

3E Consulting Engineers Ltd

2 Esh Plaza, Sir Bobby Robson Way, Great Park
Newcastle Upon Tyne, Tyne and Wear, NE13 9BA

Tel: (0191) 230 2993

Cloud a2956

Job Ref : P18-365

Sheet : AIP RW / 01

Made by : AMB

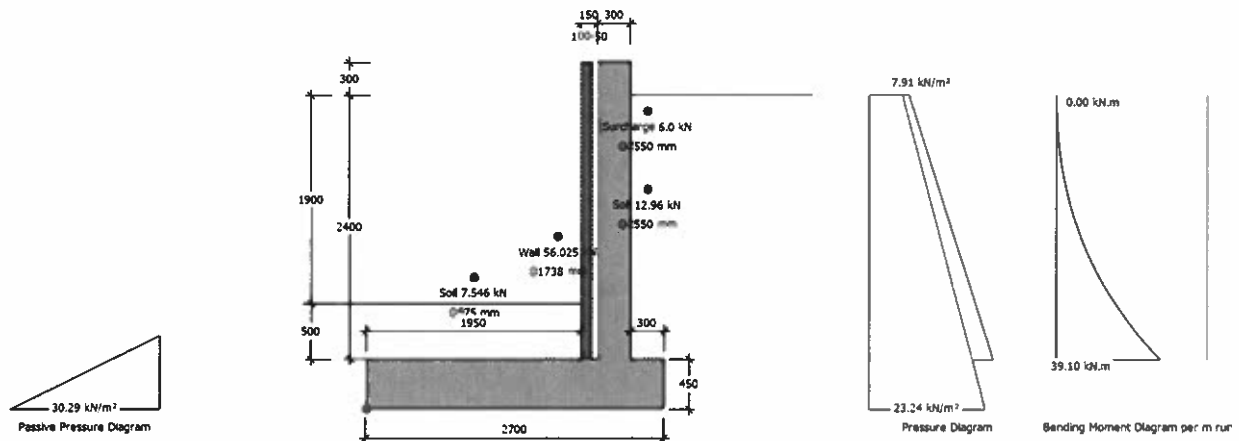
Date : 29 March 2022 / Ver. 2021.10.20

Checked : DG

Approved : 

MasterKey : Retaining Wall Design to BS 8002 : 1994 and EC 2 : 2004 Basic RC Retaining Wall - Rev A1

Reinforced Concrete Retaining Wall with External Cladding with Reinforced Base



Summary of Design Data

EC2 National Annex	UK
EC6 National Annex	UK
Notes	All dimensions are in mm and all forces are per metre run
Material Densities (kN/m³)	Soil 18.00, Concrete 25.00, Cladding 20.00
Concrete grade	C40/50 N/mm², Permissible tensile stress 1.310 N/mm²
Concrete covers (mm)	Wall inner cover 50 mm, Wall outer cover 50 mm. Base cover 50 mm
Reinforcement design	fy 500 N/mm² designed to EC 2: 2004
Surcharge and Water Table	Surcharge 20.00 kN/m², Fully drained
Unplanned excavation depth	Front of wall 285 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 150.00 kN/m², @ back 150.00 kN/m²
Back Soil Friction and Cohesion	$\alpha = \text{Atn}(\tan(30)/1.2) = 25.69^\circ$
Base Friction and Cohesion	$\delta = \text{Atn}(0.75 \times \tan(\text{Atn}(\tan(35)/1.2))) = 23.64^\circ$
Front Soil Friction and Cohesion	$\phi = \text{Atn}(\tan(30)/1.2) = 25.69^\circ$

Loading Cases

G_{Soil} - Soil Self Weight, G_{Wall} - Wall & Base Self Weight, F_{Heel} - Vertical Loads over Heel.	
P_a - Active Earth Pressure, $P_{\text{surcharge}}$ - Earth pressure from surcharge, P_p - Passive Earth Pressure	
Case 1: Geotechnical Design	1.00 G_{Soil} +1.00 G_{Wall} +1.00 F_{Heel} +1.00 P_a +1.00 $P_{\text{surcharge}}$ +1.00 P_p
Case 2: Structural Ultimate Design	1.40 G_{Soil} +1.40 G_{Wall} +1.60 F_{Heel} +1.00 P_a +1.00 $P_{\text{surcharge}}$ +1.00 P_p

Geotechnical Design

Wall Stability - Virtual Back Pressure

Case 1 Overturning/Stabilising	49.461/153.074	0.323	OK
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Wall Sliding - Virtual Back Pressure

$F_x/(R_x \text{Friction} + R_x \text{Passive})$	42.594/(36.118+10.087)	0.922	OK
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Soil Pressure

Virtual Back (No uplift)	Max(36.990/150, 24.144/150) kN/m²	0.247	OK
Wall Back (No uplift)	Max(43.087/150, 18.047/150) kN/m²	0.287	OK

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Sheet : AIP RW / 02
Made by : AMB
Date : 29 March 2022 / Ver. 2021.10.20
Checked : DG
Approved : dg

Structural Design**Cladding Details**

Partial Safety Factor (γ_{mc}/γ_{mf})	Units Category I, Execution Control Class 1	2.3/2.3	Table NA.1
Material	Concrete blocks, $\gamma = 20 \text{ kN/m}^3$		
Units and Mortar Strength	10.4 N/mm ² , Mortar designation M12/(i)		
Blocks Ratio	Unit height = 215, Least horizontal dimensions = 100	2.15	
Compressive Strength (f_k)	Group 1	7.8 N/mm ²	Table NA.4

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B10@200 (62 mm)	565 mm ²	OK
Compression Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B10@200 (62 mm)	565 mm ²	
Leverarm $z = f_n(d, b, A_s, f_y, F_{ck})$	244 mm, 1000 mm, 565 mm ² , 500 N/mm ² , 40 N/mm ²	232 mm	
$M = f_n(\text{above}, A_s', d', x, x/d)$	565 mm ² , 56 mm, 14 mm, 0.06	57.0 kN.m	
Moment Capacity Check (M/Mr)	M 39.1 kN.m, Mr 57.0 kN.m	0.686	OK
Shear Capacity Check	F 38.4 kN, vc 0.582 N/mm ² , Fvr 142.1 kN	0.27	OK

Base Top Steel Design

Steel Provided (Cover)	Main B16@200 (50 mm) Dist. B12@200 (66 mm)	1005 mm ²	OK
Compression Steel Provided (Cover)	Main B16@200 (50 mm) Dist. B12@200 (66 mm)	1005 mm ²	
Leverarm $z = f_n(d, b, A_s, f_y, F_{ck})$	392 mm, 1000 mm, 1005 mm ² , 500 N/mm ² , 40 N/mm ²	372 mm	
$M = f_n(\text{above}, A_s', d', x, x/d)$	1005 mm ² , 58 mm, 24 mm, 0.06	162.8 kN.m	
Moment Capacity Check (M/Mr)	M 2.8 kN.m, Mr 162.8 kN.m	0.017	OK
Shear Capacity Check	F 18.9 kN, vc 0.497 N/mm ² , Fvr 194.8 kN	0.10	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main B16@200 (50 mm) Dist. B12@200 (66 mm)	1005 mm ²	OK
Compression Steel Provided (Cover)	Main B16@200 (50 mm) Dist. B12@200 (66 mm)	1005 mm ²	
Leverarm $z = f_n(d, b, A_s, f_y, F_{ck})$	392 mm, 1000 mm, 1005 mm ² , 500 N/mm ² , 40 N/mm ²	372 mm	
$M = f_n(\text{above}, A_s', d', x, x/d)$	1005 mm ² , 58 mm, 24 mm, 0.06	162.8 kN.m	
Moment Capacity Check (M/Mr)	M 45.4 kN.m, Mr 162.8 kN.m	0.279	OK
Shear Capacity Check	F 40.4 kN, vc 0.497 N/mm ² , Fvr 194.8 kN	0.21	OK

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Sheet : AIP RW / 03

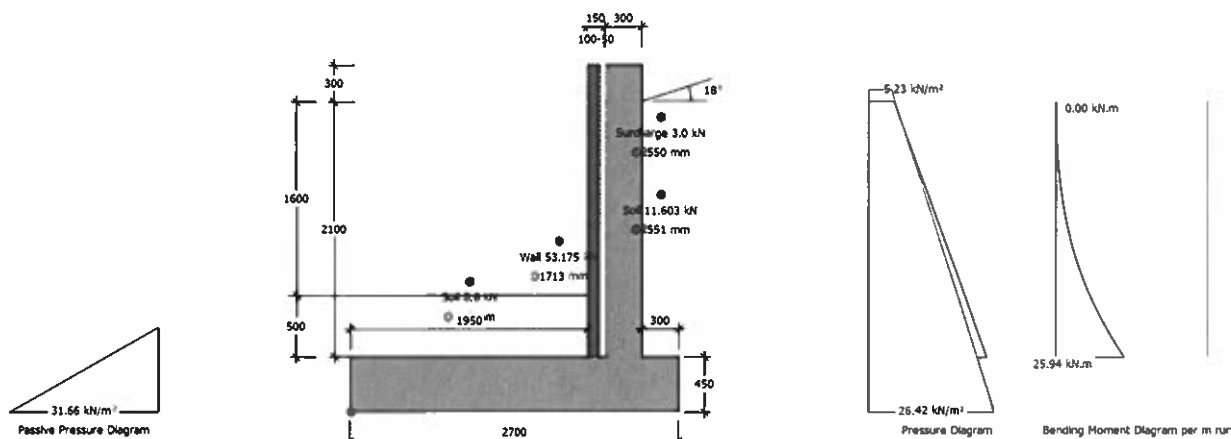
Made by : AMB

Date : 29 March 2022 / Ver. 2021.10.20

Checked : DG

Approved : 

MasterKey : Retaining Wall Design to BS 8002 : 1994 and EC 2 : 2004
Basic RC Retaining Wall - Rev A Sloping Ground
Reinforced Concrete Retaining Wall with External Cladding with Reinforced Base

**Summary of Design Data**

EC2 National Annex	UK
EC6 National Annex	UK
Notes	All dimensions are in mm and all forces are per metre run
Material Densities (kN/m³)	Soil 18.00, Concrete 25.00, Cladding 20.00
Angles	Embankment 18°
Concrete grade	C40/50 N/mm², Permissible tensile stress 1.310 N/mm²
Concrete covers (mm)	Wall inner cover 50 mm, Wall outer cover 50 mm, Base cover 50 mm
Reinforcement design	f _y 500 N/mm² designed to EC 2: 2004
Surcharge and Water Table	Surcharge 10.00 kN/m², Fully drained
Unplanned excavation depth	Front of wall 255 mm
† The Engineer must satisfy him/herself to the reinforcement detailing requirements of the relevant codes of practice	

Soil Properties

Bearing pressure	Premissible service pressure @ front 150.00 kN/m², @ back 150.00 kN/m²
Back Soil Friction and Cohesion	$\alpha_h = \text{Atn}(\text{Tan}(30)/1.2) = 25.69^\circ$
Base Friction and Cohesion	$\delta = \text{Atn}(0.75 \times \text{Tan}(\text{Atn}(\text{Tan}(35)/1.2))) = 23.64^\circ$
Front Soil Friction and Cohesion	$\phi = \text{Atn}(\text{Tan}(30)/1.2) = 25.69^\circ$

Loading Cases

G _{soil} - Soil Self Weight, G _{wall} - Wall & Base Self Weight, F _{vHeel} - 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 F _{vHeel} +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 F _{vHeel} +1.00 P _a +1.00 P _{surcharge} +1.00 P _p

Geotechnical Design**Wall Stability - Virtual Back Pressure**

Case 1 Overturning/Stabilising	41.925/136.742	0.307	OK
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Wall Sliding - Virtual Back Pressure

F _x /(R _{xFriction} + R _{xPassive})	41.311/(33.425+11.017)	0.930	OK
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Soil Pressure

Virtual Back (No uplift)	Max(35.114/150, 21.462/150) kN/m²	0.234	OK
Wall Back (No uplift)	Max(33.686/150, 22.890/150) kN/m²	0.225	OK

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Partial Safety Factor (γ_{mc}/γ_{mf})	Units Category I, Execution Control Class 1	2.3/2.3	Table NA.1
Material	Concrete blocks, $\gamma = 20 \text{ kN/m}^3$		
Units and Mortar Strength	10.4 N/mm ² , Mortar designation M12/(i)		
Blocks Ratio	Unit height=215, Least horizontal dimensions=100	2.15	
Compressive Strength (f_k)	Group 1	7.8 N/mm ²	Table NA.4

Wall Design (Inner Steel)

Critical Section	Critical @ 0 mm from base, Case 2		
Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B10@200 (62 mm)	565 mm ²	OK
Compression Steel Provided (Cover)	Main B12@200 (50 mm) Dist. B10@200 (62 mm)	565 mm ²	
Leverarm $z = f_n(d, b, A_s, f_y, F_{ck})$	244 mm, 1000 mm, 565 mm ² , 500 N/mm ² , 40 N/mm ²	232 mm	
$M_r = f_n(\text{above}, A_s', d', x, x/d)$	565 mm ² , 56 mm, 14 mm, 0.06	57.0 kN.m	
Moment Capacity Check (M/Mr)	M 25.9 kN.m, Mr 57.0 kN.m	0.455	OK
Shear Capacity Check	F 30.3 kN, vc 0.582 N/mm ² , Fvr 142.1 kN	0.21	OK

Base Top Steel Design

Steel Provided (Cover)	Main B16@200 (50 mm) Dist. B12@200 (66 mm)	1005 mm ²	OK
Compression Steel Provided (Cover)	Main B16@200 (50 mm) Dist. B12@200 (66 mm)	1005 mm ²	
Leverarm $z = f_n(d, b, A_s, f_y, F_{ck})$	392 mm, 1000 mm, 1005 mm ² , 500 N/mm ² , 40 N/mm ²	372 mm	
$M_r = f_n(\text{above}, A_s', d', x, x/d)$	1005 mm ² , 58 mm, 24 mm, 0.06	162.8 kN.m	
Moment Capacity Check (M/Mr)	M 1.8 kN.m, Mr 162.8 kN.m	0.011	OK
Shear Capacity Check	F 12.1 kN, vc 0.497 N/mm ² , Fvr 194.8 kN	0.06	OK

Base Bottom Steel Design

Steel Provided (Cover)	Main B16@200 (50 mm) Dist. B12@200 (66 mm)	1005 mm ²	OK
Compression Steel Provided (Cover)	Main B16@200 (50 mm) Dist. B12@200 (66 mm)	1005 mm ²	
Leverarm $z = f_n(d, b, A_s, f_y, F_{ck})$	392 mm, 1000 mm, 1005 mm ² , 500 N/mm ² , 40 N/mm ²	372 mm	
$M_r = f_n(\text{above}, A_s', d', x, x/d)$	1005 mm ² , 58 mm, 24 mm, 0.06	162.8 kN.m	
Moment Capacity Check (M/Mr)	M 32.2 kN.m, Mr 162.8 kN.m	0.198	OK
Shear Capacity Check	F 30.3 kN, vc 0.497 N/mm ² , Fvr 194.8 kN	0.16	OK