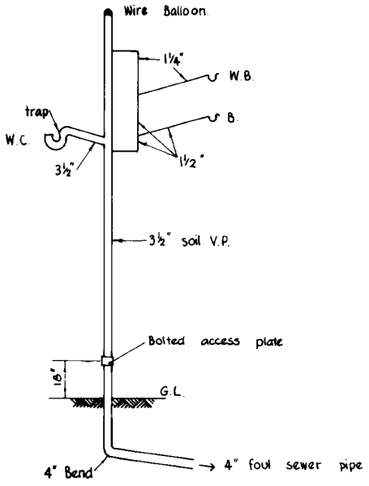
File

Amendments.
a Details included to conform to bye-laws.

Designed	E. J. BRETTELL. M.A. F.I.C.E. A.M.I.W.E. CHIEF ENGINEER.	Scale ½" TO 1 FOOT ¼ 1/1250
Drawn B.P.Woods.		
Checked	Date MAY 1970	Drg No 10 496/1

10 496/1

10 496/2



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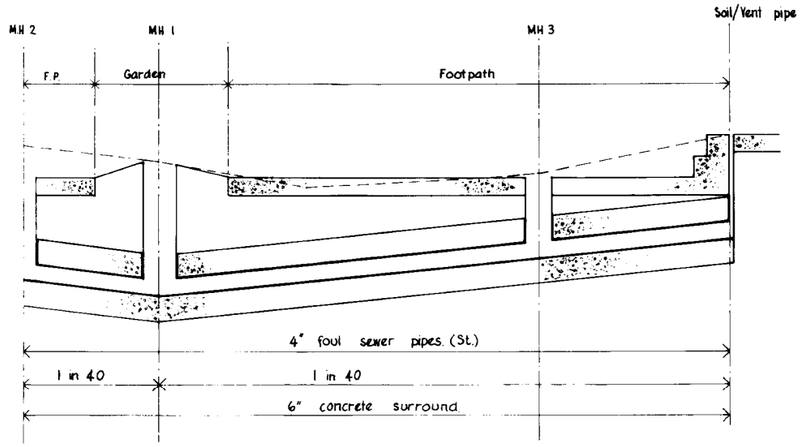

Datum 73·13 (N)

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horizontal ⅛" = 1 ft

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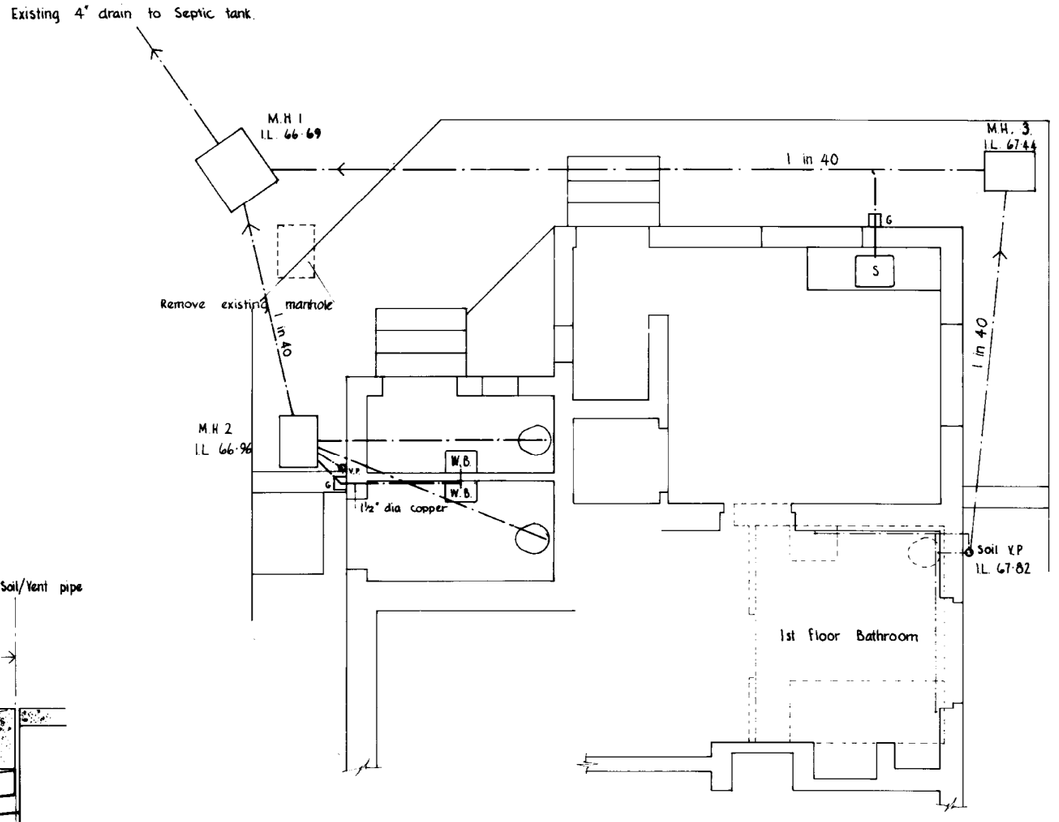


PLAN

THAMES CONSERVANCY

BOVENEY LOCK HOUSE

DETAILS OF DRAINAGE

Original frame size 960 × 667 mm

0 100mm

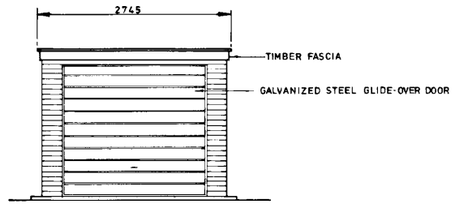
File

Amendments

Designed B.P.W.	E. J. BRETTELL. M.A. F.I.C.E.. A.M.I.W.E.. CHIEF ENGINEER.	Scales ¼ INCH TO 1 FOOT
Drawn B.P.W.		
Checked K.L.	Date JUNE 1970	Drg No. 10 496/2

GARAGE WALLS CONSTRUCTED FROM
PRESSED CONCRETE PANELS WITH
PLAIN BRICK FINISH
(BANBURY GARAGE 'SUSSEX' MODEL)

SIDE ELEVATION



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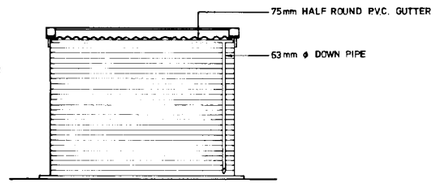

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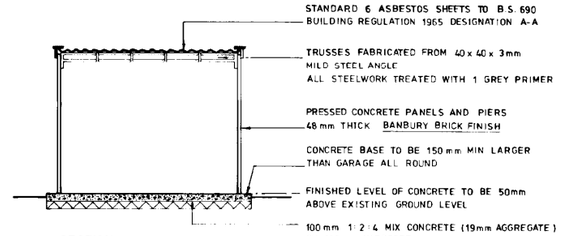

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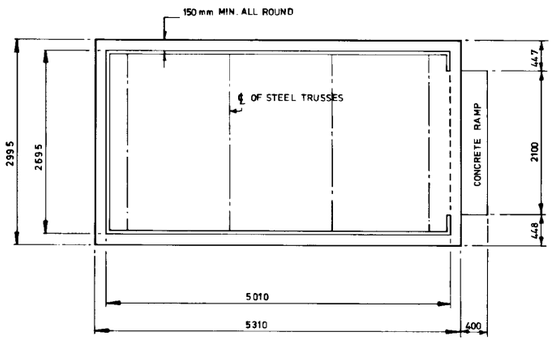

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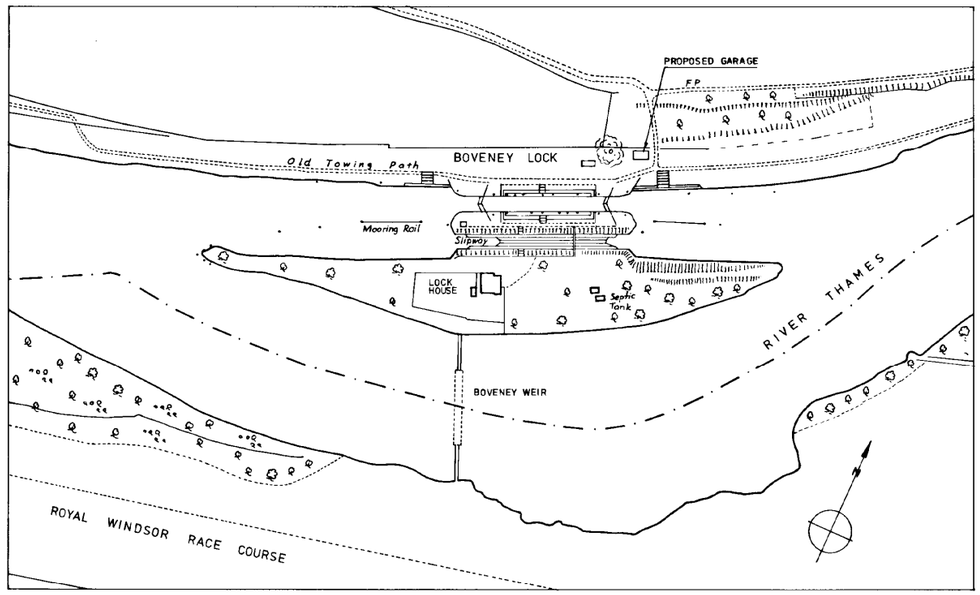

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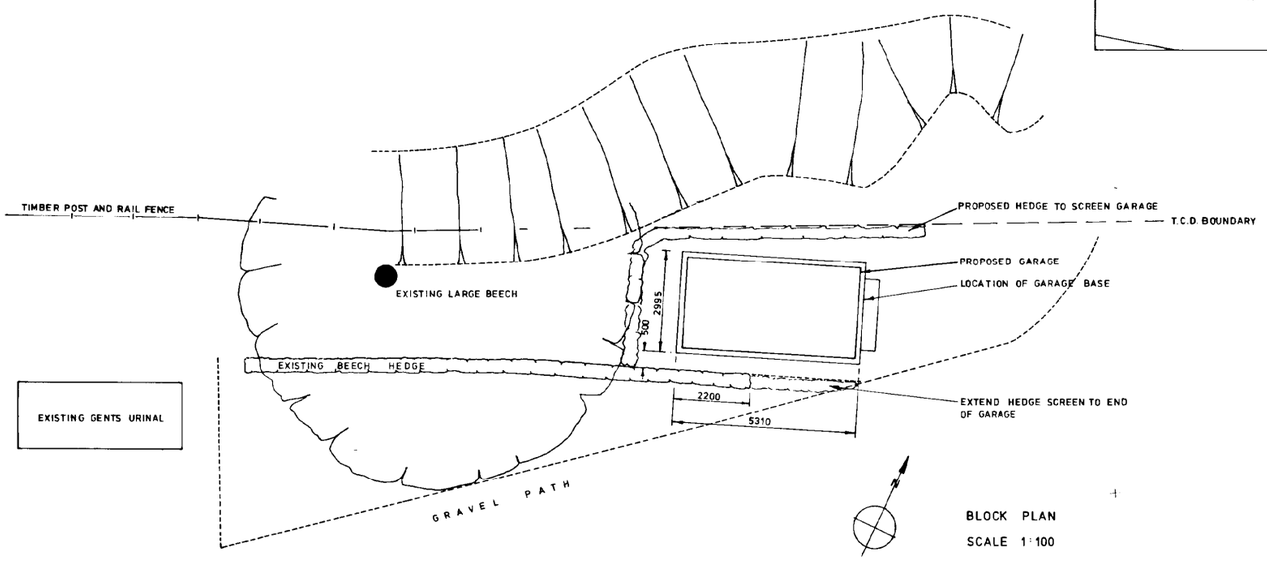

BLOCK PLAN
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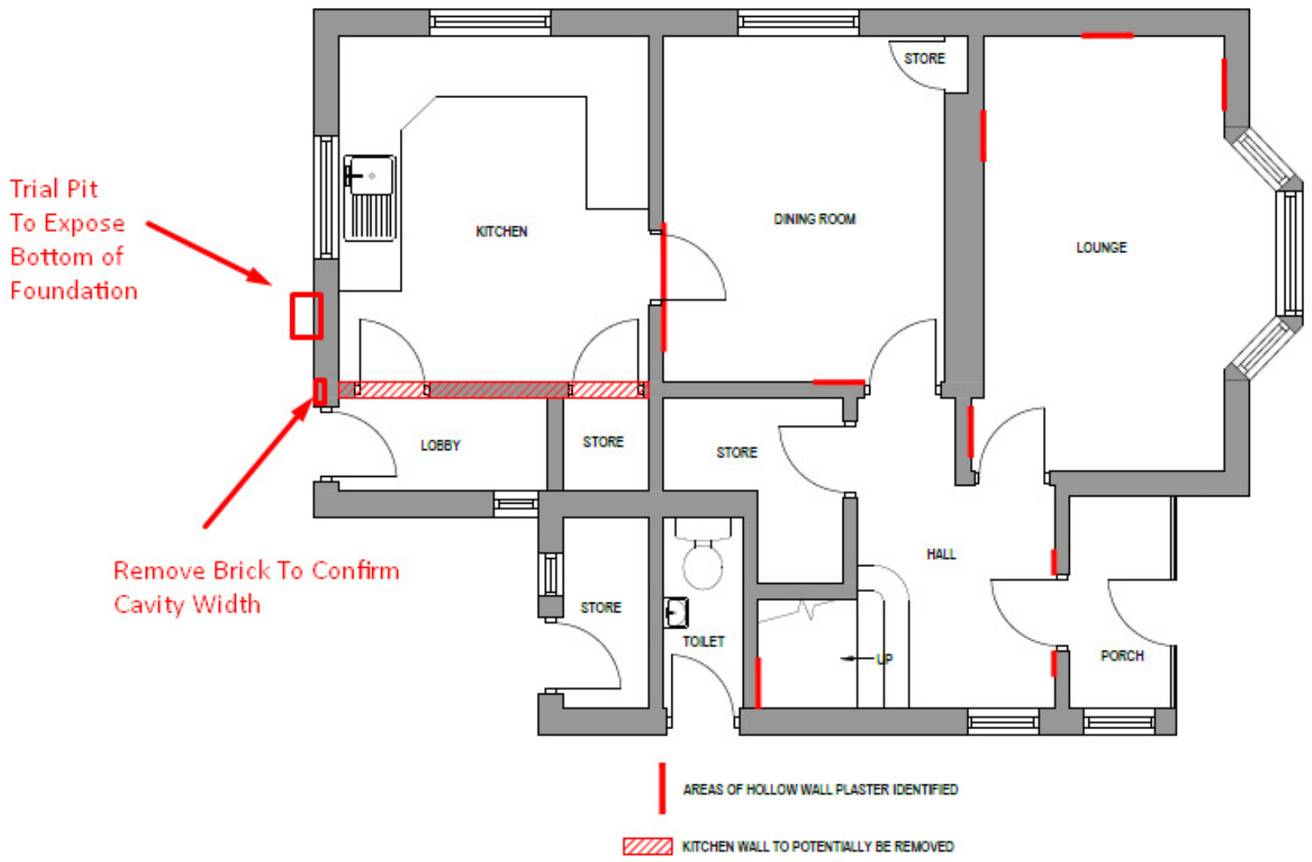
Thames Water
Thames Conservancy Division

Title
BOVENEY LOCKHOUSE
PROPOSED PRECAST CONCRETE SECTIONAL GARAGE

Section	OPERATIONS		Contract
Scale	AS SHOWN	Date Dec. 1977	
Drn. JWL	Chkd.	App.	
E. C. Reed F.I.C.E. Director of Operations			Drg. No. 11 187 / 1

11 187 / 1

APPENDIX B: SURVEY NOTES



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SCALE 1:50 m

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DRAWING NOTES:

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REV	DESCRIPTION	DATE	BY	CHKD
-	-	00/00/15	XX	XX

ORIGINATOR:
RIDGE
BEAUMONT HOUSE
59 HIGH STREET
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READING, RG7 5AL
TEL: 0118 932 3088
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CLIENT:
ENVIRONMENT AGENCY

CONTRACTOR CLIENT:

PROJECT:
BOVENEY LOCK HOUSE

TITLE:
GROUND FLOOR PLAN

DRAWN BY:	PH	SCALE: 1:50 @	A3
CHECKED BY:	SB	DATE:	17/04/2019

STATUS:
INFORMATION

DRAWING No:

PROJECT:	ORG:	ZONE:	LEVEL:	TYPE:	ROLE:	NUMBER:	REV:
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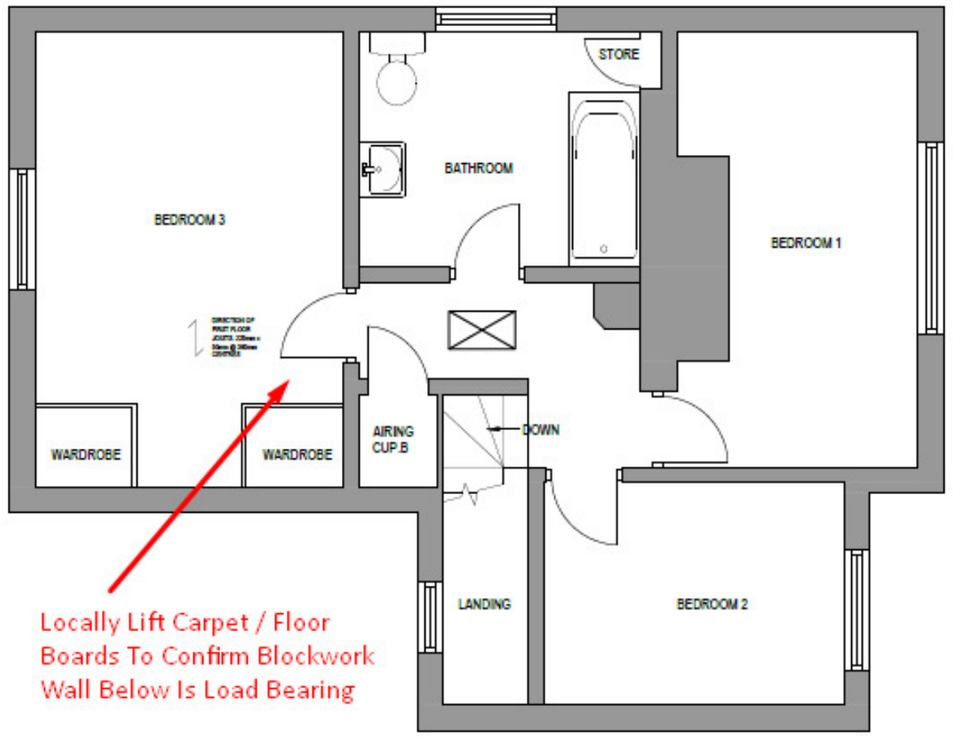

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REV	DESCRIPTION	DATE	BY	CHKD
-	-	00/00/15	XX	XX

ORIGINATOR:

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WWW.RIDGE.CO.UK

CLIENT:
ENVIRONMENT AGENCY

CONTRACTOR CLIENT:

PROJECT:
BOVENEY LOCK HOUSE

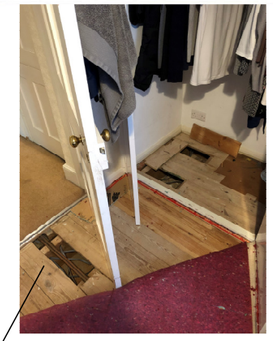
TITLE:
FIRST FLOOR PLAN

DRAWN BY:	PH	SCALE: 1:50 @	A3
CHECKED BY:	SB	DATE:	17/04/2019

STATUS: INFORMATION

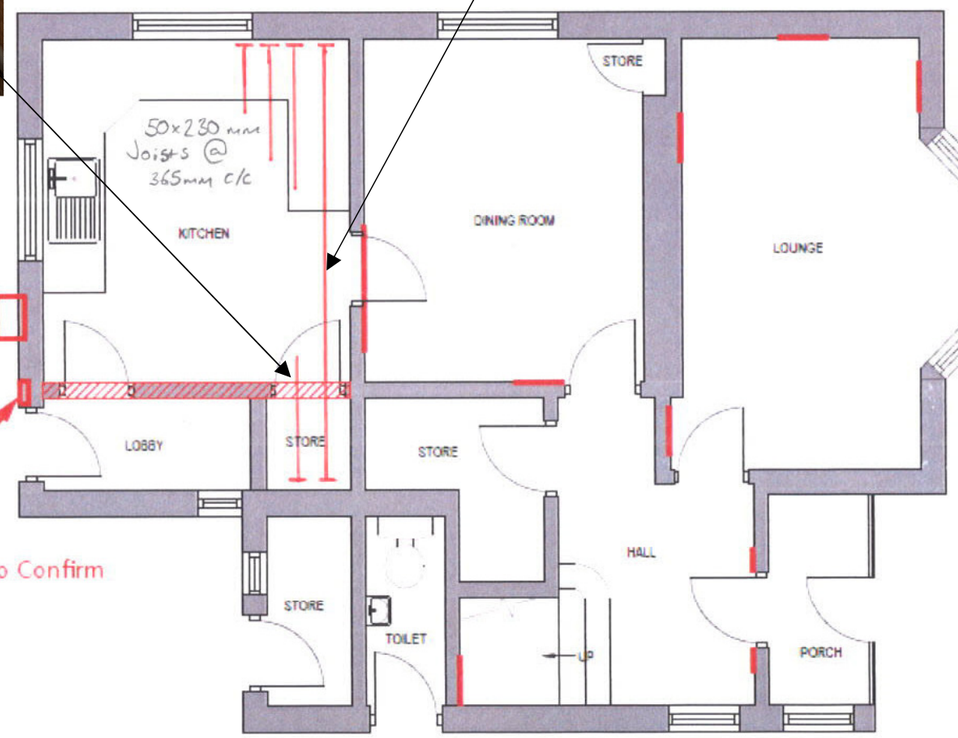
DRAWING No:

PROJECT:	ORG:	ZONE:	LEVEL:	TYPE:	ROLE:	NUMBER:	REV:
5008885	RDG	XX	00	PL	B	0002	-



Trial Pit
To Expose
Bottom of
Foundation
-See attached
Sketch

Remove Brick To Confirm
Cavity Width
- See attached
Sketch



AREAS OF HOLLOW WALL PLASTER IDENTIFIED

KITCHEN WALL TO POTENTIALLY BE REMOVED

0.5 0 0.5 1 1.5 2 2.5
SCALE 1:50 m

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DRAWING NOTES

REV	DESCRIPTION	DATE	BY	CHKD
-	-	00/00/15	XX	XX

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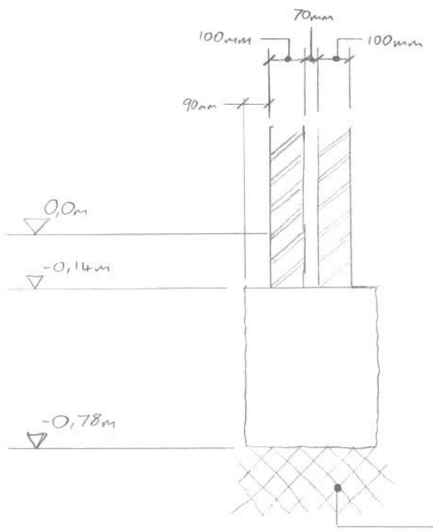
CLIENT
ENVIRONMENT AGENCY

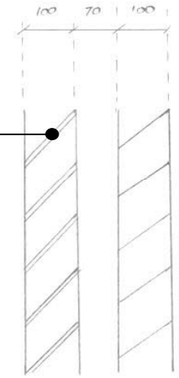
CONTRACTOR CLIENT

PROJECT
BOVENEY LOCK HOUSE

TITLE
Survey Notes: Mark-up



MASONRY WALL
FOUNDATION DETAIL



MASONRY WALL BUILD-UP

REF	DATE	REVISION	DRAWN	CHECKED

PROJECT

DRAWING

Survey Notes: Trial Pit & Brick Removal

RIDGE

THE COWYARDS
BLENHEIM PARK
OXFORD ROAD
WOODSTOCK, OX20 1QR
TEL: 01993 815000
FAX: 01993 815001
www.ridge.co.uk
Also at Reading, Bristol, London and Leicester

CLIENT

SCALE	DATE	DRAWN BY	CHECKED BY

FILE REFERENCE:

DRG NO | REV

APPENDIX C: CALCULATION PACK

TIMBER JOIST ANALYSIS & DESIGN (EN1995-1-1:2004)

In accordance with EN1995-1-1:2004 + A2:2014 incorporating corrigendum June 2006 and the UK national annex

Tedds calculation version 2.1.03

Joist details

Description — 50 x 230 C16 timber joists

Joist spacing — s_{Joist} = **360** mm

Forces input on Joist

Vertical permanent load on joist — F_{G_Joist}= **0.45** kN/m²

Vertical imposed load on joist — F_{Q_Joist}= **1.50** kN/m²

Joist loading details

Distributed loads

Vertical permanent load on joist — $p_G = F_{G\_Joist} \times s_{Joist}$= **0.16** kN/m

Vertical imposed load on joist — $p_Q = F_{Q\_Joist} \times s_{Joist}$= **0.54** kN/m

ANALYSIS

Tedds calculation version 1.0.27

Loading

Self weight included (Permanent x 1)

Load combination factors

Load combination	Permanent	Imposed	Snow	Wind
1.35G + 1.50Q (Strength)	1.35	1.50	0.00	0.00
1.00G + 1.00Q (Service)	1.00	1.00	0.00	0.00

Member Loads

Member	Load case	Load Type	Orientation	Description
Member	Permanent	UDL	GlobalZ	0.16 kN/m at 0 m to 4.403 m
Member	Imposed	UDL	GlobalZ	0.54 kN/m at 0 m to 4.403 m

Results

Total deflection

1.35G + 1.50Q (Strength) - Total deflection

1.00G + 1.00Q (Service) - Total deflection

Node deflections

Load combination: 1.35G + 1.50Q (Strength)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.16604	
2	0	0	-0.06269	
3	0	0	0.00671	

Load combination: 1.00G + 1.00Q (Service)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.11381	
2	0	0	-0.04297	
3	0	0	0.0046	

Total base reactions

Load case/combination	Force	
	FX (kN)	FZ (kN)
1.35G + 1.50Q (Strength)	0	4.8
1.00G + 1.00Q (Service)	0	3.3

Element end forces

Load combination: 1.35G + 1.50Q (Strength)

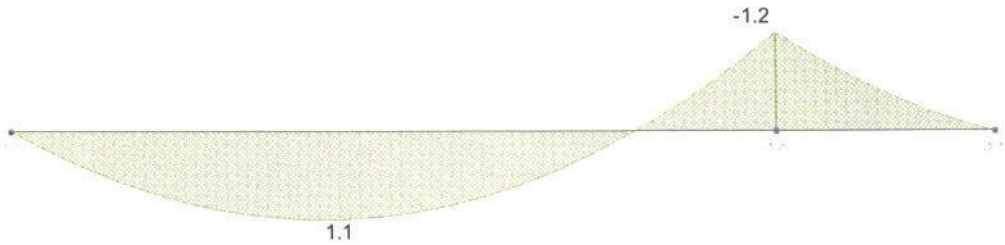
Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	3.427	1	0	-1.5	0
		2	0	-2.2	-1.2
2	0.976	2	0	-1.7	1.2
		3	0	0.7	0

Load combination: 1.00G + 1.00Q (Service)

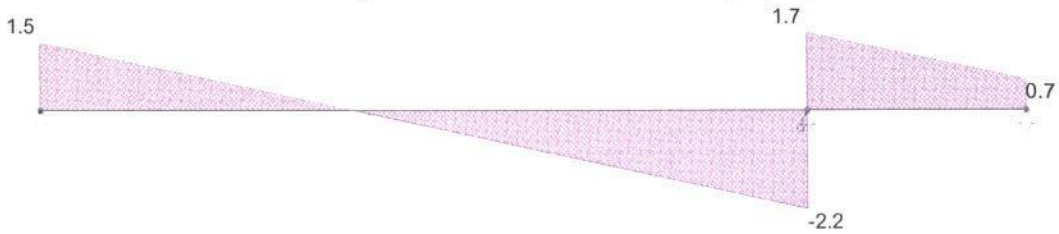
Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	3.427	1	0	-1	0
		2	0	-1.5	-0.8
2	0.976	2	0	-1.2	0.8
		3	0	0.5	0

Forces

Strength combinations - Moment envelope (kNm)



Strength combinations - Shear envelope (kN)



Member results

Envelope - Strength combinations

Member	Position (m)	Shear force (kN)		Moment (kNm)	
Member	1.396	0		1.1 (max)	
	3.427	1.7	-2.2 (max abs)	-1.2 (min)	

Member - Span 1

Partial factor for material properties and resistances

Partial factor for material properties - Table 2.3 γ_M = **2.000**

Member details

Load duration - cl.2.3.1.2 Medium-term

Service class - cl.2.3.1.3 1

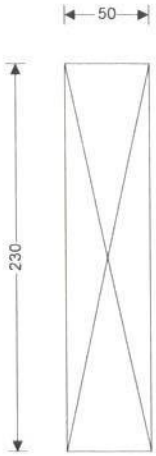
Timber section details

Number of timber sections in member N = **1**

Breadth of sections b = **50** mm

Depth of sections h = **230** mm

Timber strength class - EN 338:2016 Table 1 **C16**



50x230 timber section
Cross-sectional area, A, 11500 mm²
Section modulus, W_y, 440833.3 mm³
Section modulus, W_z, 95833 mm³
Second moment of area, I_y, 50695833 mm⁴
Second moment of area, I_z, 2395833 mm⁴
Radius of gyration, i_y, 66.4 mm
Radius of gyration, i_z, 14.4 mm
Timber strength class C16
Characteristic bending strength, $f_{m,k}$, 16 N/mm²
Characteristic shear strength, $f_{v,k}$, 3.2 N/mm²
Characteristic compression strength parallel to grain, $f_{c,0,k}$, 17 N/mm²
Characteristic compression strength perpendicular to grain, $f_{c,90,k}$, 2.2 N/mm²
Characteristic tension strength parallel to grain, $f_{t,0,k}$, 8.5 N/mm²
Mean modulus of elasticity, $E_{0,mean}$, 8000 N/mm²
Fifth percentile modulus of elasticity, $E_{0,05}$, 5400 N/mm²
Shear modulus of elasticity, G_{mean}, 500 N/mm²
Characteristic density, ρ_k, 310 kg/m³
Mean density, ρ_{mean}, 370 kg/m³

Span details

Bearing length L_b = **100** mm

Consider Combination 1 - 1.35G + 1.50Q (Strength)

Modification factors

Duration of load and moisture content - Table 3.1	k_{mod} = **0.8**
Deformation factor - Table 3.2	k_{def} = **0.6**
Bending stress re-distribution factor - cl.6.1.6(2)	k_m = **0.7**
Crack factor for shear resistance - cl.6.1.7(2)	k_{cr} = **0.67**
Load configuration factor - cl.6.1.5(4)	$k_{c,90}$ = **1.5**

Check design at start of span

Check compression perpendicular to the grain - cl.6.1.5

Design perpendicular compression - major axis	$F_{c,y,90,d}$ = **1.515** kN
Effective contact length	$L_{b,ef} = L_b$ = **100** mm
Design perpendicular compressive stress - exp.6.4	$\sigma_{c,y,90,d} = F_{c,y,90,d} / (b \times L_{b,ef})$ = **0.303** N/mm²
Design perpendicular compressive strength	$f_{c,y,90,d} = k_{mod} \times f_{c,90,k} / \gamma_M$ = **0.880** N/mm²
	$\sigma_{c,y,90,d} / (k_{c,90} \times f_{c,y,90,d})$ = **0.230**

PASS - Design perpendicular compression strength exceeds design perpendicular compression stress

Check shear force - Section 6.1.7

Design shear force	$F_{y,d}$ = **1.515** kN
Design shear stress - exp.6.60	$\tau_{y,d} = 1.5 \times F_{y,d} / (k_{cr} \times b \times h)$ = **0.295** N/mm²
Design shear strength	$f_{v,y,d} = k_{mod} \times f_{v,k} / \gamma_M$ = **1.280** N/mm²
	$\tau_{y,d} / f_{v,y,d}$ = **0.230**

PASS - Design shear strength exceeds design shear stress

Check design at end of span

Check compression perpendicular to the grain - cl.6.1.5

Design perpendicular compression - major axis	$F_{c,y,90,d}$ = **3.941** kN
Effective contact length	$L_{b,ef} = L_b$ = **100** mm
Design perpendicular compressive stress - exp.6.4	$\sigma_{c,y,90,d} = F_{c,y,90,d} / (b \times L_{b,ef})$ = **0.788** N/mm²
Design perpendicular compressive strength	$f_{c,y,90,d} = k_{mod} \times f_{c,90,k} / \gamma_M$ = **0.880** N/mm²

$\sigma_{c,y,90,d} / (k_{c,90} \times f_{c,y,90,d}) = \mathbf{0.597}$

PASS - Design perpendicular compression strength exceeds design perpendicular compression stress

Check shear force - Section 6.1.7

Design shear force	$F_{y,d} = \mathbf{2.203}$ kN
Design shear stress - exp.6.60	$\tau_{y,d} = 1.5 \times F_{y,d} / (k_{cr} \times b \times h) = \mathbf{0.429}$ N/mm^2
Design shear strength	$f_{v,y,d} = k_{mod} \times f_{v,k} / \gamma_M = \mathbf{1.280}$ N/mm^2
	$\tau_{y,d} / f_{v,y,d} = \mathbf{0.335}$

PASS - Design shear strength exceeds design shear stress

Check bending moment - Section 6.1.6

Design bending moment	$M_{y,d} = \mathbf{1.179}$ kNm
Design bending stress	$\sigma_{m,y,d} = M_{y,d} / W_y = \mathbf{2.674}$ N/mm^2
Design bending strength	$f_{m,y,d} = k_{mod} \times f_{m,k} / \gamma_M = \mathbf{6.4}$ N/mm^2
	$\sigma_{m,y,d} / f_{m,y,d} = \mathbf{0.418}$

PASS - Design bending strength exceeds design bending stress

Consider Combination 2 - 1.00G + 1.00Q (Service)

Check design 1563 mm along span

Check y-y axis deflection - Section 7.2

Instantaneous deflection	$\delta_y = \mathbf{2.1}$ mm
Final deflection	$\delta_{y,Final} = \delta_y \times (1 + k_{def}) = \mathbf{3.3}$ mm
Allowable deflection	$\delta_{y,Allowable} = \text{Min}(L_{m1\_s1} / 250, 13.7\text{ mm}) = \mathbf{13.7}$ mm
	$\delta_{y,Final} / \delta_{y,Allowable} = \mathbf{0.243}$

PASS - Allowable deflection exceeds final deflection

Member - Span 2

Partial factor for material properties and resistances

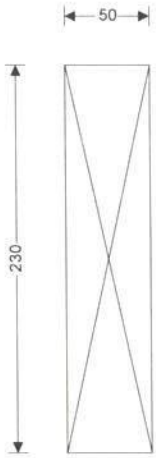
Partial factor for material properties - Table 2.3	$\gamma_M = \mathbf{1.300}$

Member details

Load duration - cl.2.3.1.2	Medium-term
Service class - cl.2.3.1.3	2

Timber section details

Number of timber sections in member	N = **1**
Breadth of sections	b = **50** mm
Depth of sections	h = **230** mm
Timber strength class - EN 338:2016 Table 1	**C16**



50x230 timber section
Cross-sectional area, A, 11500 mm²
Section modulus, W_y, 440833.3 mm³
Section modulus, W_z, 95833 mm³
Second moment of area, I_y, 50695833 mm⁴
Second moment of area, I_z, 2395833 mm⁴
Radius of gyration, i_y, 66.4 mm
Radius of gyration, i_z, 14.4 mm
Timber strength class C16
Characteristic bending strength, $f_{m,k}$, 16 N/mm²
Characteristic shear strength, $f_{v,k}$, 3.2 N/mm²
Characteristic compression strength parallel to grain, $f_{c,0,k}$, 17 N/mm²
Characteristic compression strength perpendicular to grain, $f_{c,90,k}$, 2.2 N/mm²
Characteristic tension strength parallel to grain, $f_{t,0,k}$, 8.5 N/mm²
Mean modulus of elasticity, $E_{0,mean}$, 8000 N/mm²
Fifth percentile modulus of elasticity, $E_{0.05}$, 5400 N/mm²
Shear modulus of elasticity, G_{mean}, 500 N/mm²
Characteristic density, ρ_k, 310 kg/m³
Mean density, ρ_{mean}, 370 kg/m³

Span details

Bearing length L_b = **100** mm

Consider Combination 1 - 1.35G + 1.50Q (Strength)

Modification factors

Duration of load and moisture content - Table 3.1	k_{mod} = **0.8**
Deformation factor - Table 3.2	k_{def} = **0.8**
Bending stress re-distribution factor - cl.6.1.6(2)	k_m = **0.7**
Crack factor for shear resistance - cl.6.1.7(2)	k_{cr} = **0.67**
Load configuration factor - cl.6.1.5(4)	$k_{c,90}$ = **1**
System strength factor - cl.6.6	k_{sys} = **1.1**

Check design at start of span

Check compression perpendicular to the grain - cl.6.1.5

Design perpendicular compression - major axis	$F_{c,y,90,d}$ = **3.941** kN
Effective contact length	$L_{b,ef} = L_b$ = **100** mm
Design perpendicular compressive stress - exp.6.4	$\sigma_{c,y,90,d} = F_{c,y,90,d} / (b \times L_{b,ef})$ = **0.788** N/mm²
Design perpendicular compressive strength	$f_{c,y,90,d} = k_{mod} \times k_{sys} \times f_{c.90.k} / \gamma_M$ = **1.489** N/mm²
	$\sigma_{c,y,90,d} / (k_{c,90} \times f_{c,y,90,d})$ = **0.529**

PASS - Design perpendicular compression strength exceeds design perpendicular compression stress

Check shear force - Section 6.1.7

Design shear force	$F_{y,d}$ = **1.737** kN
Design shear stress - exp.6.60	$\tau_{y,d} = 1.5 \times F_{y,d} / (k_{cr} \times b \times h)$ = **0.338** N/mm²
Design shear strength	$f_{v,y,d} = k_{mod} \times k_{sys} \times f_{v.k} / \gamma_M$ = **2.166** N/mm²
	$\tau_{y,d} / f_{v,y,d}$ = **0.156**

PASS - Design shear strength exceeds design shear stress

Check bending moment - Section 6.1.6

Design bending moment	$M_{y,d}$ = **1.179** kNm
Design bending stress	$\sigma_{m,y,d} = M_{y,d} / W_y$ = **2.674** N/mm²
Design bending strength	$f_{m,y,d} = k_{mod} \times k_{sys} \times f_{m.k} / \gamma_M$ = **10.831** N/mm²
	$\sigma_{m,y,d} / f_{m,y,d}$ = **0.247**

PASS - Design bending strength exceeds design bending stress

Check beams subjected to either bending or combined bending and compression - cl.6.3.3

Lateral buckling factor - exp.6.34 k_{crit} = **1.000**

Beam stability check - exp.6.33 $\sigma_{m,y,d} / (k_{crit} \times f_{m,y,d})$ = **0.247**

PASS - Beam stability is acceptable

Consider Combination 2 - 1.00G + 1.00Q (Service)

Check design 378 mm along span

Check y-y axis deflection - Section 7.2

Instantaneous deflection δ_y = **0.1** mm

Final deflection $\delta_{y,Final} = \delta_y \times (1 + k_{def})$ = **0.1** mm

Allowable deflection $\delta_{y,Allowable} = Min(L_{m1\_s2} / 250, 13.7\ mm)$ = **3.9** mm

$\delta_{y,Final} / \delta_{y,Allowable}$ = **0.038**

PASS - Allowable deflection exceeds final deflection

TIMBER JOIST ANALYSIS & DESIGN (EN1995-1-1:2004)

In accordance with EN1995-1-1:2004 + A2:2014 incorporating corrigendum June 2006 and the UK national annex

Tedds calculation version 2.1.03

Joist details

Description — 50 x 230 C14 timber joists

Joist spacing — s_{Joist} = **360** mm

Forces input on Joist

Vertical permanent load on joist — F_{G_Joist} = **0.45** kN/m²

Vertical imposed load on joist — F_{Q_Joist} = **1.50** kN/m²

Joist loading details

Distributed loads

Vertical permanent load on joist — $p_G = F_{G\_Joist} \times s_{Joist}$ = **0.16** kN/m

Vertical imposed load on joist — $p_Q = F_{Q\_Joist} \times s_{Joist}$ = **0.54** kN/m

ANALYSIS

Tedds calculation version 1.0.27

Loading

Self weight included (Permanent x 1)

Load combination factors

Load combination	Permanent	Imposed	Snow	Wind
1.35G + 1.50Q (Strength)	1.35	1.50	0.00	0.00
1.00G + 1.00Q (Service)	1.00	1.00	0.00	0.00

Member Loads

Member	Load case	Load Type	Orientation	Description
Member	Permanent	UDL	GlobalZ	0.16 kN/m at 0 m to 4.4 m
Member	Imposed	UDL	GlobalZ	0.54 kN/m at 0 m to 4.4 m

Results

Total deflection

1.35G + 1.50Q (Strength) - Total deflection

1.00G + 1.00Q (Service) - Total deflection

Node deflections

Load combination: 1.35G + 1.50Q (Strength)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.62004	
2	0	0	-0.62004	

Load combination: 1.00G + 1.00Q (Service)

Node	Deflection		Rotation	Co-ordinate system
	X (mm)	Z (mm)	(°)	
1	0	0	0.42491	
2	0	0	-0.42491	

Total base reactions

Load case/combination	Force	
	FX (kN)	FZ (kN)
1.35G + 1.50Q (Strength)	0	4.8
1.00G + 1.00Q (Service)	0	3.3

Element end forces

Load combination: 1.35G + 1.50Q (Strength)

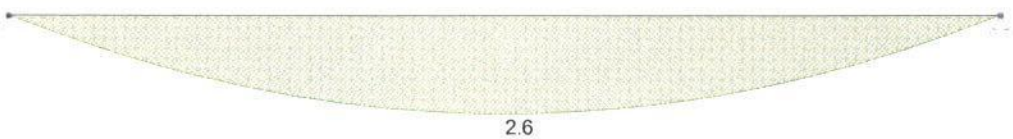
Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.4	1	0	-2.4	0
		2	0	-2.4	0

Load combination: 1.00G + 1.00Q (Service)

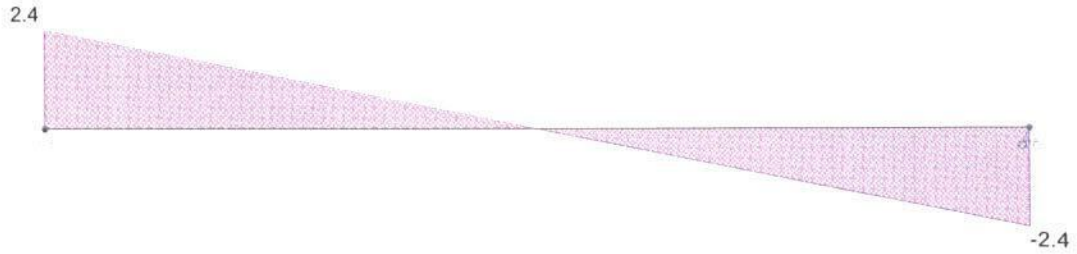
Element	Length (m)	Nodes Start/End	Axial force (kN)	Shear force (kN)	Moment (kNm)
1	4.4	1	0	-1.6	0
		2	0	-1.6	0

Forces

Strength combinations - Moment envelope (kNm)



Strength combinations - Shear envelope (kN)



Member results

Envelope - Strength combinations

Member	Position (m)	Shear force (kN)		Moment (kNm)	
Member	0	2.4 (max abs)		0 (min)	
	2.2	0		2.6 (max)	
	4.4	-2.4		0 (min)	

Member - Span 1

Partial factor for material properties and resistances

Partial factor for material properties - Table 2.3 γ_M = **2.000**

Member details

Load duration - cl.2.3.1.2 Medium-term

Service class - cl.2.3.1.3 1

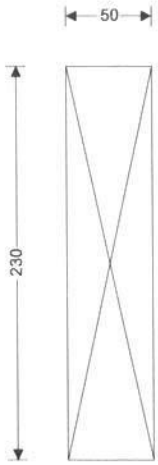
Timber section details

Number of timber sections in member N = **1**

Breadth of sections b = **50** mm

Depth of sections h = **230** mm

Timber strength class - EN 338:2016 Table 1 **C14**



50x230 timber section

Cross-sectional area, A, 11500 mm²

Section modulus, W_y, 440833.3 mm³

Section modulus, W_z, 95833 mm³

Second moment of area, I_y, 50695833 mm⁴

Second moment of area, I_z, 2395833 mm⁴

Radius of gyration, i_y, 66.4 mm

Radius of gyration, i_z, 14.4 mm

Timber strength class C14

Characteristic bending strength, $f_{m,k}$, 14 N/mm²

Characteristic shear strength, $f_{v,k}$, 3 N/mm²

Characteristic compression strength parallel to grain, $f_{c,0,k}$, 16 N/mm²

Characteristic compression strength perpendicular to grain, $f_{c,90,k}$, 2 N/mm²

Characteristic tension strength parallel to grain, $f_{t,0,k}$, 7.2 N/mm²

Mean modulus of elasticity, $E_{0,mean}$, 7000 N/mm²

Fifth percentile modulus of elasticity, $E_{0.05}$, 4700 N/mm²

Shear modulus of elasticity, G_{mean}, 440 N/mm²

Characteristic density, ρ_k, 290 kg/m³

Mean density, ρ_{mean}, 350 kg/m³

Span details

Bearing length L_b = **100** mm

Consider Combination 1 - 1.35G + 1.50Q (Strength)

Modification factors

Duration of load and moisture content - Table 3.1	k_{mod} = **0.8**
Deformation factor - Table 3.2	k_{def} = **0.6**
Bending stress re-distribution factor - cl.6.1.6(2)	k_m = **0.7**
Crack factor for shear resistance - cl.6.1.7(2)	k_{cr} = **0.67**
Load configuration factor - cl.6.1.5(4)	$k_{c,90}$ = **1.5**
System strength factor - cl.6.6	k_{sys} = **1.1**

Check design at start of span

Check compression perpendicular to the grain - cl.6.1.5

Design perpendicular compression - major axis	$F_{c,y,90,d}$ = **2.38** kN
Effective contact length	$L_{b,ef} = L_b$ = **100** mm
Design perpendicular compressive stress - exp.6.4	$\sigma_{c,y,90,d} = F_{c,y,90,d} / (b \times L_{b,ef})$ = **0.476** N/mm^2
Design perpendicular compressive strength	$f_{c,y,90,d} = k_{mod} \times k_{sys} \times f_{c,90,k} / \gamma_M$ = **0.880** N/mm^2
	$\sigma_{c,y,90,d} / (k_{c,90} \times f_{c,y,90,d})$ = **0.361**

PASS - Design perpendicular compression strength exceeds design perpendicular compression stress

Check shear force - Section 6.1.7

Design shear force	$F_{y,d}$ = **2.38** kN
Design shear stress - exp.6.60	$\tau_{y,d} = 1.5 \times F_{y,d} / (k_{cr} \times b \times h)$ = **0.463** N/mm^2
Design shear strength	$f_{v,y,d} = k_{mod} \times k_{sys} \times f_{v,k} / \gamma_M$ = **1.320** N/mm^2
	$\tau_{y,d} / f_{v,y,d}$ = **0.351**

PASS - Design shear strength exceeds design shear stress

Check design 2200 mm along span

Check bending moment - Section 6.1.6

Design bending moment	$M_{y,d}$ = **2.618** kNm
Design bending stress	$\sigma_{m,y,d} = M_{y,d} / W_y$ = **5.94** N/mm^2
Design bending strength	$f_{m,y,d} = k_{mod} \times k_{sys} \times f_{m,k} / \gamma_M$ = **6.16** N/mm^2
	$\sigma_{m,y,d} / f_{m,y,d}$ = **0.964**

PASS - Design bending strength exceeds design bending stress

Consider Combination 2 - 1.00G + 1.00Q (Service)

Check design 2200 mm along span

Check y-y axis deflection - Section 7.2

Instantaneous deflection	δ_y = **10.6** mm
Final deflection	$\delta_{y,Final} = \delta_y \times (1 + k_{def})$ = **17** mm
Allowable deflection	$\delta_{y,Allowable} = \text{Min}(L_{m1\_s1} / 250, 17.6\text{ mm})$ = **17.6** mm
	$\delta_{y,Final} / \delta_{y,Allowable}$ = **0.966**

PASS - Allowable deflection exceeds final deflection

RIDGE	Project:	CALCULATION SHEET
The Cowyards, Blenheim Park, Oxford Road, Woodstock,	Boveney Lock House	Sheet No.: 1 of 3
	Subject:	Date: 01/11/2019
		By: JMo
	Existing Foundation Load Takedown	Checked: JFB

Roof Loadings

Dead Loads

Roofing Materials

Tiles	1	kN/m^2
Battens	0.05	kN/m^2
Felt	0.05	kN/m^2
Insulation	0.05	kN/m^2
Total *(on slope)*	1.15	kN/m^2

Roof Pitch 40 deg

$$Q_{RF,plan} = Q_{RF,slope} \times \frac{1}{\cos(\alpha)}$$

Total *(on plan)* 1.50 kN/m^2

Roofing Structure

Trusses	0.25	kN/m^2
Rafters	0.2	kN/m^2
Total *(on plan)*	0.45	kN/m^2

Total Roof Load 1.95 kN/m^2

Live Loads

Maintainance Only	0.6	kN/m^2
Total *(on slope)*	0.6	kN/m^2

$$Q_{RF,plan} = Q_{RF,slope} \times \frac{1}{\cos(\alpha)}$$

Total *(on plan)* 0.78 kN/m^2

Loaded Width (w) 2.21 m

Foundation Loads

Dead	4.31	kN/m
Live	1.73	kN/m

RIDGE	Project: Boveney Lock House	CALCULATION SHEET
The Cowyards, Blenheim Park, Oxford Road, Woodstock,		Sheet No.: 2 of 3
	Subject: *Existing Foundation Load Takedown*	Date: 01/11/2019
		By: JMo
		Checked: JFB

First Floor Loadings

Dead Loads	
FF Build-up	
Boards	0.15 kN/m^2
Services	0.1 kN/m^2
Ceiling Buildup	0.1 kN/m^2
Joists	0.1 kN/m^2
Total	0.45 kN/m^2

Live Loads	
Domestic (A1)	1.5 kN/m^2
Total	1.5 kN/m^2

Loaded Width (w) 0.5 m

Foundation Loads

Dead 0.23 kN/m

Live 0.34 kN/m

Ground Floor Loadings *- GF Slab Ground Bearing*

Dead Loads	
GF Build-up	
N/A	0 kN/m^2
N/A	0 kN/m^2
N/A	0 kN/m^2
N/A	0 kN/m^2
Total	0 kN/m^2

Live Loads	
Domestic (A1)	1.5 kN/m^2
Total	1.5 kN/m^2

Loaded Width (w) 0 m

Foundation Loads

Dead 0.00 kN/m

Live 0.00 kN/m

RIDGE	Project: Boveney Lock House	CALCULATION SHEET
The Cowyards, Blenheim Park, Oxford Road, Woodstock,	Subject: *Existing Foundation Load Takedown*	Sheet No.: 3 of 3
		Date: 01/11/2019
		By: JMo
		Checked: SFB

Wall Loadings

Dead Loads		
Wall Build-up		
102mm Brick	2.1	kN/m^2
70mm Cavity	0	kN/m^2
100mm Block	1.7	kN/m^2
Total	3.8	kN/m^2

Wall Height 7.3 m

Foundation Loads

Dead 27.74 kN/m

Foundation Self-Weight

Dead Loads		
Foundation Self-Weight		
depth	0.640	m
width	0.450	m
Concrete	24	kN/m^3
Total	6.912	kN/m

Foundation Loads

Dead 6.91 kN/m

Total Foundation Dead Load = 39.11 kN/m *(Unfactored)*

Total Foundation Live Load = 2.07 kN/m *(Unfactored)*

RIDGE	Project: Boveney Lock House	CALCULATION SHEET
The Cowyards, Blenheim Park, Oxford Road, Woodstock,		Sheet No.: 1 of 3
	Subject: *Proposed Foundation Load Takedown*	Date: 01/11/2019
		By: JMo
		Checked: SFB

Roof Loadings

Dead Loads

Roofing Materials

Tiles	1	kN/m^2
Battens	0.05	kN/m^2
Felt	0.05	kN/m^2
Insulation	0.05	kN/m^2
Total *(on slope)*	1.15	kN/m^2

Roof Pitch 40 deg

$$Q_{RF,plan} = Q_{RF,slope} \times \frac{1}{\cos(\alpha)}$$

Total *(on plan)* 1.50 kN/m^2

Roofing Structure

Trusses	0.25	kN/m^2
Rafters	0.2	kN/m^2
Total *(on plan)*	0.45	kN/m^2

Total Roof Load 1.95 kN/m^2

Live Loads

Maintainance Only	0.6	kN/m^2
Total *(on slope)*	0.6	kN/m^2

$$Q_{RF,plan} = Q_{RF,slope} \times \frac{1}{\cos(\alpha)}$$

Total *(on plan)* 0.78 kN/m^2

Loaded Width (w) 2.21 m

Foundation Loads

Dead	4.31	kN/m
Live	1.73	kN/m

RIDGE	Project:	CALCULATION SHEET
The Cowyards, Blenheim Park, Oxford Road, Woodstock,	Boveney Lock House	Sheet No.: 2 of 3
	Subject:	Date: 01/11/2019
		By: JMo
	Proposed Foundation Load Takedown	Checked: SFB

First Floor Loadings

Dead Loads	
FF Build-up	
Boards	0.15 kN/m^2
Services	0.1 kN/m^2
Ceiling Buildup	0.1 kN/m^2
Joists	0.1 kN/m^2
Total	0.45 kN/m^2

Live Loads	
Domestic (A1)	1.5 kN/m^2
Total	1.5 kN/m^2

Loaded Width (w) 2.5 m

Foundation Loads

Dead	1.13 kN/m
Live	1.69 kN/m

Ground Floor Loadings *- GF Slab Ground Bearing*

Dead Loads	
GF Build-up	
N/A	0 kN/m^2
N/A	0 kN/m^2
N/A	0 kN/m^2
N/A	0 kN/m^2
Total	0 kN/m^2

Live Loads	
Domestic (A1)	1.5 kN/m^2
Total	1.5 kN/m^2

Loaded Width (w) 0 m

Foundation Loads

Dead	0.00 kN/m
Live	0.00 kN/m

RIDGE	Project:	CALCULATION SHEET
The Cowyards, Blenheim Park, Oxford Road, Woodstock,	Boveney Lock House	Sheet No.: 3 of 3
	Subject:	Date: 01/11/2019
		By: JMo
	Proposed Foundation Load Takedown	Checked: SFB

Wall Loadings

Dead Loads		
Wall Build-up		
102mm Brick	2.1	kN/m^2
70mm Cavity	0	kN/m^2
100mm Block	1.7	kN/m^2
Total	3.8	kN/m^2

Wall Height 7.3 m

Foundation Loads

Dead 27.74 kN/m

Foundation Self-Weight

Dead Loads		
Foundation Self-Weight		
depth	0.640	m
width	0.450	m
Concrete	24	kN/m^3
Total	6.912	kN/m

Foundation Loads

Dead 6.91 kN/m

Total Foundation Dead Load = 40.01 kN/m *(Unfactored)*

Total Foundation Live Load = 3.42 kN/m *(Unfactored)*

Load increase deemed acceptable ✓ O.K.

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PROJECT EA BOVENEY LOCK HOUSE

CALCULATION MASONRY WALL ANALYSIS

CALCULATION SHEET

JOB No.	5010022
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BY	JM
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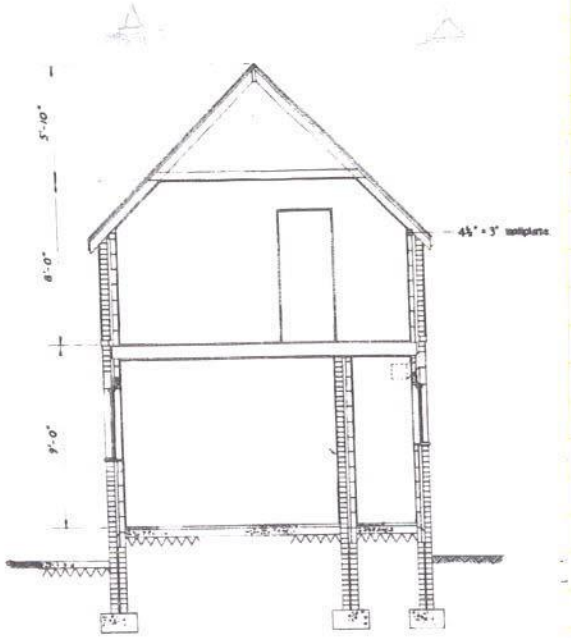
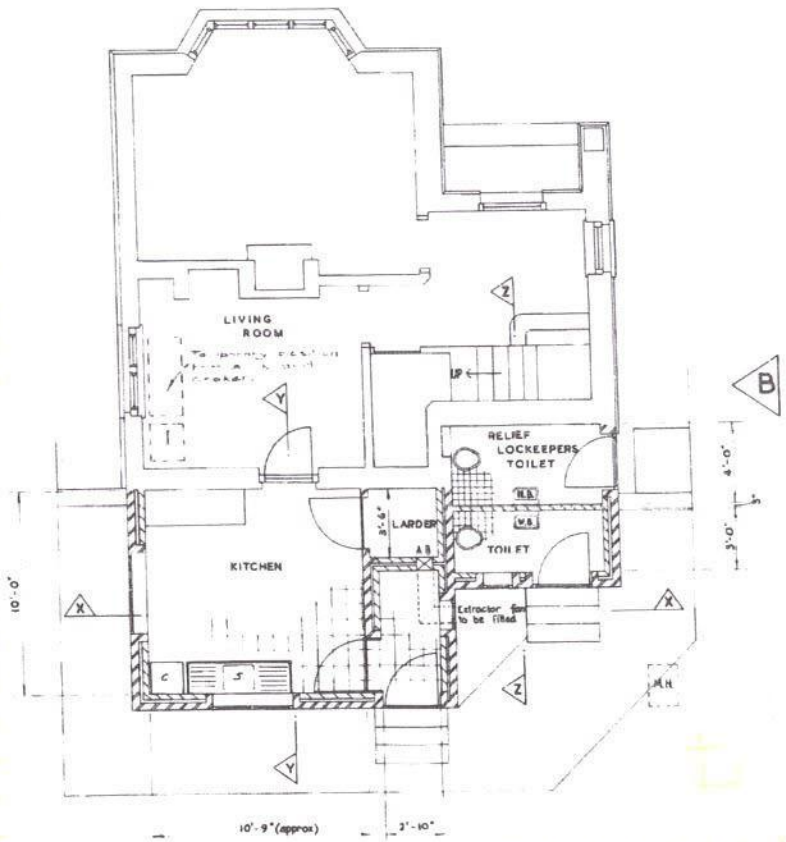
ELEVATION A



SECTION X-X



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CALCULATION MASONRY WALL ANALYSIS - INPUT DATA

CALCULATION SHEET

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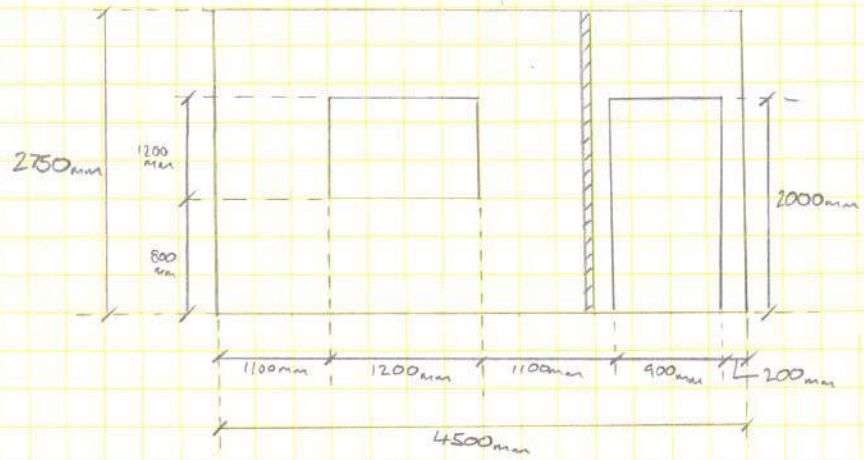
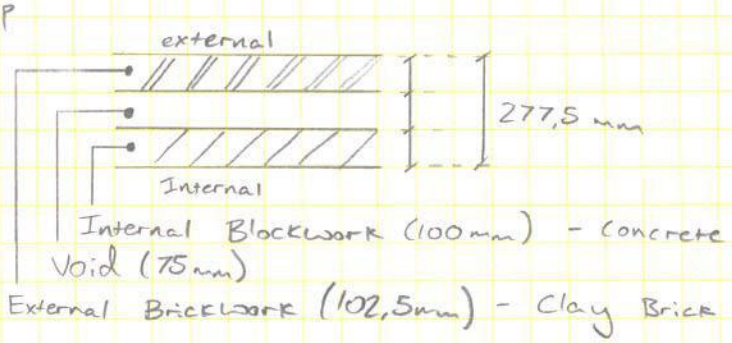
Dimensions



Build-up



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PROJECT

CALCULATION

CALCULATION SHEET

JOB No.

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LOADING

Vertical Loading

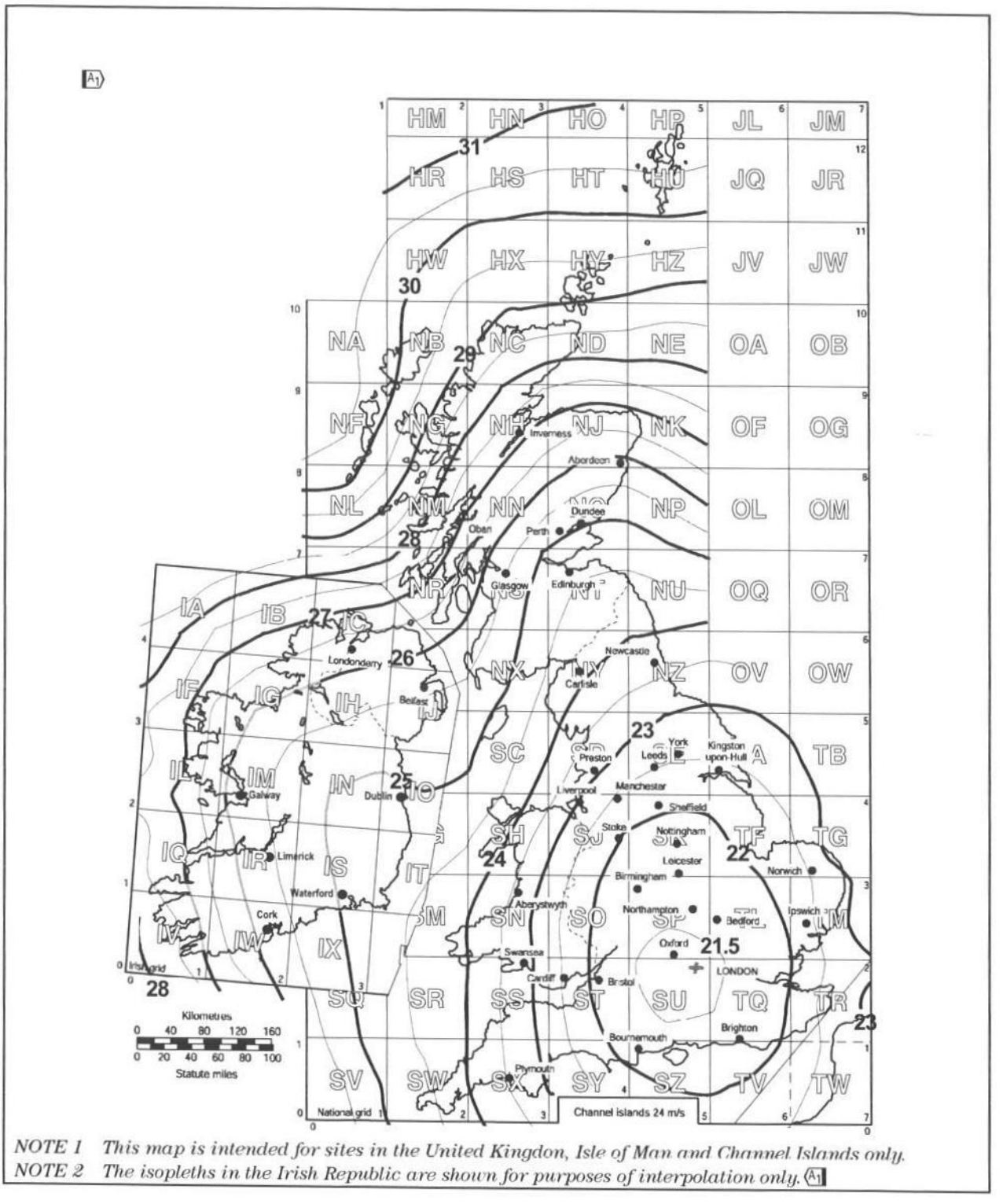
inner leaf → $\gamma = 1000\ kg/m^3$

$t = 100mm$, $h = \sim 2,4m$

$M = 240\ kg/m \rightarrow g_k = 240 \times 9,81 = 2,4\ kN/m$

outer leaf → $g_k = 2,4\ kN/m$

Figure NA.1 **Value of fundamental basic wind velocity $v_{b,map}$ (m/s) before the altitude correction is applied**



NOTE 1 This map is intended for sites in the United Kingdom, Isle of Man and Channel Islands only.
NOTE 2 The isopleths in the Irish Republic are shown for purposes of interpolation only.

The values of exposure factor $c_e(z)$ are given in Figure NA.7 and the values of exposure correction factor for Town terrain $c_{e,T}$ are given in Figure NA.8.

When orography is significant:

(NA.4a)) $q_p(z) = [\,q_p(z)$ from Equation NA.3a or NA.3b$] \cdot [(c_o(z) + 0.6)/1.6]^2$ for $z \leqslant 50$ m;

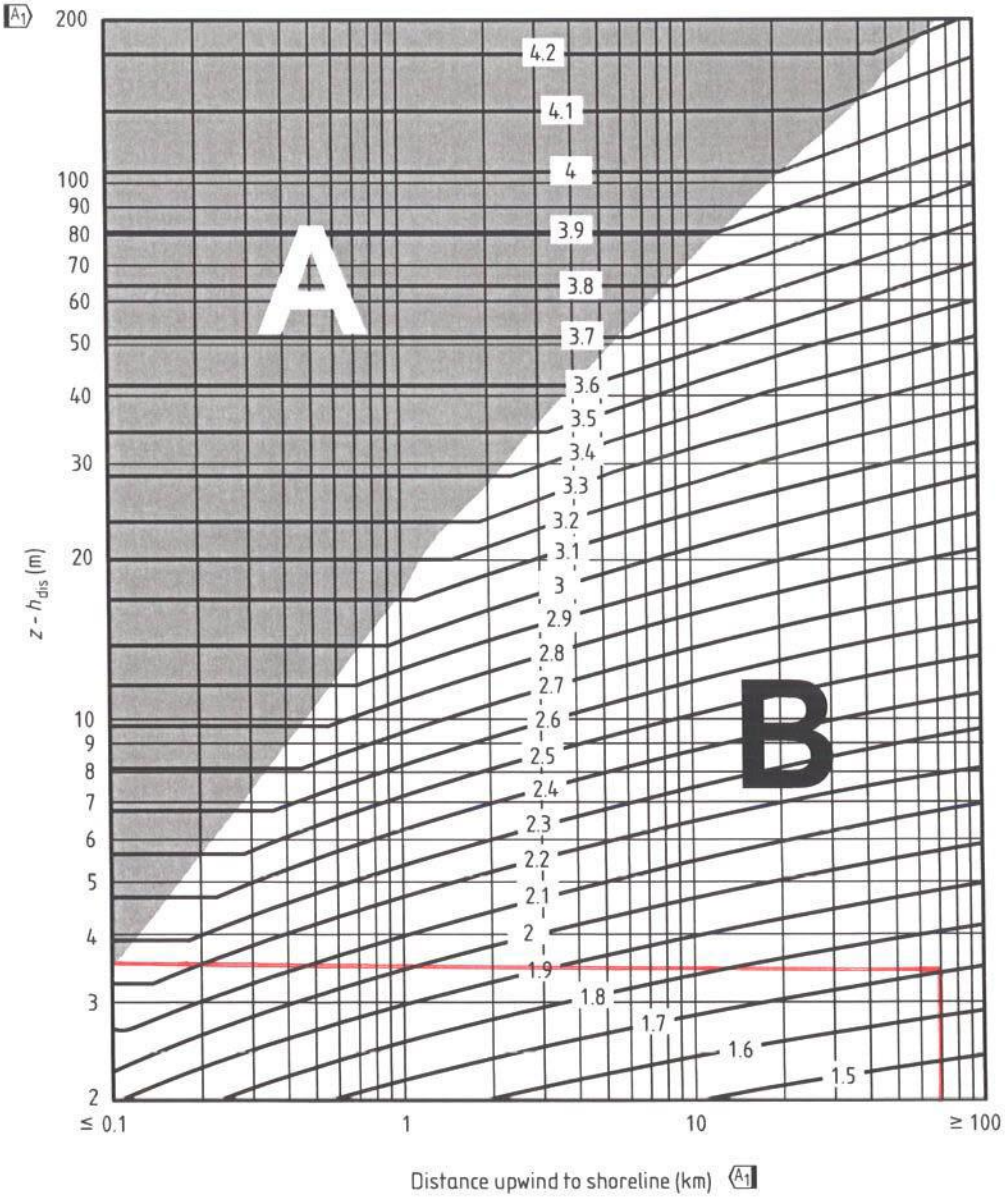
or

(NA.4b)) $q_p(z) = [1 + 3{,}0 \cdot I_v(z)]^2 \cdot 0.5 \cdot \rho \cdot v_m{}^2$ for $z > 50$ m.

Annex A to this National Annex shows flow diagrams for the determination of $q_p(z)$.

A1 *NOTE Expression NA.4b) is generally applicable.* A1

Figure NA.7 **Values of $c_e(z)$**



NOTE 1 The height z is the height at which q_p is sought using Equations NA.3a) or NA.3b).

NOTE 2 Zones A and B are indicated for use in Table NA.3.

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PROJECT: EA BOVENEY HOUSE

CALCULATION: WIND LOADING

CALCULATION SHEET

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Wind loading

$V_{b,map} = 21,5$ m/s

Altitude, $A = 23$ m

Distance to Shoreline = 78,09 km

$$V_b = V_{b,map} \cdot C_{alt} \cdot C_{dir} \cdot C_{season} \qquad (1991\text{-}1\text{-}4\ NA.1 \& Clause\ 4.1)$$

$$= 21,5 \times 1,023 \times 1.0 \times 1,0$$

$$= 22,0 \text{ m/s}$$

$$q_b = 0,613 \cdot V_b^2$$

$$= 0,613 \times 22^2$$

$$= 297 \text{ N/m}^2 = 0,3 \text{ kN/m}^2$$

$$q_p = Ce(z) \cdot Ce,T \cdot q_b$$

$Ce(3) = 1,7$
$Ce,T = 1,0$

$$q_p = 0,51 \text{ kN/m}^2$$

increase load for Zone A (worst case) - $C_g = 1,4$

$$q_p = 0,51 \times 1.4 = 0,714 \text{ kN/m}^2$$

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Sheet	: /
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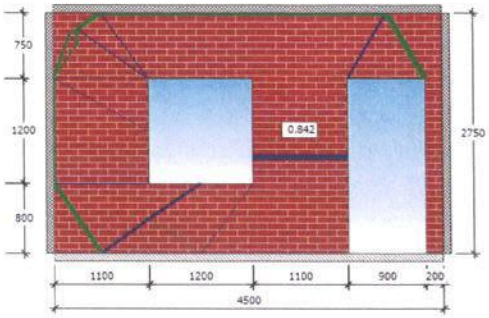
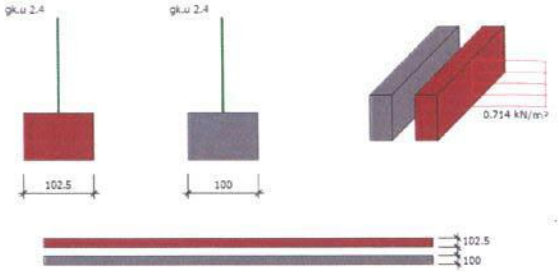
Date	: 29 October 2019 / Ver. 2019.06
Checked	: SFB
Approved	: SFB

Two Way Spanning, Vertically and Laterally Loaded, Cavity Wall
Design to BS EN 1996-1-1:2005
Masonry wall Panel





Summary of Design Data

EuroCode National Annex	Using UK values:A1 2012		
Wall Dimensions	h=2.750 m, hef=2.002 m (Eqn. 5.8), L=4.500 m, Lef=4.500 m		
Support Conditions	Bottom Simple, Top Cont., Left Cont., Right Cont.		
Lateral Loads	Wx=-0.714 kN/m²		
Cavity Wall (mm)	t1=102.5, t2=100, tef=127.6		
Limiting Dimensions	λ=15.7<=λ_{lim}=27, L/t_{ef}=35.3, H/t_{ef}=21.6, Hence H/t_{ef}<=64.2	0.581	OK

Outer-Leaf Design

Partial Safety Factor (γmc/γmf)	Construction Class 2, Unit Manufacture II	3/2.7	Table NA.1
Unit Material	Clay water absorption > 12%, Group 1,γ=9.81 kN/m³ Normalised mean compressive strength fb =10 N/mm²		
Mortar Material	M4, fm =4 N/mm²		
Compressive Strength (f_k)	k = 0.5,α = 0.7,β = 0.3	3.8 N/mm²	Table NA.4
Loads from above	Dead Load=2.4 kN/m		
Section Properties	Area=1025 cm²/m, Zp=1751 cm³/m		
Flexural Strength f_{xk2}(Perpendicular)		0.9 N/mm²	Table NA.6
Flexural Strength f_{xk1}(Parallel)	f_{xk1}=0.3, gd=0.037 N/mm²		
	f_{xk1}=f_{-k1}+min(gd, 0.2•f_k/γmc)γmf	0.4 N/mm²	Table NA.6
Critical axial compressive case	1.35(γ.tk.h+gku)		
Max local stress @	X=4.3 m,Y=1 m < fk/γ_{mc}	0.15 N/mm²	OK
Critical axial buckling case	1.35(γ.tk.h+gku)		
Max axial buckling force @	X=4.4 m, Y=1.375 m averaged over width of 0.2 m	15.1kN/m	
Moments from Lateral Load	$M_{wx,top}$=0.000 kN.m, $M_{wx,mid}$=0.000 kN.m		
Capacity reduction factor top,Φ	ex=0.0 mm, hef=300 mm, tef=127.6 mm, t=102.5 mm	0.900	
Capacity reduction factor mid,Φ_m	Creep coef. =1.5, ehm = 0.000 mm, h_{ef} = 0.300	0.900	
Fr=Φ.f_k.tk/γmc	0.900x2.89x102.5/3	88.9 kN/m	
Fd/Fr	15.1/88.9	0.170	OK
Mro=f_{xk2}.Zp/γmf	0.9x1751/2.7	0.584 kN.m/m	
Mro=f_{xk1}.Zb/γmf	0.4x1751/2.7	0.259 kN.m/m	

Inner-Leaf Design

Partial Safety Factor (γmc/γmf)	Construction Class 2, Unit Manufacture II	3/2.7	Table NA.1
Unit Material	Concrete Blocks, Group 1,γ=9.81 kN/m³ Normalised mean compressive strength fb =3.6 N/mm²		
Mortar Material	M4, fm =4 N/mm²		
Unit Ratio	Unit height=215, Least horizontal dimensions=100	2.15	
Compressive Strength (f_k)	k = 0.75,α = 0.7,β = 0.3	2.7 N/mm²	Table NA.4
Loads from above	Dead Load=2.4 kN/m		
Section Properties	Area=1000 cm²/m, Zp=1667 cm³/m		
Flexural Strength f_{xk2}(Perpendicular)		0.45 N/mm²	Table NA.6
Flexural Strength f_{xk1}(Parallel)	f_{xk1}=0.25, gd=0.037 N/mm²		
	f_{xk1}=f_{-k1}+min(gd, 0.2•f_k/γmc)γmf	0.351 N/mm²	Table NA.6
Critical axial compressive case	1.35(γ.tk.h+gku)		
Max local stress @	X=4.3 m,Y=1 m < fk/γ_{mc}	0.15 N/mm²	OK
Critical axial buckling case	1.35(γ.tk.h+gku)		

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Date : 29 October 2019 / Ver. 2019.06
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Approved : JFB

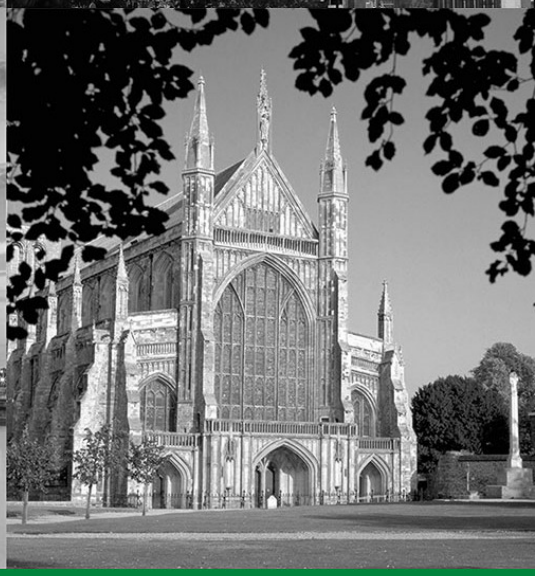
Max axial buckling force @	X=4.4 m, Y=1.375 m averaged over width of 0.2 m	14.96kN/m	
Moments from Lateral Load	$M_{wx,top}$=0.000 kN.m, $M_{wx,mid}$=0.000 kN.m		
Capacity reduction factor top,Φ	ex=0.0 mm, hef=300 mm, tef=127.6 mm, t=100.0 mm	0.900	
Capacity reduction factor mid,Φ_m	Creep coef. =1.5, ehm = 0.000 mm, h_{ef} = 0.300	0.900	
Fr=Φ.f_k.tk/γmc	0.900x2.05x100/3	61.6 kN/m	
Fd/Fr	15.0/61.6	0.243	OK
Mri=f_{xk2}.Zp/γmf	0.45x1667/2.7	0.278 kN.m/m	
Mri=f_{xk1}.Zb/γmf	0.351x1667/2.7	0.217 kN.m/m	

Design for Lateral Loads

Design Lateral Load Wd	1.5 Wx	1.071 kN/m²	
Yield Line Analysis	Load Factor,λ_p	1.188	
Ut=1/λ_p	1 / 1.188	0.842	OK





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