

Title: Structural Calculations - Rev A

Project: 9 Lletty Harri, Port Talbot

Client: IM Design

Document No: 001
Project No: 17443
Prepared By: AS
Checked By: MJ

Revision: -
Date: 22/08/2023

DESIGN STATEMENT

The design has been done in accordance with British Standards BS6399, BS5628 (Masonry).

Information provided by the client.

The design is for 1No. Block on flat retaining wall.

Ground bearing pressure assumed to be 100kN/m², to be confirmed on site.

All dimensions, weights, member lengths, member tables, and any other relevant design information contained within this package is for analysis, and design purposes only, for submission to building control, and must not be used for pricing or fabrication purposes. All queries are to be directed to the engineer prior to tendering, pricing or fabrication.

CDM Comments:

- All temporary propping/support is to correspond to contractor's specification and details.

 Vale Consultancy CONSULTING CIVIL & STRUCTURAL ENGINEERS 29 Bocam Park Old Field Road, Pencoed CF35 5LJ	Project				Job Ref.	
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Masonry design calculations have been completed in accordance with (BS5628-1:2005).

All dimensions stated in the following calculations are for design purposes only and not for use for fabrication or construction purposes. All dimensions must be checked by a competent contractor prior to fabrication or construction and any discrepancies found are to be reported to the design engineer.

Design Loadings

1. Residential Floor

Dead Loading:		
Boarding	=	0.15 kN/m ²
Insulation	=	0.05 kN/m ²
Joists	=	0.15 kN/m ²
Plaster and skim Ceiling	=	0.15 kN/m ²

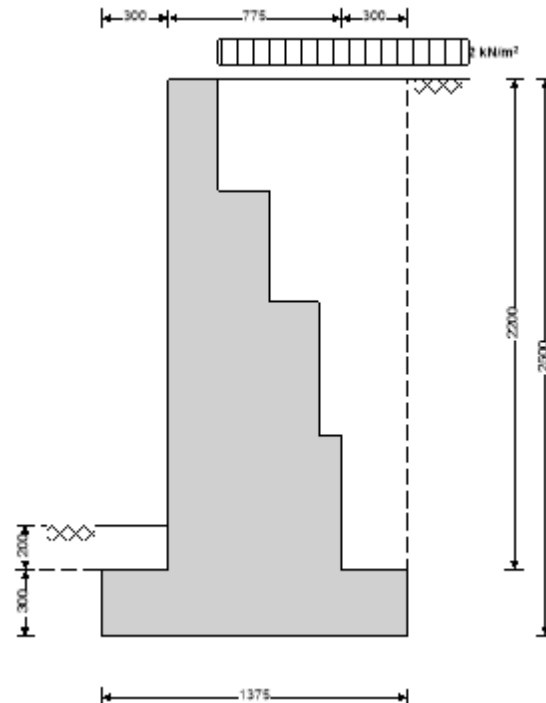
		0.5 kN/m ² Total Dead Loading

Imposed Loading:		
Residential	=	1.50 kN/m ² Total Live Loading

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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

Unpropped cantilever with stepped rear face

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$h_{\text{stem}} = 2200$ mm
 $l_{\text{toe}} = 300$ mm
 $l_{\text{heel}} = 300$ mm
 $l_{\text{base}} = l_{\text{toe}} + l_{\text{heel}} + t_{s1} = 1375$ mm
 $t_{\text{base}} = 300$ mm
 $d_{\text{ds}} = 0$ mm
 $l_{\text{ds}} = 465$ mm
 $t_{\text{ds}} = 300$ mm
 $h_{\text{wall}} = h_{\text{stem}} + t_{\text{base}} + d_{\text{ds}} = 2500$ mm
 $d_{\text{cover}} = 200$ mm
 $d_{\text{exc}} = 200$ mm
 $h_{\text{water}} = 0$ mm
 $h_{\text{sat}} = \max(h_{\text{water}} - t_{\text{base}} - d_{\text{ds}}, 0 \text{ mm}) = 0$ mm
 $\gamma_{\text{wall}} = 23.6$ kN/m³
 $\gamma_{\text{base}} = 23.6$ kN/m³
 $\alpha = 90.0$ deg
 $\beta = 0.0$ deg
 $h_{\text{eff}} = h_{\text{wall}} + (l_{\text{heel}} + t_{s1} - t_{s4}) \times \tan(\beta) = 2500$ mm

Retained material details

Mobilisation factor
Moist density of retained material

$M = 1.5$
 $\gamma_m = 18.0$ kN/m³

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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

Peat (very variable)

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 $P_{\text{bearing}} = 100 \text{ kN/m}^2$

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 Surcharge = **1.5 kN/m²**

Applied vertical dead load on wall $W_{\text{dead}} = 0.0 \text{ kN/m}$

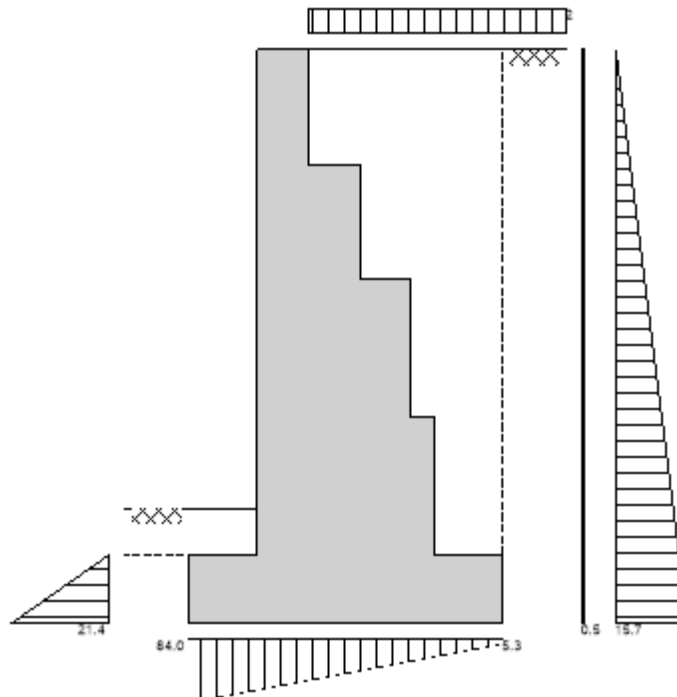
Applied vertical live load on wall $W_{\text{live}} = 0.0 \text{ kN/m}$

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. 4

$$W_{step4} = h_{s4} \times t_{s4} \times \gamma_{wall} = \mathbf{2.7 \text{ kN/m}}$$

Wall step no. 3

$$W_{step3} = h_{s3} \times t_{s3} \times \gamma_{wall} = \mathbf{5.3 \text{ kN/m}}$$

Wall step no. 2

$$W_{step2} = h_{s2} \times t_{s2} \times \gamma_{wall} = \mathbf{9.6 \text{ kN/m}}$$

Wall step no. 1

$$W_{step1} = h_{s1} \times t_{s1} \times \gamma_{wall} = \mathbf{11 \text{ kN/m}}$$

Wall base

$$W_{base} = l_{base} \times t_{base} \times \gamma_{base} = \mathbf{9.7 \text{ kN/m}}$$

Surcharge

$$W_{sur} = \text{Surcharge} \times [l_{heel} + (t_{s1} - t_{s4})] = \mathbf{1.3 \text{ kN/m}}$$

Moist backfill to step no. 4

$$W_{m_w4} = (l_{heel} + t_{s1} - t_{s4}) \times h_{s4} \times \gamma_m = \mathbf{7.7 \text{ kN/m}}$$

Moist backfill to step no. 3

$$W_{m_w3} = (l_{heel} + t_{s1} - t_{s3}) \times h_{s3} \times \gamma_m = \mathbf{5.6 \text{ kN/m}}$$

Moist backfill to step no. 2

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

Moist backfill to step no. 1

$$W_{m_w1} = (l_{heel} + t_{s1} - t_{s1}) \times h_{s1} \times \gamma_m = \mathbf{3.2 \text{ kN/m}}$$

Soil in front of wall

$$W_p = l_{toe} \times d_{cover} \times \gamma_m = \mathbf{1.1 \text{ kN/m}}$$

Total vertical load

$$W_{total} = W_{step4} + W_{step3} + W_{step2} + W_{step1} + W_{base} + W_{sur} + W_{m_w4} + W_{m_w3} +$$

$$W_{m_w2} + W_{m_w1} + W_p = \mathbf{61.4 \text{ kN/m}}$$

Horizontal forces on wall

Surcharge

$$F_{sur} = K_a \times \cos(90 - \alpha + \delta) \times \text{Surcharge} \times h_{eff} = \mathbf{1.3 \text{ kN/m}}$$

Moist backfill above water table

$$F_{m_a} = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water})^2 = \mathbf{19.7 \text{ kN/m}}$$

Total horizontal load

$$F_{total} = F_{sur} + F_{m_a} = \mathbf{21 \text{ kN/m}}$$

Calculate stability against sliding

Passive resistance of soil in front of wall

$$F_p = 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb} = \mathbf{3.2 \text{ kN/m}}$$

Resistance to sliding

$$F_{res} = F_p + (W_{total} - W_{sur} - W_p) \times \tan(\delta_b) = \mathbf{23.1 \text{ kN/m}}$$

PASS - Resistance force is greater than sliding force

Overturning moments

Surcharge

$$M_{sur} = F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2 = \mathbf{1.6 \text{ kNm/m}}$$

Moist backfill above water table

$$M_{m_a} = F_{m_a} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3 = \mathbf{16.4 \text{ kNm/m}}$$

Total overturning moment

$$M_{ot} = M_{sur} + M_{m_a} = \mathbf{18 \text{ kNm/m}}$$

Restoring moments

Wall step no. 4

$$M_{step4} = W_{step4} \times (l_{toe} + t_{s4} / 2) = \mathbf{1.1 \text{ kNm/m}}$$

Wall step no. 3

$$M_{step3} = W_{step3} \times (l_{toe} + t_{s3} / 2) = \mathbf{2.8 \text{ kNm/m}}$$

Wall step no. 2

$$M_{step2} = W_{step2} \times (l_{toe} + t_{s2} / 2) = \mathbf{6.1 \text{ kNm/m}}$$

Wall step no. 1

$$M_{step1} = W_{step1} \times (l_{toe} + t_{s1} / 2) = \mathbf{7.5 \text{ kNm/m}}$$

Wall base

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

Moist backfill to step no. 4

$$M_{m_w4} = W_{m_w4} \times (l_{base} - (l_{heel} + t_{s1} - t_{s4}) / 2) = \mathbf{7.3 \text{ kNm/m}}$$

Moist backfill to step no. 3

$$M_{m_w3} = W_{m_w3} \times (l_{base} - (l_{heel} + t_{s1} - t_{s3}) / 2) = \mathbf{6 \text{ kNm/m}}$$

Moist backfill to step no. 2

$$M_{m_w2} = W_{m_w2} \times (l_{base} - (l_{heel} + t_{s1} - t_{s2}) / 2) = \mathbf{5.1 \text{ kNm/m}}$$

Moist backfill to step no. 1

$$M_{m_w1} = W_{m_w1} \times (l_{base} - (l_{heel} + t_{s1} - t_{s1}) / 2) = \mathbf{4 \text{ kNm/m}}$$

Total restoring moment

$$M_{rest} = M_{step4} + M_{step3} + M_{step2} + M_{step1} + M_{base} + M_{m_w4} + M_{m_w3} + M_{m_w2} +$$

$$M_{m_w1} = \mathbf{46.5 \text{ kNm/m}}$$

Check stability against overturning

Total overturning moment

$$M_{ot} = \mathbf{18.0 \text{ kNm/m}}$$

Total restoring moment

$$M_{rest} = \mathbf{46.5 \text{ kNm/m}}$$

PASS - Restoring moment is greater than overturning moment

Check bearing pressure

Surcharge

$$M_{sur_r} = W_{sur} \times (l_{base} - (l_{heel} + t_{s1} - t_{s4}) / 2) = \mathbf{1.2 \text{ kNm/m}}$$

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Soil in front of wall

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

Total moment for bearing

$$M_{total} = M_{rest} - M_{ot} + M_{sur_r} + M_{p_r} = \mathbf{29.8 \text{ kNm/m}}$$

Total vertical reaction

$$R = W_{total} = \mathbf{61.4 \text{ kN/m}}$$

Distance to reaction

$$x_{bar} = M_{total} / R = \mathbf{486 \text{ mm}}$$

Eccentricity of reaction

$$e = \text{abs}((l_{base} / 2) - x_{bar}) = \mathbf{202 \text{ mm}}$$

Reaction acts within middle third of base

Bearing pressure at toe

$$p_{toe} = (R / l_{base}) + (6 \times R \times e / l_{base}^2) = \mathbf{84 \text{ kN/m}^2}$$

Bearing pressure at heel

$$p_{heel} = (R / l_{base}) - (6 \times R \times e / l_{base}^2) = \mathbf{5.3 \text{ kN/m}^2}$$

PASS - Maximum bearing pressure is less than allowable bearing pressure