

RETAINING WALL LLE HYFRYD, MOUNT PLEASANT, HEOLGERRIG, MERTHYR TYDFIL STRUCTURAL CALCULATIONS

Section 1 Wall 1.8 m

Maximum height of wall = 1.8 m

Density of earth = 18 kN/m³. Well drained cohesionless.

Angle of shearing resistance = 35°

$$\text{horizontal component} \\ k_a = \frac{1 - \sin \phi}{1 + \sin \phi} = 0.27$$

Co-efficient of friction between base and earth = 0.5

Safe ground bearing capacity = 100 kN / m²

Wall to be built of pre cast interlocking concrete blocks = 24kN / m³

Allow for surcharge = 10.0 kN/m²

Introduce free draining material to rear of wall.

Base of well compacted 30N/mm² concrete = 24kN/m³

Factor of Safety for Sliding to be minimum of 1.5 and Overturning to be minimum of 2.00

Wall 1.8m High

Vertical Loads

Part	Area m ²	density (kN/m ³)	Wt (kN)	lever arm	Moments about A
Base	0.4 x 1.500	24	14.40	0.750	10.800
Wall	0.6 x 1.200	24	17.280	0.800	13.824
	0.6 x 0.600	24	8.640	0.500	4.320
	0.6 x 0.600	24	8.640	0.500	4.320
Earth	0.100 x 1.8	18	3.24	1.450	4.698
	0.600 x 1.2	18	12.96	1.100	14.256
Surcharge	10 x 1.000		10.000	0.750	7.500
			74.200		59.718
c.g. from A	=	$\frac{59.718}{75.160}$	= 0.795		

Horizontal Loads

$$P_{\text{earth}} = 18.00 \times 0.5 \times 1.8^2 \times 0.27 = 7.873$$

Moments about A

$$7.873 \times \frac{1.8}{3} = 4.724 \text{ kN m}$$

$$P_{\text{surchage}} = 10 \times 1.8 \times 0.27 = 4.860$$

Moments about A

$$4.86 \times \frac{1.8}{3} = 2.916 \text{ kN m}$$

$$\text{Total Moment} = 4.860 + 2.916 = 7.776 \text{ kN m}$$

Overturning

$$\begin{aligned} \text{F of S against overturning} &= \frac{59.718}{7.776} \\ &= 7.680 \quad \text{Therefore OK} \end{aligned}$$

Resultant of Forces

$$\begin{aligned} x &= \frac{7.776}{75.160} \\ &= 0.103 \end{aligned}$$

$$\text{Distance from A} = 0.795 - 0.103 = 0.692$$

Eccentricity of load

$$e = 0.750 - 0.692 = 0.058 \quad L/6 = 1.8/6 = 0.300$$

Lies within middle third O.K.

Check Sliding

$$\text{FOS} = \frac{75.160 \times 0.5}{7.776} = 4.833 \quad \text{Therefore OK}$$

Bearing

Resultant of forces

$$\text{Distance from A} = \frac{\text{Restoring moment} - \text{Overturning moment}}{\text{Total Weight}}$$

$$= \frac{59.718 - 7.776}{75.160} = 0.692$$

$$e = \text{Base} / 2 - \text{offset from A} = 1500 / 2 - 692$$

$$= 58 \text{ lies within middle third O.K.}$$

Bearing Pressure / metre run

$$\frac{75.160}{1 \times 1.500} + \frac{75.160 \times 0.118}{1 \times 1.500^2} \times 6$$

$$50.107 \quad +/\quad 23.600$$

$$\text{Max} = 73.707 < 100 \quad \text{OK}$$

Check wall tension at each step (BS5628 Pt 1)

$$m = 3.5 f_k x = 0.25 \text{ N/mm}^2$$

Design moment of resistance = $(f_k x / m) Z$

$$\text{Overturning moment} = \frac{1}{2} \times 0.27 \times 18 \times h^2 \times h/3 \times 1.4 = 1.13 h^3$$

At 0.6 below top of wall

$$\text{BM} = 1.13 (0.6)^3 = 0.244 \text{ kNm}$$

$$gd = \frac{0.225 \times 0.6 \times 18 \times 0.9}{225} = 0.0097$$

$$\text{Des Moment} = (0.25/3.5 + gd) Z = (0.07 + gd) Z$$

$$= (0.07 + 0.0097) \frac{1000 \times 225^2}{6} \times 10^{-6}$$

$$= 0.672 \text{ kNm} > 0.244 \text{ kNm} \quad \text{OK}$$

At 1.2 below top of wall

$$\text{BM} = 1.13 (1.2)^3 = 1.953 \text{ kNm}$$

$$gd = \frac{0.450 \times 1.2 \times 18 \times 0.9}{450} = 0.019$$

$$\text{Des Moment} = (0.25/3.5 + gd) Z = (0.07 + gd) Z$$

$$= (0.07 + 0.019) \frac{1000 \times 450^2}{6} \times 10^{-6}$$

$$= 3.004 \text{ kNm} > 1.953 \text{ kNm} \quad \text{OK}$$

At 1.8 below top of wall

$$BM = 1.13 (1.8)^3 = 6.590$$

$$gd = \frac{0.675 \times 1.8 \times 18 \times 0.9}{675} = 0.029$$

$$\text{Des Moment} = (0.25/3.5 + gd) Z = (0.07 + gd) Z$$

$$= (0.07 + 0.029) \frac{1000 \times 675^2}{6} \times 10^{-6}$$

$$= 7.518 \text{ kNm} > 6.590 \text{ kNm} \quad \text{OK}$$

Section 2 Wall 1.2 m High

Vertical Loads

Part	Area m ²	density (kN/m ³)	Wt (kN)	lever arm	Moments about A
Base	0.3 x 0.900	24	6.48	0.450	2.916
Wall	0.6 x 1.200	24	17.28	0.450	7.776
Earth	0.150 x 1.2	18	3.24	0.825	2.673
Surcharge	10 kN = 0.675 x 10		6.75	0.563	3.797
			33.750		17.162
c.g. from A	=	$\frac{17.162}{33.750}$	= 0.509		

Horizontal Loads

$$P_{\text{earth}} = 18.00 \times 0.5 \times 1.2^2 \times 0.27 = 3.499 \text{ kN}$$

Moments about A

$$3.499 \times \frac{1.2}{3}$$

$$= 1.400 \text{ kN m}$$

$$P_{\text{surcharge}} = 10 \times 1.2 \times 0.27 = 3.240 \text{ kN}$$

Moments about A

$$3.420 \times \frac{1.2}{3}$$

$$= 1.296 \text{ kN m}$$

$$\text{Total Moment} = 1.400 + 1.296 = 2.696 \text{ kN m}$$

Overturning

$$\begin{aligned} \text{F of S against overturning} & \frac{17.162}{2.696} \\ & = 6.366 \quad \text{Therefore OK} \end{aligned}$$

Resultant of Forces

$$\begin{aligned} x &= \frac{2.696}{33.750} \\ &= 0.080 \end{aligned}$$

$$\text{Distance from A} = 0.509 - 0.080 = 0.429$$

Eccentricity of load

$$e = 0.450 - 0.429 = 0.021 \quad L/6 = 0.9/6 = 0.150$$

Lies within middle third O.K.

Check Sliding

$$\text{FOS} = \frac{33.750 \times 0.5}{2.696} = 6.259 \quad \text{Therefore OK}$$

Bearing

Resultant of forces

$$\text{Distance from A} = \frac{\text{Restoring moment} - \text{Overturning moment}}{\text{Total Weight}}$$

$$= \frac{17.162 - 2.696}{33.750} = 0.429$$

$$e = \text{Base} / 2 - \text{offset from A} = 900 / 2 - 429$$

$$= 21 \text{ lies within middle third O.K.}$$

Bearing Pressure / metre run

$$\frac{33.750}{1 \times 0.900} + \frac{33.750 \times 0.021}{1 \times 0.900^2} \times 6$$

$$37.500 \quad +/\quad 5.250$$

$$\text{Max} = 42.750 < 100 \quad \text{OK}$$

Check wall tension at each step (BS5628 Pt 1)

$$m = 3.5 f_{kx} = 0.25 \text{ N/mm}^2$$

Design moment of resistance = $(f_{kx} / m) Z$

$$\text{Overturning moment} = 1/2 \times 0.27 \times 18 \times h^2 \times h/3 \times 1.4 = 1.13 h^3$$

At 0.6 below top of wall

$$BM = 1.13 (0.6)^3 = 0.244 \text{ kNm}$$

$$gd = \frac{0.225 \times 0.6 \times 18 \times 0.9}{225} = 0.0097$$

$$\text{Des Moment} = (0.25/3.5 + gd) Z = (0.07 + gd) Z$$

$$= (0.07 + 0.0097) \frac{1000 \times 225^2}{6} \times 10^{-6}$$

$$= 0.672 \text{ kNm} > 0.244 \text{ kNm} \quad \text{OK}$$

At 1.2 below top of wall

$$BM = 1.13 (1.2)^3 = 1.953 \text{ kNm}$$

$$gd = \frac{0.450 \times 1.2 \times 18 \times 0.9}{450} = 0.019$$

$$\text{Des Moment} = (0.25/3.5 + gd) Z = (0.07 + gd) Z$$

$$= (0.07 + 0.019) \frac{1000 \times 450^2}{6} \times 10^{-6}$$

$$= 3.004 \text{ kNm} > 1.953 \text{ kNm} \quad \text{OK}$$

Section 3 Wall 0.6 m High**Vertical Loads**

Part	Area m ²	density (kN/m ³)	Wt (kN)	lever arm	Moments about A
Base	0.3 x 0.900	24	6.48	0.450	2.916
Wall	0.6 x 0.600	24	8.64	0.450	3.888
Earth	0.150 x 0.6	18	1.62	0.825	1.337
Surcharge	10 kN = 0.675 x 10		6.75	0.563	3.797

Calculation not required.