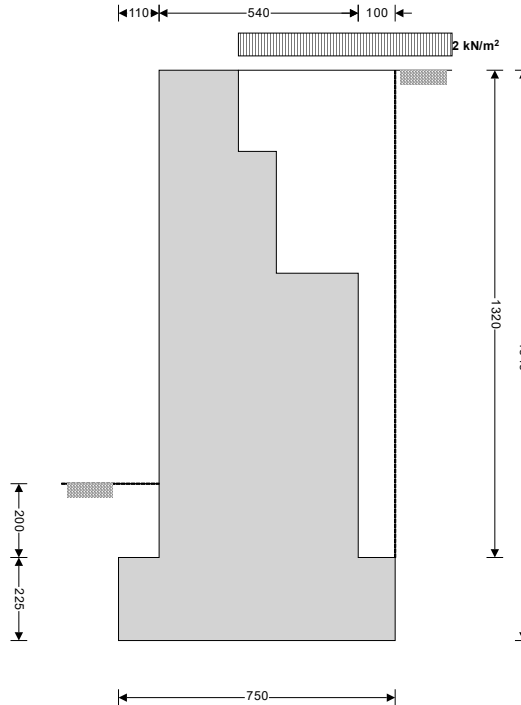


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RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.09



Wall details

Retaining wall type
 Number of steps
 Height of retaining wall stem
 Length of toe
 Length of heel
 Overall length of base
 Thickness of base
 Depth of downstand
 Position of downstand
 Thickness of downstand
 Height of retaining wall
 Depth of cover in front of wall
 Depth of unplanned excavation
 Height of ground water behind wall
 Height of saturated fill above base
 Density of wall construction
 Density of base construction
 Angle of rear face of wall
 Angle of soil surface behind wall
 Effective height at virtual back of wall

Unpropped cantilever with stepped rear face

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$h_{\text{stem}} = 1320 \text{ mm}$
 $l_{\text{toe}} = 110 \text{ mm}$
 $l_{\text{heel}} = 100 \text{ mm}$
 $l_{\text{base}} = l_{\text{toe}} + l_{\text{heel}} + t_{s1} = 750 \text{ mm}$
 $t_{\text{base}} = 225 \text{ mm}$
 $d_{\text{ds}} = 0 \text{ mm}$
 $l_{\text{ds}} = 300 \text{ mm}$
 $t_{\text{ds}} = 225 \text{ mm}$
 $h_{\text{wall}} = h_{\text{stem}} + t_{\text{base}} + d_{\text{ds}} = 1545 \text{ mm}$
 $d_{\text{cover}} = 200 \text{ mm}$
 $d_{\text{exc}} = 0 \text{ mm}$
 $h_{\text{water}} = 0 \text{ mm}$
 $h_{\text{sat}} = \max(h_{\text{water}} - t_{\text{base}} - d_{\text{ds}}, 0 \text{ mm}) = 0 \text{ mm}$
 $\gamma_{\text{wall}} = 18.0 \text{ kN/m}^3$
 $\gamma_{\text{base}} = 23.6 \text{ kN/m}^3$
 $\alpha = 90.0 \text{ deg}$
 $\beta = 0.0 \text{ deg}$
 $h_{\text{eff}} = h_{\text{wall}} + (l_{\text{heel}} + t_{s1} - t_{s3}) \times \tan(\beta) = 1545 \text{ mm}$

Retained material details

Mobilisation factor
 Moist density of retained material

$M = 1.5$
 $\gamma_m = 18.0 \text{ kN/m}^3$

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Saturated density of retained material

$$\gamma_s = 21.0 \text{ kN/m}^3$$

Design shear strength

$$\phi' = 24.2 \text{ deg}$$

Angle of wall friction

$$\delta = 18.6 \text{ deg}$$

Base material details

Moist density

$$\gamma_{mb} = 18.0 \text{ kN/m}^3$$

Design shear strength

$$\phi'_b = 24.2 \text{ deg}$$

Design base friction

$$\delta_b = 18.6 \text{ deg}$$

Allowable bearing pressure

$$P_{\text{bearing}} = 75 \text{ kN/m}^2$$

Using Coulomb theory

Active pressure coefficient for retained material

$$K_a = \sin(\alpha + \phi')^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta) \times [1 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta) / (\sin(\alpha - \delta) \times \sin(\alpha + \beta)))})^2] = 0.369$$

Passive pressure coefficient for base material

$$K_p = \sin(90 - \phi'_b)^2 / (\sin(90 - \delta_b) \times [1 - \sqrt{(\sin(\phi'_b + \delta_b) \times \sin(\phi'_b) / (\sin(90 + \delta_b)))})^2] = 4.187$$

At-rest pressure

At-rest pressure for retained material

$$K_0 = 1 - \sin(\phi') = 0.590$$

Loading details

Surcharge load on plan

$$\text{Surcharge} = 1.5 \text{ kN/m}^2$$

Applied vertical dead load on wall

$$W_{\text{dead}} = 0.0 \text{ kN/m}$$

Applied vertical live load on wall

$$W_{\text{live}} = 0.0 \text{ kN/m}$$

Position of applied vertical load on wall

$$l_{\text{load}} = 0 \text{ mm}$$

Applied horizontal dead load on wall

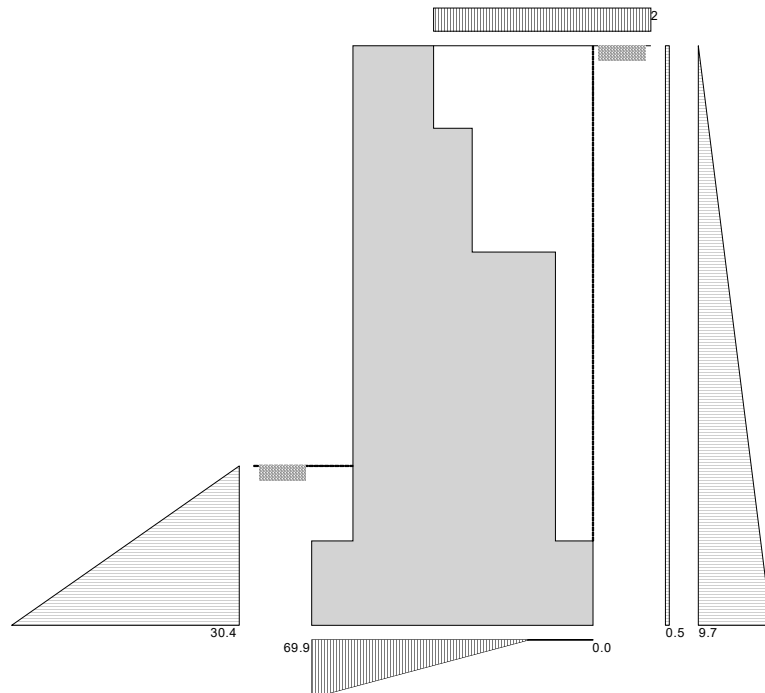
$$F_{\text{dead}} = 0.0 \text{ kN/m}$$

Applied horizontal live load on wall

$$F_{\text{live}} = 0.0 \text{ kN/m}$$

Height of applied horizontal load on wall

$$h_{\text{load}} = 0 \text{ mm}$$



Loads shown in kN/m, pressures shown in kN/m²

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Vertical forces on wall

Wall step no. 3

$$W_{\text{step3}} = h_{s3} \times t_{s3} \times \gamma_{\text{wall}} = \mathbf{0.9 \text{ kN/m}}$$

Wall step no. 2

$$W_{\text{step2}} = h_{s2} \times t_{s2} \times \gamma_{\text{wall}} = \mathbf{1.9 \text{ kN/m}}$$

Wall step no. 1

$$W_{\text{step1}} = h_{s1} \times t_{s1} \times \gamma_{\text{wall}} = \mathbf{7.5 \text{ kN/m}}$$

Wall base

$$W_{\text{base}} = l_{\text{base}} \times t_{\text{base}} \times \gamma_{\text{base}} = \mathbf{4 \text{ kN/m}}$$

Surcharge

$$W_{\text{sur}} = \text{Surcharge} \times [l_{\text{heel}} + (t_{s1} - t_{s3})] = \mathbf{0.6 \text{ kN/m}}$$

Moist backfill to step no. 3

$$W_{m_w3} = (l_{\text{heel}} + t_{s1} - t_{s3}) \times h_{s3} \times \gamma_m = \mathbf{1.7 \text{ kN/m}}$$

Moist backfill to step no. 2

$$W_{m_w2} = (l_{\text{heel}} + t_{s1} - t_{s2}) \times h_{s2} \times \gamma_m = \mathbf{1.9 \text{ kN/m}}$$

Moist backfill to step no. 1

$$W_{m_w1} = (l_{\text{heel}} + t_{s1} - t_{s1}) \times h_{s1} \times \gamma_m = \mathbf{1.4 \text{ kN/m}}$$

Soil in front of wall

$$W_p = l_{\text{toe}} \times d_{\text{cover}} \times \gamma_m = \mathbf{0.4 \text{ kN/m}}$$

Total vertical load

$$W_{\text{total}} = W_{\text{step3}} + W_{\text{step2}} + W_{\text{step1}} + W_{\text{base}} + W_{\text{sur}} + W_{m_w3} + W_{m_w2} + W_{m_w1} + W_p = \mathbf{20.2 \text{ kN/m}}$$

Horizontal forces on wall

Surcharge

$$F_{\text{sur}} = K_a \times \cos(90 - \alpha + \delta) \times \text{Surcharge} \times h_{\text{eff}} = \mathbf{0.8 \text{ kN/m}}$$

Moist backfill above water table

$$F_{m_a} = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{\text{eff}} - h_{\text{water}})^2 = \mathbf{7.5 \text{ kN/m}}$$

Total horizontal load

$$F_{\text{total}} = F_{\text{sur}} + F_{m_a} = \mathbf{8.3 \text{ kN/m}}$$

Calculate stability against sliding

Passive resistance of soil in front of wall

$$F_p = 0.5 \times K_p \times \cos(\delta_b) \times (d_{\text{cover}} + t_{\text{base}} + d_{\text{ds}} - d_{\text{exc}})^2 \times \gamma_{mb} = \mathbf{6.5 \text{ kN/m}}$$

Resistance to sliding

$$F_{\text{res}} = F_p + (W_{\text{total}} - W_{\text{sur}} - W_p) \times \tan(\delta_b) = \mathbf{12.9 \text{ kN/m}}$$

PASS - Resistance force is greater than sliding force

Overturning moments

Surcharge

$$M_{\text{sur}} = F_{\text{sur}} \times (h_{\text{eff}} - 2 \times d_{\text{ds}}) / 2 = \mathbf{0.6 \text{ kNm/m}}$$

Moist backfill above water table

$$M_{m_a} = F_{m_a} \times (h_{\text{eff}} + 2 \times h_{\text{water}} - 3 \times d_{\text{ds}}) / 3 = \mathbf{3.9 \text{ kNm/m}}$$

Total overturning moment

$$M_{\text{ot}} = M_{\text{sur}} + M_{m_a} = \mathbf{4.5 \text{ kNm/m}}$$

Restoring moments

Wall step no. 3

$$M_{\text{step3}} = W_{\text{step3}} \times (l_{\text{toe}} + t_{s3} / 2) = \mathbf{0.2 \text{ kNm/m}}$$

Wall step no. 2

$$M_{\text{step2}} = W_{\text{step2}} \times (l_{\text{toe}} + t_{s2} / 2) = \mathbf{0.5 \text{ kNm/m}}$$

Wall step no. 1

$$M_{\text{step1}} = W_{\text{step1}} \times (l_{\text{toe}} + t_{s1} / 2) = \mathbf{2.8 \text{ kNm/m}}$$

Wall base

$$M_{\text{base}} = W_{\text{base}} \times l_{\text{base}} / 2 = \mathbf{1.5 \text{ kNm/m}}$$

Moist backfill to step no. 3

$$M_{m_w3} = W_{m_w3} \times (l_{\text{base}} - (l_{\text{heel}} + t_{s1} - t_{s3}) / 2) = \mathbf{0.9 \text{ kNm/m}}$$

Moist backfill to step no. 2

$$M_{m_w2} = W_{m_w2} \times (l_{\text{base}} - (l_{\text{heel}} + t_{s1} - t_{s2}) / 2) = \mathbf{1.1 \text{ kNm/m}}$$

Moist backfill to step no. 1

$$M_{m_w1} = W_{m_w1} \times (l_{\text{base}} - (l_{\text{heel}} + t_{s1} - t_{s1}) / 2) = \mathbf{1 \text{ kNm/m}}$$

Total restoring moment

$$M_{\text{rest}} = M_{\text{step3}} + M_{\text{step2}} + M_{\text{step1}} + M_{\text{base}} + M_{m_w3} + M_{m_w2} + M_{m_w1} = \mathbf{8 \text{ kNm/m}}$$

Check stability against overturning

Total overturning moment

$$M_{\text{ot}} = \mathbf{4.5 \text{ kNm/m}}$$

Total restoring moment

$$M_{\text{rest}} = \mathbf{8.0 \text{ kNm/m}}$$

PASS - Restoring moment is greater than overturning moment

Check bearing pressure

Surcharge

$$M_{\text{sur}_r} = W_{\text{sur}} \times (l_{\text{base}} - (l_{\text{heel}} + t_{s1} - t_{s3}) / 2) = \mathbf{0.3 \text{ kNm/m}}$$

Soil in front of wall

$$M_{p_r} = W_p \times l_{\text{toe}} / 2 = \mathbf{0 \text{ kNm/m}}$$

Total moment for bearing

$$M_{\text{total}} = M_{\text{rest}} - M_{\text{ot}} + M_{\text{sur}_r} + M_{p_r} = \mathbf{3.9 \text{ kNm/m}}$$

Total vertical reaction

$$R = W_{\text{total}} = \mathbf{20.2 \text{ kN/m}}$$

Distance to reaction

$$x_{\text{bar}} = M_{\text{total}} / R = \mathbf{193 \text{ mm}}$$

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Eccentricity of reaction

$$e = \text{abs}((l_{\text{base}} / 2) - x_{\text{bar}}) = \mathbf{182 \text{ mm}}$$

Reaction acts outside middle third of base

Bearing pressure at toe

$$p_{\text{toe}} = R / (1.5 \times x_{\text{bar}}) = \mathbf{69.9 \text{ kN/m}^2}$$

Bearing pressure at heel

$$p_{\text{heel}} = 0 \text{ kN/m}^2 = \mathbf{0 \text{ kN/m}^2}$$

PASS - Maximum bearing pressure is less than allowable bearing pressure