

Structural Calculations

Design Stage Nov 2019

FOR

MASONRY RETAINING
WALL

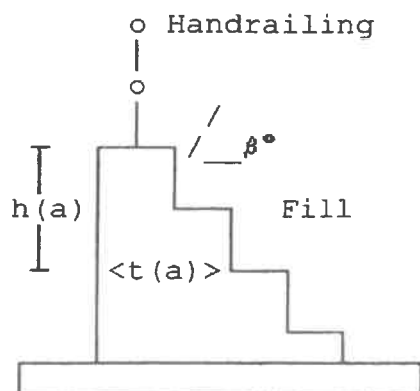
AT

12 THE UPLANDS
PEN-4-CAE
PORT TALBOT

Masonry gravity wall

Designed in accordance with BS5628:Part 1: 1992.

Location: Wall on grid line A/1-2



Steps are numbered down from the top.

 $h(a)$ is height at step a (from top) $t(a)$ is thickness at step a Soil detailsWeight/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

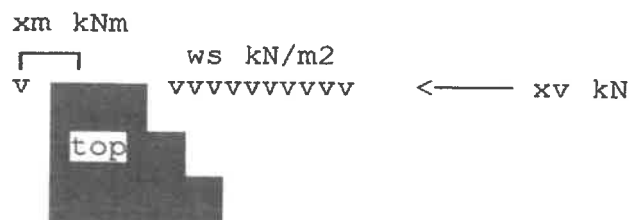
Mortar designation to Table 1 mortar=3

Masonry type (1=clay 2=cal silicate 3=conc brick 4=block)
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 $p_o = 7 \text{ N/mm}^2$
 Characteristic flexural strength for bed failure and leaf greater than 250mm thick - Table 3 $f_b(a) = \text{TABLE 3.71 for } p_o = 7, \text{ mortar} = 3 = 0.15 \text{ N/mm}^2$
 Partial safety factor material $\gamma_{mam} = 3.1$

External loading

Applied moment at top of wall $x_m = 0 \text{ kNm}$
 Applied shear at top of wall $x_v = 0 \text{ kN}$
 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 $\text{steps} = 3$

Step 1 Typical Analysis which is repeated for each step

Proposed height at step $h(1) = 0.450 \text{ m}$
 Proposed thickness at step $t(1) = 0.325 \text{ m}$
 Moment at height h earth $m_e = c_e * w_e * h(a)^3 / 6 = 0.271 * 18 * 0.45^3 / 6 = 0.07408 \text{ kNm}$
 surcharge $m_s = c_e * w_s * h(a)^2 / 2 = 0.271 * 5 * 0.45^2 / 2 = 0.1372 \text{ kNm}$
 Ultimate moment at height h $m_u = m_e * \gamma_{mae} + m_s * \gamma_{mas} + (x_m + x_v * h(a)) * \gamma_{max}$
 $= 0.07408 * 1.4 + 0.1372 * 1.6 + (0 + 0 * 0.45) * 1.6$
 $= 0.3232$

$$= 0.675 \text{ m}$$

Weight of base $wb = tb \cdot db \cdot 24 = 1.1 \cdot 0.3 \cdot 24 = 7.92 \text{ kN}$
Earth horizontal force $sfe = ce \cdot we \cdot od^2 / 2 = 0.271 \cdot 18 \cdot 1.75^2 / 2 = 7.469 \text{ kN}$
Moment due to earth pressure $me = sfe \cdot od / 3 = 7.469 \cdot 1.75 / 3 = 4.357 \text{ kNm}$
Surcharge horizontal force $sfs = ws \cdot ce \cdot od = 5 \cdot 0.271 \cdot 1.75 = 2.371 \text{ kN}$
Moment due to surcharge $ms = sfs \cdot od / 2 = 2.371 \cdot 1.75 / 2 = 2.075 \text{ kNm}$

Wall shear

Horizontal shear force $usf = (sfe \cdot \gamma_{ae}) + (sfs \cdot \gamma_{as}) = (7.469 \cdot 1.4) + (2.371 \cdot 1.6) = 14.25 \text{ kN}$
Shear stress at bottom of wall $uss = usf / (t(\text{steps}) \cdot 1000) = 14.25 / (0.675 \cdot 1000) = 0.02111 \text{ N/mm}^2$
Weight at bottom of step 1 $uwt = t(a) \cdot we \cdot h(a) \cdot \gamma_{af} = 0.325 \cdot 18 \cdot 0.45 \cdot 0.9 = 2.369 \text{ kN}$
Weight at bottom of step 2 $uwt = uwt + (t(a) \cdot we \cdot h(a) \cdot \gamma_{af}) = 2.369 + (0.45 \cdot 18 \cdot 0.9 \cdot 0.9) = 8.93 \text{ kN}$
Weight at bottom of step 3 $uwt = uwt + (t(a) \cdot we \cdot h(a) \cdot \gamma_{af}) = 8.93 + (0.675 \cdot 18 \cdot 1.45 \cdot 0.9) = 24.79 \text{ kN}$
Weight per. unit area $ga = uwt / (t(\text{steps}) \cdot 1000) = 24.79 / (0.675 \cdot 1000) = 0.03672 \text{ N/mm}^2$
Permissible shear stress $fv = 0.15 + 0.6 \cdot ga = 0.15 + 0.6 \cdot 0.03672 = 0.172 \text{ N/mm}^2$

Applied shear less than shear resistance ($0.02111 \leq 0.172$)
therefore section is satisfactory.

Overturning

Overturning moment about A $om = me + ms + (xm + xv * od)$
 $= 4.357 + 2.075 + (0 + 0 * 1.75)$
 $= 6.432 \text{ kNm}$

Restoring moment abt A fill/wall $rmf = wf * ef = 22.18 * 0.675 = 14.97 \text{ kNm}$
base $rmb = wb * tb / 2 = 7.92 * 1.1 / 2 = 4.356 \text{ kNm}$
surcharge $rms = ws * (t + th) * ef$
 $= 5 * (0.675 + 0.175) * 0.675$
 $= 2.869$
total $rm = rmf + rmb + rms = 14.97 + 4.356 + 2.869$
 $= 22.2$

Factor of safety $fso = rm / om = 22.2 / 6.432 = 3.452$

Sliding (passive resistance ignored)

Sliding force $sf = sfe + sfs + xv = 7.469 + 2.371 + 0$
 $= 9.84$

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 $rff = wf * cf = 22.18 * 0.5022 = 11.14 \text{ kN}$
base $rfb = wb * cf + tb * cu / 2 = 7.92 * 0.5022 + 1.1 * 0 / 2$
 $= 3.978 \text{ kN}$
surcharge $rfs = ws * (t + th) * cf$
 $= 5 * (0.675 + 0.175) * 0.5022$
 $= 2.134 \text{ kN}$
total $rf = rff + rfb + rfs = 11.14 + 3.978 + 2.134$
 $= 17.25 \text{ kN}$

Factor of safety $fss = rf / sf = 17.25 / 9.84 = 1.753$

Bearing pressure

Weight of surcharge	$sw = ws * (t + th) = 5 * (0.675 + 0.175)$ = 4.25 kN
Moments about centre of base	$m = om + (wf + sw) * (tb/2 - ef)$ = 6.432 + (22.18 + 4.25) * (1.1/2 - 0.675) = 3.127 kNm
Section modulus of base	$zb = tb^2/6 = 1.1^2/6 = 0.2017 \text{ m}^3$
Total weight	$tw = wf + sw + wb = 22.18 + 4.25 + 7.92$ = 34.36 kN
Pressure due to weight	$pw = tw/tb = 34.36/1.1 = 31.23 \text{ kN/m}^2$
Pressure due to moment (+/-)	$pm = m/zb = 3.127/0.2017 = 15.51 \text{ kN/m}^2$
Maximum pressure	$pmax = pw + pm = 31.23 + 15.51 = 46.74 \text{ kN/m}^2$
Minimum pressure	$pmin = pw - pm = 31.23 - 15.51 = 15.72 \text{ kN/m}^2$

Summary of stability check

Factor of safety overturning	3.452
Factor of safety sliding	1.753
Maximum base pressure	46.74 kN/m ²

DESIGN SUMMARY	Wall height	1.45 m	
	Wall design		
Step height	Step thicknes	Ultimate Moments (kNm)	
(m)	(m)	Resistance	Applied
0.45	0.325	1.059	0.3232
0.9	0.45	2.277	1.708
1.45	0.675	5.8	5.749

Summary of stability check

Factor of safety overturning	3.452
Factor of safety sliding	1.753
Maximum base pressure	46.74 kN/m ²

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

