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Job ref	: **Job Ref**
Sheet	: **Sheet Ref / 6 -**
Made By	:
Date	: **22 Nov 2023/ Version 2015.04**
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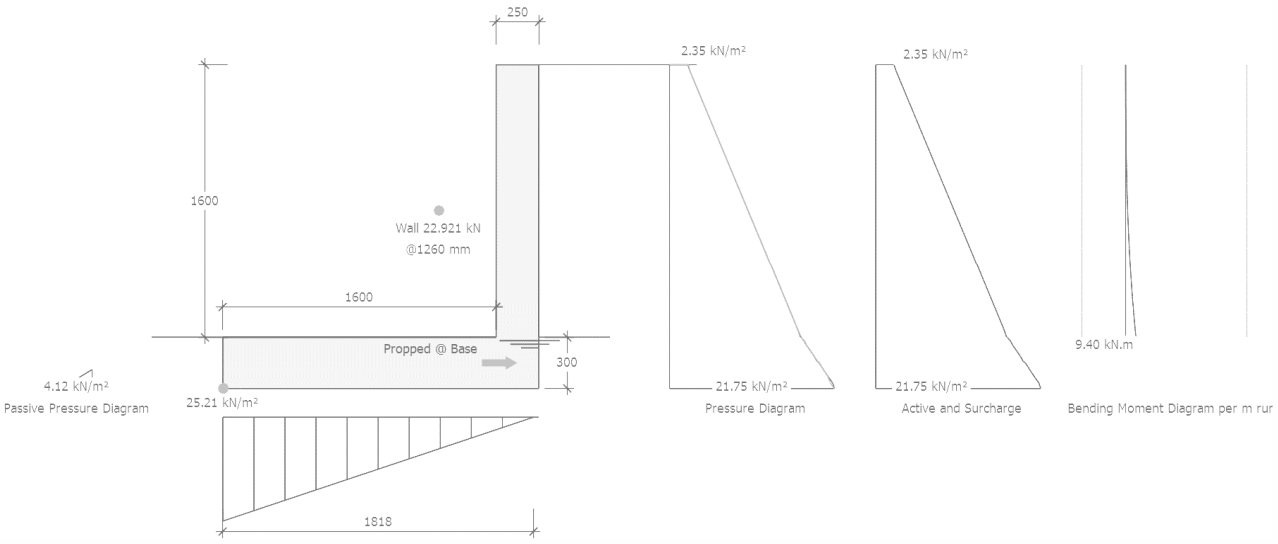
MASTERKEY : RETAINING WALL DESIGN TO BS 8002 : 1994 AND BS 8110 : 1997

RW2 (LC1)-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
Concrete grade	fcu 30 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 30 mm, Wall outer cover 30 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 190 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	Ties, line loads and partial loads are measured from the inner top edge of the wall

Soil Properties

Bearing pressure	Premissable service pressure @ front 95.00 kN/m², @ back 95.00 kN/m²
Back Soil Friction and Cohesion	ϕ = Atn(Tan(25)/1.2) = 21.24°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(25)/1.2))) = 16.25°
Front Soil Friction and Cohesion	ϕ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

G_{Wall}- Wall & Base Self Weight, P_a- Active Earth Pressure, $P_{surcharge}$- Earth pressure from surcharge, P_p- Passive Earth Pressure

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

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	14.990/28.882	0.519	OK

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Wall Sliding - Virtual Back Pressure

$Fx/(Rx_{Friction}+ Rx_{Passive})$	0.000/(6.680+0.229)	0.000	OK
Prop Reaction Case 2 (Service)	21.6 kN @ Base		

Soil Pressure

Virtual Back	25.211/95 kN/m², Length under pressure 1.818 m	0.265	OK
Wall Back	25.143/95 kN/m², Length under pressure 1.823 m	0.265	OK

Structural Design

Prop Reaction

Maximum Prop Reaction (Ultimate)	21.6 kN @ Base		

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main H16@150 (30 mm) Dist. H12@175 (46 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main H12@250 (30 mm) Dist. H12@175 (42 mm)	452 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	212 mm, 1000 mm, 1340 mm², 500 N/mm², 30.0 N/mm²	190 mm	
Mr=fn(above,As',d',x,x/d)	452 mm², 36 mm, 48 mm, 0.23	110.9 kN.m	
Moment Capacity Check (M/Mr)	M 9.4 kN.m, Mr 110.9 kN.m	0.085	OK
Shear Capacity Check	F 15.7 kN, vc 0.676 N/mm², Fvr 143.2 kN	0.11	OK

Base Top Steel Design

Steel Provided (Cover)	Main H16@150 (50 mm) Dist. H12@175 (66 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main H12@150 (50 mm) Dist. H12@175 (62 mm)	754 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	242 mm, 1000 mm, 1340 mm², 500 N/mm², 30 N/mm²	220 mm	
Mr=fn(above,As',d',x,x/d)	754 mm², 56 mm, 48 mm, 0.20	128.4 kN.m	
Moment Capacity Check (M/Mr)	M 0.0 kN.m, Mr 128.4 kN.m	0.000	OK
Shear Capacity Check	F 0.0 kN, vc 0.625 N/mm², Fvr 151.3 kN	0.00	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main H12@150 (50 mm) Dist. H12@175 (62 mm)	754 mm²	OK
Compression Steel Provided (Cover)	Main H16@150 (50 mm) Dist. H12@175 (66 mm)	1340 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	244 mm, 1000 mm, 754 mm², 500 N/mm², 30 N/mm²	232 mm	
Mr=fn(above,As',d',x,x/d)	1340 mm², 58 mm, 27 mm, 0.11	76.0 kN.m	
Moment Capacity Check (M/Mr)	M 13.3 kN.m, Mr 76.0 kN.m	0.175	OK
Shear Capacity Check	F 13.2 kN, vc 0.514 N/mm², Fvr 125.4 kN	0.11	OK

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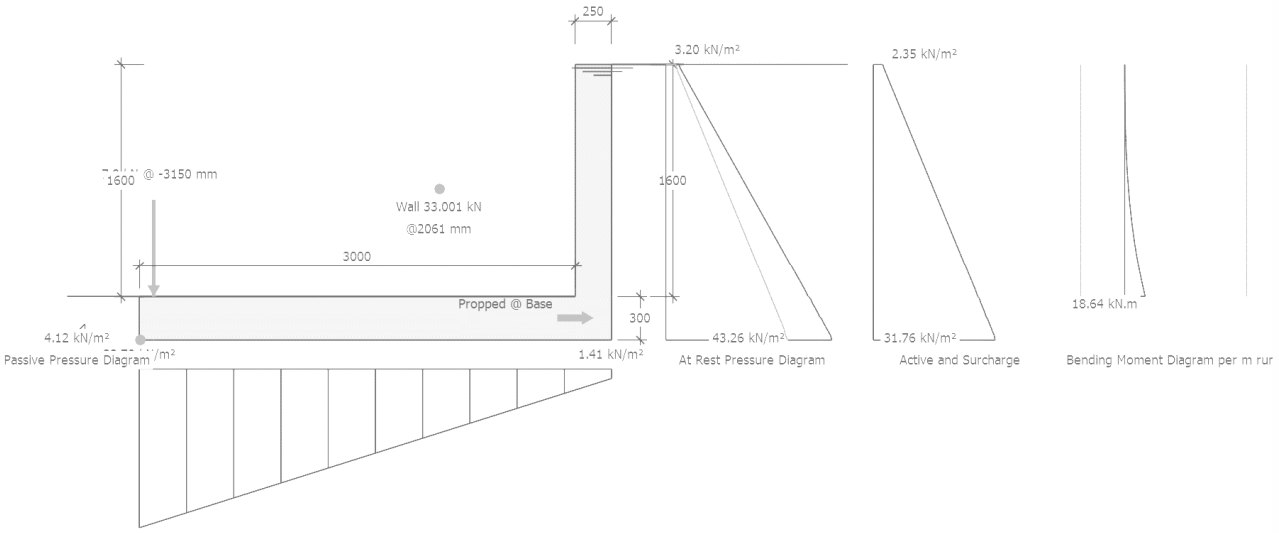
MasterKey : Retaining Wall Design to BS 8002 : 1994 and BS 8110 : 1997

RW2 (LC2)-Perm

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 30 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 30 mm, Wall outer cover 30 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 1600 mm
Unplanned excavation depth	Front of wall 190 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	7.8 kN/m @ X -3150 mm and Y 1600 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 95.00 kN/m², @ back 95.00 kN/m²
Back Soil Friction and Cohesion	ϕ = Atn(Tan(25)/1.2) = 21.24°
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_{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_{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_{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	22.129/68.807	0.322	OK

Wall Sliding - Virtual Back Pressure

$Fx/(Rx_{Friction}+ Rx_{Passive})$	0.000/(9.281+0.229)	0.000	OK

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Prop Reaction Case 2 (Service)	32.6 kN @ Base		

Soil Pressure

Virtual Back (No uplift)	Max(23.701/95, 1.407/95) kN/m²	0.249	OK
Wall Back (No uplift)	Max(23.675/95, 1.433/95) kN/m²	0.249	OK

Structural Design

At Rest Earth Pressure

At rest earth pressures magnification	(1+Sin(ϕ)) x √OCR = (1+Sin(21.24)x√1		1.36

Prop Reaction

Maximum Prop Reaction (Ultimate)	44.3 kN @ Base		

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main H16@150 (30 mm) Dist. H12@175 (46 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main H12@250 (30 mm) Dist. H12@175 (42 mm)	452 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	212 mm, 1000 mm, 1340 mm², 500 N/mm², 30.0 N/mm²	190 mm	
Mr=fn(above,As',d',x,x/d)	452 mm², 36 mm, 48 mm, 0.23	110.9 kN.m	
Moment Capacity Check (M/Mr)	M 18.6 kN.m, Mr 110.9 kN.m	0.168	OK
Shear Capacity Check	F 32.3 kN, vc 0.676 N/mm², Fvr 143.2 kN	0.23	OK

Base Top Steel Design

Steel Provided (Cover)	Main H16@150 (50 mm) Dist. H12@175 (66 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main H12@150 (50 mm) Dist. H12@175 (62 mm)	754 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	242 mm, 1000 mm, 1340 mm², 500 N/mm², 30 N/mm²	220 mm	
Mr=fn(above,As',d',x,x/d)	754 mm², 56 mm, 48 mm, 0.20	128.4 kN.m	
Moment Capacity Check (M/Mr)	M 2.2 kN.m, Mr 128.4 kN.m	0.017	OK
Shear Capacity Check	F 8.9 kN, vc 0.625 N/mm², Fvr 151.3 kN	0.06	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main H12@150 (50 mm) Dist. H12@175 (62 mm)	754 mm²	OK
Compression Steel Provided (Cover)	Main H16@150 (50 mm) Dist. H12@175 (66 mm)	1340 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	244 mm, 1000 mm, 754 mm², 500 N/mm², 30 N/mm²	232 mm	
Mr=fn(above,As',d',x,x/d)	1340 mm², 58 mm, 27 mm, 0.11	76.0 kN.m	
Moment Capacity Check (M/Mr)	M 28.2 kN.m, Mr 76.0 kN.m	0.371	OK
Shear Capacity Check	F 17.0 kN, vc 0.514 N/mm², Fvr 125.4 kN	0.14	OK

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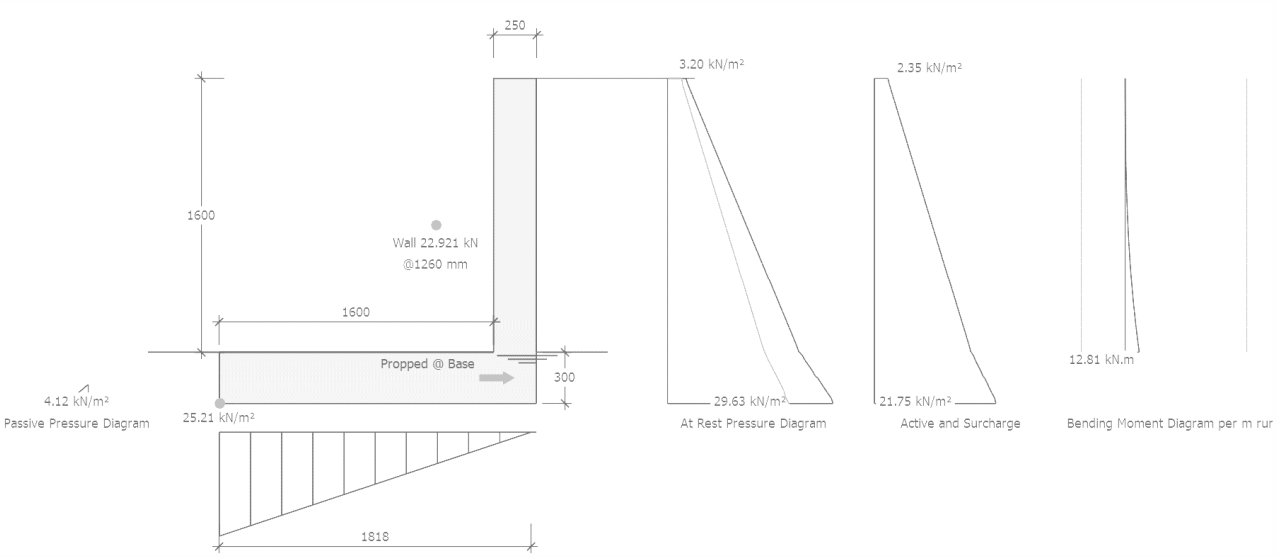
MASTERKEY : RETAINING WALL DESIGN TO BS 8002 : 1994 AND BS 8110 : 1997
RW2 (LC2)-Temp
Reinforced Concrete Retaining Wall with Reinforced Base



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
Concrete grade	fcu 30 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 30 mm, Wall outer cover 30 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 190 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	Ties, line loads and partial loads are measured from the inner top edge of the wall

Soil Properties

Bearing pressure	Premissable service pressure @ front 95.00 kN/m², @ back 95.00 kN/m²
Back Soil Friction and Cohesion	ϕ = Atn(Tan(25)/1.2) = 21.24°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(25)/1.2))) = 16.25°
Front Soil Friction and Cohesion	ϕ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

G_{Wall}- Wall & Base Self Weight, P_a- Active Earth Pressure, $P_{surcharge}$- Earth pressure from surcharge, P_p- Passive Earth Pressure

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

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	14.990/28.882	0.519	OK

Wall Sliding - Virtual Back Pressure

Fx/($Rx_{Friction}$+ $Rx_{Passive}$)	0.000/(6.680+0.229)	0.000	OK
Prop Reaction Case 2 (Service)	21.6 kN @ Base		

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Soil Pressure

Virtual Back	25.211/95 kN/m², Length under pressure 1.818 m	0.265	OK
Wall Back	25.143/95 kN/m², Length under pressure 1.823 m	0.265	OK

Structural Design

At Rest Earth Pressure

At rest earth pressures magnification	(1+Sin(ϕ)) x √OCR = (1+Sin(21.24)x√1	1.36

Prop Reaction

Maximum Prop Reaction (Ultimate)	29.4 kN @ Base

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main H16@150 (30 mm) Dist. H12@175 (46 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main H12@250 (30 mm) Dist. H12@175 (42 mm)	452 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	212 mm, 1000 mm, 1340 mm², 500 N/mm², 30.0 N/mm²	190 mm	
Mr=fn(above,As',d',x,x/d)	452 mm², 36 mm, 48 mm, 0.23	110.9 kN.m	
Moment Capacity Check (M/Mr)	M 12.8 kN.m, Mr 110.9 kN.m	0.115	OK
Shear Capacity Check	F 21.4 kN, vc 0.676 N/mm², Fvr 143.2 kN	0.15	OK

Base Top Steel Design

Steel Provided (Cover)	Main H16@150 (50 mm) Dist. H12@175 (66 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main H12@150 (50 mm) Dist. H12@175 (62 mm)	754 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	242 mm, 1000 mm, 1340 mm², 500 N/mm², 30 N/mm²	220 mm	
Mr=fn(above,As',d',x,x/d)	754 mm², 56 mm, 48 mm, 0.20	128.4 kN.m	
Moment Capacity Check (M/Mr)	M 0.0 kN.m, Mr 128.4 kN.m	0.000	OK
Shear Capacity Check	F 0.0 kN, vc 0.625 N/mm², Fvr 151.3 kN	0.00	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main H12@150 (50 mm) Dist. H12@175 (62 mm)	754 mm²	OK
Compression Steel Provided (Cover)	Main H16@150 (50 mm) Dist. H12@175 (66 mm)	1340 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	244 mm, 1000 mm, 754 mm², 500 N/mm², 30 N/mm²	232 mm	
Mr=fn(above,As',d',x,x/d)	1340 mm², 58 mm, 27 mm, 0.11	76.0 kN.m	
Moment Capacity Check (M/Mr)	M 18.4 kN.m, Mr 76.0 kN.m	0.243	OK
Shear Capacity Check	F 16.0 kN, vc 0.514 N/mm², Fvr 125.4 kN	0.13	OK

	Project		Job Ref.	
	28 Parliament Hill		20230153	
	Drawing Ref.	Calculations by	Checked by	Sheet
		AS		
	Part of Structure		Date	
	Retaining wall R-1 - with column C1moved on top of the retaining wall		Sep-23	

h = 1.6 m

The retaining walls will be designed for one load case:

• Case 1 – 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.

- Permanent case –empty pool, surcharge, water at ground level

- Temporary case –empty pool, surcharge, no water

Assumptions:

- Total retained height 1600mm

- Accidental water level assumed at 1mBGL

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

- 125Pa safe bearing pressure

Ltoe = 1.6 m

Lheel = m

Loading (w)

Dead Load (G_k):

		kN/m²	m	kN/m
ST12;ST21 - Column 1 Reaction (LGF)	146.7		3.8	38.61
TOTAL LC1				38.61
TOTAL LC2				34.74

Live Load (Q_k):

		kN/m²	m	kN/m
surcharge considered		10.00		
ST12;ST21 - Column 1 Reaction (LGF)	34.8		3.8	9.16
TOTAL LC1				9.158
TOTAL LC2				0.00

	Project		Job Ref.	
	28 Parliament Hill		20230153	
	Drawing Ref.	Calculations by	Checked by	Sheet
		AS		
	Part of Structure		Date	
	Retaining wall R-1		Sep-23	

h = 1.6 m

The retaining walls will be designed for one load case:
• Case 1 – 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.
- Permanent case –empty pool, surcharge, water at ground level
- Temporary case –empty pool, surcharge, no water

Assumptions:
- Total retained height 1600mm
- Accidental water level assumed at 1mBGL
- Surcharge of 5kN/m2 has been considered for the area underneath existing floor
- 125Pa safe bearing pressure

Ltoe = 1.6 m
Lheel = m

Loading (w)

Dead Load (G_k):

	kN/m²	m	kN/m
No vertical load considered			
TOTAL LC1			0.00
TOTAL LC2			0.00

Live Load (Q_k):

	kN/m²	m	kN/m
surcharge considered	10.00		
No vertical load considered			
TOTAL LC1			0.000
TOTAL LC2			0.00

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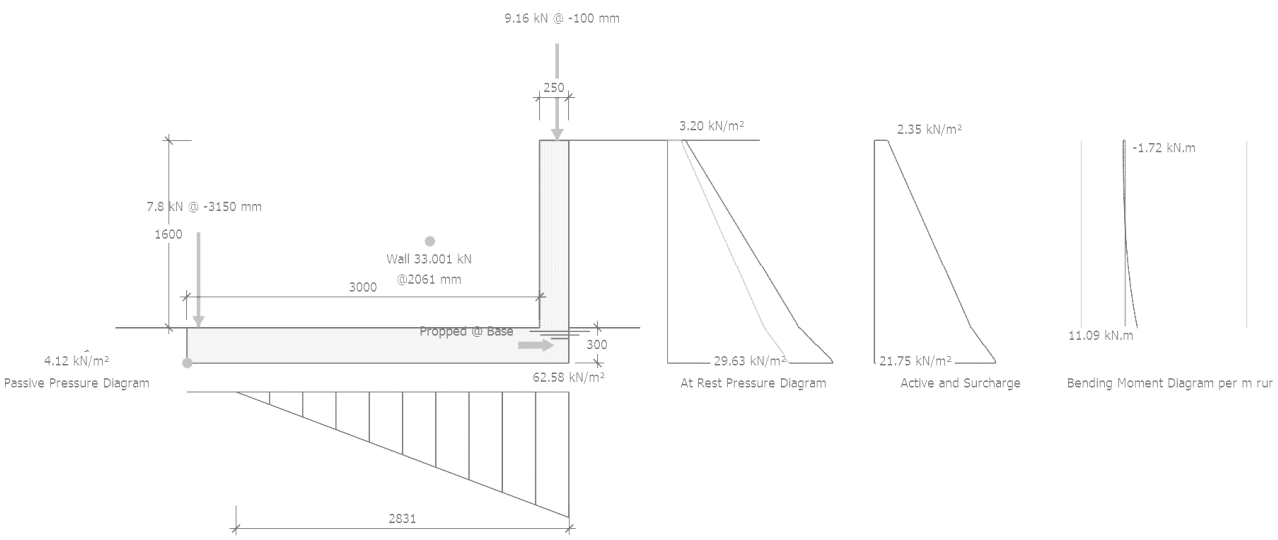
MASTERKEY : RETAINING WALL DESIGN TO BS 8002 : 1994 AND BS 8110 : 1997
RW1 (LC1)-Perm
Reinforced Concrete Retaining Wall with Reinforced Base



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 30 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 30 mm, Wall outer cover 30 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 190 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	38.61 kN/m @ X -100 mm and Y 0 mm - Load type Dead
	9.16 kN/m @ X -100 mm and Y 0 mm - Load type Live
	7.8 kN/m @ X -3150 mm and Y 1600 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 95.00 kN/m², @ back 95.00 kN/m²
Back Soil Friction and Cohesion	ϕ = Atn(Tan(25)/1.2) = 21.24°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(25)/1.2))) = 16.25°
Front Soil Friction and Cohesion	ϕ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

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_{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_{Wall}+1.60 Fv_{Heel}+1.00 P_a+1.00 $P_{surcharge}$+1.00 P_p

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Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	14.990/219.283	0.068	OK

Wall Sliding - Virtual Back Pressure

$Fx/(Rx_{Friction}+ Rx_{Passive})$	0.000/(25.813+0.229)	0.000	OK
Prop Reaction Case 2 (Service)	21.6 kN @ Base		

Soil Pressure

Virtual Back	62.579/95 kN/m², Length under pressure 2.831 m	0.659	OK
Wall Back	62.608/95 kN/m², Length under pressure 2.829 m	0.659	OK

Structural Design

At Rest Earth Pressure

At rest earth pressures magnification	$(1+\text{Sin}(\phi))\ x\ \sqrt{OCR} = (1+\text{Sin}(21.24)x\sqrt{1}$	1.36

Prop Reaction

Maximum Prop Reaction (Ultimate)	29.4 kN @ Base

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main H16@150 (30 mm) Dist. H12@175 (46 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main H12@250 (30 mm) Dist. H12@175 (42 mm)	452 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	212 mm, 1000 mm, 1340 mm², 500 N/mm², 30.0 N/mm²	190 mm	
Mr=fn(above,As',d',x,x/d)	452 mm², 36 mm, 48 mm, 0.23	110.9 kN.m	
Moment Capacity Check (M/Mr)	M 11.1 kN.m, Mr 110.9 kN.m	0.100	OK
Wall Axial Design (N/Ncap)	N 82.1 kN, Ncap 3000.0 kN	0.027	OK
Wall Slenderness λ	Leff/tk =1.09x1600.0/250.0	7.0	OK
Wall Axial-Mom Design (M/Mr_{Axial})	M 11.1 kN, Mr_{Axial}117.5 kN.m	0.094	OK
Shear Capacity Check	F 21.4 kN, vc 0.676 N/mm², Fvr 143.2 kN	0.15	OK

Wall Design (Outer Steel)

Critical Section	Critical @ 1599 mm from base, Case 2		
Steel Provided (Cover)	Main H12@250 (30 mm) Dist. H12@175 (42 mm)	452 mm²	OK
Compression Steel Provided (Cover)	Main H16@150 (30 mm) Dist. H12@175 (46 mm)	1340 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	214 mm, 1000 mm, 452 mm², 500 N/mm², 30.0 N/mm²	203 mm	
Mr=fn(above,As',d',x,x/d)	1340 mm², 38 mm, 16 mm, 0.08	40.0 kN.m	
Moment Capacity Check (M/Mr)	M 1.7 kN.m, Mr 40.0 kN.m	0.043	OK
Shear Capacity Check	F 0.0 kN, vc 0.468 N/mm², Fvr 100.1 kN	0.00	OK

Base Top Steel Design

Steel Provided (Cover)	Main H16@150 (50 mm) Dist. H12@175 (66 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main H12@150 (50 mm) Dist. H12@175 (62 mm)	754 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	242 mm, 1000 mm, 1340 mm², 500 N/mm², 30 N/mm²	220 mm	
Mr=fn(above,As',d',x,x/d)	754 mm², 56 mm, 48 mm, 0.20	128.4 kN.m	
Moment Capacity Check (M/Mr)	M 22.1 kN.m, Mr 128.4 kN.m	0.172	OK
Shear Capacity Check	F 42.8 kN, vc 0.625 N/mm², Fvr 151.3 kN	0.28	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main H12@150 (50 mm) Dist. H12@175 (62 mm)	754 mm²	OK
Compression Steel Provided (Cover)	Main H16@150 (50 mm) Dist. H12@175 (66 mm)	1340 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	244 mm, 1000 mm, 754 mm², 500 N/mm², 30 N/mm²	232 mm	
Mr=fn(above,As',d',x,x/d)	1340 mm², 58 mm, 27 mm, 0.11	76.0 kN.m	
Moment Capacity Check (M/Mr)	M 10.8 kN.m, Mr 76.0 kN.m	0.142	OK
Shear Capacity Check	F 63.0 kN, vc 0.514 N/mm², Fvr 125.4 kN	0.50	OK

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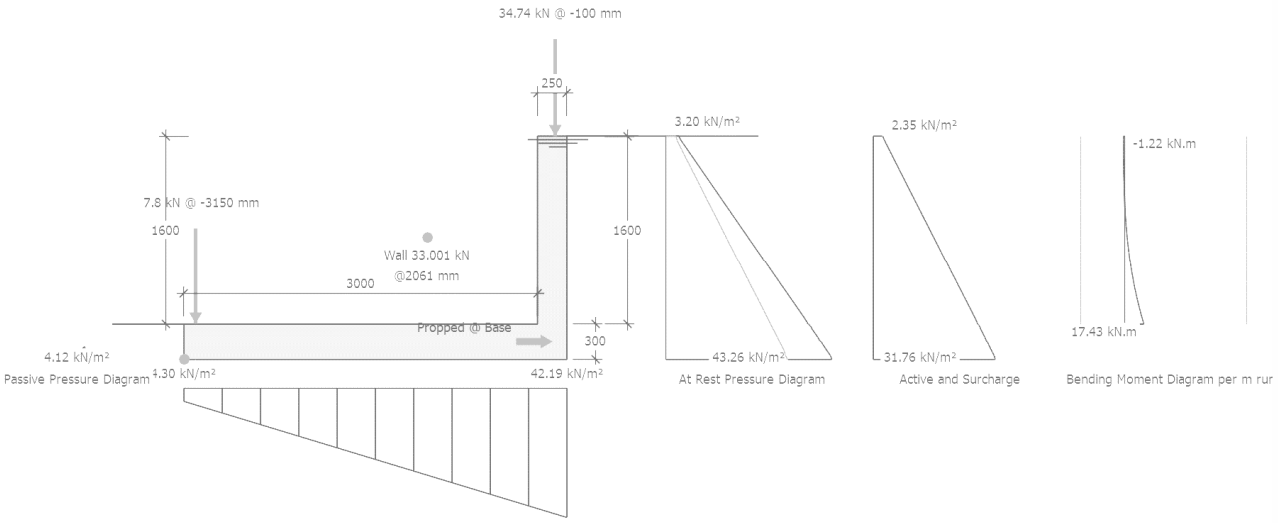
MASTERKEY : RETAINING WALL DESIGN TO BS 8002 : 1994 AND BS 8110 : 1997
RW1 (LC2)-Perm
Reinforced Concrete Retaining Wall with Reinforced Base



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 30 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 30 mm, Wall outer cover 30 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 1600 mm
Unplanned excavation depth	Front of wall 190 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	34.74 kN/m @ X -100 mm and Y 0 mm - Load type Dead
	7.8 kN/m @ X -3150 mm and Y 1600 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 95.00 kN/m², @ back 95.00 kN/m²
Back Soil Friction and Cohesion	ϕ = Atn(Tan(25)/1.2) = 21.24°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(25)/1.2))) = 16.25°
Front Soil Friction and Cohesion	ϕ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

G_{Wall}- Wall & Base Self Weight, P_a- Active Earth Pressure, $P_{surcharge}$- Earth pressure from surcharge, P_p- Passive Earth Pressure

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

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	22.129/178.239	0.124	OK

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Wall Sliding - Virtual Back Pressure

$Fx/(Rx_{Friction}+ Rx_{Passive})$	0.000/(22.016+0.229)	0.000	OK
Prop Reaction Case 2 (Service)	32.6 kN @ Base		

Soil Pressure

Virtual Back (No uplift)	Max(4.298/95, 42.187/95) kN/m²	0.444	OK
Wall Back (No uplift)	Max(4.272/95, 42.213/95) kN/m²	0.444	OK

Structural Design

At Rest Earth Pressure

At rest earth pressures magnification	$(1+\text{Sin}(\phi)) \times \sqrt{OCR} = (1+\text{Sin}(21.24)\times\sqrt{1}$		1.36

Prop Reaction

Maximum Prop Reaction (Ultimate)	44.3 kN @ Base		

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main H16@150 (30 mm) Dist. H12@175 (46 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main H12@250 (30 mm) Dist. H12@175 (42 mm)	452 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	212 mm, 1000 mm, 1340 mm², 500 N/mm², 30.0 N/mm²	190 mm	
Mr=fn(above,As',d',x,x/d)	452 mm², 36 mm, 48 mm, 0.23	110.9 kN.m	
Moment Capacity Check (M/Mr)	M 17.4 kN.m, Mr 110.9 kN.m	0.157	OK
Shear Capacity Check	F 32.3 kN, vc 0.676 N/mm², Fvr 143.2 kN	0.23	OK

Wall Design (Outer Steel)

Critical Section	Critical @ 1600 mm from base, Case 2		
Steel Provided (Cover)	Main H12@250 (30 mm) Dist. H12@175 (42 mm)	452 mm²	OK
Compression Steel Provided (Cover)	Main H16@150 (30 mm) Dist. H12@175 (46 mm)	1340 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	214 mm, 1000 mm, 452 mm², 500 N/mm², 30.0 N/mm²	203 mm	
Mr=fn(above,As',d',x,x/d)	1340 mm², 38 mm, 16 mm, 0.08	40.0 kN.m	
Moment Capacity Check (M/Mr)	M 1.2 kN.m, Mr 40.0 kN.m	0.030	OK
Shear Capacity Check	F 0.0 kN, vc 0.468 N/mm², Fvr 100.1 kN	0.00	OK

Base Top Steel Design

Steel Provided (Cover)	Main H16@150 (50 mm) Dist. H12@175 (66 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main H12@150 (50 mm) Dist. H12@175 (62 mm)	754 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	242 mm, 1000 mm, 1340 mm², 500 N/mm², 30 N/mm²	220 mm	
Mr=fn(above,As',d',x,x/d)	754 mm², 56 mm, 48 mm, 0.20	128.4 kN.m	
Moment Capacity Check (M/Mr)	M 11.1 kN.m, Mr 128.4 kN.m	0.086	OK
Shear Capacity Check	F 20.9 kN, vc 0.625 N/mm², Fvr 151.3 kN	0.14	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main H12@150 (50 mm) Dist. H12@175 (62 mm)	754 mm²	OK
Compression Steel Provided (Cover)	Main H16@150 (50 mm) Dist. H12@175 (66 mm)	1340 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	244 mm, 1000 mm, 754 mm², 500 N/mm², 30 N/mm²	232 mm	
Mr=fn(above,As',d',x,x/d)	1340 mm², 58 mm, 27 mm, 0.11	76.0 kN.m	
Moment Capacity Check (M/Mr)	M 22.6 kN.m, Mr 76.0 kN.m	0.298	OK
Shear Capacity Check	F 50.2 kN, vc 0.514 N/mm², Fvr 125.4 kN	0.40	OK

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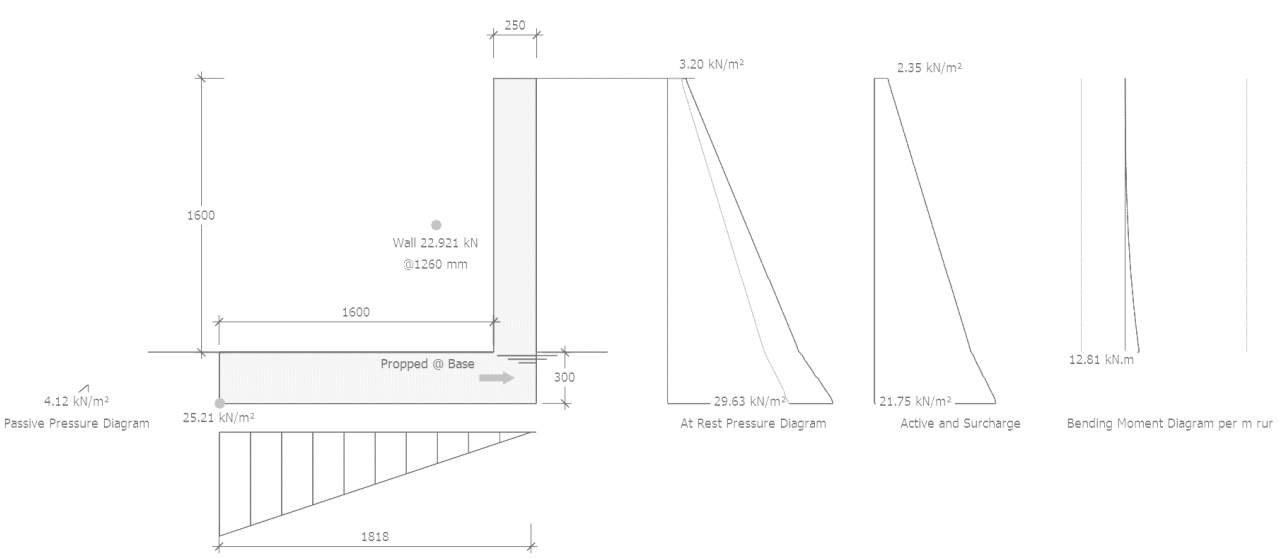
MASTERKEY : RETAINING WALL DESIGN TO BS 8002 : 1994 AND BS 8110 : 1997
RW1 (LC2)-Temp
Reinforced Concrete Retaining Wall with Reinforced Base



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
Concrete grade	fcu 30 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 30 mm, Wall outer cover 30 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 190 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	Ties, line loads and partial loads are measured from the inner top edge of the wall

Soil Properties

Bearing pressure	Premissable service pressure @ front 95.00 kN/m², @ back 95.00 kN/m²
Back Soil Friction and Cohesion	ϕ = Atn(Tan(25)/1.2) = 21.24°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(25)/1.2))) = 16.25°
Front Soil Friction and Cohesion	ϕ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

G_{Wall}- Wall & Base Self Weight, P_a- Active Earth Pressure, $P_{surcharge}$- Earth pressure from surcharge, P_p- Passive Earth Pressure

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

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	14.990/28.882	0.519	OK

Wall Sliding - Virtual Back Pressure

Fx/($Rx_{Friction}$+ $Rx_{Passive}$)	0.000/(6.680+0.229)	0.000	OK
Prop Reaction Case 2 (Service)	21.6 kN @ Base		

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Soil Pressure

Virtual Back	25.211/95 kN/m², Length under pressure 1.818 m	0.265	OK
Wall Back	25.143/95 kN/m², Length under pressure 1.823 m	0.265	OK

Structural Design

At Rest Earth Pressure

At rest earth pressures magnification	(1+Sin(ϕ)) x √OCR = (1+Sin(21.24)x√1	1.36

Prop Reaction

Maximum Prop Reaction (Ultimate)	29.4 kN @ Base

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main H16@150 (30 mm) Dist. H12@175 (46 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main H12@250 (30 mm) Dist. H12@175 (42 mm)	452 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	212 mm, 1000 mm, 1340 mm², 500 N/mm², 30.0 N/mm²	190 mm	
Mr=fn(above,As',d',x,x/d)	452 mm², 36 mm, 48 mm, 0.23	110.9 kN.m	
Moment Capacity Check (M/Mr)	M 12.8 kN.m, Mr 110.9 kN.m	0.115	OK
Shear Capacity Check	F 21.4 kN, vc 0.676 N/mm², Fvr 143.2 kN	0.15	OK

Base Top Steel Design

Steel Provided (Cover)	Main H16@150 (50 mm) Dist. H12@175 (66 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main H12@150 (50 mm) Dist. H12@175 (62 mm)	754 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	242 mm, 1000 mm, 1340 mm², 500 N/mm², 30 N/mm²	220 mm	
Mr=fn(above,As',d',x,x/d)	754 mm², 56 mm, 48 mm, 0.20	128.4 kN.m	
Moment Capacity Check (M/Mr)	M 0.0 kN.m, Mr 128.4 kN.m	0.000	OK
Shear Capacity Check	F 0.0 kN, vc 0.625 N/mm², Fvr 151.3 kN	0.00	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main H12@150 (50 mm) Dist. H12@175 (62 mm)	754 mm²	OK
Compression Steel Provided (Cover)	Main H16@150 (50 mm) Dist. H12@175 (66 mm)	1340 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	244 mm, 1000 mm, 754 mm², 500 N/mm², 30 N/mm²	232 mm	
Mr=fn(above,As',d',x,x/d)	1340 mm², 58 mm, 27 mm, 0.11	76.0 kN.m	
Moment Capacity Check (M/Mr)	M 18.4 kN.m, Mr 76.0 kN.m	0.243	OK
Shear Capacity Check	F 16.0 kN, vc 0.514 N/mm², Fvr 125.4 kN	0.13	OK

	Project		Job Ref.	
	28 Parliament Hill		20230153	
	Drawing Ref.	Calculations by AS	Checked by	Sheet
	Part of Structure Retaining wall R-3			Date Sep-23

h = 1.6 m

The retaining walls will be designed for one load case:
• Case 1 – 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.
- Permanent case –empty pool, surcharge, water at ground level
- Temporary case –empty pool, surcharge, no water

Assumptions:
- Total retained height 1600mm
- Accidental water level assumed at 1mBGL
- Surcharge of 5kN/m2 has been considered for the area underneath existing floor
- 125Pa safe bearing pressure

Ltoe = 1.6 m
Lheel = m

Loading (w)

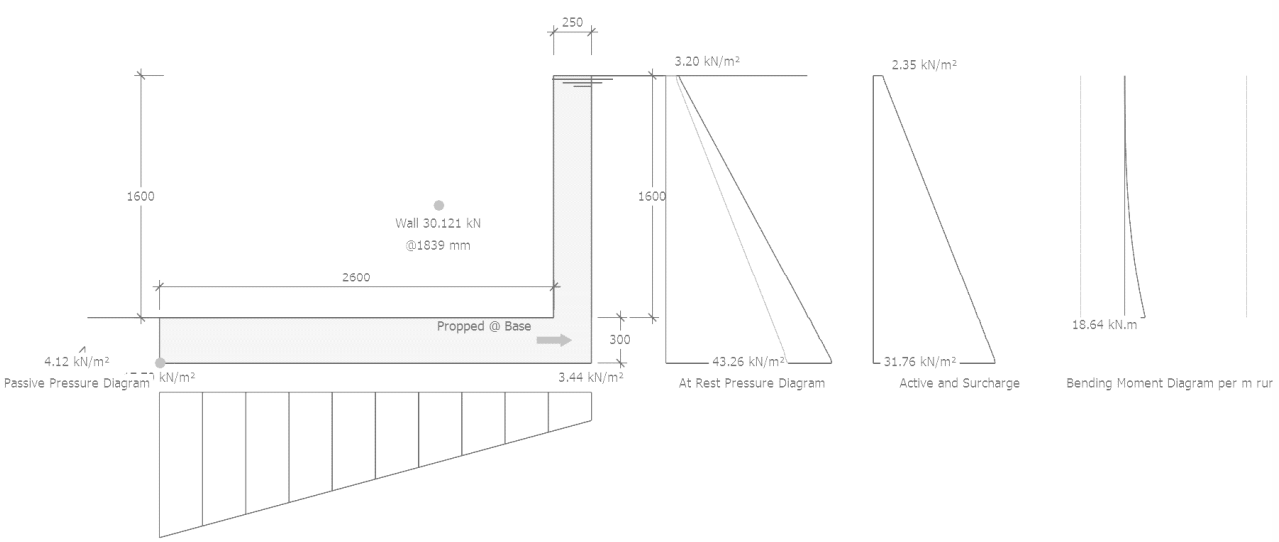
Dead Load (G_k):

	kN/m²	m	kN/m
No vertical load considered			
TOTAL LC1			0.00
TOTAL LC2			0.00

Live Load (Q_k):

	kN/m²	m	kN/m
surcharge considered	10.00		
No vertical load considered			
TOTAL LC1			0.000
TOTAL LC2			0.00

MASTERKEY : RETAINING WALL DESIGN TO BS 8002 : 1994 AND BS 8110 : 1997
RW3 (LC2)-Perm
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 30 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 30 mm, Wall outer cover 30 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 1600 mm
Unplanned excavation depth	Front of wall 190 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	Ties, line loads and partial loads are measured from the inner top edge of the wall

Soil Properties

Bearing pressure	Premissable service pressure @ front 95.00 kN/m², @ back 95.00 kN/m²
Back Soil Friction and Cohesion	ϕ = Atn(Tan(25)/1.2) = 21.24°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(25)/1.2))) = 16.25°
Front Soil Friction and Cohesion	ϕ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

G_{Wall}- Wall & Base Self Weight, P_a- Active Earth Pressure, $P_{surcharge}$- Earth pressure from surcharge, P_p- Passive Earth Pressure

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

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	22.129/55.403	0.399	OK

Wall Sliding - Virtual Back Pressure

Fx/($Rx_{Friction}$+ $Rx_{Passive}$)	0.000/(8.778+0.229)	0.000	OK
Prop Reaction Case 2 (Service)	32.6 kN @ Base		

Soil Pressure

Virtual Back (No uplift)	Max(17.696/95, 3.441/95) kN/m²	0.186	OK
Wall Back (No uplift)	Max(17.662/95, 3.475/95) kN/m²	0.186	OK

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Structural Design

At Rest Earth Pressure

At rest earth pressures magnification	(1+Sin(ϕ)) x √OCR = (1+Sin(21.24)x√1	1.36

Prop Reaction

Maximum Prop Reaction (Ultimate)	44.3 kN @ Base

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main H16@150 (30 mm) Dist. H12@175 (46 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main H12@250 (30 mm) Dist. H12@175 (42 mm)	452 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	212 mm, 1000 mm, 1340 mm², 500 N/mm², 30.0 N/mm²	190 mm	
Mr=fn(above,As',d',x,x/d)	452 mm², 36 mm, 48 mm, 0.23	110.9 kN.m	
Moment Capacity Check (M/Mr)	M 18.6 kN.m, Mr 110.9 kN.m	0.168	OK
Shear Capacity Check	F 32.3 kN, vc 0.676 N/mm², Fvr 143.2 kN	0.23	OK

Base Top Steel Design

Steel Provided (Cover)	Main H16@150 (50 mm) Dist. H12@175 (66 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main H12@150 (50 mm) Dist. H12@175 (62 mm)	754 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	242 mm, 1000 mm, 1340 mm², 500 N/mm², 30 N/mm²	220 mm	
Mr=fn(above,As',d',x,x/d)	754 mm², 56 mm, 48 mm, 0.20	128.4 kN.m	
Moment Capacity Check (M/Mr)	M 0.0 kN.m, Mr 128.4 kN.m	0.000	OK
Shear Capacity Check	F 0.0 kN, vc 0.625 N/mm², Fvr 151.3 kN	0.00	OK

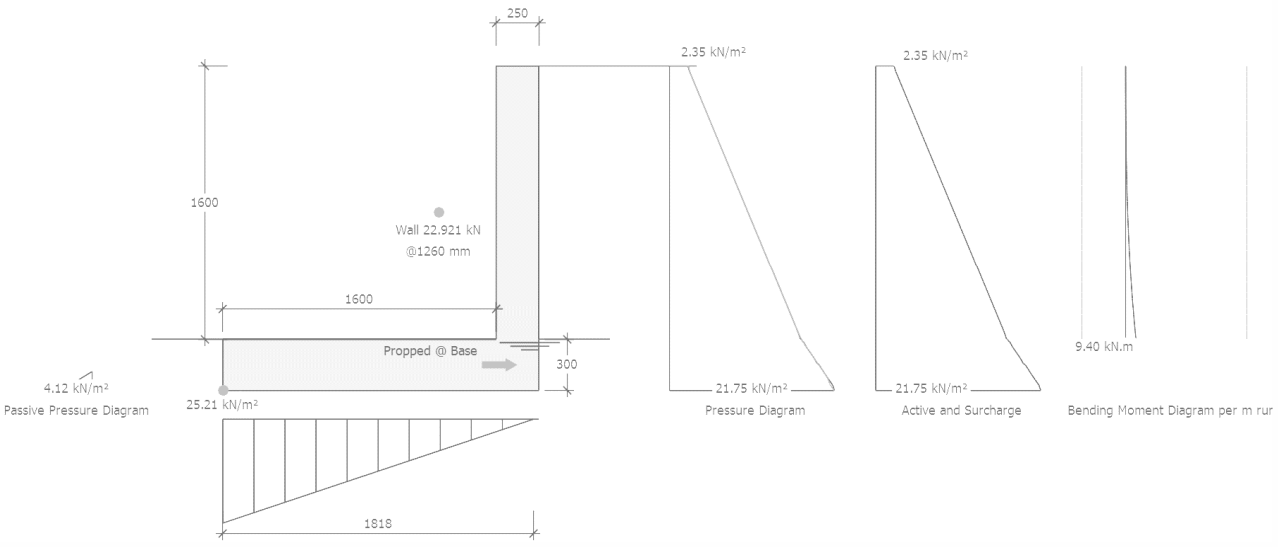
Base Bottom Steel Design

Steel Provided (Cover)	Main H12@150 (50 mm) Dist. H12@175 (62 mm)	754 mm²	OK
Compression Steel Provided (Cover)	Main H16@150 (50 mm) Dist. H12@175 (66 mm)	1340 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	244 mm, 1000 mm, 754 mm², 500 N/mm², 30 N/mm²	232 mm	
Mr=fn(above,As',d',x,x/d)	1340 mm², 58 mm, 27 mm, 0.11	76.0 kN.m	
Moment Capacity Check (M/Mr)	M 28.3 kN.m, Mr 76.0 kN.m	0.372	OK
Shear Capacity Check	F 15.0 kN, vc 0.514 N/mm², Fvr 125.4 kN	0.12	OK

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

RW3 (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

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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 30 N/mm², Permissible tensile stress 0.250 N/mm²
Concrete covers (mm)	Wall inner cover 30 mm, Wall outer cover 30 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 190 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	Ties, line loads and partial loads are measured from the inner top edge of the wall

Soil Properties

Bearing pressure	Premissable service pressure @ front 95.00 kN/m², @ back 95.00 kN/m²
Back Soil Friction and Cohesion	ϕ = Atn(Tan(25)/1.2) = 21.24°
Base Friction and Cohesion	δ = Atn(0.75xTan(Atn(Tan(25)/1.2))) = 16.25°
Front Soil Friction and Cohesion	ϕ = Atn(Tan(30)/1.2) = 25.69°

Loading Cases

G_{Wall}- Wall & Base Self Weight, P_a- Active Earth Pressure, $P_{surcharge}$- Earth pressure from surcharge, P_p- Passive Earth Pressure

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

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	14.990/28.882	0.519	OK

Wall Sliding - Virtual Back Pressure

Fx/($Rx_{Friction}$+ $Rx_{Passive}$)	0.000/(6.680+0.229)	0.000	OK
Prop Reaction Case 2 (Service)	21.6 kN @ Base		

Soil Pressure

Virtual Back	25.211/95 kN/m², Length under pressure 1.818 m	0.265	OK
Wall Back	25.143/95 kN/m², Length under pressure 1.823 m	0.265	OK

Structural Design

Prop Reaction

Maximum Prop Reaction (Ultimate)	21.6 kN @ Base

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main H16@150 (30 mm) Dist. H12@175 (46 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main H12@250 (30 mm) Dist. H12@175 (42 mm)	452 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	212 mm, 1000 mm, 1340 mm², 500 N/mm², 30.0 N/mm²	190 mm	
Mr=fn(above,As',d',x,x/d)	452 mm², 36 mm, 48 mm, 0.23	110.9 kN.m	
Moment Capacity Check (M/Mr)	M 9.4 kN.m, Mr 110.9 kN.m	0.085	OK
Shear Capacity Check	F 15.7 kN, vc 0.676 N/mm², Fvr 143.2 kN	0.11	OK

Base Top Steel Design

Steel Provided (Cover)	Main H16@150 (50 mm) Dist. H12@175 (66 mm)	1340 mm²	OK
Compression Steel Provided (Cover)	Main H12@150 (50 mm) Dist. H12@175 (62 mm)	754 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	242 mm, 1000 mm, 1340 mm², 500 N/mm², 30 N/mm²	220 mm	
Mr=fn(above,As',d',x,x/d)	754 mm², 56 mm, 48 mm, 0.20	128.4 kN.m	
Moment Capacity Check (M/Mr)	M 0.0 kN.m, Mr 128.4 kN.m	0.000	OK
Shear Capacity Check	F 0.0 kN, vc 0.625 N/mm², Fvr 151.3 kN	0.00	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main H12@150 (50 mm) Dist. H12@175 (62 mm)	754 mm²	OK
Compression Steel Provided (Cover)	Main H16@150 (50 mm) Dist. H12@175 (66 mm)	1340 mm²	
Leverarm z=fn(d,b,As,fy,Fcu)	244 mm, 1000 mm, 754 mm², 500 N/mm², 30 N/mm²	232 mm	
Mr=fn(above,As',d',x,x/d)	1340 mm², 58 mm, 27 mm, 0.11	76.0 kN.m	
Moment Capacity Check (M/Mr)	M 13.3 kN.m, Mr 76.0 kN.m	0.175	OK
Shear Capacity Check	F 13.2 kN, vc 0.514 N/mm², Fvr 125.4 kN	0.11	OK

	Project		Job Ref.	
	28 Parliament Hill		20230153	
	Drawing Ref.	Calculations by	Checked by	Sheet
		AS		
	Part of Structure		Date	
	Uplift and Buoyancy check		Sep-25	

BUOYANCY CHECK

TOTAL WEIGHT OF THE BUILDING

$$F_{weight\ total} = w_{slab\ self-weight+screed} * Aslab + underpin\ weight + party\ wall\ load$$

Aslab = 33 m2

wslab (sw+screed)= 5.23 kN/m2

underpin weight= 322.56 kN

party wall load= 0 kN

= 495 kN

445.6 x0.9 factor

TOTAL UPLIFT DUE TO GROUNDWATER

$F_{uplift\ total} = w_{H2O} * Hw * Aslab =$ 939 kN x1.0 factor

(where Aslab = 33 m2)

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

446 > 939

(CONSIDERS 0.9 FACTOR ON DEAD LOAD)

EQUILIBRIUM NOT SATISFIED UR 0.47

=> Provide 4No. Piles