APPENDIX D

GSE – DESIGN CALCULATIONS

GREEN STRUCTURAL ENGINEERING

16 PILGRIM'S LANE
NW3 1SN

Structural Design Package
Proposed Lower Ground floor

December 2022

J002378

16 PILGRIM'S LANE
STRUCTURAL DESIGN REPORT
for
Mr Andrew Lavery

If you require any additional information relating to this document, please contact:

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Revision	Date of issue	Notes	Compiled By	Checked By
A	17.02.23	Initial Issue – For BIA purpose only	NW	AA
A	21.02.23	Initial Issue – For BIA purpose only	NW	AA

	Project		Job Ref	
GSE GREEN STRUCTURAL ENGINEERING	16 PILGRIM'S LANE		J002378	
	Drawing Ref	Calculations by NW	Checked by AA	Sheet
	Part of Structure STRUCTURAL DESIGN		Date December 2022	

Contents

1.0 Design Philosophy

The design of the structural elements will be carried out in such a way to limit the impact of the structural works on the existing building construction and that of the neighbouring properties.

New Lower Ground Floor Structure

The existing load bearing structure will be underpinned in a traditional '1 to 5' sequence to form the new lower ground floor. The underpins will comprise of a vertical stem which will be immediately beneath the existing wall and will be at least the same thickness as the existing wall. In the case of a party wall, the rear face of the stem will be in line with the face of the wall above so as not to encroach into the adjacent property's space, should they wish to construct a similar basement/lower ground floor in the future. The reinforcement in the stems will be designed for bending about the top of the base in the permanent case.

The vertical loads applied to the underpin stems from the existing structure will be calculated according to the thickness and height of the existing structure above.

The underpins will be designed for the temporary and permanent cases, as follows:

- In the temporary case, the underpins will be designed for soil pressures and a surcharge. The factor of safety against overturning and sliding will be taken as 1.5.
- In the permanent case, the underpins will be designed for soil pressures, a surcharge and water pressures calculated at 1 m below the retained height. The new lower ground floor slab will be structurally connected to the underpinning bases using dowel bars, therefore it will be assumed that the new lower ground floor slab will restrain the underpins against sliding.

Surcharge on the underpins will be taken as follows:

Internal live load (e.g. floors) = 5.0 kN/m2
External: gardens, footpaths, driveways = 10 kN/m2

The lower ground floor slab will be designed for uplift due to water pressure, spanning between the bases of opposite underpins. The net uplift pressure is taken as the head of water minus the dead load of the lower ground floor slab and any permanent finishes, e.g. screed.

Geotechnical Design

The ground conditions at the proposed site are comprised of nominal layer of made ground over the London Clay as shown in geotechnical survey report from borehole record at the proposed site location.

Layer Description	Depth mBGL
Made Ground	0-1.39
London Clay Formation	>10

The lower ground floor retaining walls, underpins and foundations have been designed with the following geotechnical design parameters:

Soil	Unit Weight	Shear angle
Made Ground	17	27
Clay	20	23

For the temporary case, the retaining walls will be designed using 'active' pressures (where movement of the retaining wall is likely and acceptable), as opposed to 'at rest' pressures (where movement of the retaining wall is unlikely or unacceptable). The underpinning process, where soil is excavated underneath an existing load bearing wall and a vertical shear face of soil is exposed, allows the excavated face of soil to move, thus mobilizing the 'active' pressures. For the permanent case, the walls will be designed using 'at rest' pressures, the wall is likely to have stopped moving and, over time, at rest pressures will be generated. These movements will be very slight and will most likely have a negligible effect on the vertical settlement of the retained soil behind the underpinning / retaining walls. These movement are considered acceptable.

Ground bearing pressures below the underpinning bases will be calculated for both the temporary and permanent conditions.

Water Table

During geotechnical investigations, ground water was not encountered, therefore it is considered that the ground water is below proposed lower ground floor formation level.

An accidental case will be assumed of 1.0 m below ground level for design of uplift on the slab and lateral forces on the retaining walls.

Bearing Pressures

From the BGS information the local geology is confirmed as being medium dense sand and gravel. A borehole log at the proposed site (at no. 16 Pilgrim's Lane) indicates nominal layer of made ground underlain by London Clay - as shown in Figure 1 below.

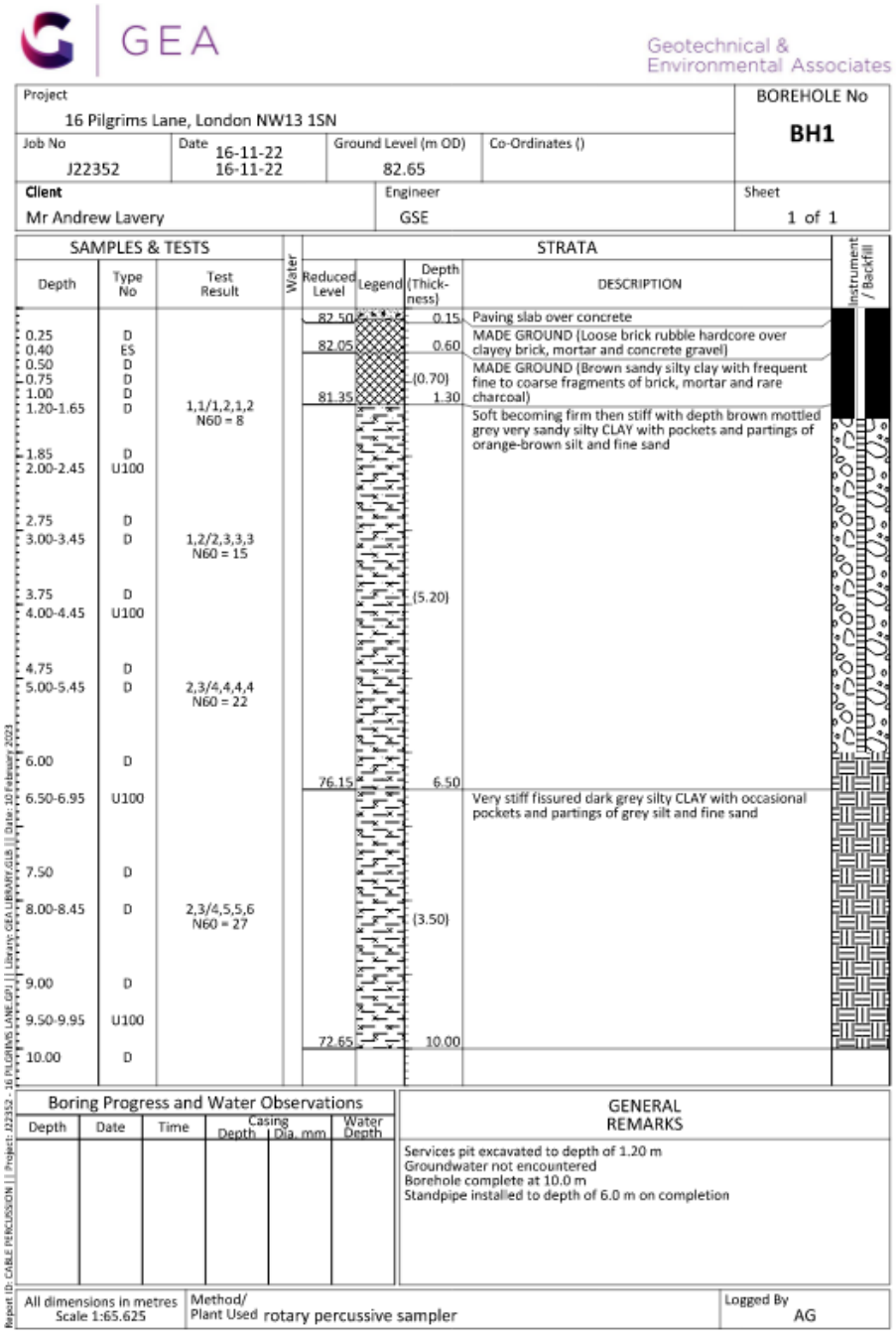


Figure 1 – no. 16 Pilgrim's Lane - Borehole log

Based on existing geology and geotechnical survey report at the proposed site, available bearing capacities within stiff clay may be designed for a bearing pressure of 125kN/m^2.

Temporary Works

The underpins/retaining walls will be designed where possible to be self-supporting under surcharge and soil loading in the construction stage of the project. The underpins will need to be propped during construction to avoid any sliding failure at the base in the granular materials.

Existing Masonry

Existing masonry is to be assessed in accordance with guidance given in CIRIA Report 111 i.e., for UNFACTORED LOADS

i) Basic brick compressive strength = 0.42 N/mm2
ii) Enhancement under bearings = 1.5
iii) Therefore, padstones to be sized on the basis of a bearing stress of (0.42 x 1.5 =) 0.63 N/mm2

New Masonry

All new masonry will be designed using FACTORED LOADS in accordance with BS5628 – Code of Practice for the use of masonry.

Design Codes

This calculation package was carried out in accordance with the relevant *British Standards and Eurocodes*.

Materials

Reinforced Concrete

Horizontal elements:	Grade C28/35
Vertical elements:	Grade C28/35
Reinforcement:	500 N/mm²

2.0 Loadings

Timber Flat Roof

Dead Loads	
Felt and chippings	0.45 kN/m^2
Boards and joists	0.20 kN/m^2
Ceiling	0.20 kN/m^2
Services	0.15 kN/m^2
Total Dead Load	**1.00 kN/m^2**
Imposed Load	**0.75 kN/m^2**

Timber Pitched Roof

Dead Loads	
Slate and felt	0.30 kN/m^2
Boards and joists	0.25 kN/m^2
Ceiling	0.25 kN/m^2
Services	0.15 kN/m^2
Total Dead Load	**1.00 kN/m^2**
Total Imposed Loading	**1.00 kN/m^2**

Timber Floors

Dead Loads	
Boards and joists	0.35 kN/m^2
Ceiling	0.25 kN/m^2
Services	0.20 kN/m^2
Total Dead Load	**0.80 kN/m^2**
Imposed Load	**1.50 kN/m^2**

Partitions (on plan) **0.60 kN/m^2**

Comflor

Dead Loads	
Screed	1.80 kN/m^2
Floor swt	2.38 kN/m^2
Ceiling, Services, FInishes	0.55 kN/m^2
Total Dead Load	**4.73 kN/m^2**
Imposed Load	**1.50 kN/m^2**

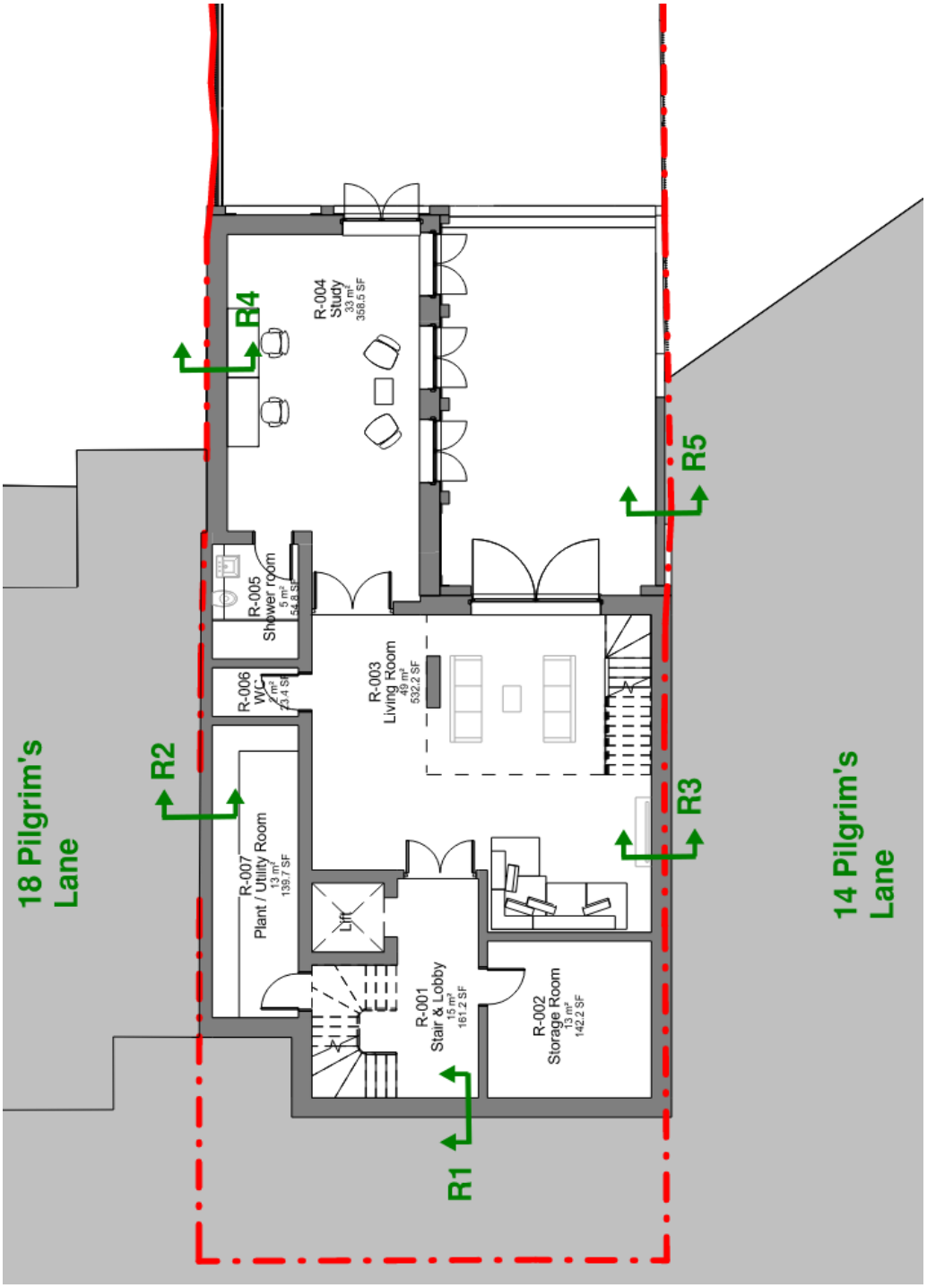
Walls Loads (on elevation)

Stud Partitions	0.60 kN/m^2
215 Brickwork + Render	5.30 kN/m^2

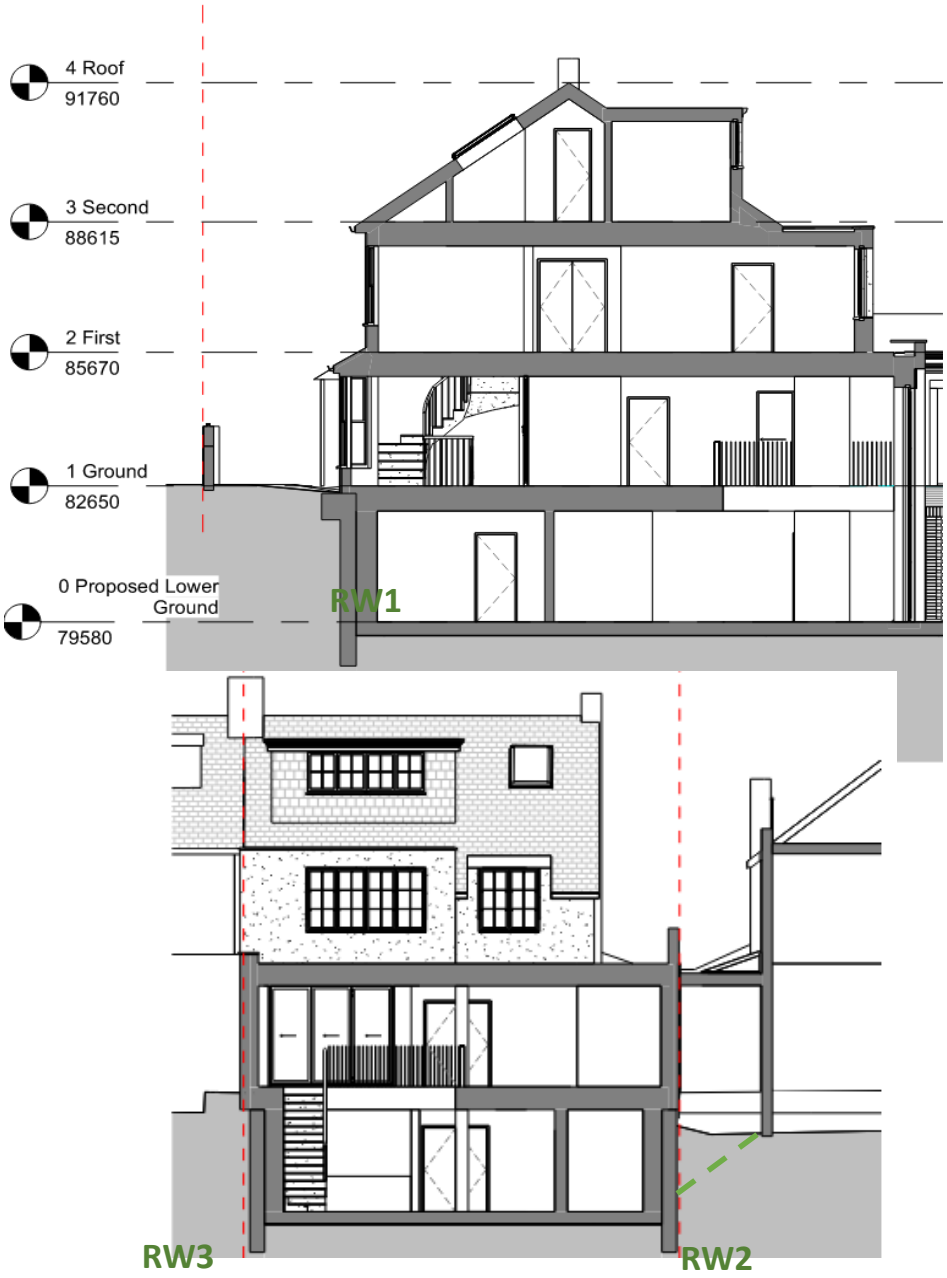
3.0 LOWER GROUND FLOOR CALCULATIONS

- **Retaining walls R1, R2, R3, R4, R5**
- **Lower Ground floor slab**
- **Buoyancy check**

GSE GREEN STRUCTURAL ENGINEERING	Project 16 Pilgrim's Lane		Job Ref. J002378	
	Drawing Ref.	Calculations by NW	Checked by	Sheet
	Part of Structure Wall section IDs		Date Dec-22	



GSE GREEN STRUCTURAL ENGINEERING	Project 16 Pilgrim's Lane		Job Ref. J002378	
	Drawing Ref.	Calculations by NW	Checked by	Sheet
	Part of Structure Retaining wall sections		Date Dec-22	



	Project		Job Ref.	
GSE GREEN STRUCTURAL ENGINEERING	16 Pilgrim's Lane		J002378	
	Drawing Ref.	Calculations by NW	Checked by ME	Sheet
	Part of Structure Underpinning R-1 (Front elevation)			Date Dec-22

h = 3.35 m

The retaining walls will be designed for two load cases:

• Case 1 – Maximum vertical forces and minimum horizontal forces: This is the most onerous case for bearing pressures on the heel;

• Case 2 – Minimum vertical forces and maximum horizontal forces: This is the most onerous case for bearing pressures on the toe and overturning. For these the live loads will be removed.

Assumptions:

- Total retained height 3350mm

- Accidental water level assumed at 1mBGL

- Surcharge of 10kN/m2 has been taken as minimum required (BS8002)

- 150Pa safe bearing pressure

- it is assumed that the floor joists span front to back of the property

Ltoe = 2.1 m

Lheel = 0.2 m

Loading (w)

Dead Load (G_k):		kN/m²	m	kN/m
Masonry 215mm (assumed) - reduced load by 30% due to window openings		3.7	6	22.26
Comflor (GF)		4.7	1.65	15.61
Timber floor (1st, 2nd)	2	0.8	1.65	2.64
Pitched roof		1.0	1	1.00
TOTAL LC1				41.51
TOTAL LC2				37.36

Live Load (Q_k):		kN/m²	m	kN/m
surcharge considered		10.00		
Comflor (GF)	2	1.5	1.65	4.95
Timber floor (1st, 2nd)	1	2.1	1.65	3.47
Pitched roof		1.00	1	1.00
TOTAL LC1				9.415
TOTAL LC2				0.00

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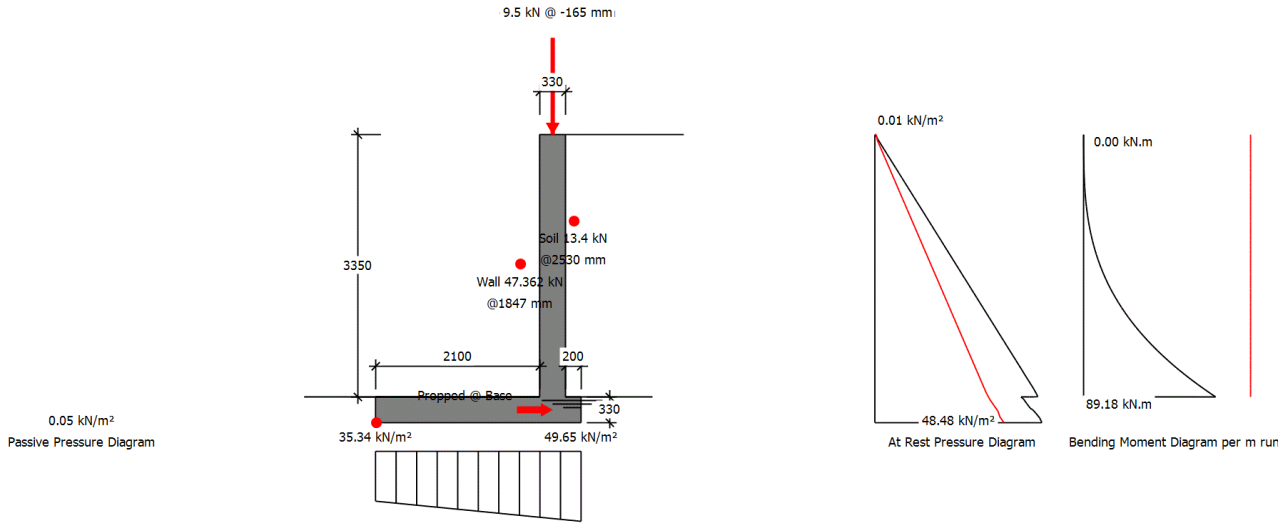
MASTERKEY : RETAINING WALL DESIGN TO BS 8002 : 1994 AND BS 8110 : 1997

R1 - Front retaining wall - LC1

Reinforced Concrete Retaining Wall with Reinforced Base



Summary of Design Data

Notes	All dimensions are in mm and all forces are per metre run
Material Densities (kN/m³)	Back Soil - Dry 20.00, Saturated 22.00, Submerged 12.00
	Front Soil - Dry 18.00, Saturated 20.80, Submerged 10.80, Concrete 24.00
Concrete grade	fcu 35 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 50 mm, Wall outer cover 35 mm, Base cover 50 mm
Reinforcement design	fy 500 N/mm² designed to BS 8110: 1997
Surcharge and Water Table	Surcharge 0.00 kN/m², Water table level 0 mm
Unplanned excavation depth	Front of wall 368 mm

† The Engineer must satisfy him/herself to the reinforcement detailing requirements of the relevant codes of practice

Additional Loads

Wall Propped at Base Level	Therefore no sliding check is required
Vertical Line Loads	41.5 kN/m @ X -165 mm and Y 0 mm - Load type Dead
	9.5 kN/m @ X -165 mm and Y 0 mm - Load type Live
† Dimensions	Ties, line loads and partial loads are measured from the inner top edge of the wall

Soil Properties

Bearing pressure	Premissable service pressure @ front 125.00 kN/m², @ back 125.00 kN/m²
Back Soil Friction and Cohesion	ϕ = Atn(Tan(20)/1.2) = 16.87°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(20)/1.2))) = 12.82°
Front Soil Friction and Cohesion	ϕ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

G_{Soil}- Soil Self Weight, G_{Wall}- Wall & Base Self Weight, Fv_{Heel}- Vertical Loads over Heel, P_a- Active Earth Pressure

Case 1: Geotechnical Design	1.00 G_{Soil}+1.00 G_{Wall}+1.00 Fv_{Heel}+1.00 P_a
Case 2: Structural Ultimate Design	1.40 G_{Soil}+1.40 G_{Wall}+1.40 Fv_{Heel}+1.00 P_a

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	81.690/236.903	0.345	OK

Wall Sliding - Virtual Back Pressure

$Fx/(Rx_{Friction}+ Rx_{Passive})$	0.000/(25.424+0.000)	0.000	OK

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Prop Reaction Case 2 (Service)	66.7 kN @ Base		

Soil Pressure

Virtual Back (No uplift)	Max(35.342/125, 49.648/125) kN/m²	0.397	OK
Wall Back (No uplift)	Max(43.728/125, 41.262/125) kN/m²	0.350	OK

Structural Design

At Rest Earth Pressure

At rest earth pressures magnification	(1+Sin(ϕ)) x √OCR = (1+Sin(16.87)x√1		1.29

Prop Reaction

Maximum Prop Reaction (Ultimate)	94.6 kN @ Base		

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main B16@200 (50 mm) Dist. B12@200 (66 mm)	1005 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (35 mm) Dist. B12@200 (47 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	272 mm, 1000 mm, 1005 mm², 500 N/mm², 35.0 N/mm²	258 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 41 mm, 31 mm, 0.12	112.8 kN.m	
Moment Capacity Check (M/Mr)	M 89.2 kN.m, Mr 112.8 kN.m	0.790	OK
Shear Capacity Check	F 79.6 kN, vc 0.559 N/mm², Fvr 152.0 kN	0.52	OK

Base Top Steel Design

Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	OK
Compression Steel Provided (Cover)	Main B16@200 (50 mm) Dist. B12@200 (66 mm)	1005 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	274 mm, 1000 mm, 565 mm², 500 N/mm², 35 N/mm²	260 mm	
Mr=fn(above,As',d',x,x/d)	1005 mm², 58 mm, 18 mm, 0.06	64.0 kN.m	
Moment Capacity Check (M/Mr)	M 0.8 kN.m, Mr 64.0 kN.m	0.012	OK
Shear Capacity Check	F 7.8 kN, vc 0.459 N/mm², Fvr 125.8 kN	0.06	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main B16@200 (50 mm) Dist. B12@200 (66 mm)	1005 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	272 mm, 1000 mm, 1005 mm², 500 N/mm², 35 N/mm²	258 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 56 mm, 31 mm, 0.12	112.8 kN.m	
Moment Capacity Check (M/Mr)	M 99.5 kN.m, Mr 112.8 kN.m	0.882	OK
Shear Capacity Check	F 98.7 kN, vc 0.559 N/mm², Fvr 152.0 kN	0.65	OK

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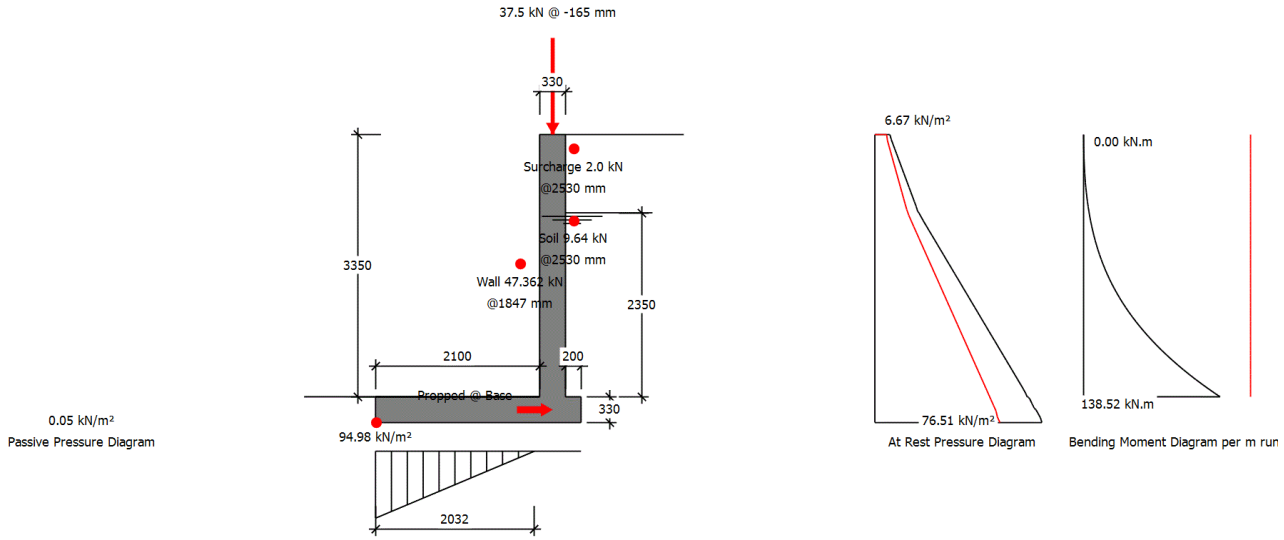
MASTERKEY : RETAINING WALL DESIGN TO BS 8002 : 1994 AND BS 8110 : 1997

R1 - Front retaining wall - LC2

Reinforced Concrete Retaining Wall with Reinforced Base



Summary of Design Data

Notes	All dimensions are in mm and all forces are per metre run
Material Densities (kN/m³)	Back Soil - Dry 20.00, Saturated 22.00, Submerged 12.00
	Front Soil - Dry 18.00, Saturated 20.80, Submerged 10.80, Concrete 24.00
Special Assumptions (virtual back)	Use δ =0 @ virtual back
Concrete grade	fcu 35 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 50 mm, Wall outer cover 35 mm, Base cover 50 mm
Reinforcement design	fy 500 N/mm² designed to BS 8110: 1997
Surcharge and Water Table	Surcharge 10.00 kN/m², Water table level 2350 mm
Unplanned excavation depth	Front of wall 368 mm

† The Engineer must satisfy him/herself to the reinforcement detailing requirements of the relevant codes of practice

Additional Loads

Wall Propped at Base Level	Therefore no sliding check is required
Vertical Line Load	37.5 kN/m @ X -165 mm and Y 0 mm - Load type Dead
† Dimensions	Ties, line loads and partial loads are measured from the inner top edge of the wall

Soil Properties

Bearing pressure	Premissable service pressure @ front 125.00 kN/m², @ back 125.00 kN/m²
Back Soil Friction and Cohesion	ϕ = Atn(Tan(23)/1.2) = 19.48°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(23)/1.2))) = 14.86°
Front Soil Friction and Cohesion	ϕ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

G_{Soil}- Soil Self Weight, G_{Wall}- Wall & Base Self Weight, Fv_{Heel}- Vertical Loads over Heel,
P_a- Active Earth Pressure, $P_{surcharge}$- Earth pressure from surcharge

Case 1: Geotechnical Design	1.00 G_{Soil}+1.00 G_{Wall}+1.00 Fv_{Heel}+1.00 P_a+1.00 $P_{surcharge}$
Case 2: Structural Ultimate Design	1.40 G_{Soil}+1.40 G_{Wall}+1.40 Fv_{Heel}+1.00 P_a+1.00 $P_{surcharge}$

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	136.508/201.873	0.676	OK

Wall Sliding - Virtual Back Pressure

$Fx/(Rx_{Friction}+ Rx_{Passive})$	0.000/(25.602+0.000)	0.000	OK
Prop Reaction Case 2 (Service)	107.6 kN @ Base		

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Soil Pressure

Virtual Back	94.980/125 kN/m², Length under pressure 2.032 m	0.760	OK
Wall Back	94.726/125 kN/m², Length under pressure 2.037 m	0.758	OK

Structural Design

At Rest Earth Pressure

At rest earth pressures magnification	(1+Sin(ϕ)) x √OCR = (1+Sin(19.48)x√1		1.33

Prop Reaction

Maximum Prop Reaction (Ultimate)	143.3 kN @ Base

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main B20@200 (50 mm) Dist. B12@200 (70 mm)	1571 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (35 mm) Dist. B12@200 (47 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	270 mm, 1000 mm, 1571 mm², 500 N/mm², 35.0 N/mm²	248 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 41 mm, 49 mm, 0.18	169.5 kN.m	
Moment Capacity Check (M/Mr)	M 138.5 kN.m, Mr 169.5 kN.m	0.817	OK
Shear Capacity Check	F 119.2 kN, vc 0.651 N/mm², Fvr 175.8 kN	0.68	OK

Base Top Steel Design

Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	OK
Compression Steel Provided (Cover)	Main B20@200 (50 mm) Dist. B12@200 (70 mm)	1571 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	274 mm, 1000 mm, 565 mm², 500 N/mm², 35 N/mm²	260 mm	
Mr=fn(above,As',d',x,x/d)	1571 mm², 60 mm, 18 mm, 0.06	64.0 kN.m	
Moment Capacity Check (M/Mr)	M 1.8 kN.m, Mr 64.0 kN.m	0.029	OK
Shear Capacity Check	F 18.5 kN, vc 0.459 N/mm², Fvr 125.8 kN	0.15	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main B20@200 (50 mm) Dist. B12@200 (70 mm)	1571 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	270 mm, 1000 mm, 1571 mm², 500 N/mm², 35 N/mm²	248 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 56 mm, 49 mm, 0.18	169.5 kN.m	
Moment Capacity Check (M/Mr)	M 158.4 kN.m, Mr 169.5 kN.m	0.935	OK
Shear Capacity Check	F 111.4 kN, vc 0.651 N/mm², Fvr 175.8 kN	0.63	OK

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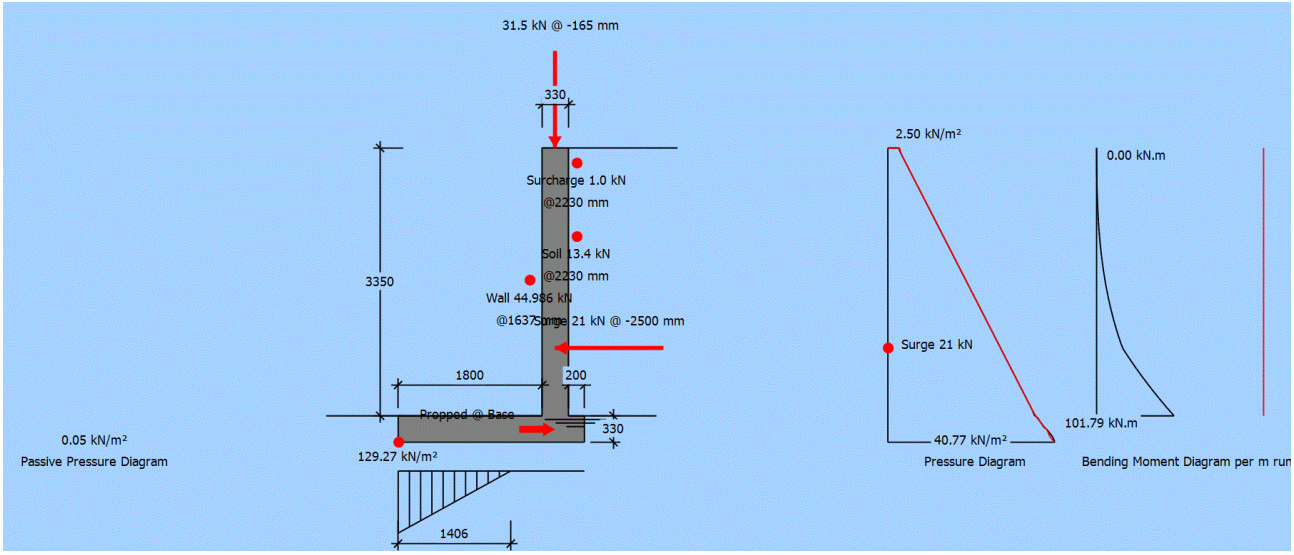
MASTERKEY : RETAINING WALL DESIGN TO BS 8002 : 1994 AND BS 8110 : 1997

R2 - Party wall with no 18 - LC2 TEMP

Reinforced Concrete Retaining Wall with Reinforced Base



Summary of Design Data

Notes	All dimensions are in mm and all forces are per metre run
Material Densities (kN/m³)	Back Soil - Dry 20.00, Saturated 22.00, Submerged 12.00
	Front Soil - Dry 18.00, Saturated 20.80, Submerged 10.80, Concrete 24.00
Special Assumptions (virtual back)	Use δ =0 @ virtual back
Concrete grade	fcu 35 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 50 mm, Wall outer cover 35 mm, Base cover 50 mm
Reinforcement design	fy 500 N/mm² designed to BS 8110: 1997
Surcharge and Water Table	Surcharge 5.00 kN/m², Water table level 0 mm
Unplanned excavation depth	Front of wall 368 mm

† The Engineer must satisfy him/herself to the reinforcement detailing requirements of the relevant codes of practice

Additional Loads

Wall Propped at Base Level	Therefore no sliding check is required
Horizontal Surge	21 kN acting @ -2500 mm above the top edge of the wall
Vertical Line Load	31.5 kN/m @ X -165 mm and Y 0 mm - Load type Dead
† Dimensions	Ties, line loads and partial loads are measured from the inner top edge of the wall

Soil Properties

Bearing pressure	Premissable service pressure @ front 125.00 kN/m², @ back 125.00 kN/m²
Back Soil Friction and Cohesion	ϕ = Atn(Tan(23)/1.2) = 19.48°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(23)/1.2))) = 14.86°
Front Soil Friction and Cohesion	ϕ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

G_{Soil}- Soil Self Weight, G_{Wall}- Wall & Base Self Weight, Fv_{Heel}- Vertical Loads over Heel,
P_a- Active Earth Pressure, $P_{surcharge}$- Earth pressure from surcharge

Case 1: Geotechnical Design	1.00 G_{Soil}+1.00 G_{Wall}+1.00 Fv_{Heel}+1.00 P_a+1.00 $P_{surcharge}$
Case 2: Structural Ultimate Design	1.40 G_{Soil}+1.40 G_{Wall}+1.40 Fv_{Heel}+1.00 P_a+1.00 $P_{surcharge}$

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	100.263/142.863	0.702	OK

Wall Sliding - Virtual Back Pressure

Fx/($Rx_{Friction}$+ $Rx_{Passive}$)	0.000/(24.112+0.000)	0.000	OK

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Job ref	: J002378
Sheet	: **Sheet Ref / 7 -**
Made By	: NW
Date	**: Dec/22**
Checked	**: AA**
Approved	:

Prop Reaction Case 2 (Service)	98.2 kN @ Base		

Soil Pressure

Virtual Back	129.267/125 kN/m², Length under pressure 1.406 m	1.034	Warning
Wall Back	128.840/125 kN/m², Length under pressure 1.411 m	1.031	Warning
Note:	Length under pressure Is less than 75% of the base width		Warning

Structural Design

Prop Reaction

Maximum Prop Reaction (Ultimate)	106.5 kN @ Base		

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main B20@150 (50 mm) Dist. B12@200 (70 mm)	2094 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (35 mm) Dist. B12@200 (47 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	270 mm, 1000 mm, 2094 mm², 500 N/mm², 35.0 N/mm²	241 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 41 mm, 65 mm, 0.24	219.4 kN.m	
Moment Capacity Check (M/Mr)	M 101.8 kN.m, Mr 219.4 kN.m	0.464	OK
Shear Capacity Check	F 93.8 kN, vc 0.717 N/mm², Fvr 193.5 kN	0.48	OK

Base Top Steel Design

Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	OK
Compression Steel Provided (Cover)	Main B20@150 (50 mm) Dist. B12@200 (70 mm)	2094 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	274 mm, 1000 mm, 565 mm², 500 N/mm², 35 N/mm²	260 mm	
Mr=fn(above,As',d',x,x/d)	2094 mm², 60 mm, 18 mm, 0.06	64.0 kN.m	
Moment Capacity Check (M/Mr)	M 2.2 kN.m, Mr 64.0 kN.m	0.034	OK
Shear Capacity Check	F 21.2 kN, vc 0.459 N/mm², Fvr 125.8 kN	0.17	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main B20@150 (50 mm) Dist. B12@200 (70 mm)	2094 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	270 mm, 1000 mm, 2094 mm², 500 N/mm², 35 N/mm²	241 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 56 mm, 65 mm, 0.24	219.4 kN.m	
Moment Capacity Check (M/Mr)	M 112.5 kN.m, Mr 219.4 kN.m	0.513	OK
Shear Capacity Check	F 100.2 kN, vc 0.717 N/mm², Fvr 193.5 kN	0.52	OK

	Project		Job Ref.	
GSE GREEN STRUCTURAL ENGINEERING	16 Pilgrim's Lane		J002378	
	Drawing Ref.	Calculations by NW	Checked by	Sheet
	Part of Structure Underpinning R-2 (party wall with no. 18 Pilgrim's Lane)			Date Dec-22

h = 3.35 m

The retaining walls will be designed for two load cases:

• Case 1 – Maximum vertical forces and minimum horizontal forces: This is the most onerous case for bearing pressures on the heel;

• Case 2 – Minimum vertical forces and maximum horizontal forces: This is the most onerous case for bearing pressures on the toe and overturning. For these the live loads will be removed.

Assumptions:

- Total retained height 3350mm

- Accidental water level assumed at 1mBGL

- Surcharge of 5kN/m2 has been considered for the area underneath existing floor

- 150Pa safe bearing pressure

- it is assumed that the floor joists of the side extension span side to side with similar arrangement considered at no.18)

Ltoe = 2.1 m

Lheel = 0.2 m

Loading (w)

Dead Load (G_k):

		kN/m²	m	kN/m
Party wall - masonry 215mm (assumed)		5.3	4.5	23.85
Comflor (GF)		4.7	1.9	8.99
Flat roof		1.0	1.9	1.90
Surge force due to no18 flank wall (multiplied by K0)	19.55	5.3	7	37.10
		1.0	2	2.00
TOTAL LC1				34.74
TOTAL LC2				31.26

Live Load (Q_k):

		kN/m²	m	kN/m
surcharge considered		5.00		
Ground floor - timber		1.5	1.9	2.85
Flat roof		0.75	1.9	1.43
Surge force due to no18 flank wall (multiplied by K0)	1	1.0	2	2.00
TOTAL LC1				4.275
TOTAL LC2				0.00

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Job ref	: J002378
Sheet	: **Sheet Ref / 8 -**
Made By	: NW
Date	**: Dec/22**
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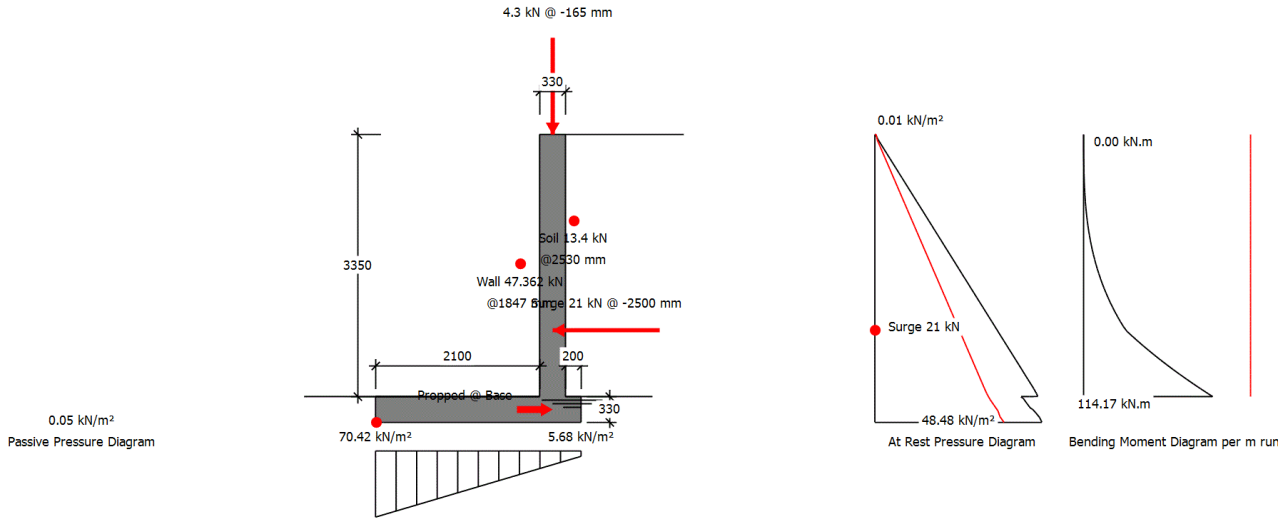
MASTERKEY : RETAINING WALL DESIGN TO BS 8002 : 1994 AND BS 8110 : 1997

R2 - Party wall with no 18 - LC1

Reinforced Concrete Retaining Wall with Reinforced Base



Summary of Design Data

Notes	All dimensions are in mm and all forces are per metre run
Material Densities (kN/m³)	Back Soil - Dry 20.00, Saturated 22.00, Submerged 12.00
	Front Soil - Dry 18.00, Saturated 20.80, Submerged 10.80, Concrete 24.00
Concrete grade	fcu 35 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 50 mm, Wall outer cover 35 mm, Base cover 50 mm
Reinforcement design	fy 500 N/mm² designed to BS 8110: 1997
Surcharge and Water Table	Surcharge 0.00 kN/m², Water table level 0 mm
Unplanned excavation depth	Front of wall 368 mm

† The Engineer must satisfy him/herself to the reinforcement detailing requirements of the relevant codes of practice

Additional Loads

Wall Propped at Base Level	Therefore no sliding check is required
Horizontal Surge	21 kN acting @ -2500 mm above the top edge of the wall
Vertical Line Loads	35 kN/m @ X -165 mm and Y 0 mm - Load type Dead
	4.3 kN/m @ X -165 mm and Y 0 mm - Load type Live
† Dimensions	Ties, line loads and partial loads are measured from the inner top edge of the wall

Soil Properties

Bearing pressure	Premissable service pressure @ front 125.00 kN/m², @ back 125.00 kN/m²
Back Soil Friction and Cohesion	ϕ = Atn(Tan(20)/1.2) = 16.87°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(20)/1.2))) = 12.82°
Front Soil Friction and Cohesion	ϕ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

G_{Soil}- Soil Self Weight, G_{Wall}- Wall & Base Self Weight, Fv_{Heel}- Vertical Loads over Heel,
P_a- Active Earth Pressure

Case 1: Geotechnical Design	1.00 G_{Soil}+1.00 G_{Wall}+1.00 Fv_{Heel}+1.00 P_a
Case 2: Structural Ultimate Design	1.40 G_{Soil}+1.40 G_{Wall}+1.40 Fv_{Heel}+1.00 P_a

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	81.690/185.622	0.440	OK

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Wall Sliding - Virtual Back Pressure

$Fx/(Rx_{Friction}+ Rx_{Passive})$	0.000/(22.762+0.000)	0.000	OK
Prop Reaction Case 2 (Service)	87.7 kN @ Base		

Soil Pressure

Virtual Back (No uplift)	Max(62.030/125, 14.063/125) kN/m²	0.496	OK
Wall Back (No uplift)	Max(70.416/125, 5.677/125) kN/m²	0.563	OK

Structural Design

At Rest Earth Pressure

At rest earth pressures magnification	$(1+\text{Sin}(\phi)) \times \sqrt{OCR} = (1+\text{Sin}(16.87)\times\sqrt{1}$	1.29

Prop Reaction

Maximum Prop Reaction (Ultimate)	124.0 kN @ Base

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main B16@150 (50 mm) Dist. B12@200 (66 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (35 mm) Dist. B12@200 (47 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	272 mm, 1000 mm, 1340 mm², 500 N/mm², 35.0 N/mm²	253 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 41 mm, 42 mm, 0.15	147.7 kN.m	
Moment Capacity Check (M/Mr)	M 114.2 kN.m, Mr 147.7 kN.m	0.773	OK
Shear Capacity Check	F 109.0 kN, vc 0.615 N/mm², Fvr 167.3 kN	0.65	OK

Base Top Steel Design

Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	OK
Compression Steel Provided (Cover)	Main B16@150 (50 mm) Dist. B12@200 (66 mm)	1340 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	274 mm, 1000 mm, 565 mm², 500 N/mm², 35 N/mm²	260 mm	
Mr=fn(above,As',d',x,x/d)	1340 mm², 58 mm, 18 mm, 0.06	64.0 kN.m	
Moment Capacity Check (M/Mr)	M 1.7 kN.m, Mr 64.0 kN.m	0.027	OK
Shear Capacity Check	F 17.1 kN, vc 0.459 N/mm², Fvr 125.8 kN	0.14	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main B16@150 (50 mm) Dist. B12@200 (66 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	272 mm, 1000 mm, 1340 mm², 500 N/mm², 35 N/mm²	253 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 56 mm, 42 mm, 0.15	147.7 kN.m	
Moment Capacity Check (M/Mr)	M 130.8 kN.m, Mr 147.7 kN.m	0.885	OK
Shear Capacity Check	F 104.1 kN, vc 0.615 N/mm², Fvr 167.3 kN	0.62	OK

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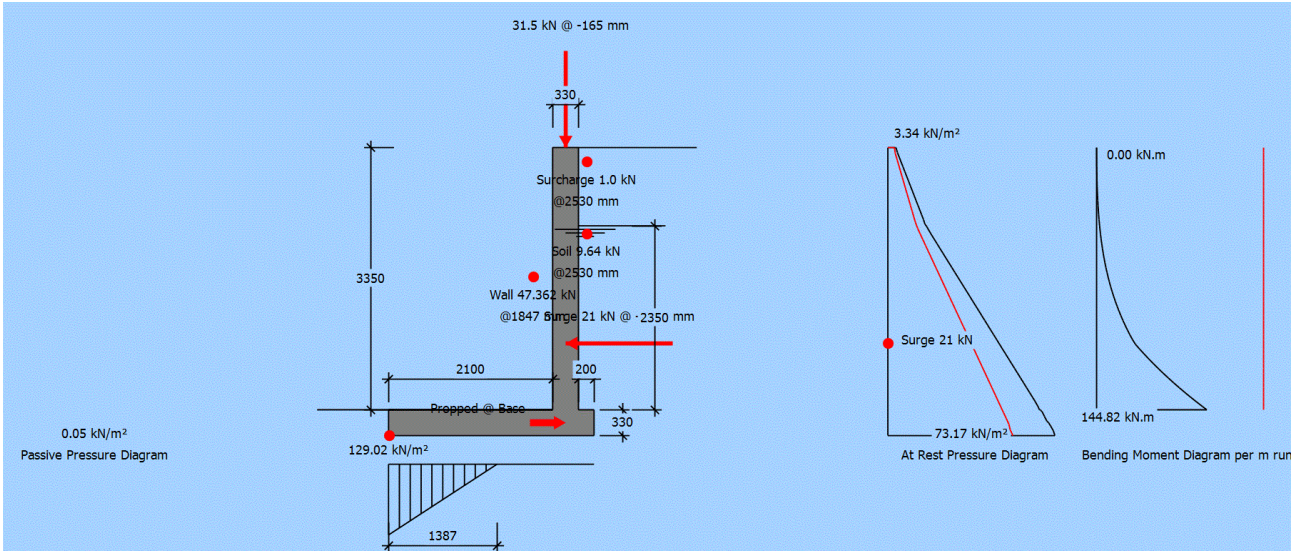
Job ref	: J002378
Sheet	: **Sheet Ref / 10 -**
Made By	: NW
Date	**: Dec/22**
Checked	**: AA**
Approved	:

MASTERKEY : RETAINING WALL DESIGN TO BS 8002 : 1994 AND BS 8110 : 1997

R2 - Party wall with no 18 - LC2

Reinforced Concrete Retaining Wall with Reinforced Base



Summary of Design Data

Notes	All dimensions are in mm and all forces are per metre run
Material Densities (kN/m³)	Back Soil - Dry 20.00, Saturated 22.00, Submerged 12.00
	Front Soil - Dry 18.00, Saturated 20.80, Submerged 10.80, Concrete 24.00
Special Assumptions (virtual back)	Use δ =0 @ virtual back
Concrete grade	fcu 35 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 50 mm, Wall outer cover 35 mm, Base cover 50 mm
Reinforcement design	fy 500 N/mm² designed to BS 8110: 1997
Surcharge and Water Table	Surcharge 5.00 kN/m², Water table level 2350 mm
Unplanned excavation depth	Front of wall 368 mm

† The Engineer must satisfy him/herself to the reinforcement detailing requirements of the relevant codes of practice

Additional Loads

Wall Propped at Base Level	Therefore no sliding check is required
Horizontal Surge	21 kN acting @ -2500 mm above the top edge of the wall
Vertical Line Load	31.5 kN/m @ X -165 mm and Y 0 mm - Load type Dead
† Dimensions	Ties, line loads and partial loads are measured from the inner top edge of the wall

Soil Properties

Bearing pressure	Premissable service pressure @ front 125.00 kN/m², @ back 125.00 kN/m²
Back Soil Friction and Cohesion	ϕ = Atn(Tan(23)/1.2) = 19.48°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(23)/1.2))) = 14.86°
Front Soil Friction and Cohesion	ϕ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

G_{Soil}- Soil Self Weight, G_{Wall}- Wall & Base Self Weight, Fv_{Heel}- Vertical Loads over Heel,
P_a- Active Earth Pressure, $P_{surcharge}$- Earth pressure from surcharge

Case 1: Geotechnical Design	1.00 G_{Soil}+1.00 G_{Wall}+1.00 Fv_{Heel}+1.00 P_a+1.00 $P_{surcharge}$
Case 2: Structural Ultimate Design	1.40 G_{Soil}+1.40 G_{Wall}+1.40 Fv_{Heel}+1.00 P_a+1.00 $P_{surcharge}$

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	119.580/160.973	0.743	OK

Wall Sliding - Virtual Back Pressure

Fx/($Rx_{Friction}$+ $Rx_{Passive}$)	0.000/(23.744+0.000)	0.000	OK

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Prop Reaction Case 2 (Service)	119.4 kN @ Base		

Soil Pressure

Virtual Back	129.017/125 kN/m², Length under pressure 1.387 m	1.032	Warning
Wall Back	128.484/125 kN/m², Length under pressure 1.393 m	1.028	Warning
Note:	Length under pressure Is less than 75% of the base width		Warning

Structural Design

At Rest Earth Pressure

At rest earth pressures magnification	$(1+\sin(\phi)) \times \sqrt{OCR} = (1+\sin(19.48)\times\sqrt{1}$	1.33

Prop Reaction

Maximum Prop Reaction (Ultimate)	160.5 kN @ Base

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main B20@150 (50 mm) Dist. B12@200 (70 mm)	2094 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (35 mm) Dist. B12@200 (47 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	270 mm, 1000 mm, 2094 mm², 500 N/mm², 35.0 N/mm²	241 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 41 mm, 65 mm, 0.24	219.4 kN.m	
Moment Capacity Check (M/Mr)	M 144.8 kN.m, Mr 219.4 kN.m	0.660	OK
Shear Capacity Check	F 137.4 kN, vc 0.717 N/mm², Fvr 193.5 kN	0.71	OK

Base Top Steel Design

Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	OK
Compression Steel Provided (Cover)	Main B20@150 (50 mm) Dist. B12@200 (70 mm)	2094 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	274 mm, 1000 mm, 565 mm², 500 N/mm², 35 N/mm²	260 mm	
Mr=fn(above,As',d',x,x/d)	2094 mm², 60 mm, 18 mm, 0.06	64.0 kN.m	
Moment Capacity Check (M/Mr)	M 1.7 kN.m, Mr 64.0 kN.m	0.027	OK
Shear Capacity Check	F 17.1 kN, vc 0.459 N/mm², Fvr 125.8 kN	0.14	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main B20@150 (50 mm) Dist. B12@200 (70 mm)	2094 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	270 mm, 1000 mm, 2094 mm², 500 N/mm², 35 N/mm²	241 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 56 mm, 65 mm, 0.24	219.4 kN.m	
Moment Capacity Check (M/Mr)	M 172.5 kN.m, Mr 219.4 kN.m	0.786	OK
Shear Capacity Check	F 108.3 kN, vc 0.717 N/mm², Fvr 193.5 kN	0.56	OK

	Project		Job Ref.	
GSE GREEN STRUCTURAL ENGINEERING	16 Pilgrim's Lane		J002378	
	Drawing Ref.	Calculations by NW	Checked by	Sheet
	Part of Structure Underpinning R-3 (party wall with no. 14 Pilgrim's Lane)			Date Dec-22

h = 3.35 m

The retaining walls will be designed for two load cases:

• Case 1 – Maximum vertical forces and minimum horizontal forces: This is the most onerous case for bearing pressures on the heel;

• Case 2 – Minimum vertical forces and maximum horizontal forces: This is the most onerous case for bearing pressures on the toe and overturning. For these the live loads will be removed.

Assumptions:

- Total retained height 3350mm

- Accidental water level assumed at 1mBGL

- Surcharge of 5kN/m2 has been considered for the area underneath existing floor

- 150Pa safe bearing pressure

- it is assumed that the floor joists span front to back of the property, therefore not loading the party wall

Ltoe = 1.7 m

Lheel = 0.2 m

Loading (w)

Dead Load (G_k):

		kN/m²	m	kN/m
Party wall - masonry 215mm (assumed)		5.3	8	42.40
Comflor (GF)		4.7	2.1	19.87
Timber floor (1st, 2nd)	2	0.8	2.1	3.36
Pitched roof		1.0	1	1.00
TOTAL LC1				66.63
TOTAL LC2				59.96

Live Load (Q_k):

		kN/m²	m	kN/m
surcharge considered		5.00		
Timber floor (GF, 1st, 2nd)	3	1.5	2.1	9.45
Pitched roof		1.00	1	1.00
TOTAL LC1				10.450
TOTAL LC2				0.00

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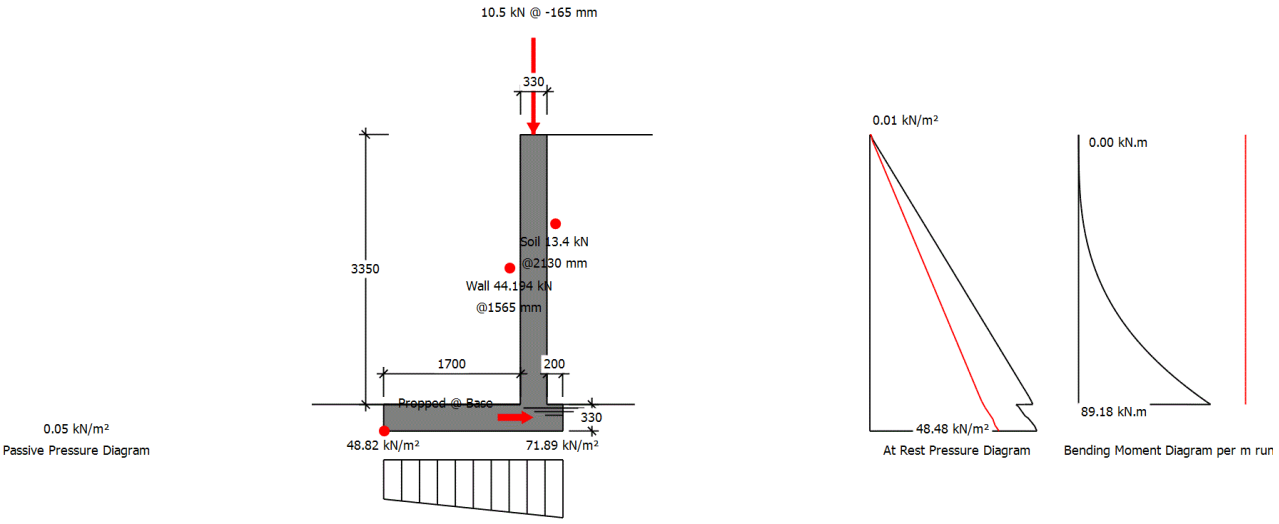
Job ref	: J002378
Sheet	: **Sheet Ref / 12 -**
Made By	: NW
Date	**: Dec/22**
Checked	**: AA**
Approved	:

MASTERKEY : RETAINING WALL DESIGN TO BS 8002 : 1994 AND BS 8110 : 1997

R3 - Party wall with no 14 - LC1

Reinforced Concrete Retaining Wall with Reinforced Base



Summary of Design Data

Notes	All dimensions are in mm and all forces are per metre run
Material Densities (kN/m³)	Back Soil - Dry 20.00, Saturated 22.00, Submerged 12.00
	Front Soil - Dry 18.00, Saturated 20.80, Submerged 10.80, Concrete 24.00
Concrete grade	fcu 35 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 50 mm, Wall outer cover 35 mm, Base cover 50 mm
Reinforcement design	fy 500 N/mm² designed to BS 8110: 1997
Surcharge and Water Table	Surcharge 0.00 kN/m², Water table level 0 mm
Unplanned excavation depth	Front of wall 368 mm

† The Engineer must satisfy him/herself to the reinforcement detailing requirements of the relevant codes of practice

Additional Loads

Wall Propped at Base Level	Therefore no sliding check is required
Vertical Line Loads	66.5 kN/m @ X -165 mm and Y 0 mm - Load type Dead
	10.5 kN/m @ X -165 mm and Y 0 mm - Load type Live
† Dimensions	Ties, line loads and partial loads are measured from the inner top edge of the wall

Soil Properties

Bearing pressure	Premissable service pressure @ front 125.00 kN/m², @ back 125.00 kN/m²
Back Soil Friction and Cohesion	ϕ = Atn(Tan(20)/1.2) = 16.87°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(20)/1.2))) = 12.82°
Front Soil Friction and Cohesion	ϕ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

G_{Soil}- Soil Self Weight, G_{Wall}- Wall & Base Self Weight, Fv_{Heel}- Vertical Loads over Heel, P_a- Active Earth Pressure

Case 1: Geotechnical Design	1.00 G_{Soil}+1.00 G_{Wall}+1.00 Fv_{Heel}+1.00 P_a
Case 2: Structural Ultimate Design	1.40 G_{Soil}+1.40 G_{Wall}+1.40 Fv_{Heel}+1.00 P_a

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	81.690/241.322	0.339	OK

Wall Sliding - Virtual Back Pressure

Fx/($Rx_{Friction}$+ $Rx_{Passive}$)	0.000/(30.618+0.000)	0.000	OK
Prop Reaction Case 2 (Service)	66.7 kN @ Base		

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Checked	**: AA**
Approved	:

Soil Pressure

Virtual Back (No uplift)	Max(48.821/125, 71.891/125) kN/m²	0.575	OK
Wall Back (No uplift)	Max(60.486/125, 60.226/125) kN/m²	0.484	OK

Structural Design

At Rest Earth Pressure

At rest earth pressures magnification	(1+Sin(ϕ)) x √OCR = (1+Sin(16.87)x√1		1.29

Prop Reaction

Maximum Prop Reaction (Ultimate)	94.6 kN @ Base		

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main B16@200 (50 mm) Dist. B12@200 (66 mm)	1005 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (35 mm) Dist. B12@200 (47 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	272 mm, 1000 mm, 1005 mm², 500 N/mm², 35.0 N/mm²	258 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 41 mm, 31 mm, 0.12	112.8 kN.m	
Moment Capacity Check (M/Mr)	M 89.2 kN.m, Mr 112.8 kN.m	0.790	OK
Wall Axial Design (N/Ncap)	N 144.9 kN, Ncap 4620.0 kN	0.031	OK
Wall Slenderness λ	Leff/tk =1.96x3350.0/330.0	19.9	OK
Kmin = (Nuz-N)/(Nuz-Nbal)	Min(1.0, 5133.3 - 144.9)/(5133.3 - 1911.2)	1.0	
M_{add}= N.Kmin.h.λ²/2000	144.9x1.0x330.0x19.9²/2000	9.5kN.m	
(M+Madd)/Mr_{Axial}	M+Madd 98.6 kN, Mr_{Axail}132.1 kN.m	0.746	OK
Shear Capacity Check	F 79.6 kN, vc 0.559 N/mm², Fvr 152.0 kN	0.52	OK

Base Top Steel Design

Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	OK
Compression Steel Provided (Cover)	Main B16@200 (50 mm) Dist. B12@200 (66 mm)	1005 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	274 mm, 1000 mm, 565 mm², 500 N/mm², 35 N/mm²	260 mm	
Mr=fn(above,As',d',x,x/d)	1005 mm², 58 mm, 18 mm, 0.06	64.0 kN.m	
Moment Capacity Check (M/Mr)	M 0.2 kN.m, Mr 64.0 kN.m	0.003	OK
Shear Capacity Check	F 1.9 kN, vc 0.459 N/mm², Fvr 125.8 kN	0.02	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main B16@200 (50 mm) Dist. B12@200 (66 mm)	1005 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	272 mm, 1000 mm, 1005 mm², 500 N/mm², 35 N/mm²	258 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 56 mm, 31 mm, 0.12	112.8 kN.m	
Moment Capacity Check (M/Mr)	M 97.6 kN.m, Mr 112.8 kN.m	0.865	OK
Shear Capacity Check	F 120.0 kN, vc 0.559 N/mm², Fvr 152.0 kN	0.79	OK

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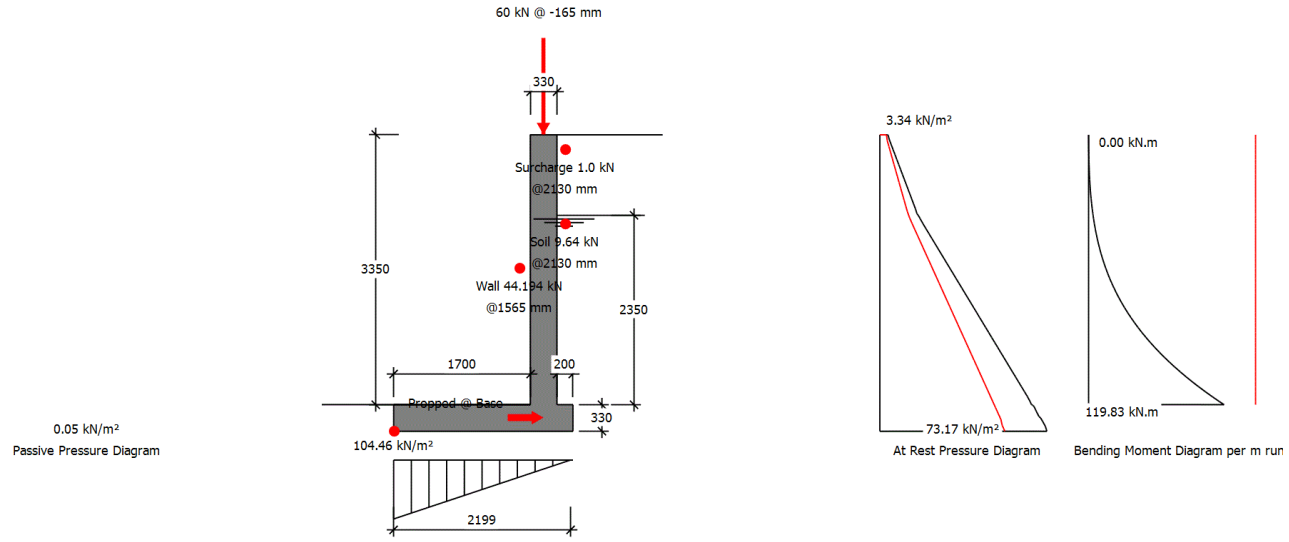
Job ref	: J002378
Sheet	: **Sheet Ref / 14 -**
Made By	: NW
Date	**: Dec/22**
Checked	**: AA**
Approved	:

MASTERKEY : RETAINING WALL DESIGN TO BS 8002 : 1994 AND BS 8110 : 1997

R3 - Party wall with no 14 - LC2

Reinforced Concrete Retaining Wall with Reinforced Base



Summary of Design Data

Notes	All dimensions are in mm and all forces are per metre run
Material Densities (kN/m³)	Back Soil - Dry 20.00, Saturated 22.00, Submerged 12.00
	Front Soil - Dry 18.00, Saturated 20.80, Submerged 10.80, Concrete 24.00
Special Assumptions (virtual back)	Use δ =0 @ virtual back
Concrete grade	fcu 35 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 50 mm, Wall outer cover 350 mm, Base cover 50 mm
Reinforcement design	fy 500 N/mm² designed to BS 8110: 1997
Surcharge and Water Table	Surcharge 5.00 kN/m², Water table level 2350 mm
Unplanned excavation depth	Front of wall 368 mm

† The Engineer must satisfy him/herself to the reinforcement detailing requirements of the relevant codes of practice

Additional Loads

Wall Propped at Base Level	Therefore no sliding check is required
Vertical Line Load	60 kN/m @ X -165 mm and Y 0 mm - Load type Dead
† Dimensions	Ties, line loads and partial loads are measured from the inner top edge of the wall

Soil Properties

Bearing pressure	Premissable service pressure @ front 125.00 kN/m², @ back 125.00 kN/m²
Back Soil Friction and Cohesion	ϕ = Atn(Tan(23)/1.2) = 19.48°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(23)/1.2))) = 14.86°
Front Soil Friction and Cohesion	ϕ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

G_{Soil}- Soil Self Weight, G_{Wall}- Wall & Base Self Weight, Fv_{Heel}- Vertical Loads over Heel,
P_a- Active Earth Pressure, $P_{surcharge}$- Earth pressure from surcharge

Case 1: Geotechnical Design	1.00 G_{Soil}+1.00 G_{Wall}+1.00 Fv_{Heel}+1.00 P_a+1.00 $P_{surcharge}$
Case 2: Structural Ultimate Design	1.40 G_{Soil}+1.40 G_{Wall}+1.40 Fv_{Heel}+1.00 P_a+1.00 $P_{surcharge}$

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	119.580/203.738	0.587	OK

Wall Sliding - Virtual Back Pressure

$Fx/(Rx_{Friction}+ Rx_{Passive})$	0.000/(30.465+0.000)	0.000	OK
Prop Reaction Case 2 (Service)	98.4 kN @ Base		

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Soil Pressure

Virtual Back	104.460/125 kN/m², Length under pressure 2.199 m	0.836	OK
Wall Back	104.248/125 kN/m², Length under pressure 2.203 m	0.834	OK

Structural Design

At Rest Earth Pressure

At rest earth pressures magnification	(1+Sin(ϕ)) x √OCR = (1+Sin(19.48)x√1		1.33

Prop Reaction

Maximum Prop Reaction (Ultimate)	131.1 kN @ Base		

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main B16@150 (50 mm) Dist. B12@200 (66 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (350 mm) Dist. B12@200 (362 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	272 mm, 1000 mm, 1340 mm², 500 N/mm², 35.0 N/mm²	253 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 356 mm, 42 mm, 0.15	147.7 kN.m	
Moment Capacity Check (M/Mr)	M 119.8 kN.m, Mr 147.7 kN.m	0.811	OK
Wall Axial Design (N/Ncap)	N 121.1 kN, Ncap 4620.0 kN	0.026	OK
Wall Slenderness λ	Leff/tk =2.00x3350.0/330.0	20.3	OK
Kmin = (Nuz-N)/(Nuz-Nbal)	Min(1.0, 5133.3 - 121.1)/(5133.3 - 1519.5)	1.0	
M_{add}= N.Kmin.h.λ²/2000	121.1x1.0x330.0x20.3²/2000	8.2kN.m	
(M+Madd)/Mr_{Axial}	M+Madd 127.2 kN, Mr_{Axail}237.5 kN.m	0.535	OK
Shear Capacity Check	F 108.0 kN, vc 0.615 N/mm², Fvr 167.3 kN	0.65	OK

Base Top Steel Design

Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	OK
Compression Steel Provided (Cover)	Main B16@150 (50 mm) Dist. B12@200 (66 mm)	1340 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	274 mm, 1000 mm, 565 mm², 500 N/mm², 35 N/mm²	260 mm	
Mr=fn(above,As',d',x,x/d)	1340 mm², 58 mm, 18 mm, 0.06	64.0 kN.m	
Moment Capacity Check (M/Mr)	M 1.5 kN.m, Mr 64.0 kN.m	0.023	OK
Shear Capacity Check	F 14.4 kN, vc 0.459 N/mm², Fvr 125.8 kN	0.11	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main B16@150 (50 mm) Dist. B12@200 (66 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	272 mm, 1000 mm, 1340 mm², 500 N/mm², 35 N/mm²	253 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 56 mm, 42 mm, 0.15	147.7 kN.m	
Moment Capacity Check (M/Mr)	M 133.8 kN.m, Mr 147.7 kN.m	0.906	OK
Shear Capacity Check	F 129.7 kN, vc 0.615 N/mm², Fvr 167.3 kN	0.78	OK

	Project		Job Ref.	
GSE GREEN STRUCTURAL ENGINEERING	16 Pilgrim's Lane		J002378	
	Drawing Ref.	Calculations by NW	Checked by	Sheet
	Part of Structure Underpinning R-4 (party wall with no. 18 Pilgrim's Lane)			Date Dec-22

h = 0.6 m

The retaining walls will be designed for two load cases:

• Case 1 – Maximum vertical forces and minimum horizontal forces: This is the most onerous case for bearing pressures on the heel;

• Case 2 – Minimum vertical forces and maximum horizontal forces: This is the most onerous case for bearing pressures on the toe and overturning. For these the live loads will be removed.

Assumptions:

- Total retained height 600mm

- Accidental water level assumed at 1mBGL

- Surcharge of 10kN/m2 has been taken as minimum required (BS8002)

- 150Pa safe bearing pressure

Ltoe = 0.3 m

Lheel = 0.2 m

Loading (w)

Dead Load (G_k):

		kN/m^2	m	kN/m
Party wall - masonry 215mm (assumed)		5.3	4.9	25.97
Comflor (GF)		4.7	2.3	10.88
Flat Roof		1.0	2.3	2.30
TOTAL LC1				39.15
TOTAL LC2				35.23

Live Load (Q_k):

		kN/m^2	m	kN/m
surcharge considered		5.00		
Timber floor (GF, 1st)	2	1.5	2.3	6.90
Flat Roof		0.75	2.3	1.73
TOTAL LC1				8.625
TOTAL LC2				0.00

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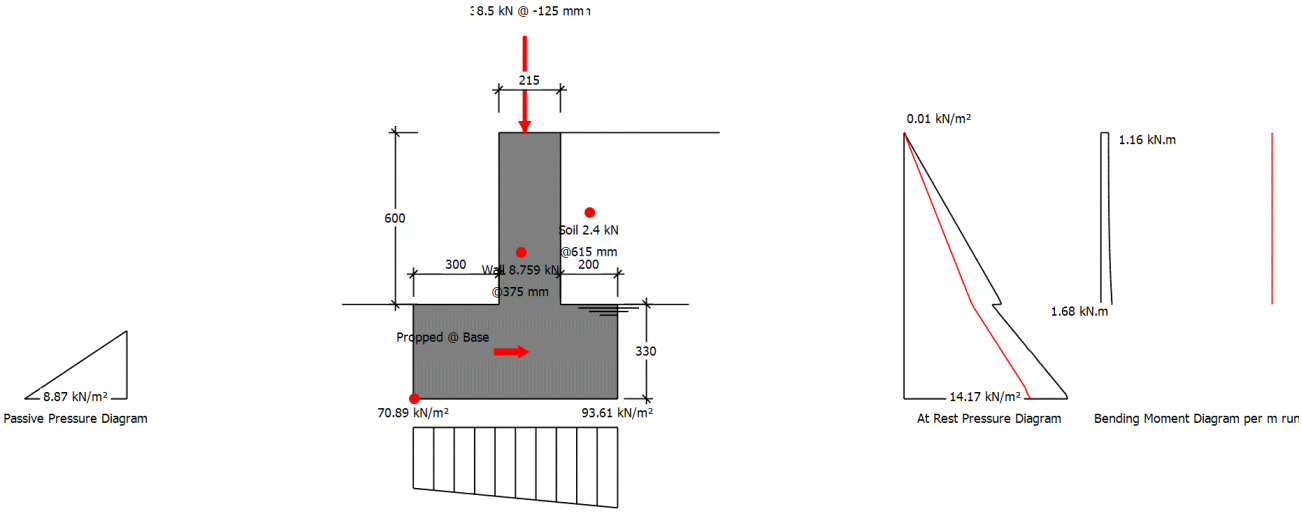
R4 - Party wall with no 18 - LC1

Reinforced Concrete Retaining Wall with Reinforced Base



Summary of Design Data

Notes	All dimensions are in mm and all forces are per metre run
Material Densities (kN/m³)	Back Soil - Dry 20.00, Saturated 22.00, Submerged 12.00 Front Soil - Dry 18.00, Saturated 20.80, Submerged 10., Concrete 24.00
Concrete grade	fcu 35 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 50 mm, Wall outer cover 35 mm, Base cover 50 mm
Reinforcement design	fy 500 N/mm² designed to BS 8110: 1997
Surcharge and Water Table	Surcharge 0.00 kN/m², Water table level 0 mm
Unplanned excavation depth	Front of wall 93 mm

† The Engineer must satisfy him/herself to the reinforcement detailing requirements of the relevant codes of practice

Additional Loads

Wall Propped at Base Level	Therefore no sliding check is required
Vertical Line Loads	39.15 kN/m @ X -125 mm and Y 0 mm - Load type Dead 8.5 kN/m @ X -125 mm and Y 0 mm - Load type Live
† Dimensions	Ties, line loads and partial loads are measured from the inner top edge of the wall

Soil Properties

Bearing pressure	Premissable service pressure @ front 150.00 kN/m², @ back 150.00 kN/m²
Back Soil Friction and Cohesion	Φ = Atn(Tan(20)/1.2) = 16.87°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(20)/1.2))) = 12.82°
Front Soil Friction and Cohesion	Φ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

G_{Soil} - Soil Self Weight, G_{Wall} - Wall & Base Self Weight, Fv_{Heel} - Vertical Loads over Heel,
P_a - Active Earth Pressure, P_p - Passive Earth Pressure

Case 1: Geotechnical Design	1.00 G_{Soil}+1.00 G_{Wall}+1.00 Fv_{Heel}+1.00 P_a+1.00 P_p
Case 2: Structural Ultimate Design	1.40 G_{Soil}+1.40 G_{Wall}+1.40 Fv_{Heel}+1.00 P_a+1.00 P_p

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	1.355/23.346	0.058	OK

Wall Sliding - Virtual Back Pressure

$Fx/(Rx_{Friction} + Rx_{Passive})$	0.000/(13.378+1.056)	0.000	OK
Prop Reaction Case 2 (Service)	4.6 kN @ Base		

Soil Pressure

Virtual Back (No uplift)	Max(70.894/150, 93.606/150) kN/m²	0.624	OK
Wall Back (No uplift)	Max(71.211/150, 93.289/150) kN/m²	0.622	OK

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Structural Design

At Rest Earth Pressure

At rest earth pressures magnification	(1+Sin(Φ)) x √OCR = (1+Sin(16.87)x√1	1.29

Prop Reaction

Maximum Prop Reaction (Ultimate)	6.1 kN @ Base

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main B10@200 (50 mm) Dist. B12@200 (60 mm)	393 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (35 mm) Dist. B12@200 (47 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	160 mm, 1000 mm, 393 mm², 500 N/mm², 35.0 N/mm²	152 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 41 mm, 12 mm, 0.08	26.0 kN.m	
Moment Capacity Check (M/Mr)	M 1.7 kN.m, Mr 26.0 kN.m	0.065	OK
Shear Capacity Check	F 2.5 kN, vc 0.557 N/mm², Fvr 89.1 kN	0.03	OK

Base Top Steel Design

Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	274 mm, 1000 mm, 565 mm², 500 N/mm², 35 N/mm²	260 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 56 mm, 18 mm, 0.06	64.0 kN.m	
Moment Capacity Check (M/Mr)	M 0.0 kN.m, Mr 64.0 kN.m	0.000	OK
Shear Capacity Check	F 0.0 kN, vc 0.459 N/mm², Fvr 125.8 kN	0.00	OK

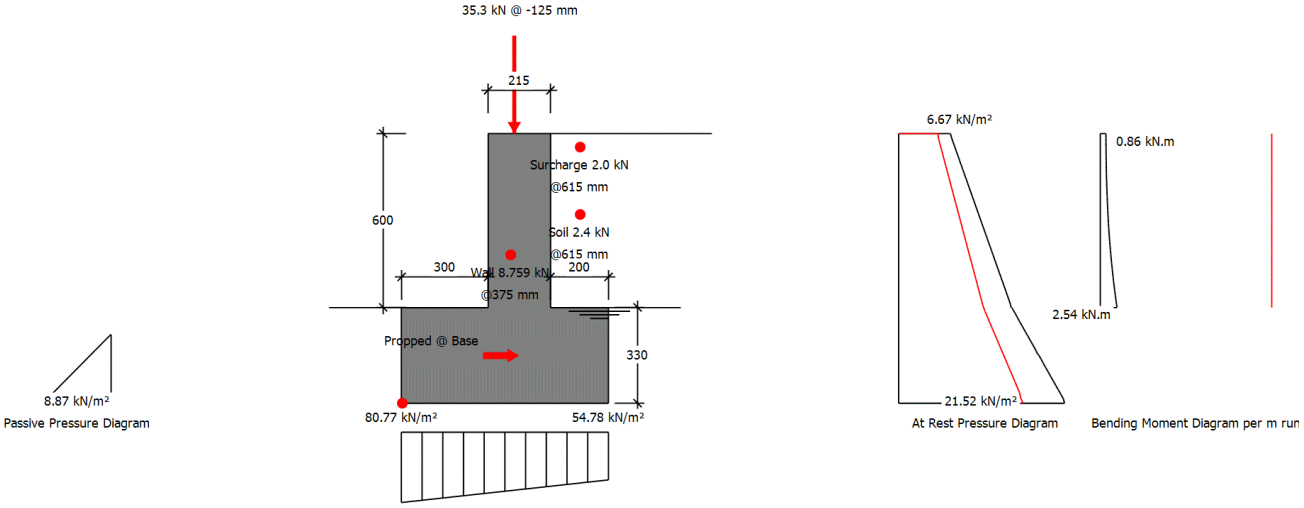
Base Bottom Steel Design

Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	274 mm, 1000 mm, 565 mm², 500 N/mm², 35 N/mm²	260 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 56 mm, 18 mm, 0.06	64.0 kN.m	
Moment Capacity Check (M/Mr)	M 4.1 kN.m, Mr 64.0 kN.m	0.065	OK
Shear Capacity Check	F 28.3 kN, vc 0.459 N/mm², Fvr 125.8 kN	0.22	OK

MASTERKEY : RETAINING WALL DESIGN TO BS 8002 : 1994 AND BS 8110 : 1997

R4 - Party wall with no 18 - LC2

Reinforced Concrete Retaining Wall with Reinforced Base



Summary of Design Data

Notes	All dimensions are in mm and all forces are per metre run
Material Densities (kN/m³)	Back Soil - Dry 20.00, Saturated 22.00, Submerged 12.00
	Front Soil - Dry 18.00, Saturated 20.80, Submerged 10., Concrete 24.00
Special Assumptions (virtual back)	Use δ =0 @ virtual back
Concrete grade	fcu 35 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 50 mm, Wall outer cover 35 mm, Base cover 50 mm
Reinforcement design	fy 500 N/mm² designed to BS 8110: 1997
Surcharge and Water Table	Surcharge 10.00 kN/m², Water table level 0 mm

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Unplanned excavation depth	Front of wall 93 mm

† The Engineer must satisfy him/herself to the reinforcement detailing requirements of the relevant codes of practice

Additional Loads

Wall Propped at Base Level	Therefore no sliding check is required
Vertical Line Load	35.3 kN/m @ X -125 mm and Y 0 mm - Load type Dead
† Dimensions	Ties, line loads and partial loads are measured from the inner top edge of the wall

Soil Properties

Bearing pressure	Premissable service pressure @ front 150.00 kN/m², @ back 150.00 kN/m²
Back Soil Friction and Cohesion	Φ = Atn(Tan(23)/1.2) = 19.48°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(23)/1.2))) = 14.86°
Front Soil Friction and Cohesion	Φ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

G_{Soil} - Soil Self Weight, G_{Wall} - Wall & Base Self Weight, Fv_{Heel} - Vertical Loads over Heel,
P_a - Active Earth Pressure, $P_{surcharge}$ - Earth pressure from surcharge, P_p - Passive Earth Pressure

Case 1: Geotechnical Design	1.00 G_{Soil}+1.00 G_{Wall}+1.00 Fv_{Heel}+1.00 P_a+1.00 $P_{surcharge}$+1.00 P_p
Case 2: Structural Ultimate Design	1.40 G_{Soil}+1.40 G_{Wall}+1.40 Fv_{Heel}+1.00 P_a+1.00 $P_{surcharge}$+1.00 P_p

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	3.543/19.760	0.179	OK

Wall Sliding - Virtual Back Pressure

Fx/($Rx_{Friction}$ + $Rx_{Passive}$)	0.000/(12.856+1.056)	0.000	OK
Prop Reaction Case 2 (Service)	9.3 kN @ Base		

Soil Pressure

Virtual Back (No uplift)	Max(80.766/150, 54.783/150) kN/m²	0.538	OK
Wall Back (No uplift)	Max(79.631/150, 55.918/150) kN/m²	0.531	OK

Structural Design

At Rest Earth Pressure

At rest earth pressures magnification	(1+Sin(Φ)) x √OCR = (1+Sin(19.48)x√1	1.33

Prop Reaction

Maximum Prop Reaction (Ultimate)	12.3 kN @ Base

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main B10@200 (50 mm) Dist. B12@200 (60 mm)	393 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (35 mm) Dist. B12@200 (47 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	160 mm, 1000 mm, 393 mm², 500 N/mm², 35.0 N/mm²	152 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 41 mm, 12 mm, 0.08	26.0 kN.m	
Moment Capacity Check (M/Mr)	M 2.5 kN.m, Mr 26.0 kN.m	0.098	OK
Shear Capacity Check	F 6.4 kN, vc 0.557 N/mm², Fvr 89.1 kN	0.07	OK

Base Top Steel Design

Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	274 mm, 1000 mm, 565 mm², 500 N/mm², 35 N/mm²	260 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 56 mm, 18 mm, 0.06	64.0 kN.m	
Moment Capacity Check (M/Mr)	M 0.0 kN.m, Mr 64.0 kN.m	0.000	OK
Shear Capacity Check	F 0.0 kN, vc 0.459 N/mm², Fvr 125.8 kN	0.00	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	274 mm, 1000 mm, 565 mm², 500 N/mm², 35 N/mm²	260 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 56 mm, 18 mm, 0.06	64.0 kN.m	
Moment Capacity Check (M/Mr)	M 4.2 kN.m, Mr 64.0 kN.m	0.066	OK
Shear Capacity Check	F 27.6 kN, vc 0.459 N/mm², Fvr 125.8 kN	0.22	OK

	Project		Job Ref.	
GSE GREEN STRUCTURAL ENGINEERING	16 Pilgrim's Lane		J002378	
	Drawing Ref.	Calculations by NW	Checked by	Sheet
	Part of Structure Underpinning R-5 (party wall with no. 14 Pilgrim's Lane)			Date Dec-22

h = 3.35 m

The retaining walls will be designed for two load cases:

• Case 1 – Maximum vertical forces and minimum horizontal forces: No considered as no vertical forces are acting no this wall;

• Case 2 – Minimum vertical forces and maximum horizontal forces: This is the most onerous case for bearing pressures on the toe and overturning. For these the live loads will be removed.

Assumptions:

- Total retained height 3350mm

- Accidental water level assumed at 1mBGL

- Surcharge of 10kN/m2 has been taken as minimum required (BS8002)

- 150Pa safe bearing pressure

Ltoe = raft m

Lheel = 0.2 m

Loading (w)

Dead Load (G_k):

		kN/m²	m	kN/m
No vertical loading				

TOTAL LC2 0.00

Live Load (Q_k):

		kN/m²	m	kN/m
surcharge considered		10.00		
No vertical loading				

TOTAL LC2 0.00

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Date	**: Dec/22**
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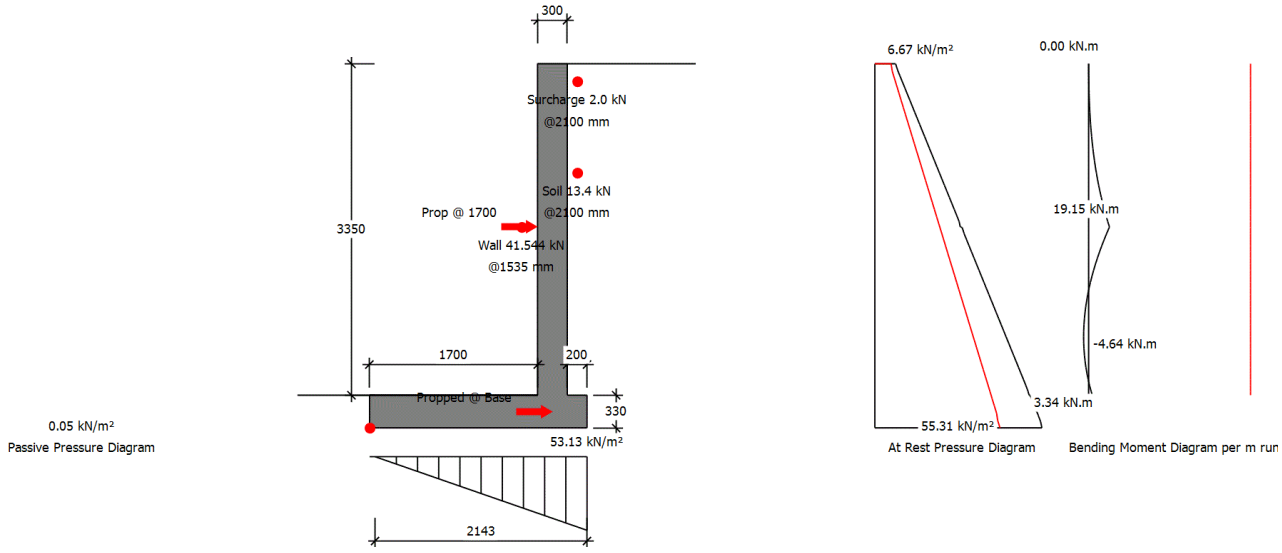
R5 - Party wall with no 14 - LC2 TEMP

Reinforced Concrete Retaining Wall with Reinforced Base



Summary of Design Data

Notes	All dimensions are in mm and all forces are per metre run
Material Densities (kN/m³)	Back soil 20.00, Front soil 18.00, Concrete 24.00
Special Assumptions (virtual back)	Use δ =0 @ virtual back
Concrete grade	fcu 35 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 50 mm, Wall outer cover 35 mm, Base cover 50 mm
Reinforcement design	fy 500 N/mm² designed to BS 8110: 1997
Surcharge and Water Table	Surcharge 10.00 kN/m², Fully drained
Unplanned excavation depth	Front of wall 368 mm

† The Engineer must satisfy him/herself to the reinforcement detailing requirements of the relevant codes of practice

Additional Loads

Wall Propped at Base Level	Therefore no sliding check is required
Additional Wall Prop	Prop @ 1.7 m
† Dimensions	All props are measured from the top of the base

Soil Properties

Bearing pressure	Premissable service pressure @ front 125.00 kN/m², @ back 125.00 kN/m²
Back Soil Friction and Cohesion	ϕ = Atn(Tan(23)/1.2) = 19.48°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(23)/1.2))) = 14.86°
Front Soil Friction and Cohesion	ϕ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

G_{Soil}- Soil Self Weight, G_{Wall}- Wall & Base Self Weight, Fv_{Heel}- Vertical Loads over Heel,
P_a- Active Earth Pressure, $P_{surcharge}$- Earth pressure from surcharge

Case 1: Geotechnical Design	1.00 G_{Soil}+1.00 G_{Wall}+1.00 Fv_{Heel}+1.00 P_a+1.00 $P_{surcharge}$
Case 2: Structural Ultimate Design	1.40 G_{Soil}+1.40 G_{Wall}+1.40 Fv_{Heel}+1.00 P_a+1.00 $P_{surcharge}$

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	117.142/201.733	0.581	OK

Wall Sliding - Virtual Back Pressure

Fx/($Rx_{Friction}$+ $Rx_{Passive}$)	0.000/(15.107+0.000)	0.000	OK
Prop Reactions Case 2 (Service)	34.1 kN @ Base, 52.0 kN @ 2.030 m		

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Approved	:

Soil Pressure

Virtual Back	53.133/125 kN/m², Length under pressure 2.143 m	0.425	OK
Wall Back	53.139/125 kN/m², Length under pressure 2.143 m	0.425	OK

Structural Design

At Rest Earth Pressure

At rest earth pressures magnification	(1+Sin(ϕ)) x √OCR = (1+Sin(19.48)x√1		1.33

Prop Reactions

Maximum Prop Reactions (Ultimate)	45.3 kN @ Base, 69.2 kN @ 1.700 m

Wall Design (Inner Steel)

Critical Section	Critical @ 1700 mm from base, Case 2		
Steel Provided (Cover)	Main B20@200 (50 mm) Dist. B12@200 (70 mm)	1571 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (35 mm) Dist. B12@200 (47 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	240 mm, 1000 mm, 1571 mm², 500 N/mm², 35.0 N/mm²	218 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 41 mm, 49 mm, 0.20	149.0 kN.m	
Moment Capacity Check (M/Mr)	M 19.2 kN.m, Mr 149.0 kN.m	0.128	OK
Shear Capacity Check	F 40.1 kN, vc 0.697 N/mm², Fvr 167.4 kN	0.24	OK

Wall Design (Outer Steel)

Critical Section	Critical @ 590 mm from base, Case 2		
Steel Provided (Cover)	Main B12@200 (35 mm) Dist. B12@200 (47 mm)	565 mm²	OK
Compression Steel Provided (Cover)	Main B20@200 (50 mm) Dist. B12@200 (70 mm)	1571 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	259 mm, 1000 mm, 565 mm², 500 N/mm², 35.0 N/mm²	246 mm	
Mr=fn(above,As',d',x,x/d)	1571 mm², 60 mm, 18 mm, 0.07	60.5 kN.m	
Moment Capacity Check (M/Mr)	M 4.6 kN.m, Mr 60.5 kN.m	0.077	OK
Shear Capacity Check	F 0.0 kN, vc 0.475 N/mm², Fvr 122.9 kN	0.00	OK

Base Top Steel Design

Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	OK
Compression Steel Provided (Cover)	Main B20@150 (50 mm) Dist. B12@200 (70 mm)	2094 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	274 mm, 1000 mm, 565 mm², 500 N/mm², 35 N/mm²	260 mm	
Mr=fn(above,As',d',x,x/d)	2094 mm², 60 mm, 18 mm, 0.06	64.0 kN.m	
Moment Capacity Check (M/Mr)	M 1.4 kN.m, Mr 64.0 kN.m	0.022	OK
Shear Capacity Check	F 9.4 kN, vc 0.459 N/mm², Fvr 125.8 kN	0.07	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main B20@150 (50 mm) Dist. B12@200 (70 mm)	2094 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	270 mm, 1000 mm, 2094 mm², 500 N/mm², 35 N/mm²	241 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 56 mm, 65 mm, 0.24	219.4 kN.m	
Moment Capacity Check (M/Mr)	M 9.0 kN.m, Mr 219.4 kN.m	0.041	OK
Shear Capacity Check	F 27.6 kN, vc 0.717 N/mm², Fvr 193.5 kN	0.14	OK

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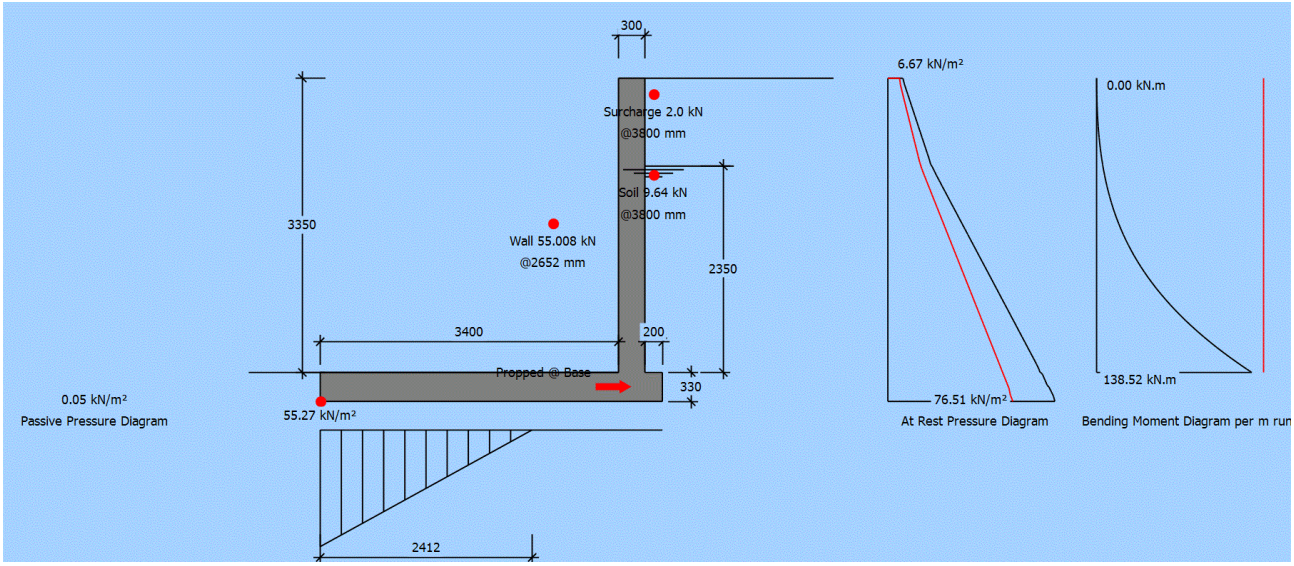
Job ref	: J002378
Sheet	: **Sheet Ref / 24 -**
Made By	: NW
Date	**: Dec/22**
Checked	**: AA**
Approved	:

MASTERKEY : RETAINING WALL DESIGN TO BS 8002 : 1994 AND BS 8110 : 1997

R5 - Party wall with no 14 - LC2

Reinforced Concrete Retaining Wall with Reinforced Base



Summary of Design Data

Notes	All dimensions are in mm and all forces are per metre run
Material Densities (kN/m³)	Back Soil - Dry 20.00, Saturated 22.00, Submerged 12.00
	Front Soil - Dry 18.00, Saturated 20.80, Submerged 10.80, Concrete 24.00
Special Assumptions (virtual back)	Use δ =0 @ virtual back
Concrete grade	fcu 35 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 50 mm, Wall outer cover 35 mm, Base cover 50 mm
Reinforcement design	fy 500 N/mm² designed to BS 8110: 1997
Surcharge and Water Table	Surcharge 10.00 kN/m², Water table level 2350 mm
Unplanned excavation depth	Front of wall 368 mm

† The Engineer must satisfy him/herself to the reinforcement detailing requirements of the relevant codes of practice

Additional Loads

Wall Propped at Base Level	Therefore no sliding check is required
† Dimensions	

Soil Properties

Bearing pressure	Premissable service pressure @ front 125.00 kN/m², @ back 125.00 kN/m²
Back Soil Friction and Cohesion	ϕ = Atn(Tan(23)/1.2) = 19.48°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(23)/1.2))) = 14.86°
Front Soil Friction and Cohesion	ϕ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

G_{Soil}- Soil Self Weight, G_{Wall}- Wall & Base Self Weight, Fv_{Heel}- Vertical Loads over Heel,
P_a- Active Earth Pressure, $P_{surcharge}$- Earth pressure from surcharge

Case 1: Geotechnical Design	1.00 G_{Soil}+1.00 G_{Wall}+1.00 Fv_{Heel}+1.00 P_a+1.00 $P_{surcharge}$
Case 2: Structural Ultimate Design	1.40 G_{Soil}+1.40 G_{Wall}+1.40 Fv_{Heel}+1.00 P_a+1.00 $P_{surcharge}$

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	136.508/190.090	0.718	OK

Wall Sliding - Virtual Back Pressure

$Fx/(Rx_{Friction}+ Rx_{Passive})$	0.000/(17.682+0.000)	0.000	OK
Prop Reaction Case 2 (Service)	107.6 kN @ Base		

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Job ref	: J002378
Sheet	: **Sheet Ref / 25 -**
Made By	: NW
Date	**: Dec/22**
Checked	**: AA**
Approved	:

Soil Pressure

Virtual Back	55.267/125 kN/m², Length under pressure 2.412 m	0.442	OK
Wall Back	55.087/125 kN/m², Length under pressure 2.42 m	0.441	OK
Note:	Length under pressure Is less than 75% of the base width		Warning

Structural Design

At Rest Earth Pressure

At rest earth pressures magnification	(1+Sin(ϕ)) x √OCR = (1+Sin(19.48)x√1	1.33

Prop Reaction

Maximum Prop Reaction (Ultimate)	143.3 kN @ Base

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main B20@200 (50 mm) Dist. B12@200 (70 mm)	1571 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (35 mm) Dist. B12@200 (47 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	240 mm, 1000 mm, 1571 mm², 500 N/mm², 35.0 N/mm²	218 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 41 mm, 49 mm, 0.20	149.0 kN.m	
Moment Capacity Check (M/Mr)	M 138.5 kN.m, Mr 149.0 kN.m	0.929	OK
Shear Capacity Check	F 119.2 kN, vc 0.697 N/mm², Fvr 167.4 kN	0.71	OK

Base Top Steel Design

Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	OK
Compression Steel Provided (Cover)	Main B20@150 (50 mm) Dist. B12@200 (70 mm)	2094 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	274 mm, 1000 mm, 565 mm², 500 N/mm², 35 N/mm²	260 mm	
Mr=fn(above,As',d',x,x/d)	2094 mm², 60 mm, 18 mm, 0.06	64.0 kN.m	
Moment Capacity Check (M/Mr)	M 1.8 kN.m, Mr 64.0 kN.m	0.029	OK
Shear Capacity Check	F 18.5 kN, vc 0.459 N/mm², Fvr 125.8 kN	0.15	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main B20@150 (50 mm) Dist. B12@200 (70 mm)	2094 mm²	OK
Compression Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B12@200 (62 mm)	565 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	270 mm, 1000 mm, 2094 mm², 500 N/mm², 35 N/mm²	241 mm	
Mr=fn(above,As',d',x,x/d)	565 mm², 56 mm, 65 mm, 0.24	219.4 kN.m	
Moment Capacity Check (M/Mr)	M 168.8 kN.m, Mr 219.4 kN.m	0.769	OK
Shear Capacity Check	F 65.6 kN, vc 0.717 N/mm², Fvr 193.5 kN	0.34	OK

GSE GREEN STRUCTURAL ENGINEERING	Project	16 Pilgrim's Lane		Project No.	J002378
	Calculations by	NW	Checked by AA	Sheet No.	1
	Element	Slab design		Date	December 2022

1) Slab design @ lower ground floor level

Slab at lower ground floor level, to be ground bearing and span between the toes of the existing underpins, is to be doweled into the R/C underpins, to tie the floor together.
The slab will be designed for a condition for hydrostatic pressure, where water level is passed to in below ground level

Assumption

Min slab span	4.00	m
Depth of the slab	0.3	m
Factored load for Water	1.00	
Factored load for concrete	1.00	

Loading to lower ground floor slab *- design as a 1.00m strip - simply supported*

Load due to hydrostatic pressure

2.35 m x 10.00 kN/m^3 = 23.50 kN/m^2

Load due to heave

3.35 m x 20 kN/m^3 x50% = 33.50 kN/m^2 **Clays only**

Max Uplift **33.50 kN/m2**

Self Weight of slab +Screed

0.30 m x 24.00 kN/m^3 = 7.20 kN/m^2

0.08 m x 24.00 kN/m^3 = 1.80 kN/m^2

9.00 kN/m2

Net Ultimate uplift

(1.20 x 23.5) - (0.9 x 9) x 1.00 m = 24.50 kN/m

Slab design *- design as a 1.00m strip - simply supported*

A393 MESH ϕ = 10 mm

steel cover 50 mm

Effective depth d = 235 mm

Design Moment - [w · l^2]/8 = 49.00 kNm (Hogging)

Shear Force - [w · l]/2 = 49.00 kN

K = M / (f_{cu} · b · d^2) = 0.0254

z = d [0.5 + √(0.25-K/0.9) 228 mm ≤ 0.95d

z = 223.25 mm

A_s = M / (0.87 · F_y · z) 505 mm^2/m width of slab

Min area of reinforcement = *0.13* % b·d = 305.5 mm^2/m width of slab *Provide As*

∴ Use 2 x A393 mesh 786 mm^2/m width of slab

∴ Use H 0 Bars @ 200 crs T&B 0 mm^2/m width of slab

A_s provided = 786 mm^2/m width of slab *Verified*

	Project		Job Ref.	
GSE GREEN STRUCTURAL ENGINEERING	16 Pilgrim's Lane		J002378	
	Drawing Ref.	Calculations by NW	Checked by	Sheet 5
	Part of Structure BOUYANCY CHECK		Date Jan-00	

BUOYANCY CHECK

TOTAL WEIGHT OF THE BUILDING

$F_{weight\ total} = floor\ loading + underpin\ weight + party\ wall\ load =$

Loading (w)

Dead Load (G_k):

	kN/m²	m	m²	kN
External masonry walls - 215mm (3m H, 76m L) GF and 1st	5.30	76.0		1208
External masonry walls - 215mm (av 1.5m H, 16m L)	5.30	16.0		127
RC Retaining walls (330mm thk, 3.35m H, 34m L)	8.09	34.0		921
RC Liftcore walls (150thkm, 8.5m H, 10m L)	3.68	10.0		312
Basement Slab 330mm thk	9.74		147.66	1437
Comflor (GF)	4.73		80	378
Timber floor - 1st	0.80		110	88
Timber floor - 2nd	0.80		70	56
Roof	1.00		100	100

= 4629 kN

4165.9 x0.9 factor

TOTAL UPLIFT DUE TO HEAVE AND GROUNDWATER

$F_{uplift\ total} = w_{total\ upward\ force} * Aslab =$

3470 kN x1.0 factor

(where $w\_(total\ upward\ force)$ = 23.5 kN/m2)

(where Aslab = 147.66 m2)

EQUILIBRIUM $F_{weight\ total\ factored} > F_{uplift\ total}$

4166 > 3470

EQUILIBRIUM SATISFIED UR 1.20 (CONSIDERS 0.9 FACTOR ON DEAD LOAD)

GSE GREEN STRUCTURAL ENGINEERING	Project 16 Pilgrim's Lane		Job Ref. J002378	
	Drawing Ref.	Calculations by NW	Checked by	Sheet 5
	Part of Structure BOUYANCY CHECK - AREA CONSIDERED FOR BOUYANCY		Date Jan-00	

LOWER GROUND FLOOR AREA CONSIDERED FOR BOUYANCY UNDER MAIN HOUSE. DUE TO CHANGE OF REAR, REAR IS CONSIDERED TO BE OPEN SPACE AND AT SIMILAR LEVEL TO EXTERNAL GROUND SO NO BOUYANCY APPLICABLE FOR REAR AREA.