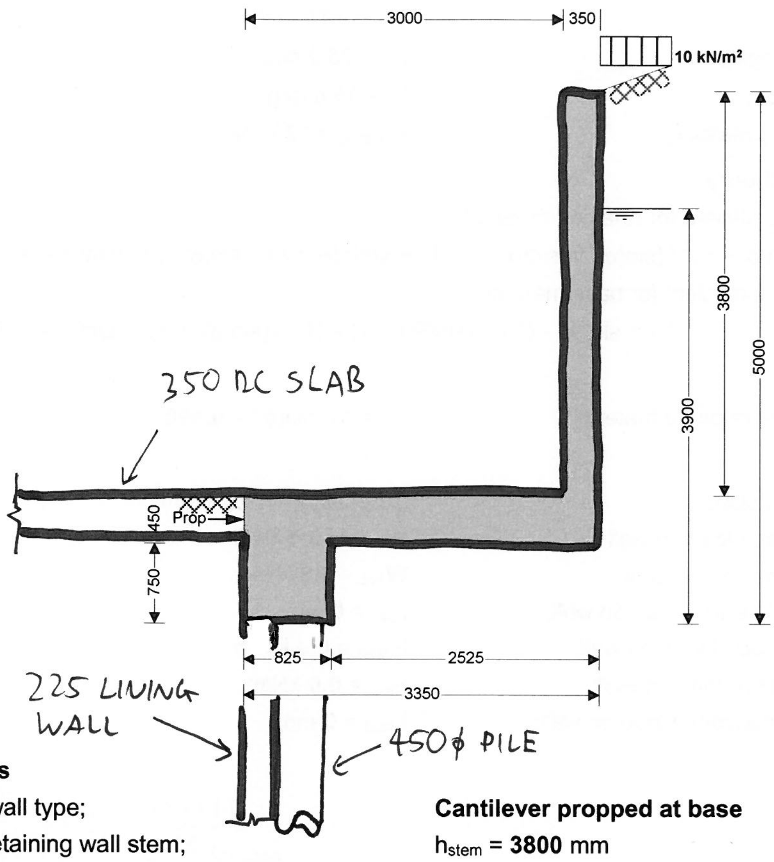
RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.06



Wall details

Retaining wall type;	**Cantilever propped at base**
Height of retaining wall stem;	h_{stem} = **3800** mm
Thickness of wall stem;	t_{wall} = **350** mm
Length of toe;	l_{toe} = **3000** mm
Length of heel;	l_{heel} = **0** mm
Overall length of base;	$l_{base} = l_{toe} + l_{heel} + t_{wall}$ = **3350** mm
Thickness of base;	t_{base} = **450** mm
Depth of downstand;	d_{ds} = **750** mm
Position of downstand;	l_{ds} = **0** mm
Thickness of downstand;	t_{ds} = **825** mm
Height of retaining wall;	$h_{wall} = h_{stem} + t_{base} + d_{ds}$ = **5000** mm
Depth of cover in front of wall;	d_{cover} = **0** mm
Depth of unplanned excavation;	d_{exc} = **0** mm
Height of ground water behind wall;	h_{water} = **3900** mm
Height of saturated fill above base;	$h_{sat} = \max(h_{water} - t_{base} - d_{ds}, 0 \text{ mm})$ = **2700** 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 = **20.0** deg
Effective height at virtual back of wall;	$h_{eff} = h_{wall} + l_{heel} \times \tan(\beta)$ = **5000** 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 = **18.6** deg

Base material details

Stiff clay

Moist density; γ_{mb} = **19.0** kN/m^3

Design shear strength; ϕ'_b = **25.0** deg

Design base friction; δ_b = **18.6** deg

Allowable bearing pressure; $P_{bearing}$ = **125** kN/m^2

Using Coulomb theory

Active pressure coefficient for retained material

$$K_a = \sin(\alpha + \phi')^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta) \times [1 + \sqrt{}(\sin(\phi' + \delta) \times \sin(\phi' - \beta) / (\sin(\alpha - \delta) \times \sin(\alpha + \beta)))]^2) = \mathbf{0.574}$$

Passive pressure coefficient for base material

$$K_p = \sin(90 - \phi'_b)^2 / (\sin(90 - \delta_b) \times [1 - \sqrt{}(\sin(\phi'_b + \delta_b) \times \sin(\phi'_b) / (\sin(90 + \delta_b)))]^2) = \mathbf{4.367}$$

At-rest pressure

At-rest pressure for retained material; $K_0 = 1 - \sin(\phi')$ = **0.590**

Loading details

Surcharge load on plan; Surcharge = **10.0** kN/m^2

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

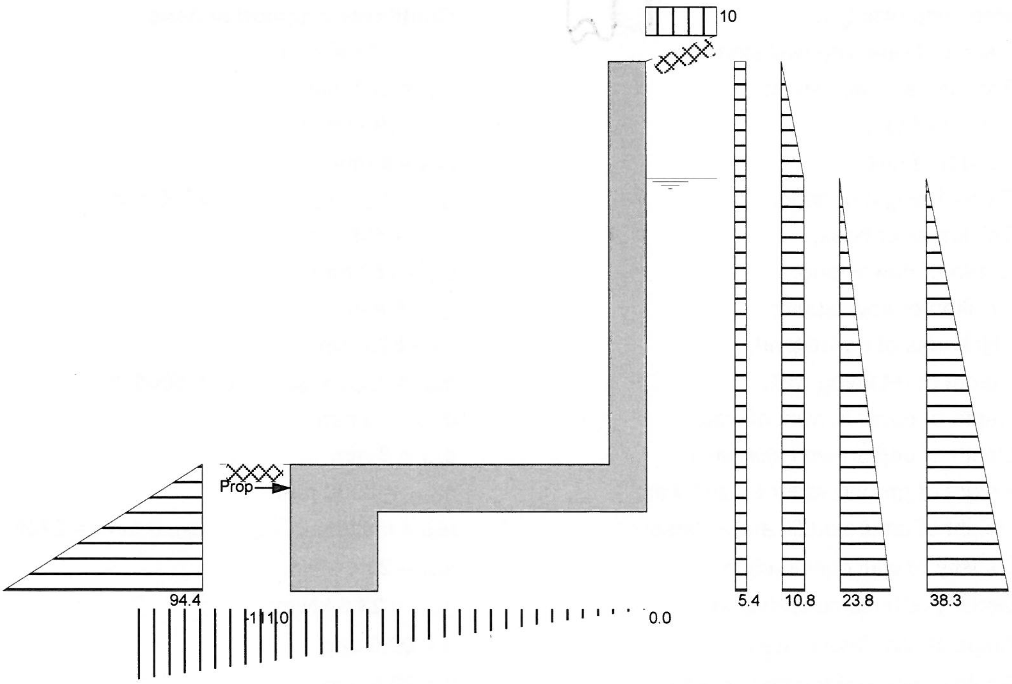
Applied vertical live load on wall; W_{live} = **0.0** kN/m

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 stem; $w_{wall} = h_{stem} \times t_{wall} \times \gamma_{wall}$ = **31.4** kN/m

Wall base; $w_{base} = l_{base} \times t_{base} \times \gamma_{base}$ = **35.6** kN/m

Wall downstand; $w_{ds} = d_{ds} \times t_{ds} \times \gamma_{base}$ = **14.6** kN/m

Total vertical load; $W_{total} = w_{wall} + w_{base} + w_{ds}$ = **81.6** kN/m

Horizontal forces on wall

Surcharge; $F_{sur} = K_a \times \cos(90 - \alpha + \delta) \times \text{Surcharge} \times h_{eff}$ = **27.2** kN/m

Moist backfill above water table; $F_{m\_a} = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water})^2$ = **5.9** kN/m

Moist backfill below water table; $F_{m\_b} = K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water}$ = **42** kN/m

Saturated backfill; $F_s = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times (\gamma_s - \gamma_{water}) \times h_{water}^2$ = **46.3** kN/m

Water; $F_{water} = 0.5 \times h_{water}^2 \times \gamma_{water}$ = **74.6** kN/m

Total horizontal load; $F_{total} = F_{sur} + F_{m\_a} + F_{m\_b} + F_s + F_{water}$ = **196.1** kN/m

Calculate propping force

Passive resistance of soil in front of wall; $F_p = 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb}$ = **56.6** kN/m

Propping force; $F_{prop} = \max(F_{total} - F_p - (W_{total}) \times \tan(\delta_b), 0 \text{ kN/m})$

F_{prop} = **112.0** kN/m

Overturning moments

Surcharge; $M_{sur} = F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2$ = **47.6** kNm/m

Moist backfill above water table; $M_{m\_a} = F_{m\_a} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3$ = **20.8** kNm/m

Moist backfill below water table; $M_{m\_b} = F_{m\_b} \times (h_{water} - 2 \times d_{ds}) / 2$ = **50.4** kNm/m

Saturated backfill; $M_s = F_s \times (h_{water} - 3 \times d_{ds}) / 3$ = **25.5** kNm/m

Water; $M_{water} = F_{water} \times (h_{water} - 3 \times d_{ds}) / 3$ = **41** kNm/m

Soil in front of wall; $M_{p\_o} = F_p \times [2 \times d_{ds} - t_{base} - d_{cover} + d_{exc}] / 3$ = **19.8** kNm/m

Total overturning moment; $M_{ot} = M_{sur} + M_{m\_a} + M_{m\_b} + M_s + M_{water} + M_{p\_o}$ = **205.2** kNm/m

Restoring moments

Wall stem; $M_{wall} = w_{wall} \times (l_{toe} + t_{wall} / 2)$ = **99.7** kNm/m

Wall base; $M_{base} = w_{base} \times l_{base} / 2$ = **59.6** kNm/m

Wall downstand; $M_{ds} = w_{ds} \times (l_{ds} + t_{ds} / 2)$ = **6** kNm/m

Total restoring moment; $M_{rest} = M_{wall} + M_{base} + M_{ds}$ = **165.3** kNm/m

Check bearing pressure

Total moment for bearing; $M_{total} = M_{rest} - M_{ot}$ = **-40** kNm/m

Total vertical reaction; $R = W_{total}$ = **81.6** kN/m

Distance to reaction; $x_{bar} = M_{total} / R$ = **-490** mm

Eccentricity of reaction; $e = \text{abs}((l_{base} / 2) - x_{bar})$ = **2165** mm

WARNING - Beyond scope of calculation

Bearing pressure at toe; $p_{toe} = R / (1.5 \times x_{bar})$ = **-111** kN/m^2

Bearing pressure at heel; $p_{heel} = 0$ kN/m^2 = **0** kN/m^2

PASS - Maximum bearing pressure is less than allowable bearing pressure

RETAINING WALL DESIGN (BS 8002:1994)

TEDDS calculation version 1.2.01.06

Ultimate limit state load factors

Dead load factor; γ_{f_d} = **1.4**

Live load factor; γ_{f_l} = **1.6**

Earth and water pressure factor; γ_{f_e} = **1.4**

Factored vertical forces on wall

Wall stem; $w_{wall\_f} = \gamma_{f\_d} \times h_{stem} \times t_{wall} \times \gamma_{wall}$ = **43.9** kN/m

Wall base; $w_{base\_f} = \gamma_{f\_d} \times l_{base} \times t_{base} \times \gamma_{base}$ = **49.8** kN/m

Wall downstand; $w_{ds\_f} = \gamma_{f\_d} \times d_{ds} \times t_{ds} \times \gamma_{base}$ = **20.4** kN/m

Total vertical load; $W_{total\_f} = w_{wall\_f} + w_{base\_f} + w_{ds\_f}$ = **114.2** kN/m

Factored horizontal at-rest forces on wall

Surcharge; $F_{sur\_f} = \gamma_{f\_l} \times K_0 \times Surcharge \times h_{eff}$ = **47.2** kN/m

Moist backfill above water table; $F_{m\_a\_f} = \gamma_{f\_e} \times 0.5 \times K_0 \times \gamma_m \times (h_{eff} - h_{water})^2$ = **9** kN/m

Moist backfill below water table; $F_{m\_b\_f} = \gamma_{f\_e} \times K_0 \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water}$ = **63.8** kN/m

Saturated backfill; $F_{s\_f} = \gamma_{f\_e} \times 0.5 \times K_0 \times (\gamma_s - \gamma_{water}) \times h_{water}^2$ = **70.3** kN/m

Water; $F_{water\_f} = \gamma_{f\_e} \times 0.5 \times h_{water}^2 \times \gamma_{water}$ = **104.4** kN/m

Total horizontal load; $F_{total\_f} = F_{sur\_f} + F_{m\_a\_f} + F_{m\_b\_f} + F_{s\_f} + F_{water\_f}$ = **294.7** kN/m

Calculate propping force

Passive resistance of soil in front of wall; $F_{p\_f} = \gamma_{f\_e} \times 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb}$ = **79.3** kN/m

Propping force; $F_{prop\_f} = \max(F_{total\_f} - F_{p\_f} - (W_{total\_f}) \times \tan(\delta_b), 0 \text{ kN/m})$

F_{prop_f} = **177.0** kN/m

Factored overturning moments

Surcharge; $M_{sur\_f} = F_{sur\_f} \times (h_{eff} - 2 \times d_{ds}) / 2$ = **82.6** kNm/m

Moist backfill above water table; $M_{m\_a\_f} = F_{m\_a\_f} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3$ = **31.6** kNm/m

Moist backfill below water table; $M_{m\_b\_f} = F_{m\_b\_f} \times (h_{water} - 2 \times d_{ds}) / 2$ = **76.6** kNm/m

Saturated backfill; $M_{s\_f} = F_{s\_f} \times (h_{water} - 3 \times d_{ds}) / 3$ = **38.7** kNm/m

Water; $M_{water\_f} = F_{water\_f} \times (h_{water} - 3 \times d_{ds}) / 3$ = **57.4** kNm/m

Soil in front of wall; $M_{p\_o\_f} = F_{p\_f} \times [2 \times d_{ds} - t_{base} - d_{cover} + d_{exc}] / 3$ = **27.7** kNm/m

Total overturning moment; $M_{ot\_f} = M_{sur\_f} + M_{m\_a\_f} + M_{m\_b\_f} + M_{s\_f} + M_{water\_f} + M_{p\_o\_f}$ = **314.7** kNm/m

Restoring moments

Wall stem; $M_{wall\_f} = w_{wall\_f} \times (l_{toe} + t_{wall} / 2)$ = **139.5** kNm/m

Wall base; $M_{base\_f} = w_{base\_f} \times l_{base} / 2$ = **83.4** kNm/m

Wall downstand; $M_{ds\_f} = w_{ds\_f} \times (l_{ds} + t_{ds} / 2)$ = **8.4** kNm/m

Total restoring moment; $M_{rest\_f} = M_{wall\_f} + M_{base\_f} + M_{ds\_f}$ = **231.4** kNm/m

Factored bearing pressure

Total moment for bearing; $M_{total\_f} = M_{rest\_f} - M_{ot\_f}$ = **-83.3** kNm/m

Total vertical reaction; $R_f = W_{total\_f}$ = **114.2** kN/m

Distance to reaction; $x_{bar\_f} = M_{total\_f} / R_f$ = **-729** mm

Eccentricity of reaction; $e_f = abs((l_{base} / 2) - x_{bar\_f})$ = **2404** mm

WARNING - Beyond scope of calculation

Bearing pressure at toe; $p_{toe\_f} = R_f / (1.5 \times x_{bar\_f})$ = **-104.4** kN/m²

Bearing pressure at heel; p_{heel_f} = 0 kN/m² = **0** kN/m²

Rate of change of base reaction; $rate = p_{toe\_f} / (3 \times x_{bar\_f})$ = **47.72** kN/m²/m

Bearing pressure at stem / toe; $p_{stem\_toe\_f} = \max(p_{toe\_f} - (rate \times l_{toe}), 0\ kN/m^2) = \mathbf{0}\ kN/m^2$

Bearing pressure at mid stem; $p_{stem\_mid\_f} = \max(p_{toe\_f} - (rate \times (l_{toe} + t_{wall} / 2)), 0\ kN/m^2) = \mathbf{0}$ kN/m²

Bearing pressure at stem / heel; $p_{stem\_heel\_f} = \max(p_{toe\_f} - (rate \times (l_{toe} + t_{wall})), 0\ kN/m^2) = \mathbf{0}$ kN/m²

Design of reinforced concrete retaining wall toe (BS 8002:1994)

Material properties

Characteristic strength of concrete; $f_{cu} = \mathbf{40}\ N/mm^2$

Characteristic strength of reinforcement; $f_y = \mathbf{500}\ N/mm^2$

Base details

Minimum area of reinforcement; $k = \mathbf{0.13}$ %

Cover to reinforcement in toe; $c_{toe} = \mathbf{75}$ mm

Calculate shear for toe design

Shear from weight of base; $V_{toe\_wt\_base} = \gamma_{f\_d} \times \gamma_{base} \times l_{toe} \times t_{base} = \mathbf{44.6}$ kN/m

Shear from weight of downstand; $V_{toe\_wt\_ds} = \gamma_{f\_d} \times \gamma_{base} \times d_{ds} \times t_{ds} = \mathbf{20.4}$ kN/m

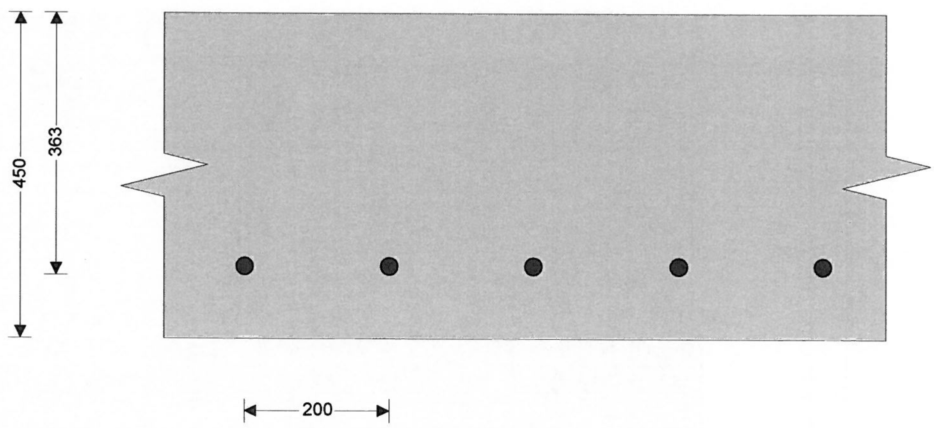
Total shear for toe design; $V_{toe} = V_{toe\_wt\_base} - V_{toe\_wt\_ds} = \mathbf{24.2}$ kN/m

Calculate moment for toe design

Moment from weight of base; $M_{toe\_wt\_base} = (\gamma_{f\_d} \times \gamma_{base} \times t_{base} \times (l_{toe} + t_{wall} / 2)^2 / 2) = \mathbf{74.9}$ kNm/m

Moment from weight of downstand; $M_{toe\_wt\_ds} = \gamma_{f\_d} \times \gamma_{base} \times d_{ds} \times t_{ds} \times (l_{toe} - l_{ds} + (t_{wall} - t_{ds}) / 2) =$ **56.5** kNm/m

Total moment for toe design; $M_{toe} = M_{toe\_wt\_base} - M_{toe\_wt\_ds} = \mathbf{18.5}$ kNm/m



Check toe in bending

Width of toe; $b = \mathbf{1000}$ mm/m

Depth of reinforcement; $d_{toe} = t_{base} - c_{toe} - (\phi_{toe} / 2) = \mathbf{362.5}$ mm

Constant; $K_{toe} = M_{toe} / (b \times d_{toe}^2 \times f_{cu}) = \mathbf{0.004}$

Compression reinforcement is not required

Lever arm; $z_{toe} = \min(0.5 + \sqrt{(0.25 - (\min(K_{toe}, 0.225) / 0.9))}, 0.95) \times d_{toe}$

$z_{toe} = \mathbf{344}$ mm

Area of tension reinforcement required; $A_{s\_toe\_des} = M_{toe} / (0.87 \times f_y \times z_{toe}) = \mathbf{123}\ mm^2/m$

Minimum area of tension reinforcement; $A_{s\_toe\_min} = k \times b \times t_{base} = \mathbf{585}\ mm^2/m$

Area of tension reinforcement required; $A_{s\_toe\_req} = \text{Max}(A_{s\_toe\_des}, A_{s\_toe\_min}) = \mathbf{585}\ mm^2/m$

Reinforcement provided; **25 mm dia.bars @ 200 mm centres**

Area of reinforcement provided; $A_{s\_toe\_prov} = \mathbf{2454}\ mm^2/m$

PASS - Reinforcement provided at the retaining wall toe is adequate

Check shear resistance at toe

Design shear stress; $v_{toe} = V_{toe} / (b \times d_{toe})$ = **0.067** N/mm^2

Allowable shear stress; $v_{adm} = \min(0.8 \times \sqrt{(f_{cu} / 1 \text{ N/mm}^2)}, 5) \times 1 \text{ N/mm}^2$ = **5.000** N/mm^2

PASS - Design shear stress is less than maximum shear stress

From BS8110:Part 1:1997 – Table 3.8

Design concrete shear stress; v_{c_toe} = **0.665** N/mm^2

$v_{toe} < v_{c\_toe}$ - No shear reinforcement required

<u>Design of reinforced concrete retaining wall downstand (BS 8002:1994)</u>

Material properties

Characteristic strength of concrete; f_{cu} = **40** N/mm^2

Characteristic strength of reinforcement; f_y = **500** N/mm^2

Base details

Minimum area of reinforcement; k = **0.13** %

Cover to reinforcement in downstand; c_{ds} = **75** mm

Calculate shear for downstand design

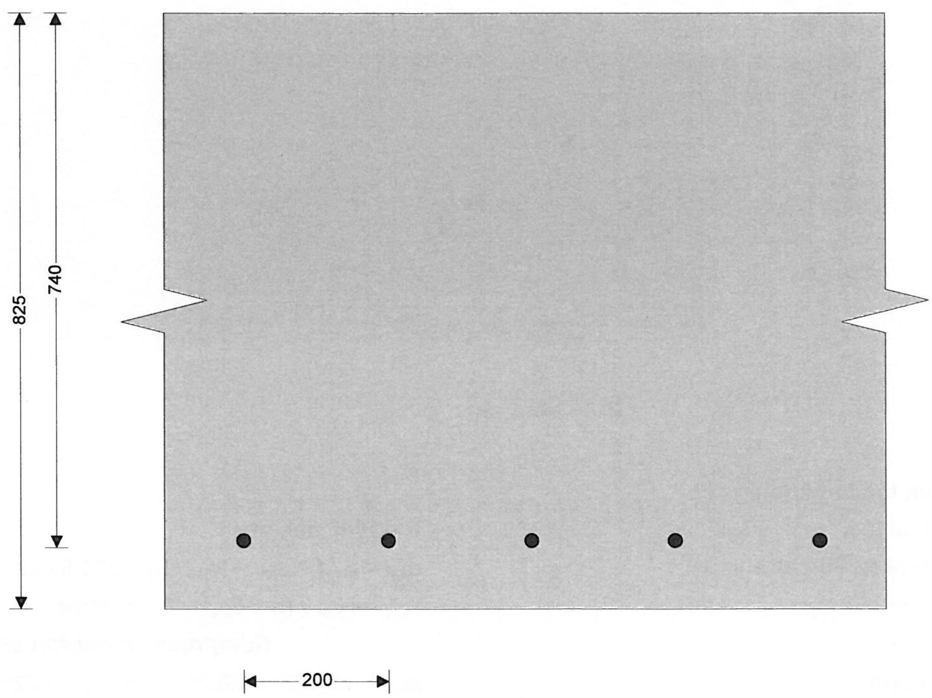
Total shear for downstand design

$V_{down} = \gamma_{f\_e} \times K_p \times \cos(\delta_b) \times \gamma_m \times d_{ds} \times (d_{cover} + t_{base} + d_{ds} / 2)$ = **64.5** kN/m

Calculate moment for downstand design

Total moment for downstand design

$M_{down} = \gamma_{f\_e} \times K_p \times \cos(\delta_b) \times \gamma_m \times d_{ds} \times [(d_{cover} + t_{base}) \times (t_{base} + d_{ds}) + d_{ds} \times (t_{base} / 2 + 2 \times d_{ds} / 3)] / 2$ = **42.4** kNm/m



Check downstand in bending

Width of downstand; b = **1000** mm/m

Depth of reinforcement; $d_{down} = t_{ds} - c_{ds} - (\phi_{down} / 2)$ = **740.0** mm

Constant; $K_{down} = M_{down} / (b \times d_{down}^2 \times f_{cu})$ = **0.002**

Compression reinforcement is not required

Lever arm; z_{down} = Min(0.5 + √(0.25 - (min(K_{down}, 0.225) / 0.9)),0.95) × d_{down}

z_{down} = **703** mm

Area of tension reinforcement required; $A_{s\_down\_des} = M_{down} / (0.87 \times f_y \times z_{down})$ = **139** mm^2/m

Minimum area of tension reinforcement; $A_{s\_down\_min} = k \times b \times t_{ds}$ = **1073** mm^2/m

Area of tension reinforcement required; $A_{s\_down\_req} = Max(A_{s\_down\_des}, A_{s\_down\_min})$ = **1073** mm^2/m

Reinforcement provided; **20 mm dia.bars @ 200 mm centres**

Area of reinforcement provided; $A_{s\_down\_prov}$ = **1571** mm^2/m

PASS - Reinforcement provided at the retaining wall downstand is adequate

Check shear resistance at downstand

Design shear stress; $v_{down} = V_{down} / (b \times d_{down})$ = **0.087** N/mm^2

Allowable shear stress; $v_{adm} = min(0.8 \times \sqrt{(f_{cu} / 1 N/mm^2)}, 5) \times 1 N/mm^2$ = **5.000** N/mm^2

PASS - Design shear stress is less than maximum shear stress

From BS8110:Part 1:1997 – Table 3.8

Design concrete shear stress; v_{c_down} = **0.441** N/mm^2

$v_{down} < v_{c\_down}$ - No shear reinforcement required

<u>Design of reinforced concrete retaining wall stem (BS 8002:1994)</u>

Material properties

Characteristic strength of concrete; f_{cu} = **40** N/mm^2

Characteristic strength of reinforcement; f_y = **500** N/mm^2

Wall details

Minimum area of reinforcement; k = **0.13** %

Cover to reinforcement in stem; c_{stem} = **75** mm

Cover to reinforcement in wall; c_{wall} = **75** mm

Factored horizontal at-rest forces on stem

Surcharge; $F_{s\_sur\_f} = \gamma_{f\_l} \times K_0 \times Surcharge \times (h_{eff} - t_{base} - d_{ds})$ = **35.9** kN/m

Moist backfill above water table; $F_{s\_m\_a\_f} = 0.5 \times \gamma_{f\_e} \times K_0 \times \gamma_m \times (h_{eff} - t_{base} - d_{ds} - h_{sat})^2$ = **9** kN/m

Moist backfill below water table; $F_{s\_m\_b\_f} = \gamma_{f\_e} \times K_0 \times \gamma_m \times (h_{eff} - t_{base} - d_{ds} - h_{sat}) \times h_{sat}$ = **44.2** kN/m

Saturated backfill; $F_{s\_s\_f} = 0.5 \times \gamma_{f\_e} \times K_0 \times (\gamma_s - \gamma_{water}) \times h_{sat}^2$ = **33.7** kN/m

Water; $F_{s\_water\_f} = 0.5 \times \gamma_{f\_e} \times \gamma_{water} \times h_{sat}^2$ = **50.1** kN/m

Calculate shear for stem design

Shear at base of stem; $V_{stem} = F_{s\_sur\_f} + F_{s\_m\_a\_f} + F_{s\_m\_b\_f} + F_{s\_s\_f} + F_{s\_water\_f} - F_{prop\_f}$ = **-4.2** kN/m

Calculate moment for stem design

Surcharge; $M_{s\_sur} = F_{s\_sur\_f} \times (h_{stem} + t_{base}) / 2$ = **76.2** kNm/m

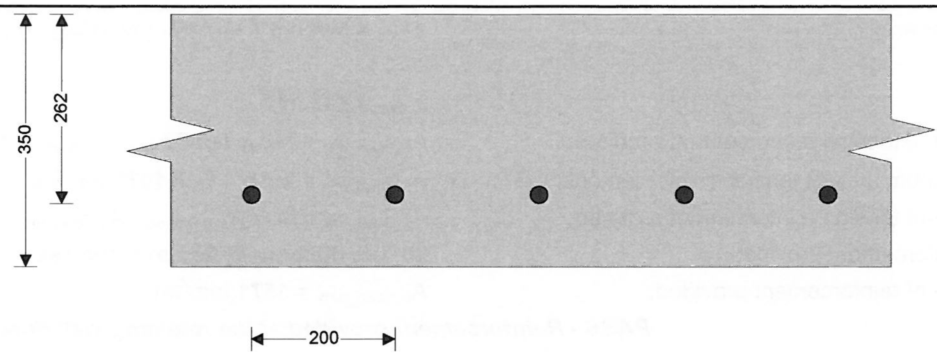
Moist backfill above water table; $M_{s\_m\_a} = F_{s\_m\_a\_f} \times (2 \times h_{sat} + h_{eff} - d_{ds} + t_{base} / 2) / 3$ = **29.6** kNm/m

Moist backfill below water table; $M_{s\_m\_b} = F_{s\_m\_b\_f} \times h_{sat} / 2$ = **59.6** kNm/m

Saturated backfill; $M_{s\_s} = F_{s\_s\_f} \times h_{sat} / 3$ = **30.3** kNm/m

Water; $M_{s\_water} = F_{s\_water\_f} \times h_{sat} / 3$ = **45.1** kNm/m

Total moment for stem design; $M_{stem} = M_{s\_sur} + M_{s\_m\_a} + M_{s\_m\_b} + M_{s\_s} + M_{s\_water}$ = **240.9** kNm/m



Check wall stem in bending

Width of wall stem; b = **1000** mm/m

Depth of reinforcement; $d_{stem} = t_{wall} - c_{stem} - (\phi_{stem} / 2)$ = **262.5** mm

Constant; $K_{stem} = M_{stem} / (b \times d_{stem}^2 \times f_{cu})$ = **0.087**

Compression reinforcement is not required

Lever arm; $z_{stem} = \min(0.5 + \sqrt{(0.25 - (\min(K_{stem}, 0.225) / 0.9))}, 0.95) \times d_{stem}$

z_{stem} = **234** mm

Area of tension reinforcement required; $A_{s\_stem\_des} = M_{stem} / (0.87 \times f_y \times z_{stem})$ = **2367** mm^2/m

Minimum area of tension reinforcement; $A_{s\_stem\_min} = k \times b \times t_{wall}$ = **455** mm^2/m

Area of tension reinforcement required; $A_{s\_stem\_req} = \mathrm{Max}(A_{s\_stem\_des}, A_{s\_stem\_min})$ = **2367** mm^2/m

Reinforcement provided; **25 mm dia.bars @ 200 mm centres**

Area of reinforcement provided; $A_{s\_stem\_prov}$ = **2454** mm^2/m

PASS - Reinforcement provided at the retaining wall stem is adequate

Check shear resistance at wall stem

Design shear stress; $v_{stem} = V_{stem} / (b \times d_{stem})$ = **-0.016** N/mm^2

Allowable shear stress; $v_{adm} = \min(0.8 \times \sqrt{(f_{cu} / 1\ \text{N/mm}^2)}, 5) \times 1\ \text{N/mm}^2$ = **5.000** N/mm^2

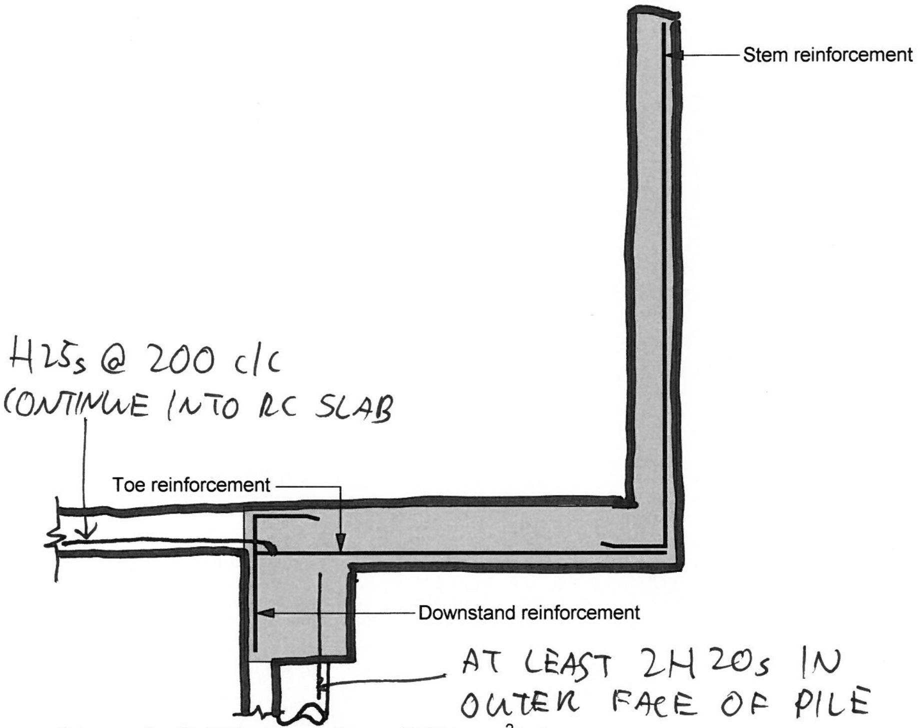
PASS - Design shear stress is less than maximum shear stress

From BS8110:Part 1:1997 – Table 3.8

Design concrete shear stress; v_{c_stem} = **0.803** N/mm^2

$v_{stem} < v_{c\_stem}$ - No shear reinforcement required

Indicative retaining wall reinforcement diagram



Toe bars - 25 mm dia.@ 200 mm centres - (2454 mm^2/m)
Downstand bars - 20 mm dia.@ 200 mm centres - (1571 mm^2/m)
Stem bars - 25 mm dia.@ 200 mm centres - (2454 mm^2/m)

Overturning Moment resistance

Overturning moment will be resisted by the 350 thick lower ground floor slab.

M_{OT} = 201.2kNm/m => Factored = 1.4 x 201.2kNm/m = 282kNm/m

Design 350 thick slab to resist this force.

h = 350mm, c = 25mm, ϕ = 25mm, d = 300mm, f_y = 500N/mm^2

$A_{s,req} = M/0.87f_yz = 282x10^6/0.87x500x0.9x300 = 2401mm^2/m$

Provide H25s @ 200 c/c $A_{s,prov}$ = 2454mm^2

Ensure piled wall has sufficient stiffness as well.

Pile ϕ = 450mm, Lining wall = 225mm, outside cover = 75mm => d = 600mm

$A_{s,req} = M/0.87f_yz = 282x10^6/0.87x500x0.9x600 = 1201mm^2/m$

Provide 0.45 x 1201mm^2/m = 541mm^2 per pile => Provide at least 2 H10 bars per pile

$A_{s,prov}$ = 628mm^2