



Cwm Planning & Design Ltd.
(Civil, Structural & Architectural)

STRUCTURAL CALCULATIONS

**Masonry Retaining wall
(Driveway / Parking Area)**

at:

**19 Cook Rees Avenue,
Neath**

Date: 31st October 2024

BRIEF:

- 1) Produce design calculations for new masonry retaining wall to facilitate the formation of a parking area at the front of the property at 19 Cook Rees Avenue, Neath.

REFERENCES:

TEDDS structural computer package.

DESIGN LOADINGS:

Refer to structural calculations attached.

Surcharge	= 1.5kN (garden Path)
Loads from existing dwelling	= 15kN (Dead + Live)
Vertical loads on top of wall (Glass balustrade)	= 0.5kN/m (Dead)
	= 0.3kN/m (Live)

SUMMARY

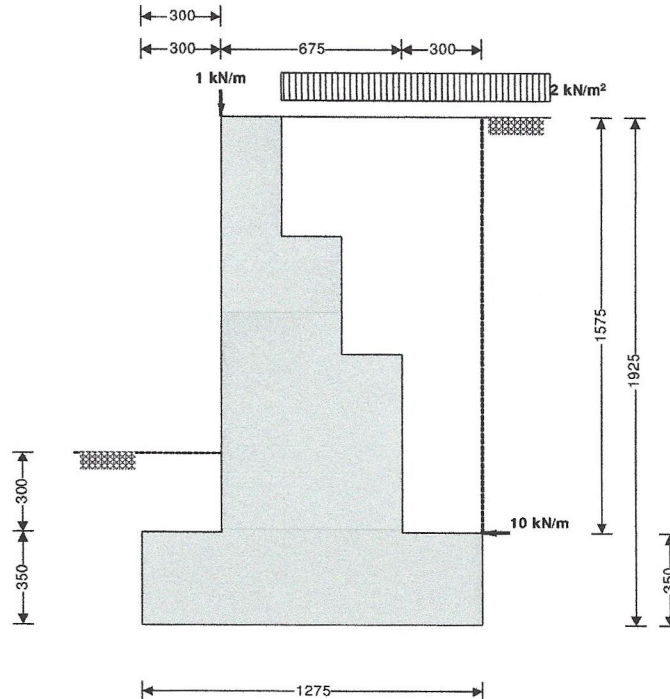
Retained height taken as **1275mm** (Stem Height = 1575mm / 300mm cover to front)

**RETAINING WALL
DESIGN CALCULATIONS**

Project 19 Cook Rees Avenue, Neath				Job no.	
Calcs for Driveway Retaining Wall				Start page no./Revision 1	
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RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.08



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

Retained material details

Mobilisation factor

Unpropped cantilever with stepped rear face

3

$$h_{\text{stem}} = 1575 \text{ mm}$$

$$l_{\text{toe}} = 300 \text{ mm}$$

$$l_{\text{heel}} = 300 \text{ mm}$$

$$l_{\text{base}} = l_{\text{toe}} + l_{\text{heel}} + t_{s1} = \mathbf{1275 \text{ mm}}$$

$$t_{\text{base}} = 350 \text{ mm}$$

$$d_{ds} = 0 \text{ mm}$$

$$l_{ds} = 525 \text{ mm}$$

$$t_{ds} = 350 \text{ mm}$$

$$h_{\text{wall}} = h_{\text{stem}} + t_{\text{base}} + d_{\text{ds}} = \mathbf{1925 \text{ mm}}$$

$$d_{\text{cover}} = 300 \text{ mm}$$

$$d_{\text{exc}} = 0 \text{ mm}$$

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

$$h_{\text{sat}} = \max(h_{\text{water}} - t_{\text{base}} - d_{\text{ds}}, 0 \text{ mm}) = 0 \text{ mm}$$

$$\gamma_{\text{wall}} = 23.6 \text{ kN/m}^3$$

$$\gamma_{\text{base}} = 23.6 \text{ kN/m}^3$$

$\alpha = 90.0^\circ$ deg

$\beta = 0.0 \text{ deg}$

$$h_{\text{eff}} = h_{\text{wall}} + (l_{\text{heel}} + t_{s1} - t_{s3}) \times \tan(\beta) = \mathbf{1925 \text{ mm}}$$

$\dot{M} = 1.5$



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Moist density of retained material

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

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

$$P_{\text{bearing}} = 150 \text{ kN/m}^2$$

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

$$W_{\text{dead}} = 0.5 \text{ kN/m}$$

Applied vertical live load on wall

$$W_{\text{live}} = 0.3 \text{ kN/m}$$

Position of applied vertical load on wall

$$l_{\text{load}} = 300 \text{ mm}$$

Applied horizontal dead load on wall

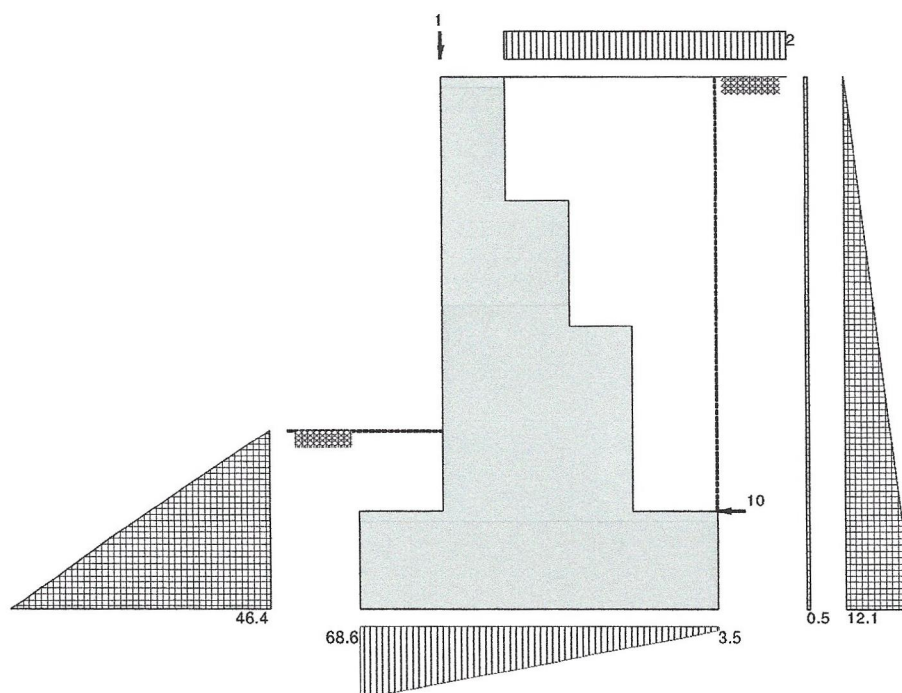
$$F_{\text{dead}} = 10.0 \text{ kN/m}$$

Applied horizontal live load on wall

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

Height of applied horizontal load on wall

$$h_{\text{load}} = 350 \text{ mm}$$



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



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Vertical forces on wall

Wall step no. 3

$$W_{\text{step3}} = h_{s3} \times t_{s3} \times \gamma_{\text{wall}} = \mathbf{2.4 \text{ kN/m}}$$

Wall step no. 2

$$W_{\text{step2}} = h_{s2} \times t_{s2} \times \gamma_{\text{wall}} = \mathbf{4.8 \text{ kN/m}}$$

Wall step no. 1

$$W_{\text{step1}} = h_{s1} \times t_{s1} \times \gamma_{\text{wall}} = \mathbf{10.8 \text{ kN/m}}$$

Wall base

$$W_{\text{base}} = l_{\text{base}} \times t_{\text{base}} \times \gamma_{\text{base}} = \mathbf{10.5 \text{ kN/m}}$$

Surcharge

$$W_{\text{sur}} = \text{Surcharge} \times [l_{\text{heel}} + (t_{s1} - t_{s3})] = \mathbf{1.1 \text{ kN/m}}$$

Moist backfill to step no. 3

$$W_{m_w3} = (l_{\text{heel}} + t_{s1} - t_{s3}) \times h_{s3} \times \gamma_m = \mathbf{6.1 \text{ kN/m}}$$

Moist backfill to step no. 2

$$W_{m_w2} = (l_{\text{heel}} + t_{s1} - t_{s2}) \times h_{s2} \times \gamma_m = \mathbf{4.3 \text{ kN/m}}$$

Moist backfill to step no. 1

$$W_{m_w1} = (l_{\text{heel}} + t_{s1} - t_{s1}) \times h_{s1} \times \gamma_m = \mathbf{3.6 \text{ kN/m}}$$

Soil in front of wall

$$W_p = l_{\text{toe}} \times d_{\text{cover}} \times \gamma_m = \mathbf{1.6 \text{ kN/m}}$$

Applied vertical load

$$W_v = W_{\text{dead}} + W_{\text{live}} = \mathbf{0.8 \text{ kN/m}}$$

Total vertical load

$$W_{\text{total}} = W_{\text{step3}} + W_{\text{step2}} + W_{\text{step1}} + W_{\text{base}} + W_{\text{sur}} + W_{m_w3} + W_{m_w2} + W_{m_w1} +$$

$$W_p + W_v = \mathbf{45.9 \text{ kN/m}}$$

Horizontal forces on wall

Surcharge

$$F_{\text{sur}} = K_a \times \cos(90 - \alpha + \delta) \times \text{Surcharge} \times h_{\text{eff}} = \mathbf{1 \text{ kN/m}}$$

Moist backfill above water table

$$F_{m_a} = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{\text{eff}} - h_{\text{water}})^2 = \mathbf{11.7 \text{ kN/m}}$$

Applied horizontal load

$$F_h = F_{\text{dead}} + F_{\text{live}} = \mathbf{10 \text{ kN/m}}$$

Total horizontal load

$$F_{\text{total}} = F_{\text{sur}} + F_{m_a} + F_h = \mathbf{22.7 \text{ kN/m}}$$

Calculate stability against sliding

Passive resistance of soil in front of wall

$$F_p = 0.5 \times K_p \times \cos(\delta_b) \times (d_{\text{cover}} + t_{\text{base}} + d_{\text{ds}} - d_{\text{exc}})^2 \times \gamma_{\text{mb}} = \mathbf{15.1 \text{ kN/m}}$$

Resistance to sliding

$$F_{\text{res}} = F_p + (W_{\text{total}} - W_{\text{sur}} - W_p - W_{\text{live}}) \times \tan(\delta_b) = \mathbf{29.5 \text{ kN/m}}$$

PASS - Resistance force is greater than sliding force

Overturning moments

Surcharge

$$M_{\text{sur}} = F_{\text{sur}} \times (h_{\text{eff}} - 2 \times d_{\text{ds}}) / 2 = \mathbf{1 \text{ kNm/m}}$$

Moist backfill above water table

$$M_{m_a} = F_{m_a} \times (h_{\text{eff}} + 2 \times h_{\text{water}} - 3 \times d_{\text{ds}}) / 3 = \mathbf{7.5 \text{ kNm/m}}$$

Applied horizontal load

$$M_{\text{hor}} = F_h \times h_{\text{load}} = \mathbf{3.5 \text{ kNm/m}}$$

Total overturning moment

$$M_{\text{ot}} = M_{\text{sur}} + M_{m_a} + M_{\text{hor}} = \mathbf{12 \text{ kNm/m}}$$

Restoring moments

Wall step no. 3

$$M_{\text{step3}} = W_{\text{step3}} \times (l_{\text{toe}} + t_{s3} / 2) = \mathbf{1 \text{ kNm/m}}$$

Wall step no. 2

$$M_{\text{step2}} = W_{\text{step2}} \times (l_{\text{toe}} + t_{s2} / 2) = \mathbf{2.5 \text{ kNm/m}}$$

Wall step no. 1

$$M_{\text{step1}} = W_{\text{step1}} \times (l_{\text{toe}} + t_{s1} / 2) = \mathbf{6.9 \text{ kNm/m}}$$

Wall base

$$M_{\text{base}} = W_{\text{base}} \times l_{\text{base}} / 2 = \mathbf{6.7 \text{ kNm/m}}$$

Moist backfill to step no. 3

$$M_{m_w3} = W_{m_w3} \times (l_{\text{base}} - (l_{\text{heel}} + t_{s1} - t_{s3}) / 2) = \mathbf{5.5 \text{ kNm/m}}$$

Moist backfill to step no. 2

$$M_{m_w2} = W_{m_w2} \times (l_{\text{base}} - (l_{\text{heel}} + t_{s1} - t_{s2}) / 2) = \mathbf{4.3 \text{ kNm/m}}$$

Moist backfill to step no. 1

$$M_{m_w1} = W_{m_w1} \times (l_{\text{base}} - (l_{\text{heel}} + t_{s1} - t_{s1}) / 2) = \mathbf{4.1 \text{ kNm/m}}$$

Design vertical dead load

$$M_{\text{dead}} = W_{\text{dead}} \times l_{\text{load}} = \mathbf{0.2 \text{ kNm/m}}$$

Total restoring moment

$$M_{\text{rest}} = M_{\text{step3}} + M_{\text{step2}} + M_{\text{step1}} + M_{\text{base}} + M_{m_w3} + M_{m_w2} + M_{m_w1} + M_{\text{dead}} =$$

$$\mathbf{31.1 \text{ kNm/m}}$$

Check stability against overturning

Total overturning moment

$$M_{\text{ot}} = \mathbf{12.0 \text{ kNm/m}}$$

Total restoring moment

$$M_{\text{rest}} = \mathbf{31.1 \text{ kNm/m}}$$

PASS - Restoring moment is greater than overturning moment



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Check bearing pressure

Surcharge

$$M_{sur_r} = w_{sur} \times (l_{base} - (l_{heel} + t_{s1} - t_{s3}) / 2) = 1 \text{ kNm/m}$$

Soil in front of wall

$$M_{p_r} = w_p \times l_{toe} / 2 = 0.2 \text{ kNm/m}$$

Design vertical live load

$$M_{live} = W_{live} \times l_{load} = 0.1 \text{ kNm/m}$$

Total moment for bearing

$$M_{total} = M_{rest} - M_{ot} + M_{sur_r} + M_{p_r} + M_{live} = 20.5 \text{ kNm/m}$$

Total vertical reaction

$$R = W_{total} = 45.9 \text{ kN/m}$$

Distance to reaction

$$x_{bar} = M_{total} / R = 446 \text{ mm}$$

Eccentricity of reaction

$$e = \text{abs}((l_{base} / 2) - x_{bar}) = 192 \text{ mm}$$

Reaction acts within middle third of base

Bearing pressure at toe

$$p_{toe} = (R / l_{base}) + (6 \times R \times e / l_{base}^2) = 68.6 \text{ kN/m}^2$$

Bearing pressure at heel

$$p_{heel} = (R / l_{base}) - (6 \times R \times e / l_{base}^2) = 3.5 \text{ kN/m}^2$$

PASS - Maximum bearing pressure is less than allowable bearing pressure