



Structures Centre

PROJECT: PROPOSED RESIDENTIAL DEVELOPMENT

STRUCTURE: DESIGNING A COUNTERFORT RETAINING WALL

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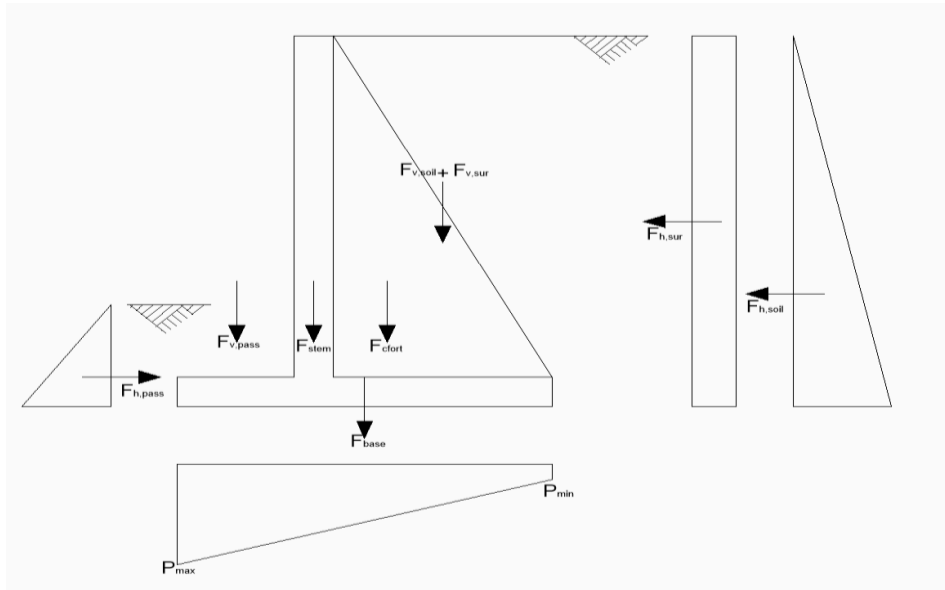
DATE:

JOB REF:

SHEET NO: S01

DISCLAIMER: This spreadsheet is intended to be used for preliminary design only. Structurescentre.com will not be liable for any damages arising from the use of this spreadsheet.

RETAINING WALL ANALYSIS



RETAINING WALL DETAILS	
Stem height; h_{stem}	7000 mm
Stem thickness; t_{stem}	300 mm
Counterfort spacing; s_{cfort}	5000 mm
counterfort width; b_{cfort}	350 mm
Toe length; l_{toe}	1000 mm
Heel length; l_{heel}	3700 mm
Base thiknees; t_{base}	500 mm
Height of backfill; h_{ret}	7000 mm
Height of frontfill; h_{pass}	300 mm

ADDITIONAL LOADING	
Surcharge; q	10 kN/m ²

MATERIAL PROPERTIES			
Soil density γ_s	18	Mpa	
Concrete unit weight γ_c	25	Mpa	
Chararistics shear resistance angle; ϕ'_{rk}	30	deg	
Characteristic friction angle; $\delta_{r,k}$	30	Mpa	
Concrete Strength; f_{ck}	20	Mpa	
Steel Yield Strength; f_{yk}	410	Mpa	
EQU PARTIAL FACTORS			
$\gamma_{g,unfav.}$	1.1	$\gamma_{q,unfav.}$	1.5
$\gamma_{g,fav.}$	0.9	$\gamma_{q,fav.}$	0
M2 PARTIAL FACTORS		STR PARTIAL FACTORS	
$\gamma_{\phi'}$	1.25	γ_g	1.35
γ_{γ_s}	1.00	γ_q	1.50
Presumed Bearing Pressure; $q_{presumed}$		250	Mpa

RETAINING WALL GEOMETRY			
Base length;	l_{base}	5000	mm
Moist soil height	h_{moist}	7000.00	mm
Length of surcharge	l_{sur}	3700	mm
-distance to vertical component	$x_{sur,v}$	3150	mm
Effective height of wall	h_{eff}	7500	mm
-distance to horizontal component	$x_{sur,h}$	3750	mm
Area of wall stem	A_{stem}	2100000	mm ²
-distance to vertical component	x_{stem}	1150	mm
Area of counterfort	A_{cfort}	12950000	mm ²
-distance to vertical component	x_{cfort}	2533.3	mm
Area of wall base	A_{base}	2500000	mm ²
-distance to vertical component	x_{base}	2500	mm

Area of backfill	A_{soil}	2590000	mm^2
-distance to vertical component	$X_{soil,v}$	3150	mm
-distance to horizontal component	$X_{soil,h}$	2333	mm
Area of frontfill	A_{pass}	300000	mm^2
-distance to vertical component	$X_{pass,v}$	500	mm
-distance to horizontal component	$X_{pass,h}$	100	mm

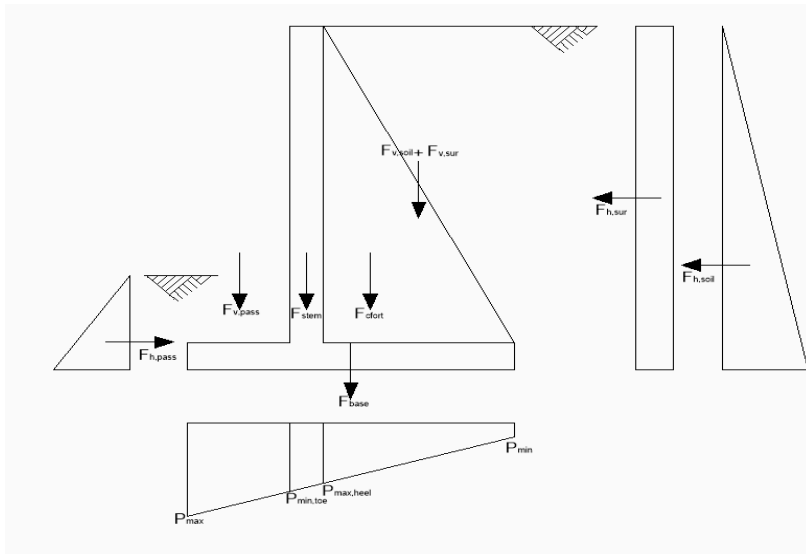
RANKINE COEFFICIENT OF PRESSURE		
Active pressure coefficient; k_a	0.49	
Passive pressure coefficient; k_p	2.04	

SLIDING CHECK			
Resisting Forces			
Wall stem	F_{stem}	52.5	kN/m
Counterfort	F_{cfort}	22.6625	kN/m
Wall base	F_{base}	62.5	kN/m
Backfill	$F_{soil,v}$	466.2	kN/m
Frontfill	$F_{pass,v}$	5.4	kN/m
Surcharge	$F_{sur,v}$	37	kN/m
	F_{Res}	337.8619	kN/m
Sliding Force			
Backfill	$F_{soil,h}$	248.2096	kN/m
Surcharge	$F_{sur,h}$	36.77179	kN/m
	$F_{sliding}$	328.1883	kN/m
Sliding Result		0.971	Pass

OVERTURNING CHECK			
Restoring Moment			
Wall stem	M_{stem}	60.375	kN.m/m
Counterfort	M_{cfort}	57.41166667	kN.m/m
Wall base	M_{base}	156.25	kN.m/m
Backfill	M_{bfill}	1468.53	kN.m/m
Frontfill	M_{ffill}	2.7	kN.m/m
Surcharge	M_{sur}	0	kN.m/m
	M_T	1570.74	kN.m/m
Overturning Moment			
Backfill	M_{soil}	682.5764399	kN.m/m
Surcharge	M_{sur}	206.8413454	kN.m/m
	M_o	889.4177853	kN.m/m
Overturning Result		0.57	Pass

PRESSURE CHECK @ SLS							
Vertical Loads			Out of Balance Moment				
Wall stem	F_{stem}	52.5	kN/m	Wall stem	M_{stem}	60.38	kN.m/m
Counterfort	F_{cfort}	22.66	kN/m	Counterfort	M_{cfort}	57.41	kN.m/m
Wall base	F_{base}	62.5	kN/m	Wall base	M_{base}	156.25	kN.m/m
Backfill	$F_{soil,v}$	466.2	kN/m	Backfill	M_{soil}	889.37	kN.m/m
Frontfill	$F_{pass,v}$	5.4	kN/m	Frontfill	M_{pass}	2.53	kN.m/m
Surcharge	$F_{sur,v}$	37	kN/m	Surcharge	M_{sur}	-21.34	kN.m/m
	F_{TOTAL}	646.26	Kn/m		M	1144.60	kN.m/m
Horizontal Loads			Eccentricity	e	-728.89	mm	
Backfill	$F_{soil,h}$	248.2096	kN/m	Pressure at Toe	q_{toe}	242.31	$kN/m^2/m$
Surcharge	$F_{sur,h}$	36.77179	kN/m	Pressure at Heel	q_{heel}	16.20	$kN/m^2/m$
Frontfill	$F_{pass,h}$	1.652081	kN/m	Pressure Result		Pass	

RETAINING WALL DESIGN



PRESSURE @ ULS		
$P_{h,soil}$	44.67773	kN/m ² /m
$P_{h,sur}$	7.354359	kN/m ² /m
P_{max}	332.321	kN/m ² /m
P_{min}	18.88073	kN/m ² /m
$P_{max,heel}$	250.8265	kN/m ² /m
$P_{min,toe}$	269.633	kN/m ² /m

TABLE FOR COEFFICIENTS OF FOR TWO - WAY RECTANGULAR PANEL FIXED ON THREE EDGES						
Boundary Conditions		Slab Aspect Ratio				
Three Edge Continous		1	1.25	1.5	1.75	2
-Positive Moment in Span		0.027	0.029	0.031	0.032	0.034
-Negative Moment in Support		0.057	0.060	0.063	0.066	0.069

FLEXURAL DESIGN - STEM					
Input		Equivalent UDL Pressure		40.86 kN/m ²	
L_y/L_x	1.4	α_+	0.031	α_-	0.063
Span Design Moment	31.66856 kN.m	Cover to tensile bar; c	50 mm		
Support Design Moment	64.35868 kN.m	Cover to compr. bar; c'	50 mm		
Overall depth of wall	300 mm	Eff. depth to tensile bar; d	244		
Tensile bar; Φ	12 mm	Eff. depth to compr. bar; d'	56		
Compression bar; Φ'	12 mm				
Output - Span			Output - Support		
k'	0.17	k'	0.17		
k	0.03	k'	0.0540502		
z	231.80 mm	z	231.80 mm		
$A_{st, req}$	383.01 mm ²	$A_{st, req}$	778.378 mm ²		
$A_{st, min}$	366.00 mm ²	$A_{st, min}$	366.00 mm ²		

FLEXURAL DESIGN - TOE		
Input		
Design Moment MED	145.26	kN.m/m
Overall depth of Base	500	mm
Tensile bar; Φ	16	mm
Compression bar; Φ'	16	mm
Cover to tensile bar; c	50	mm
Cover to compr. Bar c'	50	mm
Eff depth (tensile bar); d	442	mm
Eff depth (compr. bar); d	58	mm
Output		
k'	0.17	
k	0.04	
z	419.90	mm ² /m
$A_{st, req}$	969.86	mm ² /m
$A_{st, min}$	663.00	mm ² /m

FLEXURAL DESIGN - HEEL		
Input		
Design Moment MED	76.88	kN.m/m
Overall depth of Base	500	mm
Tensile bar; Φ	16	mm
Compression bar; Φ'	16	mm
Cover to tensile bar; c	50	mm
Cover to compr. Bar c'	50	mm
Eff depth (tensile bar); d	442	mm
Eff depth (compr. bar); d	58	mm
Output		
k'	0.17	
k	0.02	
z	419.90	mm ² /m
$A_{st, req}$	513.27	mm ² /m
$A_{st, min}$	663.00	mm ² /m

FLEXURAL DESIGN - COUNTERFORT					
Input					
Design Moment @ Base	2502.84	kN.m	Cover to tensile bar; c	50	mm
Design Moment @ 1m-Base	1838.82	kN.m	Cover to compr. bar; c'	50	mm
Overall depth of wall @ Base	3700	mm	Eff. depth ; dbase	3610	mm
Tensile bar; Φ	20	mm	Eff. depth d1-base	3081.4	mm
Links Φ'	10	mm	Overall depth @ 1m - Base	3171.4	mm
Width of counterfort; b	350	mm			
Output - Base			Output - 1m-Base		
k'	0.17		k'	0.17	
k	0.03		k	0.028	
z	3429.50	mm	z	2927.3571	mm
$A_{st,req}$	2045.97	mm ²	$A_{st,req}$	1672.9536	mm ²
$A_{st,min}$	1895.25	mm ²	$A_{st,min}$	1895.25	mm ²

REBAR SUMMARY					
Wall Stem					
Span			Support		
$A_{s,req}$; mm ² /m	383.01		$A_{s,req}$; mm ² /m	778.378	
Bar Size	12		Bar Size	12	
Spacing	200		Spacing	150	
$A_{s,prov}$; mm ² /m	565.4866776	PASS	$A_{s,prov}$; mm ² /m	753.9822369	FAIL
Wall Toe			Wall Heel		
$A_{s,req}$; mm ² /m	969.86		$A_{s,req}$; mm ² /m	663.00	
Bar Size	16		Bar Size	16	
Spacing	200		Spacing	200	
$A_{s,prov}$; mm ² /m	1005.309649	PASS	$A_{s,prov}$; mm ² /m	1005.309649	PASS
Counterforts					
Base			Mid-height		
$A_{s,req}$; mm ²	2045.97		$A_{s,req}$; mm ²	1895.25	
Bar Size	20		Bar Size	20	
No	7		No	7	
$A_{s,prov}$; mm ²	2199.114858	PASS	$A_{s,prov}$; mm ²	2199.11	PASS