

**BRACKENDALE, HEOLGERRIG
GABION RETAINING WALL DESIGN**

Wall to be founded on existing well compacted soil with safe bearing pressure capability of 100 kN / m³

Wall to be 2.0 metres high.

Wall friction

The wall friction is taken into account in the stability computations as equal to phi for the backfill material.

Where no geotextile is required or the rear face is stepped, the value of the wall friction is taken as equal to the phi of the backfill soil.

Where the rear face is flush the wall friction

= 0.75 x phi of backfill soil.

In both cases if the cut angle is greater than 45 degrees, use the soil friction angle of the retained soil and not the backfill in the above.

For the base, the frictional value is taken as 0.66 x unfactored phi of the founding soil.

Initial Base Width Assessment = 0.7 x Wall Height.

Wall Height 2.0 m.

Therefore Base Width (bw) = 0.7 x 1.7 = 1.40.

Computation below reduces base width needed. Therefore wall constructed as below

Course

1 1.0 x 1.40

2 1.0 x 1.0

Total Volume 2.4 m³

$$W_g = 2.4 \times 16 \text{ kN / m}^3 = 38.4 \text{ kN}$$

$$K_a = \frac{\sin^2 (\beta + \phi)}{\sin^2 \beta (\beta - \phi) [1 + \frac{\sin (\phi + \delta) \sin (\phi - \epsilon)}{\sin (\beta - \delta) \sin (\beta + \epsilon)}]^2}$$

$$= 1.216 \times \frac{0.998}{[1 + \frac{0.641 \times 0.358}{0.789 \times 0.945}]^2}$$

$$= 1.216 \times \frac{0.988}{[1 + 0.229]^2}$$

$$= 1.216 \times \frac{0.998}{[1 + 0.306]^2}$$

$$= 1.216 \times [1 + 0.553]^2 = 1.216 \times 2.412 = 2.932$$

$$K_a = 0.998 / 2.932 = 0.340$$

$$\begin{aligned}
\beta &= 71^\circ \\
\phi &= \text{weathered clay} = 21 \\
\delta &= \text{wall friction value} = 0.9 \times \phi = 18.9 \\
\varepsilon &= \text{slope angle of the retained soil} = 0^\circ \\
\gamma &= \text{density of soil} = 19
\end{aligned}$$

2.1 Active thrust calculations

Active thrust due to soil and surcharge are as follow:-

$$P_{a_{\text{soil}}} = 0.5 \times k_a \times \gamma \times H \times H_i = 0.5 \times 0.340 \times 19 \times 2.0 \times 2.0 = 12.92$$

$$P_{a_{\text{surcharge}}} = P_o \times k_a \times H_i = 10 \times 0.340 \times 2.0 = 6.80$$

$$\begin{aligned}
\text{Where } P_{a_{\text{soil}}} &= \text{active thrust due to soil} \\
P_{a_{\text{surcharge}}} &= \text{active thrust due to imposed loadings} \\
H &= \text{vertical effective wall height at rear of wall} \\
H_i &= \text{slope length of rear face of wall} \\
P_o &= \text{surcharge loading above the wall}
\end{aligned}$$

Total active thrust P_a

$$P_a = P_{a_{\text{soil}}} + P_{a_{\text{surcharge}}} = 12.92 + 6.80 = 19.72$$

Height of application is $h/3$ for spoil loadings and $H/2$ for uniform surcharge loading.

Height of point of action

$$\begin{aligned}
dh_{\text{soil}} &= H/3 [(H + 3h_s) / (H + 2h_s)] \\
&= 2.0 / 3 [(2.0 + 0.897) / (2.0 + 0.598)] \\
&= 0.666 [2.897 / 2.598] = 0.743 \\
dh &= dh_{\text{soil}} - b_w \sin \alpha \quad \alpha = \text{Angle of front face} = 10^\circ \\
&= 0.743 - 1.4 \times 0.172 \\
&= 0.743 - 0.241 \\
&= 0.502 \quad \text{above toe of wall}
\end{aligned}$$

Resolve the active thrust P_a into horizontal and vertical components (active thrusts acts at an angle to the normal of the effective plane of the rear face of the wall).

$$\begin{aligned}
P_h &= P_a \times \cos (90 - 71 + 18.9) = 19.72 \times 0.789 = 15.56 \\
P_v &= P_a \times \sin (90 - 71 + 18.9) = 19.72 \times 0.614 = 12.11
\end{aligned}$$

Overturning Stability

$$M_o = \text{moment of overturning} = P_h \times dh = 15.56 \times 0.502 = 7.81 \text{ kNm/m run}$$

$$b_v = b_w \times \cos \alpha - dh_{\text{soil}} / \tan \beta = 1.4 \times 0.984 - 0.632 / 2.904 = 1.378 - 0.218 = 1.160 \text{ m}$$

Mr = Moment of Resistance = Pv x bv + Wg x Xg = 12.11 x 0.962 + 38.4 x 0.6 = 11.65 + 23.04 = 34.69 kNm/m run

Factor of Safety Overtuning Fo= Mr/Mo = 34.69 / 7.81 = 4.442 > 2.0 therefore satisfactory.

Sliding Stability

Normal Force on plane of sliding N = Wg + Pv = 38.40 + 12.11 = 50.51 kN/m run.

Tangential Forces T = Ph = 15.56 kN/m run.

$$\begin{aligned}
 \text{Factor of Safety Sliding } F_s &= \frac{(N \cos \alpha + T \sin \alpha) \tan \phi_{\text{des founding soil}}}{(T \cos \alpha - N \sin \alpha)} \\
 &= \frac{(50.51 \times 0.984 + 15.56 \times 0.174) \times 0.384}{15.56 \times 0.984 - 50.51 \times 0.174} \\
 &= \frac{(49.70 + 2.71) \times 0.384}{15.31 - 8.79} \\
 &= \frac{52.41 \times 0.384}{6.52} \\
 &= 20.13 / 6.52 = 3.09 > 1.5
 \end{aligned}$$

Soil friction for founding soil is 30 degrees

Fs = 3.09 > 1.5 therefore satisfactory

Bearing

$$\begin{aligned}
 \text{Eccentricity } e &= bw / 2 - (Mr - Mo) / N \\
 &= 1.4 / 2 - (34.69 - 7.81) / 50.51 \\
 &= 0.7 - 26.88 / 50.51 \\
 &= 0.7 - 0.532 \\
 &= 0.168 < 1.4/6 = 0.233 \text{ therefore satisfactory}
 \end{aligned}$$

$$\begin{aligned}
 \sigma_{\text{toe}} &= N / bw \times (1 + 6e / bw) \\
 &= 50.51 / 1.4 \times (1 + 6 \times 0.168 / 1.4) \\
 &= 36.08 \times (1.72) \\
 &= 62.06 \text{ kN/sqm}
 \end{aligned}$$

$$\begin{aligned}
 \sigma_{\text{heel}} &= N / bw \times (1 - 6e / bw) \\
 &= 50.51 / 1.4 \times (1 - 6 \times 0.168 / 2) \\
 &= 36.08 \times (0.496) \\
 &= 17.90 \text{ kN/sqm}
 \end{aligned}$$

Maximum bearing pressure = 62.06 kN / m²

Safe bearing pressure = 100 kN / m² Therefore ok

Design computations above are for a check on the full height structure and are satisfactory.