

COMPLETE CAD & STRUCTURAL SOLUTIONS LIMITED



Structural Calculations

Design Stage

For

RETAINING WALL

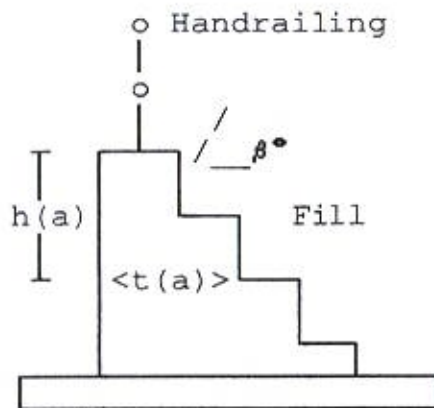
At

7 Tyla Moes, Caewern,
Neath, SA10 7SA

28/10/2022

Masonry gravity wall

Designed in accordance with BS5628:Part 1: 1992.
Location: Front Garden 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

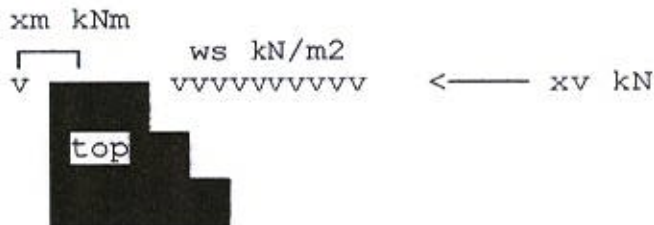
Weight/unit volume of soil & wall $w_e=18 \text{ kN/m}^3$
Internal angle of friction $\phi=35^\circ$
Angle of backfill $\beta=0^\circ$
Active soil pressure is applicable.
Sine angle of internal friction $sp=\sin(\text{RAD}(\phi))=0.5736$
Active pressure coefficient $ce=(1-sp)/(1+sp)$
 $= (1-0.5736)/(1+0.5736)$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

Masonry details

Mortar designation to Table 1 $\text{mortar}=3$
Masonry type (1=clay 2=calc 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 $po=10.5 \text{ N/mm}^2$

Characteristic flexural strength for bed failure and leaf greater than 250mm thick - Table 3 $fb(a) = \text{TABLE 3.71 for } po=10.5, \text{ mortar} = 0.25 \text{ N/mm}^2$
 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 steps=3

Step 1 Typical Analysis which is repeated for each step

Proposed height at step $h(1) = 0.50 \text{ m}$
 Proposed thickness at step $t(1) = 0.225 \text{ m}$
 Moment at height h earth $me = ce * we * h(a)^3 / 6 = 0.271 * 18 * 0.5^3 / 6 = 0.1016 \text{ kNm}$
 surcharge $ms = ce * ws * h(a)^2 / 2 = 0.271 * 5 * 0.5^2 / 2 = 0.1694 \text{ kNm}$
 Ultimate moment at height h $mu = me * \gamma_{mae} + ms * \gamma_{mas} + (xm + xv * h(a)) * \gamma_{max} = 0.1016 * 1.4 + 0.1694 * 1.6 + (0 + 0 * 0.5) * 1.6 = 0.4133$
 Section modulus at thickness t $z = t(a)^2 / 6 = 0.225^2 / 6 = 0.008438 \text{ m}^3$

Weight/unit area at depth h $gd = (ws + we \cdot h(a)) \cdot \gamma_{maf} / 1000$
 $= (5 + 18 \cdot 0.5) \cdot 0.9 / 1000$
 $= 0.0126 \text{ N/mm}^2$

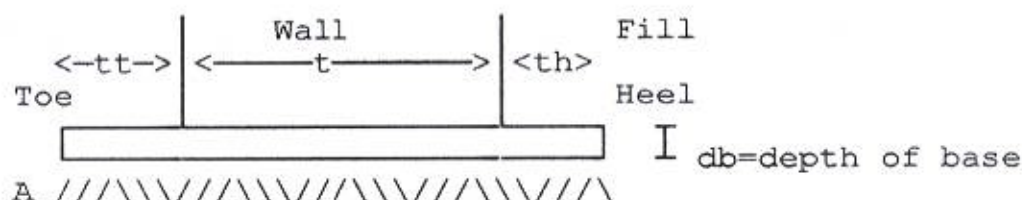
Moment of resistance $mr = (fb(1) / \gamma_{mam} + gd) \cdot z \cdot 1000$
 $= (0.25 / 3.5 + 0.0126) \cdot 0.008438 \cdot 1000$
 $= 0.709 \text{ kNm}$

Applied moment less than moment of resistance ($0.4133 \leq 0.709$)
 therefore section is satisfactory.

Step 1 width 0.225 m
 height 0.5 m

Step height (m)	Step thicknes (m)	Ultimate Moments (kNm)	
		Resistance	Applied
0.5	0.225	0.709	0.4133
0.7	0.35	1.782	0.9215
0.9	0.45	3.055	1.708

Stability and bearing check



Width of toe $tt = 0.20 \text{ m}$
 Width of heel $th = 0.20 \text{ m}$
 Thickness of wall $t = 0.45 \text{ m}$
 Height of wall $h = 0.9 \text{ m}$
 Width of base $tb = t + tt + th = 0.45 + 0.2 + 0.2 = 0.85$
 Depth of base $db = 0.30 \text{ m}$
 Overall depth $od = h + db = 0.9 + 0.3 = 1.2 \text{ m}$
 Weight of fill and wall $wf = we \cdot (t + th) \cdot h = 18 \cdot (0.45 + 0.2) \cdot 0.9$
 $= 10.53 \text{ kN}$

Eccentricity from A $ef = tt + (t + th) / 2 = 0.2 + (0.45 + 0.2) / 2$
 $= 0.525 \text{ m}$

Weight of base $wb = tb \cdot db \cdot 24 = 0.85 \cdot 0.3 \cdot 24 = 6.12 \text{ kN}$
 Earth horizontal force $sfe = ce \cdot we \cdot od^2 / 2 = 0.271 \cdot 18 \cdot 1.2^2 / 2$
 $= 3.512 \text{ kN}$

Moment due to earth pressure $me = sfe \cdot od / 3 = 3.512 \cdot 1.2 / 3 = 1.405 \text{ kNm}$
Surcharge horizontal force $sfs = ws \cdot ce \cdot od = 5 \cdot 0.271 \cdot 1.2 = 1.626 \text{ kN}$
Moment due to surcharge $ms = sfs \cdot od / 2 = 1.626 \cdot 1.2 / 2 = 0.9756 \text{ kNm}$

Wall shear

Horizontal shear force $usf = (sfe \cdot \gamma_{mae}) + (sfs \cdot \gamma_{mas}) = (3.512 \cdot 1.4) + (1.626 \cdot 1.6) = 7.518 \text{ kN}$

Shear stress at bottom of wall $uss = usf / (t(\text{steps}) \cdot 1000) = 7.518 / (0.45 \cdot 1000) = 0.01671 \text{ N/mm}^2$

Weight at bottom of step 1 $uwt = t(a) \cdot we \cdot h(a) \cdot \gamma_{maf} = 0.225 \cdot 18 \cdot 0.5 \cdot 0.9 = 1.823 \text{ kN}$

Weight at bottom of step 2 $uwt = uwt + (t(a) \cdot we \cdot h(a) \cdot \gamma_{maf}) = 1.823 + (0.35 \cdot 18 \cdot 0.7 \cdot 0.9) = 5.791 \text{ kN}$

Weight at bottom of step 3 $uwt = uwt + (t(a) \cdot we \cdot h(a) \cdot \gamma_{maf}) = 5.791 + (0.45 \cdot 18 \cdot 0.9 \cdot 0.9) = 12.35 \text{ kN}$

Weight per. unit area $ga = uwt / (t(\text{steps}) \cdot 1000) = 12.35 / (0.45 \cdot 1000) = 0.02745 \text{ N/mm}^2$

Permissible shear stress $fv = 0.15 + 0.6 \cdot ga = 0.15 + 0.6 \cdot 0.02745 = 0.1665 \text{ N/mm}^2$

Applied shear less than shear resistance ($0.01671 \leq 0.1665$)
therefore section is satisfactory.

Overturning

Overturning moment about A $om = me + ms + (xm + xv \cdot od) = 1.405 + 0.9756 + (0 + 0 \cdot 1.2) = 2.38 \text{ kNm}$

Restoring moment abt A fill/wall
base $rmf = wf \cdot ef = 10.53 \cdot 0.525 = 5.528 \text{ kNm}$
surcharge $rmb = wb \cdot tb / 2 = 6.12 \cdot 0.85 / 2 = 2.601 \text{ kNm}$
 $rms = ws \cdot (t + th) \cdot ef = 5 \cdot (0.45 + 0.2) \cdot 0.525 = 1.706$

	total	$rm = rmf + rmb + rms = 5.528 + 2.601 + 1.706$ $= 9.836$
Factor of safety		$fso = rm / om = 9.836 / 2.38 = 4.132$
<u>Sliding (passive resistance ignored)</u>		
Sliding force		$sf = sfe + sfs + xv = 3.512 + 1.626 + 0$ $= 5.138$
Details of bearing stratas		
angle of friction		$\text{phib} = 40^\circ$
cohesion		$cu = 0 \text{ kN/m}^2$
Coefficient of friction		$cf = \text{TAN}(\text{RAD}(\text{phib} * 2/3))$ $= \text{TAN}(\text{RAD}(40 * 2/3))$ $= 0.5022$
Resisting force	fill	$rff = wf * cf = 10.53 * 0.5022 = 5.288 \text{ kN}$
	base	$rfb = wb * cf + tb * cu / 2$ $= 6.12 * 0.5022 + 0.85 * 0 / 2$ $= 3.074 \text{ kN}$
	surcharge	$rfs = ws * (t + th) * cf = 5 * (0.45 + 0.2) * 0.5022$ $= 1.632 \text{ kN}$
	total	$rf = rff + rfb + rfs = 5.288 + 3.074 + 1.632$ $= 9.994 \text{ kN}$
Factor of safety		$fss = rf / sf = 9.994 / 5.138 = 1.945$
<u>Bearing pressure</u>		
Weight of surcharge		$sw = ws * (t + th) = 5 * (0.45 + 0.2)$ $= 3.25 \text{ kN}$
Moments about centre of base		$m = om + (wf + sw) * (tb / 2 - ef)$ $= 2.38 + (10.53 + 3.25) * (0.85 / 2 - 0.525)$ $= 1.002 \text{ kNm}$
Section modulus of base		$zb = tb^2 / 6 = 0.85^2 / 6 = 0.1204 \text{ m}^3$
Total weight		$tw = wf + sw + wb = 10.53 + 3.25 + 6.12$ $= 19.9 \text{ kN}$
Pressure due to weight		$pw = tw / tb = 19.9 / 0.85 = 23.41 \text{ kN/m}^2$
Pressure due to moment (+/-)		$pm = m / zb = 1.002 / 0.1204 = 8.324 \text{ kN/m}^2$
Maximum pressure		$pmax = pw + pm = 23.41 + 8.324 = 31.74 \text{ kN/m}^2$
Minimum pressure		$pmin = pw - pm = 23.41 - 8.324 = 15.09 \text{ kN/m}^2$
<u>Summary of stability check</u>		
Factor of safety overturning		4.132
Factor of safety sliding		1.945
Maximum base pressure		31.74 kN/m ²

Proposed Masonry Retaining Wall at:
7 Tyla Moes
Caewern
Neath

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Made by:
Date: 27.10.22
Ref No:

DESIGN SUMMARY		0.9 m	
Wall height			
Wall design			
Step height	Step thicknes	Ultimate Moments (kNm)	
(m)	(m)	Resistance	Applied
0.5	0.225	0.709	0.4133
0.7	0.35	1.782	0.9215
0.9	0.45	3.055	1.708

Summary of stability check

Factor of safety overturning	4.132
Factor of safety sliding	1.945
Maximum base pressure	31.74 kN/m ²

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

Masonry Retaining wall for 7 Tyla Moes, Caewern, Neath

