Vale Consultancy

CONSULTING CIVIL & STRUCTURAL ENGINEERS

STRUCTURAL CALCULATIONS

2m Mass Block Retaining Wall
Penrhiwfer Allotments
Tonyrefail

Prepared for: Tonyrefail & District Community Council
Project Ref: 21690

01656 863 794 | *enquiries@vale-consultancy.co.uk* | http://vale-consultancy.co.uk
29 Bocam Park | Old Field Road | Pencoed | Bridgend | CF35 5LJ

Thornlink Limited T/A Vale Consultancy
Registered Number | 04140053 | VAT Number | 879 7269 45

DOCUMENT CONTROL

Project:	2m Retaining Wall, Penrhiwfer Allotments, Tonyrefail
Client:	Tonyrefail & District Community Council
Vale Consultancy Ref:	21690

Issue	Prepared by	Approved by	Date	Status
01	Chris Danielsen BEng (Hons) CEng MIStructE	Matt Jones MEng (Hons) CEng FIStructE FICE	11/07/2025	First issue

DESIGN STATEMENT

The design has been completed in accordance with British Standards BS6399, BS5628 (Masonry) & BS8002:2004.

Information provided by the client.

The design is for 1no mass block retaining wall with max retained height of 2m between plots on Penrhiwfer Allotments, Tonyrefail.

The contractor must check all site dimensions prior to construction.

Ground bearing pressure assumed to be 100kPa, to be confirmed on site by contractor prior to works.

Contractor to check suitability of existing masonry for padstone and steel bearing.

Existing & proposed blockwork assumed to have minimum 7.3N/mm2 compressive strength.

Refer to our sketches 21690 SK01 for references.

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. All structural members dimensions need to be taken accurately on site by the contractor prior to fabrication.

During any initial site visits performed by our Engineer, assumptions have to be made where structural elements may have been obscured by finishes. Opening up works should be undertaken prior to fabrication or construction of any structural members to confirm that the structural layout as indicated in our proposed sketches/detailed drawings is correct.

If there are any discrepancies, the Engineer MUST be informed immediately, and prior to proceeding with construction works on site.

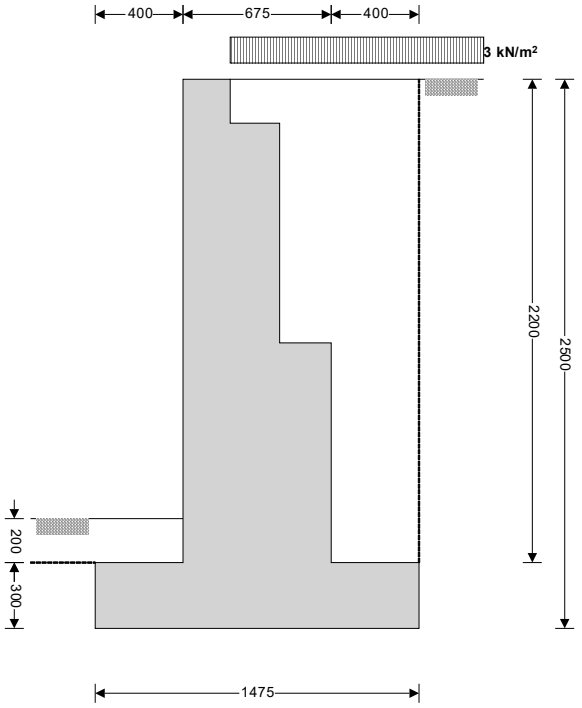
CDM Comments:

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

Vale Consultancy 29 Bocam Park, Old Field Road Pencoed, Bridgend. CF63 4AT	Project Retaining Wall, Penrhiwfer Allotments, Tonyrefail				Job no. 21690
	Calcs for 2m High Mass Block Retaining Wall				Start page no./Revision 1
	Calcs by CD	Calcs date 11/07/2025	Checked by MJ	Checked date 11/07/2025	Approved by CD	Approved date 11/07/2025

RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.09



Wall details

Retaining wall type	**Unpropped cantilever with stepped rear face**
Number of steps	**3**
Height of retaining wall stem	h_{stem} = **2200** mm
Length of toe	l_{toe} = **400** mm
Length of heel	l_{heel} = **400** mm
Overall length of base	$l_{base} = l_{toe} + l_{heel} + t_{s1}$ = **1475** mm
Thickness of base	t_{base} = **300** mm
Depth of downstand	d_{ds} = **0** mm
Position of downstand	l_{ds} = **500** mm
Thickness of downstand	t_{ds} = **300** mm
Height of retaining wall	$h_{wall} = h_{stem} + t_{base} + d_{ds}$ = **2500** mm
Depth of cover in front of wall	d_{cover} = **200** mm
Depth of unplanned excavation	d_{exc} = **200** mm
Height of ground water behind wall	h_{water} = **0** mm
Height of saturated fill above base	$h_{sat} = \max(h_{water} - t_{base} - d_{ds}, 0\ mm)$ = **0** mm
Density of wall construction	γ_{wall} = **23.6** kN/m^3
Density of base construction	γ_{base} = **23.6** kN/m^3
Angle of rear face of wall	α = **90.0** deg
Angle of soil surface behind wall	β = **0.0** deg
Effective height at virtual back of wall	$h_{eff} = h_{wall} + (l_{heel} + t_{s1} - t_{s3}) \times \tan(\beta)$ = **2500** mm

Retained material details

Mobilisation factor	M = **1.5**
Moist density of retained material	γ_m = **18.0** kN/m^3

Saturated density of retained material γ_s = **21.0** kN/m^3

Design shear strength ϕ' = **24.2** deg

Angle of wall friction δ = **0.0** deg

Base material details

Moist density γ_{mb} = **18.0** kN/m^3

Design shear strength ϕ'_b = **24.2** deg

Design base friction δ_b = **23.0** deg

Allowable bearing pressure $P_{bearing}$ = **100** kN/m^2

Using Coulomb theory

Active pressure coefficient for retained material

$$K_a = \sin(\alpha + \phi')^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta) \times [1 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta) / (\sin(\alpha - \delta) \times \sin(\alpha + \beta)))}]^2) = \mathbf{0.419}$$

Passive pressure coefficient for base material

$$K_p = \sin(90 - \phi'_b)^2 / (\sin(90 - \delta_b) \times [1 - \sqrt{(\sin(\phi'_b + \delta_b) \times \sin(\phi'_b) / (\sin(90 + \delta_b)))}]^2) = \mathbf{4.925}$$

At-rest pressure

At-rest pressure for retained material $K_0 = 1 - \sin(\phi') = \mathbf{0.590}$

Loading details

Surcharge load on plan Surcharge = **2.5** kN/m^2

Applied vertical dead load on wall W_{dead} = **0.0** kN/m

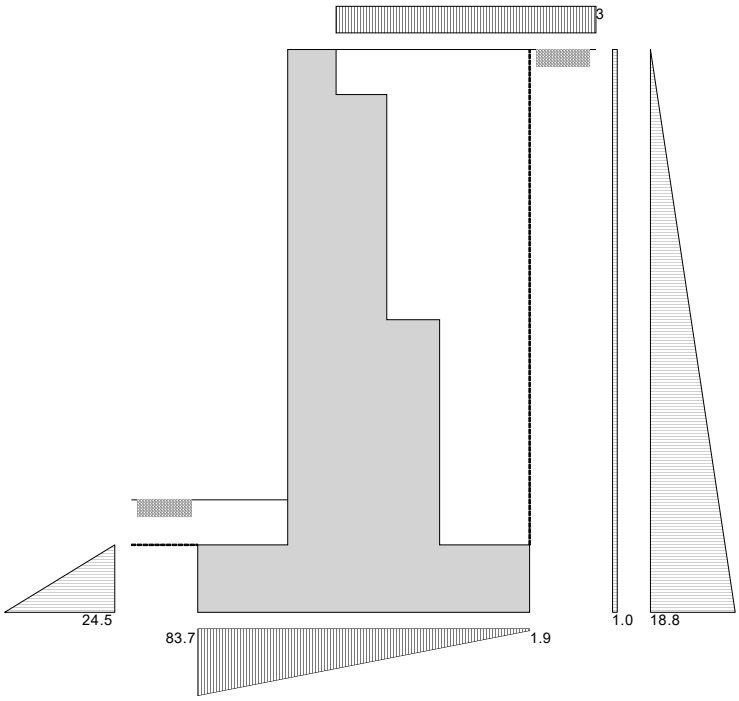
Applied vertical live load on wall W_{live} = **0.0** kN/m

Position of applied vertical load on wall l_{load} = **0** mm

Applied horizontal dead load on wall F_{dead} = **0.0** kN/m

Applied horizontal live load on wall F_{live} = **0.0** kN/m

Height of applied horizontal load on wall h_{load} = **0** mm



Loads shown in kN/m, pressures shown in kN/m^2

Vertical forces on wall

Wall step no. 3 $w_{step3} = h_{s3} \times t_{s3} \times \gamma_{wall}$ = **1** kN/m

Wall step no. 2 $w_{step2} = h_{s2} \times t_{s2} \times \gamma_{wall}$ = **10.4** kN/m

Wall step no. 1 $w_{step1} = h_{s1} \times t_{s1} \times \gamma_{wall}$ = **15.9** kN/m

Wall base $w_{base} = l_{base} \times t_{base} \times \gamma_{base}$ = **10.4** kN/m

Surcharge w_{sur} = Surcharge $\times [l_{heel} + (t_{s1} - t_{s3})]$ = **2.2** kN/m

Moist backfill to step no. 3 $w_{m\_w3} = (l_{heel} + t_{s1} - t_{s3}) \times h_{s3} \times \gamma_m$ = **3.1** kN/m

Moist backfill to step no. 2 $w_{m\_w2} = (l_{heel} + t_{s1} - t_{s2}) \times h_{s2} \times \gamma_m$ = **11.4** kN/m

Moist backfill to step no. 1 $w_{m\_w1} = (l_{heel} + t_{s1} - t_{s1}) \times h_{s1} \times \gamma_m$ = **7.2** kN/m

Soil in front of wall $w_p = l_{toe} \times d_{cover} \times \gamma_m$ = **1.4** kN/m

Total vertical load $W_{total} = w_{step3} + w_{step2} + w_{step1} + w_{base} + w_{sur} + w_{m\_w3} + w_{m\_w2} + w_{m\_w1} + w_p$ = **63.1** kN/m

Horizontal forces on wall

Surcharge $F_{sur} = K_a \times$ Surcharge $\times h_{eff}$ = **2.6** kN/m

Moist backfill above water table $F_{m\_a} = 0.5 \times K_a \times \gamma_m \times (h_{eff} - h_{water})^2$ = **23.5** kN/m

Total horizontal load $F_{total} = F_{sur} + F_{m\_a}$ = **26.2** kN/m

Calculate stability against sliding

Passive resistance of soil in front of wall $F_p = 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb}$ = **3.7** kN/m

Resistance to sliding $F_{res} = F_p + (W_{total} - w_{sur} - w_p) \times \tan(\delta_b)$ = **28.9** kN/m

PASS - Resistance force is greater than sliding force

Overturning moments

Surcharge $M_{sur} = F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2$ = **3.3** kNm/m

Moist backfill above water table $M_{m\_a} = F_{m\_a} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3$ = **19.6** kNm/m

Total overturning moment $M_{ot} = M_{sur} + M_{m\_a}$ = **22.9** kNm/m

Restoring moments

Wall step no. 3 $M_{step3} = w_{step3} \times (l_{toe} + t_{s3} / 2)$ = **0.5** kNm/m

Wall step no. 2 $M_{step2} = w_{step2} \times (l_{toe} + t_{s2} / 2)$ = **6.4** kNm/m

Wall step no. 1 $M_{step1} = w_{step1} \times (l_{toe} + t_{s1} / 2)$ = **11.7** kNm/m

Wall base $M_{base} = w_{base} \times l_{base} / 2$ = **7.7** kNm/m

Moist backfill to step no. 3 $M_{m\_w3} = w_{m\_w3} \times (l_{base} - (l_{heel} + t_{s1} - t_{s3}) / 2)$ = **3.2** kNm/m

Moist backfill to step no. 2 $M_{m\_w2} = w_{m\_w2} \times (l_{base} - (l_{heel} + t_{s1} - t_{s2}) / 2)$ = **13.2** kNm/m

Moist backfill to step no. 1 $M_{m\_w1} = w_{m\_w1} \times (l_{base} - (l_{heel} + t_{s1} - t_{s1}) / 2)$ = **9.2** kNm/m

Total restoring moment $M_{rest} = M_{step3} + M_{step2} + M_{step1} + M_{base} + M_{m\_w3} + M_{m\_w2} + M_{m\_w1}$ = **52** kNm/m

Check stability against overturning

Total overturning moment M_{ot} = **22.9** kNm/m

Total restoring moment M_{rest} = **52.0** kNm/m

PASS - Restoring moment is greater than overturning moment

Check bearing pressure

Surcharge $M_{sur\_r} = w_{sur} \times (l_{base} - (l_{heel} + t_{s1} - t_{s3}) / 2)$ = **2.2** kNm/m

Soil in front of wall $M_{p\_r} = w_p \times l_{toe} / 2$ = **0.3** kNm/m

Total moment for bearing $M_{total} = M_{rest} - M_{ot} + M_{sur\_r} + M_{p\_r}$ = **31.7** kNm/m

Total vertical reaction $R = W_{total}$ = **63.1** kN/m

Distance to reaction $x_{bar} = M_{total} / R$ = **502** mm

Eccentricity of reaction $e = abs((l_{base} / 2) - x_{bar}) = \mathbf{235}$ mm

Reaction acts within middle third of base

Bearing pressure at toe $p_{toe} = (R / l_{base}) + (6 \times R \times e / l_{base}^2) = \mathbf{83.7}$ kN/m^2

Bearing pressure at heel $p_{heel} = (R / l_{base}) - (6 \times R \times e / l_{base}^2) = \mathbf{1.9}$ kN/m^2

PASS - Maximum bearing pressure is less than allowable bearing pressure