

Horizontal Loads

$$P_{\text{earth}} = 18.00 \times 0.5 \times 2.2^2 \times 0.27 = 10.716$$

$$\begin{aligned} \text{Moments about A} &= 10.716 \times \frac{2.2}{3} \\ &= 7.858 \text{ kN m} \end{aligned}$$

$$P_{\text{surcharge}} = 10 \times 2.2 \times 0.27 = 5.94$$

$$\begin{aligned} \text{Moments about A} &= 5.94 \times \frac{2.2}{3} \\ &= 4.356 \text{ kN m} \end{aligned}$$

$$\text{Total Moment} = 7.858 + 4.356 = 12.214 \text{ kN m}$$

Overturning

$$\begin{aligned} \text{F of S against overturning} &= \frac{32.564}{12.214} \\ &= 2.665 \quad \text{Therefore OK} \end{aligned}$$

Resultant of Forces

$$\begin{aligned} x &= \frac{12.214}{53.230} \\ &= 0.229 \end{aligned}$$

$$\text{Distance from A} = 0.611 - 0.229 = 0.382$$

Eccentricity of load

$$e = 0.550 - 0.382 = 0.168 \quad L/6 = 1.8/6 = 0.300$$

Lies within middle third O.K.

Check Sliding

$$\text{FOS} = \frac{53.230 \times 0.5}{12.214} = 2.179 \quad \text{Therefore OK}$$

Bearing

Resultant of forces

$$\begin{aligned} \text{Distance from A} &= \frac{\text{Restoring moment} - \text{Overturning moment}}{\text{Total Weight}} \\ &= \frac{32.564 - 12.214}{53.230} = 382 \end{aligned}$$

$$e = \text{Base} / 2 - \text{offset from A} = 900 / 2 - 382$$

$$= 68 \text{ lies within middle third O.K.}$$

Bearing Pressure / metre run

$$\frac{53.230}{1 \times 0.900} + \frac{53.230 \times 0.068}{1 \times 0.900^2} \times 6$$

$$59.144 \quad +/\quad 26.812$$

$$\text{Max} = 85.956 < 100 \quad \text{OK}$$

Check wall tension at each step (BS5628 Pt 1)

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

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

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

At 0.6 below top of wall

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

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

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

$$\begin{aligned} &= (0.07 + 0.0097) \frac{1000 \times 225^2 \times 10^{-6}}{6} \\ &= 0.672 \text{ kNm} > 0.244 \text{ kNm} \quad \text{OK} \end{aligned}$$

At 1.2 below top of wall

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

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

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

$$\begin{aligned} &= (0.07 + 0.019) \frac{1000 \times 450^2 \times 10^{-6}}{6} \\ &= 3.004 \text{ kNm} > 1.953 \text{ kNm} \quad \text{OK} \end{aligned}$$

At 1.8 below top of wall

$$\text{BM} = 1.13 (1.8)^3 = 6.590$$

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

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

$$\begin{aligned} &= (0.07 + 0.029) \frac{1000 \times 675^2 \times 10^{-6}}{6} \\ &= 7.518 \text{ kNm} > 6.590 \text{ kNm} \quad \text{OK} \end{aligned}$$

Value of 18 for density of earth may also be considered conservative an average value of 19 ensures compliance

WALL TYPE 3 (1.3 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 0.450	20	5.4	0.450	2.430
	0.7 x 0.225	20	3.38	0.312	1.053
Earth	0.225 x 1.2	18	4.86	0.788	3.830
	0.225 x 0.6	18	2.43	0.563	1.368
Surcharge 10 kN = 0.675 x 10			6.75	0.563	3.797
			29.300		15.394
c.g. from A = $\frac{15.394}{29.300}$ = 0.525					

Horizontal Loads

$$P_{\text{earth}} = 18.00 \times 0.5 \times 1.65^2 \times 0.27 = 6.616 \text{ kN}$$

Moments about A

$$6.616 \times \frac{1.65}{3} = 3.639 \text{ kN m}$$

$$P_{\text{surcharge}} = 10 \times 1.65 \times 0.27 = 4.455 \text{ kN}$$

Moments about A

$$4.455 \times \frac{1.65}{3} = 2.450 \text{ kN m}$$

$$\text{Total Moment} = 3.639 + 2.450 = 6.089 \text{ kN m}$$

Overturning

$$\begin{aligned} F \text{ of S against overturning} &= \frac{15.394}{6.089} \\ &= 2.528 \quad \text{Therefore OK} \end{aligned}$$

Resultant of Forces

$$\begin{aligned} x &= \frac{6.089}{29.300} \\ &= 0.208 \end{aligned}$$

$$\text{Distance from A} = 0.525 - 0.208 = 0.317$$

Eccentricity of load

$$e = 0.450 - 0.317 = 0.133 \quad L/6 = 0.9/6 = 0.150$$

Lies within middle third O.K.

Check Sliding

$$\text{FOS} = \frac{21.870 \times 0.5}{5.468} = 2.000 \quad \text{Therefore OK}$$

Bearing

Resultant of forces

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

$$= \frac{11.386 - 2.734}{21.870} = 396$$

$$e = \text{Base} / 2 - \text{offset from A} = 900 / 2 - 567$$

$$= -117 \text{ lies within middle third O.K.}$$

Bearing Pressure / metre run

$$\frac{21.870}{1 \times 0.900} + \frac{21.870 \times 0.117}{1 \times 0.900^2} \times 6$$

$$24.300 \quad +/\quad 18.954$$

$$\text{Max} = 43.254 < 100 \quad \text{OK}$$

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 = $(f_k x / m) Z$

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

At 0.6 below top of wall

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

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

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

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

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

Value of 18 for density of earth may also be considered conservative an average value of 19 ensures compliance.