Design it
Structural Solutions Ltd

m: 07794510438
e: designit.struct@gmail.com

Job Ref.	22/001
Rev.	0
Date.	Nov 22

Calculations for:

BMBC Housing Growth
Dev. Goldthorpe, Barnsley

External Works –
Proposed Retaining Wall Designs

Prepared By:

Ian R Thorpe
BEng (Hons) CEng MIStructE

November 2022

Design-it	Project	Dev. Goldthorpe Markets, Barnsley			Job Ref
	Section	External Works – Retaining Walls			22001
	Calc By	Date	Checked	Date	Sht No.
	I.T.	Nov 22	I.T.	Nov 22	1

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	<u>Design Statement</u> It is proposed to build new housing on a development on the market area and carpark in Goldthorpe Town Centre, as indicated on the attached site plan. The proposed development is to comprise 9 properties with 4 different house types. A single semi-detached bunglow, a single detached bungalow, 2 detached 2 storey houses and 2 semi-detached 2 storey house. **External Walls** From the site investigation report allowable bearing pressures of 100kN/m² are to be adopted. There are level differences requiring built up retaining walls between plots 7&8. Wall will support surcharge from driveway in final condition. Gardens are to be built up to plot 9 above the level of the existing access to the rear of terrace houses along the boundary line. Approx level will increase towards the rear boundary to plot 9 of approx. 600mm to 700mm. A 6ft panel fence, (to Architects details), is to be built above the wall. The wall will be thickened out at post locations with posts embedded into the ground by a min 600mm. Moment forces from the fence will be transferred direct to ground. (Refer to extract of Plots 7, 8 & 9 for locations.) ***<u>Notes</u>*** ***Dimensions defined in these calculations are taken from Architects details, and are defined here-in for design purposes <u>only</u>.*** ***Any variations to the proposed drawing details are to be notified to check proposed design details / requirements*** ***<u>It is a requirement to submit all design calculations to building control for checking and approval prior to works commencing.</u>***	

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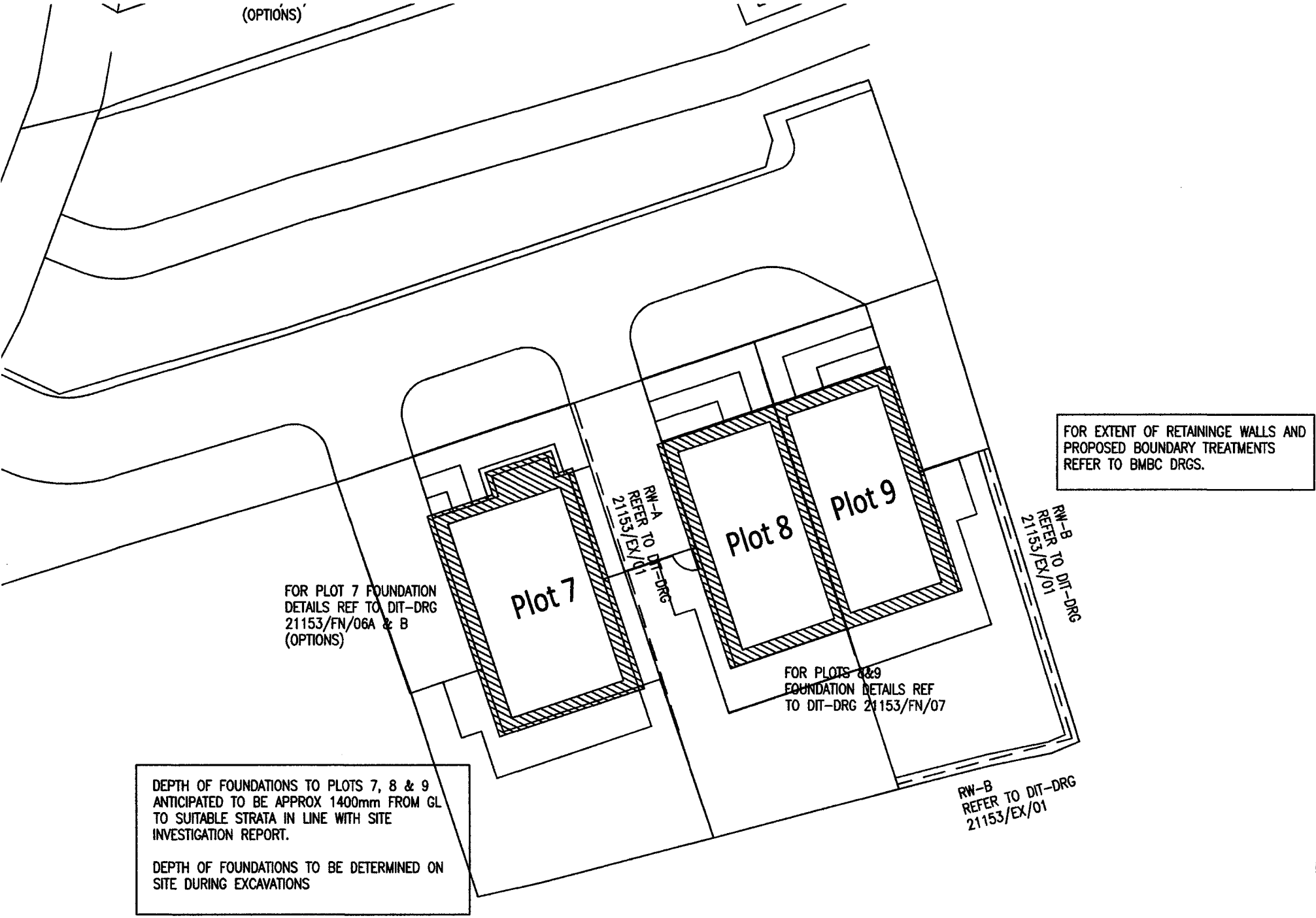
Loadings (BS 6399 Pt 1)

Dead		kN/m²
Surcharge Loads	Driveways & roads + construction loads on roads	**10**
	Gardens – No traffic, No Access Gravel backfill No compaction	**2.5 - 5**
Densities	Walls - Masonry	**10**
	Soil	**18**
	Concrete	**24**
	Water	**10**


(OPTIONS)
Plot 7
Plot 8
Plot 9
RW-A
REFER TO DIT-DRG
21153/EX/01
RW-B
REFER TO DIT-DRG
21153/EX/01
RW-B
REFER TO DIT-DRG
21153/EX/01
FOR PLOT 7 FOUNDATION
DETAILS REF TO DIT-DRG
21153/FN/06A & B
(OPTIONS)
FOR PLOTS 8&9
FOUNDATION DETAILS REF
TO DIT-DRG 21153/FN/07
FOR EXTENT OF RETAININGE WALLS AND
PROPOSED BOUNDARY TREATMENTS
REFER TO BMBC DRGS.
DEPTH OF FOUNDATIONS TO PLOTS 7, 8 & 9
ANTICIPATED TO BE APPROX 1400mm FROM GL
TO SUITABLE STRATA IN LINE WITH SITE
INVESTIGATION REPORT.
DEPTH OF FOUNDATIONS TO BE DETERMINED ON
SITE DURING EXCAVATIONS

Design-it	Project	DEV. GOLDTHORPE MARKETS.			Job Ref
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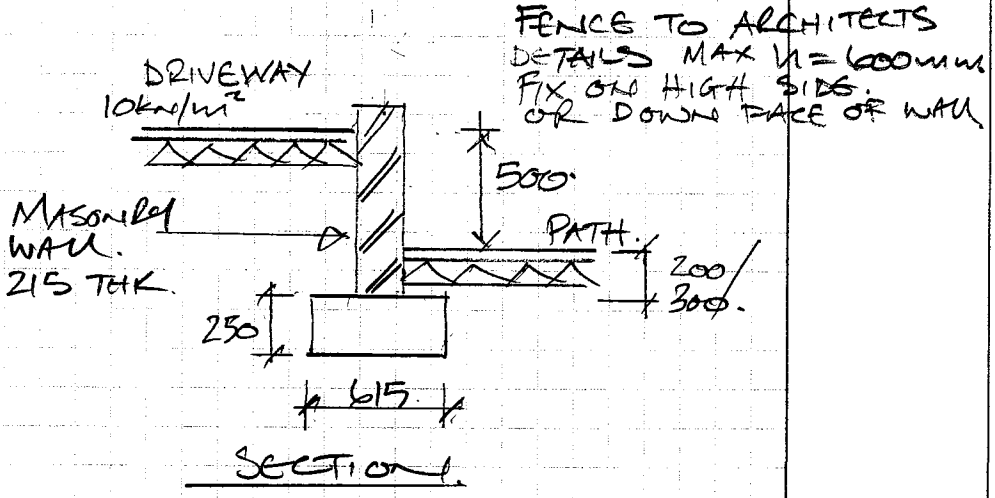
WALL BETWEEN PLOTS 7 & 8.

REF RW-A



SECTION 1.

NOTE WALL MAY BE MIRRORED TO SUIT LEVELS.

REFER TO SHTS FOR WALL DESIGN

NOTE HOUSE FOUNDATIONS MIN DEPTH TO PLOTS TO BE 1400mm. NO LATERAL SURCHARGE.

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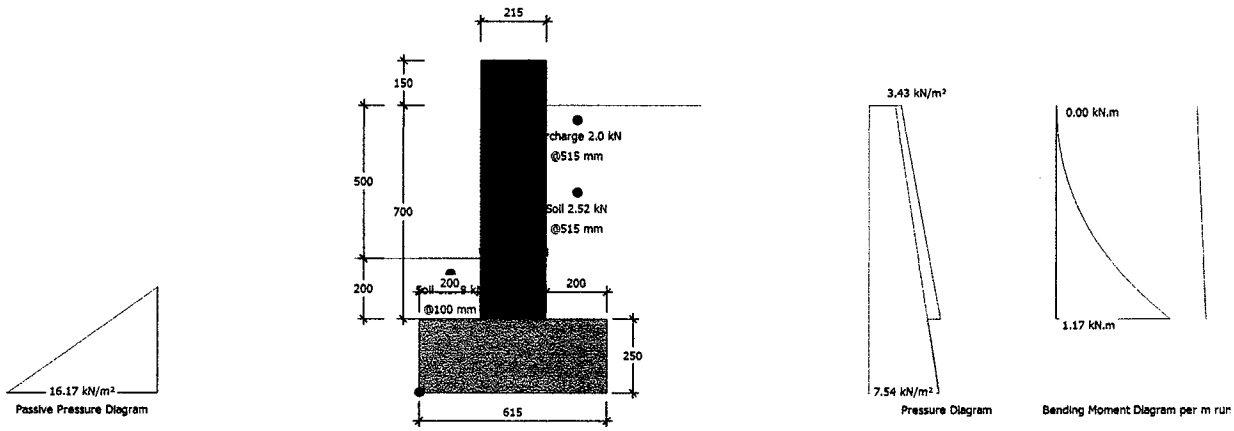
MasterKey : Retaining Wall Design to BS 8002 : 1994, BS EN 1996-1-1:2005+A1:2012 and BS 8110 : 1997

Boundary wall 500

Gravity Masonry Retaining Wall with Un-Reinforced Concrete Base



Summary of Design Data

Notes	All dimensions are in mm and all forces are per metre run
Material Densities (kN/m³)	Soil 18.00, Concrete 24.00, Masonry 20.00
Concrete grade	fcu 30 N/mm², Permissible tensile stress 0.250 N/mm²
Surcharge and Water Table	Surcharge 10.00 kN/m², Fully drained
Unplanned excavation depth	Front of wall 95 mm

Soil Properties

Bearing pressure	Premissable service pressure @ front 100.00 kN/m², @ back 100.00 kN/m²
Back Soil Friction and Cohesion	ϕ_h = Atn(Tan(34)/1.2) = 29.34°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(34)/1.2))) = 22.86°
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}+1.60 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	1.986/4.626	0.429	OK

Wall Sliding - Virtual Back Pressure

$Fx/(Rx_{Friction}+Rx_{Passive})$	4.935/(5.162+2.878)	0.614	OK

Soil Pressure

Virtual Back (No uplift)	Max(37.760/100, 2.057/100) kN/m²	0.378	OK
Wall Back (No uplift)	Max(38.487/100, 1.331/100) kN/m²	0.385	OK

Structural Design

Masonry Wall Details

Partial Safety Factor ($\gamma mc/\gamma mf$)	Units Category II, Execution Control Class 2	3/2.7	Table NA.1
Material	Clay bricks with water absorption between 7% and 12%		
Units and Mortar Strength	5 N/mm². Mortar designation M12/(i)		
Compressive Strength (f_k)	Group 1,γ=20 kN/m³	2.5 N/mm²	Table NA.4

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Wall Design (Inner Face Tension)

Critical Section	Critical @ 0 mm from base, Case 2		
Section Properties @ Base	t=215 mm, Area=2150 cm², Zb=7704 cm³		
Flexural Strength f_{xk1}	f_{xk1}=0.5, gd=0.017 N/mm², f_{xk1}=f_{xk1}+0.9 gd.γmf	0.541 N/mm²	Table NA.6
Mr=f_{xk1}.Zb/γmf	0.541x7704/2.7	1.54 kN.m	
Moment Capacity Check (M/Mr)	M 1.2 kN.m, Mr 1.5 kN.m	0.762	OK
Shear Capacity Check	F 3.6 kN, f_{vk}0.307 N/mm², Fvr 26.4 kN	0.14	OK

Base Top Face Tension

Maximum Tensile Stress	M 0.452, h 250, fcu 30, Permissible 0.25 N/mm²	0.04 N/mm²	OK
Shear Capacity Check	F 4.3 kN, vc 0.350 N/mm², Fvr 43.8 kN	0.10	OK

Base Bottom Face Tension

Maximum Tensile Stress	M 0.534, h 250, fcu 30, Permissible 0.25 N/mm²	0.05 N/mm²	OK
Shear Capacity Check	F 5.1 kN, vc 0.350 N/mm², Fvr 43.8 kN	0.12	OK

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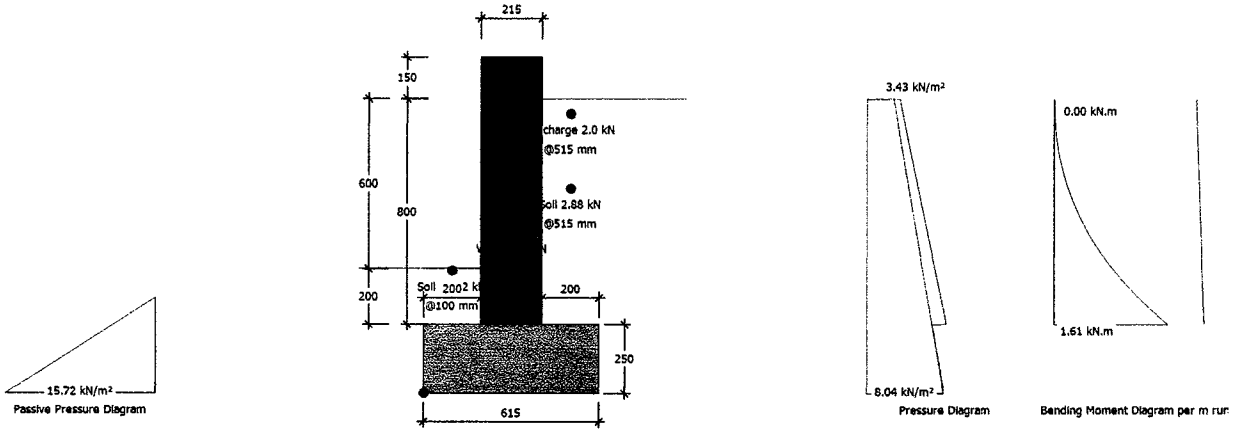
MasterKey : Retaining Wall Design to BS 8002 : 1994, BS EN 1996-1-1:2005+A1:2012 and BS 8110 : 1997

Boundary wall 600 Max

Reinforced Masonry Retaining Wall with Un-Reinforced Concrete Base



Summary of Design Data

Notes	All dimensions are in mm and all forces are per metre run
Material Densities (kN/m³)	Soil 18.00, Concrete 24.00, Masonry 20.00
Concrete grade	fcu 30 N/mm², Permissible tensile stress 0.250 N/mm²
Reinforcement design	fy 460 N/mm², fyb 460 N/mm² designed to BS 8110: 1997
Surcharge and Water Table	Surcharge 10.00 kN/m², Fully drained
Unplanned excavation depth	Front of wall 105 mm

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

Soil Properties

Bearing pressure	Premissable service pressure @ front 100.00 kN/m², @ back 100.00 kN/m²
Back Soil Friction and Cohesion	ϕ_b = Atn(Tan(34)/1.2) = 29.34°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(34)/1.2))) = 22.86°
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}+1.60 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	2.517/4.940	0.509	OK

Wall Sliding - Virtual Back Pressure

$Fx/(Rx_{Friction}+Rx_{Passive})$	5.713/(5.480+2.719)	0.697	OK

Soil Pressure

Virtual Back	46.473/100 kN/m², Length under pressure 0.559 m	0.465	OK
Wall Back	50.323/100 kN/m², Length under pressure 0.517 m	0.503	OK

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Structural Design

Masonry Wall Details

Partial Safety Factor ($\gamma mc/\gamma mf$)	Units Category II, Execution Control Class 2	3/2.7	Table NA.1
Material	Clay bricks with water absorption less than 7%		
Units and Mortar Strength	10 N/mm², Mortar designation M12/(i)		
Compressive Strength (f_k)	Group 1,γ=20 kN/m³	5.0 N/mm²	Table NA.4

Wall Design (Inner Face Tension)

Critical Section	Critical @ 0 mm from base, Case 2		
Section Properties @ Base	t=215 mm, Area=2150 cm², Zb=7704 cm³		
Flexural Strength f_{xk1}	f_{xk1}=0.7, gd=0.019 N/mm², $f_{xk1}=f_{xk1}+0.9$ gd.γmf	0.746 N/mm²	Table NA.6
$Mr=f_{xk1}.Zb/\gamma mf$	0.746x7704/2.7	2.13 kN.m	
Moment Capacity Check (M/Mr)	M 1.6 kN.m, Mr 2.1 kN.m	0.755	OK
Shear Capacity Check	F 4.5 kN, f_{vk}0.308 N/mm², Fvr 26.5 kN	0.17	OK

Base Top Face Tension

Maximum Tensile Stress	M 0.608, h 250, fcu 30, Permissible 0.25 N/mm²	0.06 N/mm²	OK
Shear Capacity Check	F 5.7 kN, vc 0.350 N/mm², Fvr 43.8 kN	0.13	OK

Base Bottom Face Tension

Maximum Tensile Stress	M 0.711, h 250, fcu 30, Permissible 0.25 N/mm²	0.07 N/mm²	OK
Shear Capacity Check	F 6.7 kN, vc 0.350 N/mm², Fvr 43.8 kN	0.15	OK

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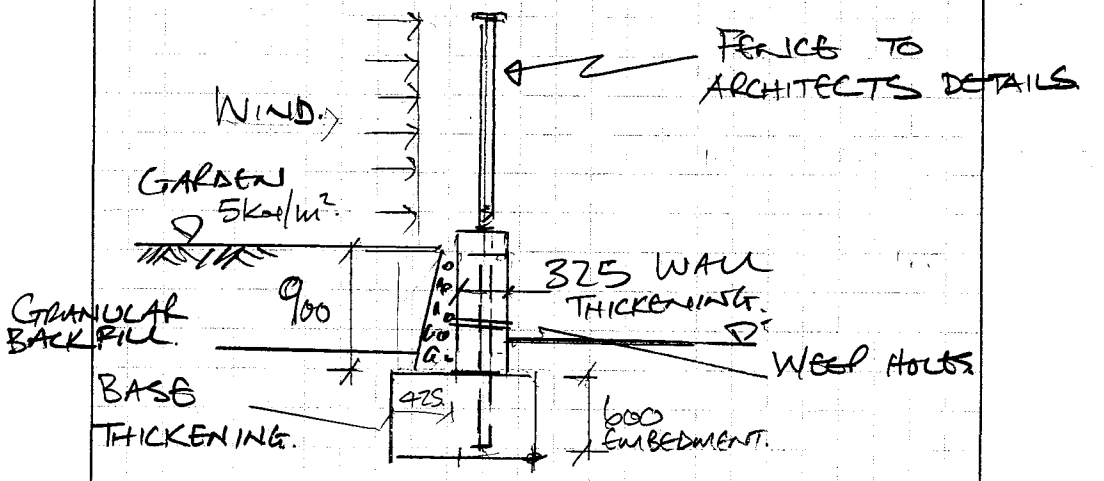
BOUNDARY WALL - PLOT 9.

STATEMENT :- BOUNDARY RETAINING WALL, MASONRY CONSTRUCTION WITH 1830mm FENCE ABOVE. FENCE SPANS BETWEEN POSTS SECURED INTO WALL THICKENINGS. & EMBEDDED A MIN 600mm

REF RW-B ON PLAN.



WALL TO REAR OF PLOT.

RETAINED HEIGHT REDUCES UP TO HOUSE

PROXIMITY OF HOUSE IS GREATER THAN DEPTH OF SUPPORT PLUS BASE.
NO LATERAL SURCHARGE.

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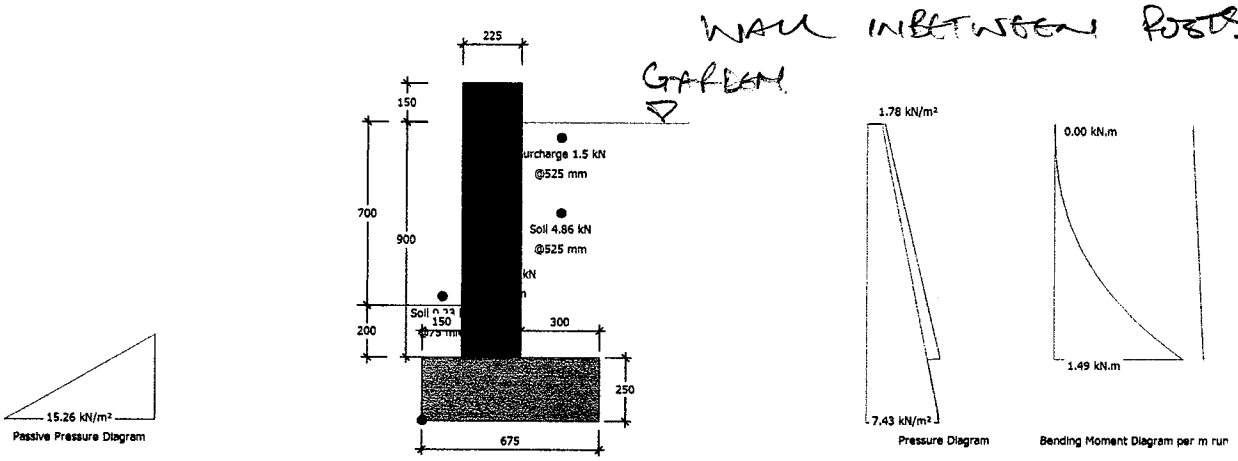
MasterKey : Retaining Wall Design to BS 8002 : 1994, BS EN 1996-1-1:2005+A1:2012 and BS 8110 : 1997

Garden Boundary wall 700 215 thk

Reinforced Masonry Retaining Wall with Reinforced Concrete Base

WALL INBETWEEN POSTS.



Summary of Design Data

Notes	All dimensions are in mm and all forces are per metre run
Material Densities (kN/m³)	Soil 18.00, Concrete 24.00, Masonry 20.00
Concrete grade	fcu 30 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Base cover 50 mm
Reinforcement design	fy 460 N/mm², fyb 460 N/mm² designed to BS 8110: 1997
Surcharge and Water Table	Surcharge 5.00 kN/m², Fully drained
Unplanned excavation depth	Front of wall 115 mm

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

Soil Properties

Bearing pressure	Premissable service pressure @ front 100.00 kN/m², @ back 100.00 kN/m²
Back Soil Friction and Cohesion	ϕ_h = Atn(Tan(33)/1.2) = 28.42°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(33)/1.2))) = 22.09°
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}+1.60 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	2.296/5.966	0.385	OK

Wall Sliding - Virtual Back Pressure

$Fx/(Rx_{Friction}+Rx_{Passive})$	5.141/(6.237+2.564)	0.584	OK

Soil Pressure

Virtual Back (No uplift)	Max(42.732/100, 2.797/100) kN/m²	0.427	OK
Wall Back (No uplift)	Max(44.903/100, 0.626/100) kN/m²	0.449	OK

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Structural Design

Masonry Wall Details

Partial Safety Factor (γmc/γmf)	Units Category II, Execution Control Class 2	3/2.7	Table NA.1
Material	Clay bricks with water absorption between 7% and 12%		
Units and Mortar Strength	5 N/mm². Mortar designation M12/(i)		
Compressive Strength (f_k)	Group 1,γ=20 kN/m³	2.5 N/mm²	Table NA.4

Wall Design (Inner Face Tension)

Critical Section	Critical @ 0 mm from base, Case 2		
Section Properties @ Base	t=225 mm, Area=2250 cm², Zb=8438 cm³		
Flexural Strength f_{xk1}	f_{xk1}=0.5, gd=0.021 N/mm², f_{xk1}=f_{xk1}+0.9 gd.γmf	0.551 N/mm²	Table NA.6
Mr=f_{xk1}.Zb/γmf	0.551x8438/2.7	1.72 kN.m	
Moment Capacity Check (M/Mr)	M 1.5 kN.m, Mr 1.7 kN.m	0.865	OK
Shear Capacity Check	F 4.0 kN, f_{vk}0.308 N/mm², Fvr 27.8 kN	0.14	OK

Base Top Face Tension

Maximum Tensile Stress	M 0.854, h 250, fcu 30, Permissible 0.25 N/mm²	0.08 N/mm²	OK
Shear Capacity Check	F 4.9 kN, vc 0.350 N/mm², Fvr 43.8 kN	0.11	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main B10@200 (50 mm) Dist. B10@200 (60 mm)	393 mm²	OK
Leverarm z=fn(d,b,As,fy,Fcu)	195 mm, 1000 mm, 393 mm², 460 N/mm², 30 N/mm²	185 mm	
Mr=fn(above,x,x/d)	14 mm, 0.07	31.8 kN.m	
Moment Capacity Check (M/Mr)	M 0.4 kN.m, Mr 31.8 kN.m	0.013	OK
Shear Capacity Check	F 5.3 kN, vc 0.471 N/mm², Fvr 91.9 kN	0.06	OK

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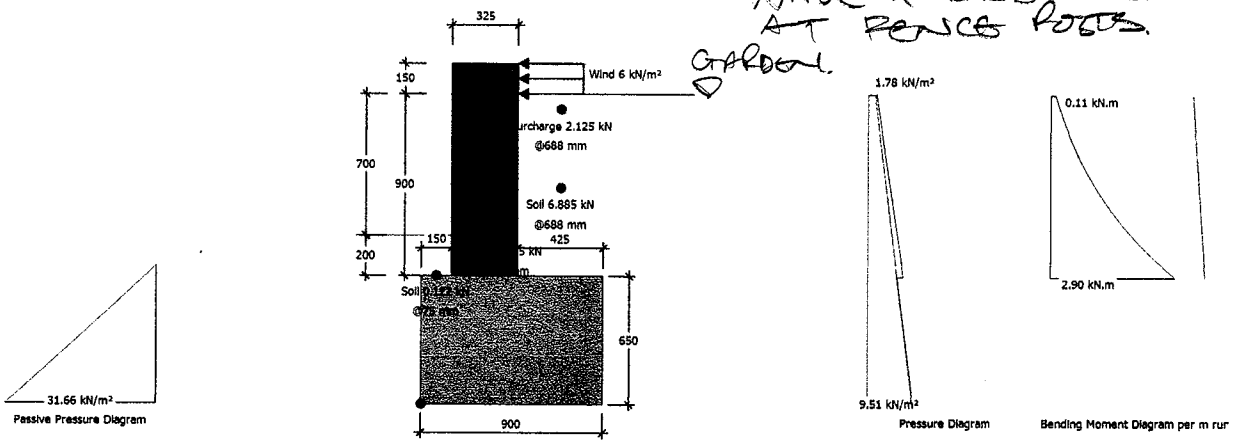
MasterKey : Retaining Wall Design to BS 8002 : 1994, BS EN 1996-1-1:2005+A1:2012 and BS 8110 : 1997

Boundary wall 600 Max Plus Fence

Gravity Masonry Retaining Wall with Un-Reinforced Concrete Base

WALL & BASE THICKENING AT FENCE POSTS.



Summary of Design Data

Notes	All dimensions are in mm and all forces are per metre run
Material Densities (kN/m³)	Soil 18.00, Concrete 24.00, Masonry 20.00
Special Assumptions (virtual back)	No surcharge over heel
Concrete grade	fcu 30 N/mm², Permissible tensile stress 0.250 N/mm²
Surcharge and Water Table	Surcharge 5.00 kN/m², Fully drained
Unplanned excavation depth	Front of wall 155 mm

Soil Properties

Bearing pressure	Premissable service pressure @ front 100.00 kN/m², @ back 100.00 kN/m²
Back Soil Friction and Cohesion	ϕ_h = Atn(Tan(33)/1.2) = 28.42°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(33)/1.2))) = 22.09°
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}+1.60 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	5.016/11.734	0.427	OK

Wall Sliding - Virtual Back Pressure

$Fx/(Rx_{Friction}+Rx_{Passive})$	8.558/(11.313+10.118)	0.399	OK

Soil Pressure

Virtual Back	73.346/100 kN/m², Length under pressure 0.818 m	0.733	OK
Wall Back (No uplift)	Max(59.285/100, 7.377/100) kN/m²	0.593	OK

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13.

Structural Design

Masonry Wall Details

Partial Safety Factor ($\gamma mc/\gamma mf$)	Units Category II, Execution Control Class 2	3/2.7	Table NA.1
Material	Clay bricks with water absorption between 7% and 12%		
Units and Mortar Strength	5 N/mm². Mortar designation M12/(i)		
Compressive Strength (f_k)	Group 1,γ=20 kN/m³	2.5 N/mm²	Table NA.4

Wall Design (Inner Face Tension)

Critical Section	Critical @ 0 mm from base, Case 2		
Section Properties @ Base	t=325 mm, Area=3250 cm², Zb=17604 cm³		
Flexural Strength f_{xk1}	f_{xk1}=0.5, gd=0.021 N/mm², f_{xk1}=f_{xk1}+0.9 gd.γmf	0.551 N/mm²	Table NA.6
Mr=f_{xk1}.Zb/γmf	0.551x17604/2.7	3.59 kN.m	
Moment Capacity Check (M/Mr)	M 2.9 kN.m, Mr 3.6 kN.m	0.806	OK
Shear Capacity Check	F 5.6 kN, f_{vk}0.308 N/mm², Fvr 40.1 kN	0.14	OK

Base Top Face Tension

Maximum Tensile Stress	M 2.236, h 650, fcu 30, Permissible 0.25 N/mm²	0.03 N/mm²	OK
Shear Capacity Check	F 8.6 kN, vc 0.350 N/mm², Fvr 113.8 kN	0.08	OK

Base Bottom Face Tension

Maximum Tensile Stress	M 0.554, h 650, fcu 30, Permissible 0.25 N/mm²	0.01 N/mm²	OK
Shear Capacity Check	F 7.2 kN, vc 0.350 N/mm², Fvr 113.8 kN	0.06	OK