

Structural Calculations

Design Stage Jan 2023

FOR

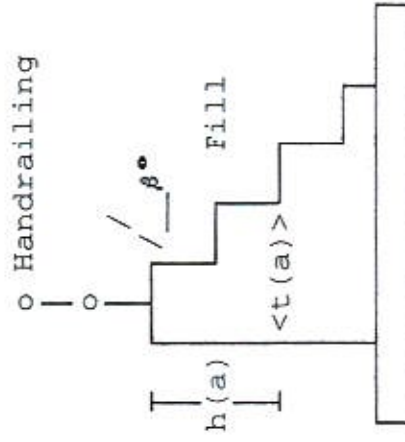
BACK RETAINING WALL

AT

18 EFAIL FACH
PONTRHYDYFEN

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 $sp=\sin(\text{RAD}(\phi))=0.5736$
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
Least horiz dimension
ratio height/least horiz dim
Compressive strength of blocks

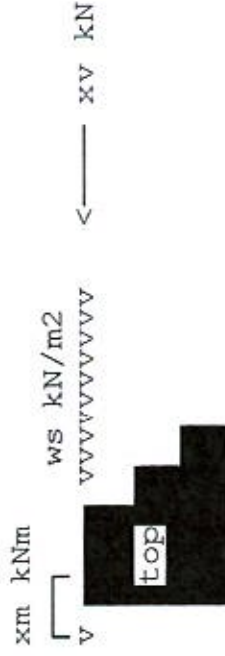
hb=215 mm
lhd=100 mm
rb=hb/lhd=215/100=2.15
po=7.3 N/mm²

Characteristic flexural strength for bed failure and leaf greater than 250mm thick - Table 3

$fb(a)=TABLE\ 3.71\ for\ po=7.3,\ mortar=3$
 $=0.1586\ N/mm^2$

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

External loading



Applied moment at top of wall	xm=0 kNm
Applied shear at top of wall	xv=0 kN
Weight/unit area of surcharge	ws=10 kN/m ²
Load factor external loads at top	gamma=1.6
Load factor surcharge	gamma=1.6
Load factor earth pressure	gamma=1.4
Load factor self weight	gamma=0.9

Wall design

Number of steps proposed in wall steps=5

Step 1 Typical Analysis which is repeated for each step

[illegible]

Eccentricity from A

$$ef = \frac{t + t_h}{2} = 0.15 + (1.45 + 0.15) / 2 = 0.95 \text{ m}$$

Weight of base

$$wb = tb \cdot db \cdot 24 = 1.75 \cdot 0.3 \cdot 24 = 12.6 \text{ kN}$$

Earth horizontal force

$$sfe = ce \cdot we \cdot od^2 / 2 = 0.271 \cdot 18 \cdot 2.775^2 / 2 = 18.78 \text{ kN}$$

Moment due to earth pressure

$$me = sfe \cdot od / 3 = 18.78 \cdot 2.775 / 3 = 17.37 \text{ kNm}$$

Surcharge horizontal force

$$sfs = ws \cdot ce \cdot od = 10 \cdot 0.271 \cdot 2.775 = 7.52 \text{ kN}$$

Moment due to surcharge

$$ms = sfs \cdot od / 2 = 7.52 \cdot 2.775 / 2 = 10.43 \text{ kNm}$$

Wall shear

Horizontal shear force

$$usf = (sfe \cdot gamma_e) + (sfs \cdot gamma_{mas}) = (18.78 \cdot 1.4) + (7.52 \cdot 1.6) = 38.33 \text{ kN}$$

Shear stress at bottom of wall

$$uss = usf / (t \cdot steps) \cdot 1000 = 38.33 / (1.45 \cdot 1000) = 0.02643 \text{ N/mm}^2$$

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

$$uwt = uwt + (t(a) \cdot we \cdot h(a) \cdot gamma_{maf}) = 2.369 + (0.55 \cdot 18 \cdot 0.9 \cdot 0.9) = 10.39 \text{ kN}$$

Weight at bottom of step 3

$$uwt = uwt + (t(a) \cdot we \cdot h(a) \cdot gamma_{maf}) = 10.39 + (0.775 \cdot 18 \cdot 1.35 \cdot 0.9) = 27.34 \text{ kN}$$

Weight at bottom of step 4

$$uwt = uwt + (t(a) \cdot we \cdot h(a) \cdot gamma_{maf}) = 27.34 + (1.125 \cdot 18 \cdot 1.8 \cdot 0.9) = 60.14 \text{ kN}$$

Weight at bottom of step 5

$$uwt = uwt + (t(a) \cdot we \cdot h(a) \cdot gamma_{maf}) = 60.14 + (1.45 \cdot 18 \cdot 2.475 \cdot 0.9) = 118.3 \text{ kN}$$

Weight per. unit area

$$ga = uwt / (t \cdot steps) \cdot 1000 = 118.3 / (1.45 \cdot 1000) = 0.08157 \text{ N/mm}^2$$

Permissible shear stress

$$fv = 0.15 + 0.6 \cdot ga = 0.15 + 0.6 \cdot 0.08157 = 0.1989 \text{ N/mm}^2$$

Applied shear less than shear resistance (0.02643 <= 0.1989)
therefore section is satisfactory.

Overturning

Overturning moment about A	$om = me + ms + (xm + xv * od)$ $= 17.37 + 10.43 + (0 + 0 * 2.775)$ $= 27.81 \text{ kNm}$
Restoring moment abt A fill/wall base surcharge	$rmf = wf * ef = 71.28 * 0.95 = 67.72 \text{ kNm}$ $rmb = wb * tb / 2 = 12.6 * 1.75 / 2 = 11.02 \text{ kNm}$ $rms = ws * (t + th) * ef = 10 * (1.45 + 0.15) * 0.95 = 15.2$
total	$rm = rmf + rmb + rms = 67.72 + 11.02 + 15.2 = 93.94$
Factor of safety	$fso = rm / om = 93.94 / 27.81 = 3.378$

Sliding (passive resistance ignored)

Sliding force	$sf = sfe + sfs + xv = 18.78 + 7.52 + 0 = 26.3$
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Details of bearing stratas
angle of friction
cohesion

Coefficient of friction	$\text{phib} = 40^\circ$ $cu = 0 \text{ kN/m}^2$ $cf = \text{TAN}(\text{RAD}(\text{phib} * 2 / 3))$ $= \text{TAN}(\text{RAD}(40 * 2 / 3))$ $= 0.5022$
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Resisting force

fill base	$rff = wf * cf = 71.28 * 0.5022 = 35.8 \text{ kN}$ $rfb = wb * cf + tb * cu / 2$ $= 12.6 * 0.5022 + 1.75 * 0 / 2$ $= 6.328 \text{ kN}$
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surcharge

	$rfs = ws * (t + th) * cf$ $= 10 * (1.45 + 0.15) * 0.5022$ $= 8.036 \text{ kN}$
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total

	$rf = rff + rfb + rfs = 35.8 + 6.328 + 8.036 = 50.16 \text{ kN}$
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Factor of safety

	$fss = rf / sf = 50.16 / 26.3 = 1.907$
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Bearing pressure

Weight of surcharge

$$sw=ws*(t+th)=10*(1.45+0.15)=16 \text{ kN}$$

Moments about centre of base

$$m=om+(wf+sw)*(tb/2-ef)=27.81+(71.28+16)*(1.75/2-0.95)=21.26 \text{ kNm}$$

Section modulus of base

$$zb=tb^2/6=1.75^2/6=0.5104 \text{ m}^3$$

Total weight

$$tw=wf+sw+wb=71.28+16+12.6=99.88 \text{ kN}$$

Pressure due to weight

$$pw=tw/tb=99.88/1.75=57.07 \text{ kN/m}^2$$

Pressure due to moment (+/-)

$$pm=m/zb=21.26/0.5104=41.65 \text{ kN/m}^2$$

Maximum pressure

$$pmax=pw+pm=57.07+41.65=98.73 \text{ kN/m}^2$$

Minimum pressure

$$pmin=pw-pm=57.07-41.65=15.42 \text{ kN/m}^2$$

Summary of stability check

Factor of safety overturning

$$3.378$$

Factor of safety sliding

$$1.907$$

Maximum base pressure

$$98.73 \text{ kN/m}^2$$

DESIGN SUMMARY

2.475 m

Wall height

Wall design

Step thickness

(m)

Ultimate Moments (kNm)

Resistance Applied

0.45	0.325	1.084	0.5427
0.9	0.55	3.473	2.586
1.35	0.775	7.626	6.751
1.8	1.125	17.61	13.66
2.475	1.45	33.08	30.54

Summary of stability check

Factor of safety overturning

$$3.378$$

Factor of safety sliding

$$1.907$$

Maximum base pressure

$$98.73 \text{ kN/m}^2$$

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

Masonry Retaining wall for 18 Efail Fach, Pontrhydyfen

BACK WALL

