

Structural Calculations

Design Stage Aug 2021

FOR

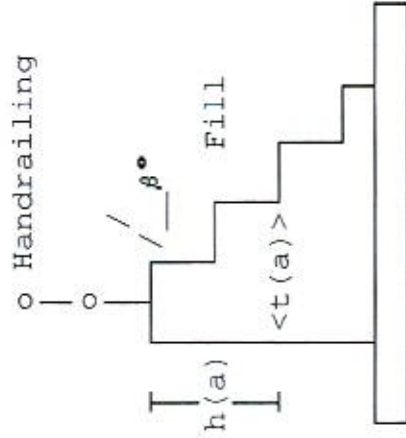
MASONRY RETAINING WALL

AT

LAND ADJ. 1E NEW ROAD
CILFREW, NEATH

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

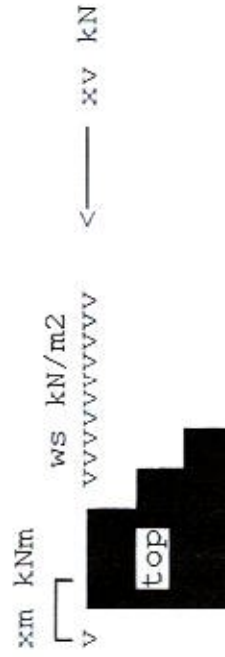
Weight/unit volume of soil & wall $w_e=18 \text{ kN/m}^3$
Internal angle of friction $\phi=35^\circ$
Angle of backfill $\beta=0^\circ$
Active soil pressure is applicable.
Sine angle of internal friction $\text{sp}=\text{SIN}(\text{RAD}(\phi))=0.5736$
Active pressure coefficient $\text{ce}=(1-\text{sp})/(1+\text{sp})$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

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 $\text{hb}=215 \text{ mm}$
Least horiz dimension $\text{lhd}=100 \text{ mm}$
ratio height/least horiz dim $\text{rb}=\text{hb}/\text{lhd}=215/100=2.15$
Compressive strength of blocks $\text{po}=7 \text{ N/mm}^2$

Characteristic flexural strength for bed failure and leaf greater than 250mm thick - Table 3
 $fb(a) = \text{TABLE } 3.71 \text{ for } po=7, \text{ mortar}=3$
 $= 0.15 \text{ N/mm}^2$
Partial safety factor material $\gamma_{mm} = 3.5$

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
Proposed thickness at step
Moment at height h earth

$h(1) = 0.55 \text{ m}$
 $t(1) = 0.325 \text{ m}$
 $me = ce * ws * h(a)^3 / 6 = 0.271 * 18 * 0.55^3 / 6$
 $= 0.1353 \text{ kNm}$
 $ms = ce * ws * h(a)^2 / 2 = 0.271 * 5 * 0.55^2 / 2$
 $= 0.2049 \text{ kNm}$
 $mu = me * \gamma_{mae} + ms * \gamma_{mas} + (xm + xv * h(a)) * \gamma_{max}$
 $= 0.1353 * 1.4 + 0.2049 * 1.6 + (0 + 0 * 0.55) * 1.6$
 $= 0.5173$

Ultimate moment at height h

Weight of base
Earth horizontal force
 $wb=tb*db*24=1.3*0.3*24=9.36 \text{ kN}$
 $sfe=ce*we*od^2/2=0.271*18*2^2/2=9.756 \text{ kN}$
Moment due to earth pressure
Surcharge horizontal force
Moment due to surcharge
 $me=sfe*od/3=9.756*2/3=6.504 \text{ kNm}$
 $sfs=ws*ce*od=5*0.271*2=2.71 \text{ kN}$
 $ms=sfs*od/2=2.71*2/2=2.71 \text{ kNm}$

Wall shear

Horizontal shear force
 $usf=(sfe*gammae)+(sfs*gammaas)$
 $= (9.756*1.4)+(2.71*1.6)$
 $=17.99 \text{ kN}$
Shear stress at bottom of wall
 $uss=usf/(t(steps)*1000)$
 $=17.99/(0.9*1000)$
 $=0.01999 \text{ N/mm}^2$

Weight at bottom of step 1
 $uwt=t(a)*we*h(a)*gammaf$
 $=0.325*18*0.55*0.9$
 $=2.896 \text{ kN}$
Weight at bottom of step 2
 $uwt=uwt+(t(a)*we*h(a)*gammaf)$
 $=2.896+(0.55*18*1.1*0.9)$
 $=12.7 \text{ kN}$
Weight at bottom of step 3
 $uwt=uwt+(t(a)*we*h(a)*gammaf)$
 $=12.7+(0.9*18*1.7*0.9)$
 $=37.48 \text{ kN}$
Weight per. unit area
 $ga=uwt/(t(steps)*1000)$
 $=37.48/(0.9*1000)$
 $=0.04165 \text{ N/mm}^2$
Permissible shear stress
 $fv=0.15+0.6*ga=0.15+0.6*0.04165$
 $=0.175 \text{ N/mm}^2$

Applied shear less than shear resistance ($0.01999 < 0.175$)
therefore section is satisfactory.

Overturning

Overturning moment about A
 $om=me+ms+(xm+xv*od)$
 $=6.504+2.71+(0+0*2)$
 $=9.214 \text{ kNm}$
Restoring moment abt A fill/wall
base
 $rmf=wf*ef=32.13*0.775=24.9 \text{ kNm}$
 $rmb=wb*tb/2=9.36*1.3/2=6.084 \text{ kNm}$

surcharge	$\text{rms}=\text{ws}*(\text{t}+\text{th})*\text{ef}=5*(0.9+0.15)*0.775$ $=4.069$
total	$\text{rm}=\text{rmf}+\text{rmb}+\text{rms}=24.9+6.084+4.069$ $=35.05$
Factor of safety	$\text{fso}=\text{rm}/\text{om}=35.05/9.214=3.805$
<u>Sliding (passive resistance ignored)</u>	
Sliding force	$\text{sf}=\text{sfe}+\text{sfs}+\text{xv}=9.756+2.71+0$ $=12.47$
Details of bearing stratas	$\text{phib}=40^\circ$
angle of friction	$\text{cu}=0 \text{ kN/m}^2$
cohesion	$\text{cf}=\text{TAN}(\text{RAD}(\text{phib}*2/3))$ $=\text{TAN}(\text{RAD}(40*2/3))$ $=0.5022$
Coefficient of friction	$\text{rff}=\text{wf}*\text{cf}=32.13*0.5022=16.14 \text{ kN}$ $\text{rfb}=\text{wb}*\text{cf}+\text{tb}*\text{cu}/2=9.36*0.5022+1.3*0/2$ $=4.701 \text{ kN}$
Resisting force	$\text{rfs}=\text{ws}*(\text{t}+\text{th})*\text{cf}=5*(0.9+0.15)*0.5022$ $=2.637 \text{ kN}$
fill	$\text{rf}=\text{rff}+\text{rfb}+\text{rfs}=16.14+4.701+2.637$ $=23.47 \text{ kN}$
base	$\text{fss}=\text{rf}/\text{sf}=23.47/12.47=1.883$
surcharge	
total	
Factor of safety	
<u>Bearing pressure</u>	
<u>Weight of surcharge</u>	
Moments about centre of base	$\text{sw}=\text{ws}*(\text{t}+\text{th})=5*(0.9+0.15)$ $=5.25 \text{ kN}$ $\text{m}=\text{om}+(\text{wf}+\text{sw})*(\text{tb}/2-\text{ef})$ $=9.214+(32.13+5.25)*(1.3/2-0.775)$ $=4.541 \text{ kNm}$
Section modulus of base	$\text{zb}=\text{tb}^2/6=1.3^2/6=0.2817 \text{ m}^3$
Total weight	$\text{tw}=\text{wf}+\text{sw}+\text{wb}=32.13+5.25+9.36$ $=46.74 \text{ kN}$ $\text{pw}=\text{tw}/\text{tb}=46.74/1.3=35.95 \text{ kN/m}^2$ $\text{pm}=\text{m}/\text{zb}=4.541/0.2817=16.12 \text{ kN/m}^2$ $\text{pmax}=\text{pw}+\text{pm}=35.95+16.12=52.08 \text{ kN/m}^2$ $\text{pmin}=\text{pw}-\text{pm}=35.95-16.12=19.83 \text{ kN/m}^2$
Pressure due to weight	
Pressure due to moment (+/-)	
Maximum pressure	
Minimum pressure	

Summary of stability check

Factor of safety overturning 3.805
Factor of safety sliding 1.883
Maximum base pressure 52.08 kN/m²

DESIGN SUMMARY Wall height 1.7 m
 Wall design

Step height Step thickness Ultimate Moments (kNm)
(m) (m) Resistance Applied

0.55	0.325	0.9905	0.5173
1.1	0.55	3.286	2.826
1.7	0.9	10.11	8.724

Summary of stability check

Factor of safety overturning 3.805
Factor of safety sliding 1.883
Maximum base pressure 52.08 kN/m²

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

