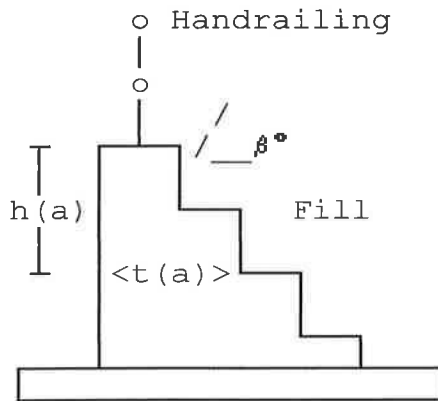


Masonry gravity wall

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 details

Weight/unit volume of soil & wall $w_e = 18 \text{ kN/m}^3$

Internal angle of friction $\phi = 40^\circ$

Angle of backfill $\beta = 0^\circ$

Active soil pressure is applicable.

Sine angle of internal friction $sp = \sin(\text{RAD}(\phi)) = 0.6428$

Active pressure coefficient $ce = (1 - sp) / (1 + sp)$
 $= (1 - 0.6428) / (1 + 0.6428)$
 $= 0.2174$

Masonry details

Mortar designation to Table 1 $\text{mortar} = 1$

Masonry type (1=clay 2=calc silicate 3=conc brick 4=block)
 $\text{typ}(1) = 4$

Concrete Blocks Dimensions

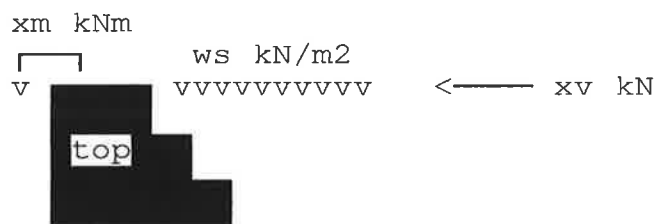
Height $hb = 215 \text{ mm}$

Least horiz dimension $lhd = 100 \text{ mm}$

ratio height/least horiz dim $rb = hb / lhd = 215 / 100 = 2.15$

Compressive strength of blocks $p_o = 7 \text{ N/mm}^2$
 Characteristic flexural strength for bed failure and leaf greater than 250mm thick - Table 3 $f_b(a) = \text{TABLE 3.71 for } p_o = 7, \text{ mortar} = 1 = 0.15 \text{ N/mm}^2$
 Partial safety factor material $\gamma_{mm} = 3.1$

External loading



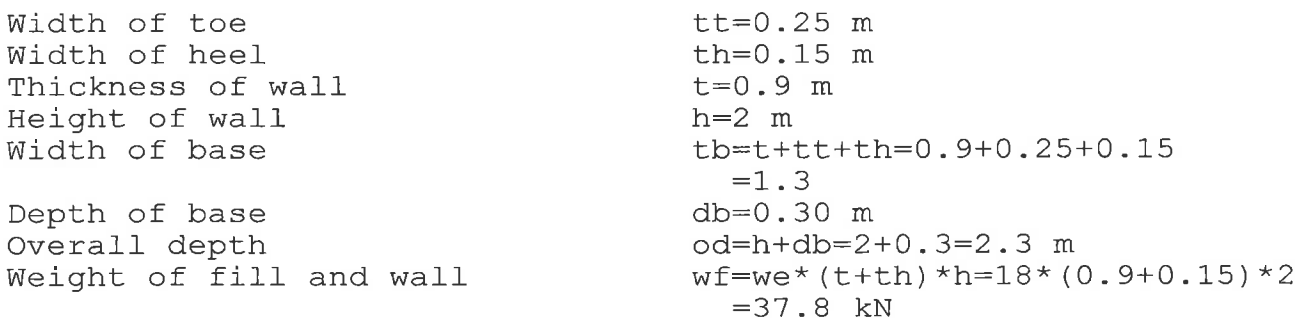
Applied moment at top of wall $x_m = 0 \text{ kNm}$
 Applied shear at top of wall $x_v = 0 \text{ kN}$
 Weight/unit area of surcharge $w_s = 5 \text{ kN/m}^2$
 Load factor external loads at top $\gamma_{max} = 1.6$
 Load factor surcharge $\gamma_{as} = 1.6$
 Load factor earth pressure $\gamma_{ae} = 1.4$
 Load factor self weight $\gamma_{af} = 0.9$

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 $t(1) = 0.225 \text{ m}$
 Moment at height h $\begin{matrix} \text{earth} \\ \text{surcharge} \end{matrix}$ $\begin{aligned} m_e &= c_e * w_e * h(a)^3 / 6 = 0.2174 * 18 * 0.45^3 / 6 \\ &= 0.05944 \text{ kNm} \\ m_s &= c_s * w_s * h(a)^2 / 2 = 0.2174 * 5 * 0.45^2 / 2 \\ &= 0.1101 \text{ kNm} \end{aligned}$
 Ultimate moment at height h $\begin{aligned} m_u &= m_e * \gamma_{ae} + m_s * \gamma_{as} + (x_m + x_v * h(a)) * \gamma_{max} \\ &= 0.05944 * 1.4 + 0.1101 * 1.6 + (0 + 0 * 0.45) * 1.6 \\ &= 0.2593 \end{aligned}$



Eccentricity from A	$ef = tt + (t + th) / 2 = 0.25 + (0.9 + 0.15) / 2$ $= 0.775 \text{ m}$
Weight of base	$wb = tb * db * 24 = 1.3 * 0.3 * 24 = 9.36 \text{ kN}$
Earth horizontal force	$sfe = ce * we * od^2 / 2 = 0.2174 * 18 * 2.3^2 / 2$ $= 10.35 \text{ kN}$
Moment due to earth pressure	$me = sfe * od / 3 = 10.35 * 2.3 / 3 = 7.937 \text{ kNm}$
Surcharge horizontal force	$sfs = ws * ce * od = 5 * 0.2174 * 2.3$ $= 2.501 \text{ kN}$
Moment due to surcharge	$ms = sfs * od / 2 = 2.501 * 2.3 / 2 = 2.876 \text{ kNm}$
<u>Wall shear</u>	
Horizontal shear force	$usf = (sfe * gammae) + (sfs * gammas)$ $= (10.35 * 1.4) + (2.501 * 1.6)$ $= 18.49 \text{ kN}$
Shear stress at bottom of wall	$uss = usf / (t * (steps) * 1000)$ $= 18.49 / (0.9 * 1000)$ $= 0.02055 \text{ N/mm}^2$
Weight at bottom of step 1	$uwt = t(a) * we * h(a) * gammaf$ $= 0.225 * 18 * 0.45 * 0.9$ $= 1.64 \text{ kN}$
Weight at bottom of step 2	$uwt = uwt + (t(a) * we * h(a) * gammaf)$ $= 1.64 + (0.45 * 18 * 0.9 * 0.9)$ $= 8.201 \text{ kN}$
Weight at bottom of step 3	$uwt = uwt + (t(a) * we * h(a) * gammaf)$ $= 8.201 + (0.675 * 18 * 1.45 * 0.9)$ $= 24.06 \text{ kN}$
Weight at bottom of step 4	$uwt = uwt + (t(a) * we * h(a) * gammaf)$ $= 24.06 + (0.9 * 18 * 2 * 0.9)$ $= 53.22 \text{ kN}$
Weight per. unit area	$ga = uwt / (t * (steps) * 1000)$ $= 53.22 / (0.9 * 1000)$ $= 0.05913 \text{ N/mm}^2$
Permissible shear stress	$fv = 0.35 + 0.6 * ga = 0.35 + 0.6 * 0.05913$ $= 0.3855 \text{ N/mm}^2$
Applied shear less than shear resistance ($0.02055 \leq 0.3855$) therefore section is satisfactory.	

Overturning

Overturning moment about A $om = me + ms + (xm + xv * od)$
 $= 7.937 + 2.876 + (0 + 0 * 2.3)$
 $= 10.81 \text{ kNm}$

Restoring moment abt A fill/wall $rmf = wf * ef = 37.8 * 0.775 = 29.3 \text{ kNm}$
base $rmb = wb * tb / 2 = 9.36 * 1.3 / 2 = 6.084 \text{ kNm}$
surcharge $rms = ws * (t + th) * ef = 5 * (0.9 + 0.15) * 0.775$
 $= 4.069$
total $rm = rmf + rmb + rms = 29.3 + 6.084 + 4.069$
 $= 39.45$

Factor of safety $fso = rm / om = 39.45 / 10.81 = 3.648$

Sliding (passive resistance ignored)

Sliding force $sf = sfe + sfs + xv = 10.35 + 2.501 + 0$
 $= 12.85$

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 $rff = wf * cf = 37.8 * 0.5022 = 18.98 \text{ kN}$
base $rfb = wb * cf + tb * cu / 2 = 9.36 * 0.5022 + 1.3 * 0 / 2$
 $= 4.701 \text{ kN}$
surcharge $rfs = ws * (t + th) * cf = 5 * (0.9 + 0.15) * 0.5022$
 $= 2.637 \text{ kN}$
total $rf = rff + rfb + rfs = 18.98 + 4.701 + 2.637$
 $= 26.32 \text{ kN}$

Factor of safety $fss = rf / sf = 26.32 / 12.85 = 2.048$

Bearing pressure

Weight of surcharge $sw = ws * (t + th) = 5 * (0.9 + 0.15)$
 $= 5.25 \text{ kN}$

Moments about centre of base $m = om + (wf + sw) * (tb / 2 - ef)$
 $= 10.81 + (37.8 + 5.25) * (1.3 / 2 - 0.775)$
 $= 5.431 \text{ kNm}$

Section modulus of base $zb = tb^2 / 6 = 1.3^2 / 6 = 0.2817 \text{ m}^3$

Total weight	$tw = wf + sw + wb = 37.8 + 5.25 + 9.36 = 52.41 \text{ kN}$
Pressure due to weight	$pw = tw / tb = 52.41 / 1.3 = 40.32 \text{ kN/m}^2$
Pressure due to moment (+/-)	$pm = m / zb = 5.431 / 0.2817 = 19.28 \text{ kN/m}^2$
Maximum pressure	$pmax = pw + pm = 40.32 + 19.28 = 59.6 \text{ kN/m}^2$
Minimum pressure	$pmin = pw - pm = 40.32 - 19.28 = 21.03 \text{ kN/m}^2$

Summary of stability check

Factor of safety overturning	3.648
Factor of safety sliding	2.048
Maximum base pressure	59.6 kN/m ²

DESIGN SUMMARY	Wall height	2 m	
	Wall design		
Step height (m)	Step thicknes (m)	Ultimate Moments (kNm)	
		Resistance	Applied
0.45	0.225	0.5077	0.2593
0.9	0.45	2.277	1.37
1.45	0.675	5.8	4.613
2	0.9	11.51	10.79

Summary of stability check

Factor of safety overturning	3.648
Factor of safety sliding	2.048
Maximum base pressure	59.6 kN/m ²