

COMPLETE CAD & STRUCTURAL SOLUTIONS LIMITED



Structural Calculations

**For masonry retaining wall
at**

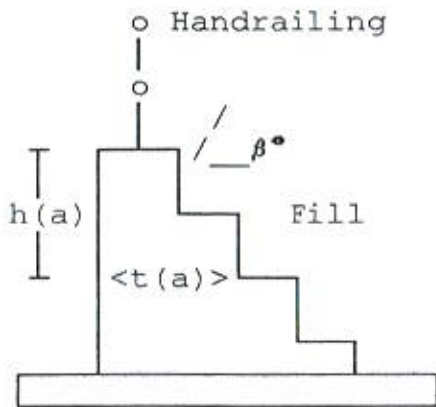
**71 Bay View Gardens
Skewen,
SA10 6NF**

4th April 2023

Tel: 07458335128 Email: info@ccs-solutions.co.uk Address: 39 Tan Y Lan Terrace, Morriston,
Swansea website: www.ccs-solutions.co.uk

Masonry gravity wall

Designed in accordance with BS5628:Part 1: 1992.
Location: Masonry Retaining Wall



Steps are numbered down from the top.

$h(a)$ is height at step a (from top)

$t(a)$ is thickness at step a

Soil details

Weight/unit volume of soil & wall $w_e = 18 \text{ kN/m}^3$
Internal angle of friction $\phi = 35^\circ$
Angle of backfill $\beta = 0^\circ$
Active soil pressure is applicable.
Sine angle of internal friction $sp = \sin(\text{RAD}(\phi)) = 0.5736$
Active pressure coefficient $ce = (1 - sp) / (1 + sp)$
 $= (1 - 0.5736) / (1 + 0.5736)$
 $= 0.271$

Masonry details

Mortar designation to Table 1 $\text{mortar} = 3$
Masonry type (1=clay 2=cal silicate 3=conc brick 4=block) $\text{typ}(1) = 4$
Concrete Blocks Dimensions
Height $hb = 215 \text{ mm}$
Least horiz dimension $lhd = 100 \text{ mm}$
ratio height/least horiz dim $rb = hb / lhd = 215 / 100 = 2.15$
Compressive strength of blocks $po = 7 \text{ N/mm}^2$

Proposed Retaining Wall at:
71 Bay View Gardens
Skewen
Neath

Page: 2
Made by:
Date: 07.04.23
Ref No:

Characteristic flexural strength for bed failure and leaf greater than 250mm thick - Table 3
 $fb(a) = \text{TABLE 3.71 for } po=7, \text{ mortar}=3$
 $= 0.15 \text{ N/mm}^2$

Partial safety factor material $\gamma_{mam}=3.5$

External loading



Applied moment at top of wall	$xm=0 \text{ kNm}$
Applied shear at top of wall	$xv=0 \text{ kN}$
Weight/unit area of surcharge	$ws=5 \text{ kN/m}^2$
Load factor external loads at top	$\gamma_{max}=1.6$
Load factor surcharge	$\gamma_{mas}=1.6$
Load factor earth pressure	$\gamma_{mae}=1.4$
Load factor self weight	$\gamma_{maf}=0.9$

Wall design

Number of steps proposed in wall $\text{steps}=4$

Step 1 Typical Analysis which is repeated for each step

Proposed height at step	$h(1)=0.45 \text{ m}$
Proposed thickness at step	$t(1)=0.325 \text{ m}$
Moment at height h earth	$me=ce*we*h(a)^3/6=0.271*18*0.45^3/6$ $=0.07408 \text{ kNm}$
surcharge	$ms=ce*ws*h(a)^2/2=0.271*5*0.45^2/2$ $=0.1372 \text{ kNm}$
Ultimate moment at height h	$mu=me*\gamma_{mae}+ms*\gamma_{mas}+(xm+xv*h(a))$ $\quad * \gamma_{max}$ $=0.07408*1.4+0.1372*1.6+(0+0*0.45)$ $\quad *1.6$ $=0.3232$

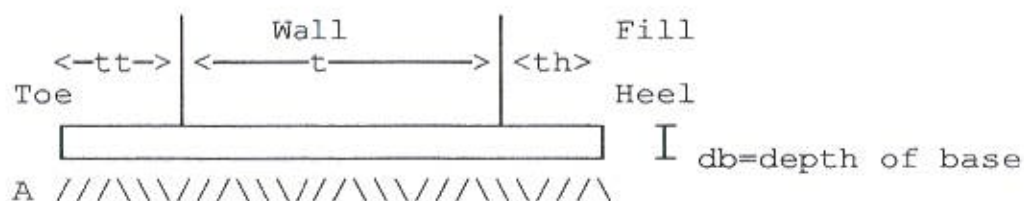
Proposed Retaining Wall at:
 71 Bay View Gardens
 Skewen
 Neath

Page: 3
 Made by:
 Date: 07.04.23
 Ref No:

Section modulus at thickness t $z = t(a)^2/6 = 0.325^2/6 = 0.0176 \text{ m}^3$
 Weight/unit area at depth h $gd = (ws + we \cdot h(a)) \cdot \gamma_{maf}/1000$
 $= (5 + 18 \cdot 0.45) \cdot 0.9/1000$
 $= 0.01179 \text{ N/mm}^2$
 Moment of resistance $mr = (fb(1)/\gamma_{mam} + gd) \cdot z \cdot 1000$
 $= (0.15/3.5 + 0.01179) \cdot 0.0176 \cdot 1000$
 $= 0.962 \text{ kNm}$
 Applied moment less than moment of resistance ($0.3232 \leq 0.962$)
 therefore section is satisfactory.
 Step 1 width 0.325 m
 height 0.45 m

Step height (m)	Step thicknes (m)	Ultimate Moments (kNm)	
		Resistance	Applied
0.45	0.325	0.962	0.3232
0.9	0.45	2.09	1.708
1.35	0.9	9.346	4.776
1.9	1.35	23.73	11.72

Stability and bearing check



Width of toe $tt = 0.25 \text{ m}$
 Width of heel $th = 0.25 \text{ m}$
 Thickness of wall $t = 1.35 \text{ m}$
 Height of wall $h = 1.9 \text{ m}$
 Width of base $tb = t + tt + th = 1.35 + 0.25 + 0.25$
 $= 1.85$
 Depth of base $db = 0.3 \text{ m}$
 Overall depth $od = h + db = 1.9 + 0.3 = 2.2 \text{ m}$
 Weight of fill and wall $wf = we \cdot (t + th) \cdot h = 18 \cdot (1.35 + 0.25) \cdot 1.9$
 $= 54.72 \text{ kN}$
 Eccentricity from A $ef = tt + (t + th)/2 = 0.25 + (1.35 + 0.25)/2$
 $= 1.05 \text{ m}$

Proposed Retaining Wall at:
71 Bay View Gardens
Skewen
Neath

Page: 4
Made by:
Date: 07.04.23
Ref No:

Weight of base	$w_b = t_b \cdot d_b \cdot 24 = 1.85 \cdot 0.3 \cdot 24 = 13.32 \text{ kN}$
Earth horizontal force	$sfe = ce \cdot we \cdot od^2 / 2 = 0.271 \cdot 18 \cdot 2.2^2 / 2 = 11.8 \text{ kN}$
Moment due to earth pressure	$me = sfe \cdot od / 3 = 11.8 \cdot 2.2 / 3 = 8.657 \text{ kNm}$
Surcharge horizontal force	$sfs = ws \cdot ce \cdot od = 5 \cdot 0.271 \cdot 2.2 = 2.981 \text{ kN}$
Moment due to surcharge	$ms = sfs \cdot od / 2 = 2.981 \cdot 2.2 / 2 = 3.279 \text{ kNm}$
<u>Wall shear</u>	
Horizontal shear force	$usf = (sfe \cdot \gamma_{mae}) + (sfs \cdot \gamma_{mas}) = (11.8 \cdot 1.4) + (2.981 \cdot 1.6) = 21.3 \text{ kN}$
Shear stress at bottom of wall	$uss = usf / (t(\text{steps}) \cdot 1000) = 21.3 / (1.35 \cdot 1000) = 0.01577 \text{ N/mm}^2$
Weight at bottom of step 1	$uwt = t(a) \cdot we \cdot h(a) \cdot \gamma_{maf} = 0.325 \cdot 18 \cdot 0.45 \cdot 0.9 = 2.369 \text{ kN}$
Weight at bottom of step 2	$uwt = uwt + (t(a) \cdot we \cdot h(a) \cdot \gamma_{maf}) = 2.369 + (0.45 \cdot 18 \cdot 0.9 \cdot 0.9) = 8.93 \text{ kN}$
Weight at bottom of step 3	$uwt = uwt + (t(a) \cdot we \cdot h(a) \cdot \gamma_{maf}) = 8.93 + (0.9 \cdot 18 \cdot 1.35 \cdot 0.9) = 28.61 \text{ kN}$
Weight at bottom of step 4	$uwt = uwt + (t(a) \cdot we \cdot h(a) \cdot \gamma_{maf}) = 28.61 + (1.35 \cdot 18 \cdot 1.9 \cdot 0.9) = 70.17 \text{ kN}$
Weight per. unit area	$ga = uwt / (t(\text{steps}) \cdot 1000) = 70.17 / (1.35 \cdot 1000) = 0.05198 \text{ N/mm}^2$
Permissible shear stress	$fv = 0.15 + 0.6 \cdot ga = 0.15 + 0.6 \cdot 0.05198 = 0.1812 \text{ N/mm}^2$
Applied shear less than shear resistance (0.01577 <= 0.1812) therefore section is satisfactory.	

Overturning

Overturning moment about A $om = me + ms + (xm + xv * od)$
 $= 8.657 + 3.279 + (0 + 0 * 2.2)$
 $= 11.94 \text{ kNm}$

Restoring moment abt A fill/wall
 base $rmf = wf * ef = 54.72 * 1.05 = 57.46 \text{ kNm}$
 $rmb = wb * tb / 2 = 13.32 * 1.85 / 2$
 $= 12.32 \text{ kNm}$

surcharge $rms = ws * (t + th) * ef = 5 * (1.35 + 0.25) * 1.05$
 $= 8.4$

total $rm = rmf + rmb + rms = 57.46 + 12.32 + 8.4$
 $= 78.18$

Factor of safety $fso = rm / om = 78.18 / 11.94 = 6.55$

Sliding (passive resistance ignored)

Sliding force $sf = sfe + sfs + xv = 11.8 + 2.981 + 0$
 $= 14.79$

Details of bearing stratas
 angle of friction $phib = 40^\circ$
 cohesion $cu = 0 \text{ kN/m}^2$

Coefficient of friction $cf = \text{TAN}(\text{RAD}(phib * 2 / 3))$
 $= \text{TAN}(\text{RAD}(40 * 2 / 3))$
 $= 0.5022$

Resisting force fill $rff = wf * cf = 54.72 * 0.5022 = 27.48 \text{ kN}$
 base $rfb = wb * cf + tb * cu / 2$
 $= 13.32 * 0.5022 + 1.85 * 0 / 2$
 $= 6.69 \text{ kN}$

surcharge $rfs = ws * (t + th) * cf = 5 * (1.35 + 0.25) * 0.5022$
 $= 4.018 \text{ kN}$

total $rf = rff + rfb + rfs = 27.48 + 6.69 + 4.018$
 $= 38.19 \text{ kN}$

Factor of safety $fss = rf / sf = 38.19 / 14.79 = 2.583$

Bearing pressure

Weight of surcharge $sw = ws * (t + th) = 5 * (1.35 + 0.25)$
 $= 8 \text{ kN}$

Moments about centre of base $m = om + (wf + sw) * (tb / 2 - ef)$
 $= 11.94 + (54.72 + 8) * (1.85 / 2 - 1.05)$
 $= 4.095 \text{ kNm}$

Proposed Retaining Wall at:
 71 Bay View Gardens
 Skewen
 Neath

Page: 6
 Made by:
 Date: 07.04.23
 Ref No:

Section modulus of base	$z_b = t_b^2/6 = 1.85^2/6 = 0.5704 \text{ m}^3$
Total weight	$t_w = w_f + s_w + w_b = 54.72 + 8 + 13.32 = 76.04 \text{ kN}$
Pressure due to weight	$p_w = t_w/t_b = 76.04/1.85 = 41.1 \text{ kN/m}^2$
Pressure due to moment (+/-)	$p_m = m/z_b = 4.095/0.5704 = 7.18 \text{ kN/m}^2$
Maximum pressure	$p_{max} = p_w + p_m = 41.1 + 7.18 = 48.28 \text{ kN/m}^2$
Minimum pressure	$p_{min} = p_w - p_m = 41.1 - 7.18 = 33.92 \text{ kN/m}^2$

Summary of stability check

Factor of safety overturning	6.55
Factor of safety sliding	2.583
Maximum base pressure	48.28 kN/m ²

DESIGN SUMMARY		Wall height 1.9 m	
		Wall design	
Step height (m)	Step thicknes (m)	Ultimate Moments (kNm)	
		Resistance	Applied
0.45	0.325	0.962	0.3232
0.9	0.45	2.09	1.708
1.35	0.9	9.346	4.776
1.9	1.35	23.73	11.72

Summary of stability check

Factor of safety overturning	6.55
Factor of safety sliding	2.583
Maximum base pressure	48.28 kN/m ²

THIS IS AN UPDATE AND NEEDS YOUR OWN L.NAM FILE.

Masonry Retaining wall for 71 Bay View Gardens, Skewen

FRONT WALL

