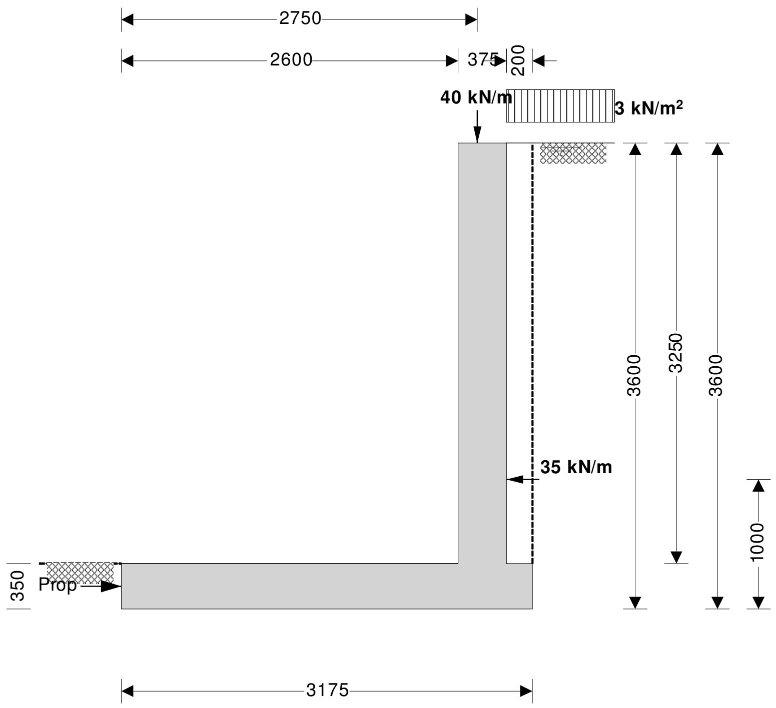
Mitchinson Macken Ltd Unit 1 100 North Road BN1 1YE	Project PARSIFAL HOUSE - 521 FINCHLEY ROAD LONDON				Job no. 19313	
	Calcs for Retaining Wall A-A				Start page no./Revision 1 A	
	Calcs by SM	Calcs date 25/09/2020	Checked by MM	Checked date	Approved by	Approved date

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} = **3250** mm
Thickness of wall stem	t_{wall} = **375** mm
Length of toe	l_{toe} = **2600** mm
Length of heel	l_{heel} = **200** mm
Overall length of base	$l_{base} = l_{toe} + l_{heel} + t_{wall}$ = **3175** mm
Thickness of base	t_{base} = **350** mm
Depth of downstand	d_{ds} = **0** mm
Position of downstand	l_{ds} = **1500** mm
Thickness of downstand	t_{ds} = **350** mm
Height of retaining wall	$h_{wall} = h_{stem} + t_{base} + d_{ds}$ = **3600** 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} = **3600** mm
Height of saturated fill above base	$h_{sat} = \max(h_{water} - t_{base} - d_{ds}, 0\ mm)$ = **3250** 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	$h_{eff} = h_{wall} + l_{heel} \times \tan(\beta)$ = **3600** mm

Retained material details

Mobilisation factor	M = **1.2**
Moist density of retained material	γ_m = **18.0** kN/m^3

Saturated density of retained material	γ_s = **20.0** kN/m^3
Design shear strength	ϕ' = **24.2** deg
Angle of wall friction	δ = **0.0** deg

Base material details

Stiff clay

Moist density	γ_{mb} = **20.0** kN/m^3
Design shear strength	ϕ'_b = **22.0** deg
Design base friction	δ_b = **22.0** deg
Allowable bearing pressure	$P_{bearing}$ = **170** 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

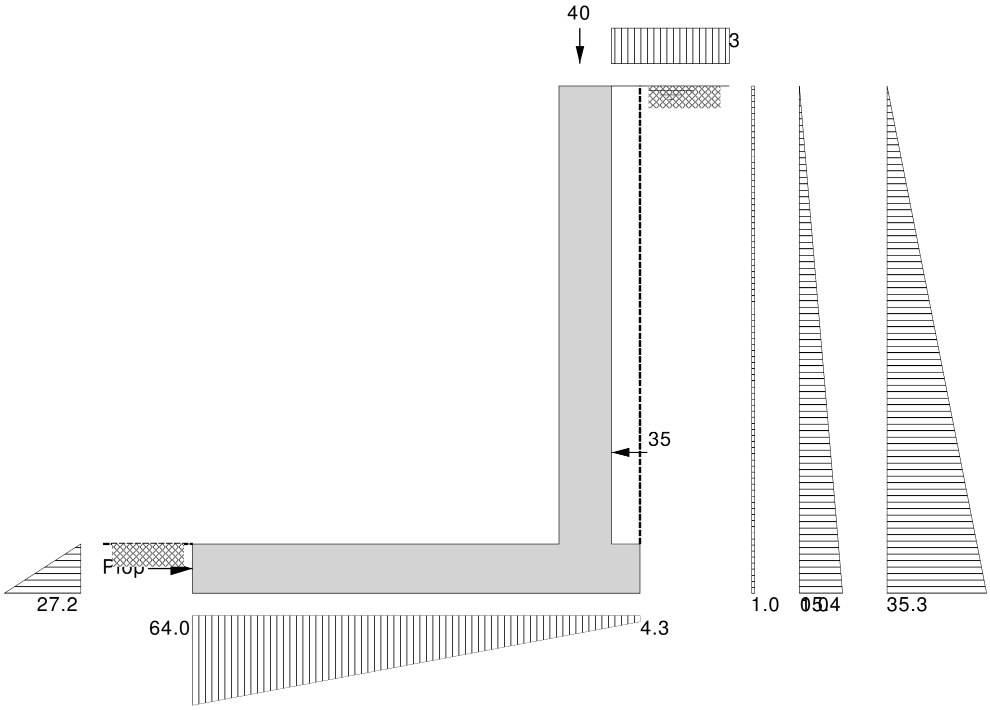
$$K_p = \sin(90 - \phi'_b)^2 / (\sin(90 - \delta_b) \times [1 - \sqrt{(\sin(\phi'_b + \delta_b) \times \sin(\phi'_b) / (\sin(90 + \delta_b)))}]^2) = \mathbf{4.193}$$

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} = **20.0** kN/m
Applied vertical live load on wall	W_{live} = **20.0** kN/m
Position of applied vertical load on wall	l_{load} = **2750** mm
Applied horizontal dead load on wall	F_{dead} = **35.0** kN/m
Applied horizontal live load on wall	F_{live} = **0.0** kN/m
Height of applied horizontal load on wall	h_{load} = **1000** mm



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

Vertical forces on wall

Wall stem $w_{wall} = h_{stem} \times t_{wall} \times \gamma_{wall}$ = **28.8** kN/m

Wall base $w_{base} = l_{base} \times t_{base} \times \gamma_{base}$ = **26.2** kN/m

Surcharge $w_{sur} = Surcharge \times l_{heel}$ = **0.5** kN/m

Saturated backfill $w_s = l_{heel} \times h_{sat} \times \gamma_s$ = **13** kN/m

Applied vertical load $W_v = W_{dead} + W_{live}$ = **40** kN/m

Total vertical load $W_{total} = w_{wall} + w_{base} + w_{sur} + w_s + W_v$ = **108.5** kN/m

Horizontal forces on wall

Surcharge $F_{sur} = K_a \times Surcharge \times h_{eff}$ = **3.8** kN/m

Saturated backfill $F_s = 0.5 \times K_a \times (\gamma_s - \gamma_{water}) \times h_{water}^2$ = **27.6** kN/m

Water $F_{water} = 0.5 \times h_{water}^2 \times \gamma_{water}$ = **63.6** kN/m

Applied horizontal load $F_h = F_{dead} + F_{live}$ = **35** kN/m

Total horizontal load $F_{total} = F_{sur} + F_s + F_{water} + F_h$ = **130** kN/m

Calculate propping force

Passive resistance of soil in front of wall $F_p = 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb}$ = **4.8** kN/m

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

F_{prop} = **89.7** kN/m

Overturning moments

Surcharge $M_{sur} = F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2$ = **6.8** kNm/m

Saturated backfill $M_s = F_s \times (h_{water} - 3 \times d_{ds}) / 3$ = **33.2** kNm/m

Water $M_{water} = F_{water} \times (h_{water} - 3 \times d_{ds}) / 3$ = **76.3** kNm/m

Applied horizontal load $M_{hor} = F_h \times h_{load}$ = **35** kNm/m

Total overturning moment $M_{ot} = M_{sur} + M_s + M_{water} + M_{hor}$ = **151.2** kNm/m

Restoring moments

Wall stem $M_{wall} = w_{wall} \times (l_{toe} + t_{wall} / 2)$ = **80.2** kNm/m

Wall base $M_{base} = w_{base} \times l_{base} / 2$ = **41.6** kNm/m

Saturated backfill $M_{s\_r} = w_s \times (l_{base} - l_{heel} / 2)$ = **40** kNm/m

Design vertical dead load $M_{dead} = W_{dead} \times l_{load}$ = **55** kNm/m

Total restoring moment $M_{rest} = M_{wall} + M_{base} + M_{s\_r} + M_{dead}$ = **216.8** kNm/m

Check bearing pressure

Surcharge $M_{sur\_r} = w_{sur} \times (l_{base} - l_{heel} / 2)$ = **1.5** kNm/m

Design vertical live load $M_{live} = W_{live} \times l_{load}$ = **55** kNm/m

Total moment for bearing $M_{total} = M_{rest} - M_{ot} + M_{sur\_r} + M_{live}$ = **122.1** kNm/m

Total vertical reaction $R = W_{total}$ = **108.5** kN/m

Distance to reaction $x_{bar} = M_{total} / R$ = **1125** mm

Eccentricity of reaction $e = abs((l_{base} / 2) - x_{bar})$ = **462** mm

Reaction acts within middle third of base

Bearing pressure at toe $p_{toe} = (R / l_{base}) + (6 \times R \times e / l_{base}^2)$ = **64** kN/m^2

Bearing pressure at heel $p_{heel} = (R / l_{base}) - (6 \times R \times e / l_{base}^2)$ = **4.3** 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 $w_{wall\_f} = \gamma_{f\_d} \times h_{stem} \times t_{wall} \times \gamma_{wall}$ = **40.3** kN/m

Wall base $w_{base\_f} = \gamma_{f\_d} \times l_{base} \times t_{base} \times \gamma_{base}$ = **36.7** kN/m

Surcharge $w_{sur\_f} = \gamma_{f\_l} \times Surcharge \times l_{heel}$ = **0.8** kN/m

Saturated backfill $w_{s\_f} = \gamma_{f\_d} \times l_{heel} \times h_{sat} \times \gamma_s$ = **18.2** kN/m

Applied vertical load $W_{v\_f} = \gamma_{f\_d} \times W_{dead} + \gamma_{f\_l} \times W_{live}$ = **60** kN/m

Total vertical load $W_{total\_f} = w_{wall\_f} + w_{base\_f} + w_{sur\_f} + w_{s\_f} + W_{v\_f}$ = **156** kN/m

Factored horizontal at-rest forces on wall

Surcharge $F_{sur\_f} = \gamma_{f\_l} \times K_0 \times Surcharge \times h_{eff}$ = **8.5** kN/m

Saturated backfill $F_{s\_f} = \gamma_{f\_e} \times 0.5 \times K_0 \times (\gamma_s - \gamma_{water}) \times h_{water}^2$ = **54.5** kN/m

Water $F_{water\_f} = \gamma_{f\_e} \times 0.5 \times h_{water}^2 \times \gamma_{water}$ = **89** kN/m

Applied horizontal load $F_{h\_f} = \gamma_{f\_e} \times F_{dead} + \gamma_{f\_l} \times F_{live}$ = **49** kN/m

Total horizontal load $F_{total\_f} = F_{sur\_f} + F_{s\_f} + F_{water\_f} + F_{h\_f}$ = **201** kN/m

Calculate propping force

Passive resistance of soil in front of wall $F_{p\_f} = \gamma_{f\_e} \times 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb}$ = **6.7** kN/m

Propping force $F_{prop\_f} = \max(F_{total\_f} - F_{p\_f} - (W_{total\_f} - w_{sur\_f} - \gamma_{f\_l} \times W_{live}) \times \tan(\delta_b), 0\ kN/m)$

F_{prop_f} = **144.6** kN/m

Factored overturning moments

Surcharge $M_{sur\_f} = F_{sur\_f} \times (h_{eff} - 2 \times d_{ds}) / 2$ = **15.3** kNm/m

Saturated backfill $M_{s\_f} = F_{s\_f} \times (h_{water} - 3 \times d_{ds}) / 3$ = **65.5** kNm/m

Water $M_{water\_f} = F_{water\_f} \times (h_{water} - 3 \times d_{ds}) / 3$ = **106.8** kNm/m

Applied horizontal load $M_{hor\_f} = F_{h\_f} \times h_{load}$ = **49** kNm/m

Total overturning moment $M_{ot\_f} = M_{sur\_f} + M_{s\_f} + M_{water\_f} + M_{hor\_f}$ = **236.5** kNm/m

Restoring moments

Wall stem $M_{wall\_f} = w_{wall\_f} \times (l_{toe} + t_{wall} / 2)$ = **112.2** kNm/m

Wall base $M_{base\_f} = w_{base\_f} \times l_{base} / 2$ = **58.3** kNm/m

Surcharge $M_{sur\_r\_f} = w_{sur\_f} \times (l_{base} - l_{heel} / 2)$ = **2.5** kNm/m

Saturated backfill $M_{s\_r\_f} = w_{s\_f} \times (l_{base} - l_{heel} / 2)$ = **56** kNm/m

Design vertical load $M_{v\_f} = W_{v\_f} \times l_{load}$ = **165** kNm/m

Total restoring moment $M_{rest\_f} = M_{wall\_f} + M_{base\_f} + M_{sur\_r\_f} + M_{s\_r\_f} + M_{v\_f}$ = **394** kNm/m

Factored bearing pressure

Total moment for bearing $M_{total\_f} = M_{rest\_f} - M_{ot\_f}$ = **157.4** kNm/m

Total vertical reaction $R_f = W_{total\_f}$ = **156.0** kN/m

Distance to reaction $x_{bar\_f} = M_{total\_f} / R_f$ = **1009** mm

Eccentricity of reaction $e_f = abs((l_{base} / 2) - x_{bar\_f})$ = **578** mm

Reaction acts outside middle third of base

Bearing pressure at toe $p_{toe\_f} = R_f / (1.5 \times x_{bar\_f})$ = **103** kN/m^2

Bearing pressure at heel — p_{heel_f} = 0 kN/m^2 = **0** kN/m^2

Rate of change of base reaction — rate = p_{toe_f} / (3 × x_{bar_f}) = **34.04** kN/m^2/m

Bearing pressure at stem / toe — $p_{stem\_toe\_f}$ = max(p_{toe_f} - (rate × l_{toe}), 0 kN/m^2) = **14.5** kN/m^2

Bearing pressure at mid stem — $p_{stem\_mid\_f}$ = max(p_{toe_f} - (rate × (l_{toe} + t_{wall} / 2)), 0 kN/m^2) = **8.2** kN/m^2

Bearing pressure at stem / heel — $p_{stem\_heel\_f}$ = max(p_{toe_f} - (rate × (l_{toe} + t_{wall})), 0 kN/m^2) = **1.8** kN/m^2

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

Material properties

Characteristic strength of concrete — f_{cu} = **35** 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 toe — c_{toe} = **45** mm

Calculate shear for toe design

Shear from bearing pressure — V_{toe_bear} = (p_{toe_f} + $p_{stem\_toe\_f}$) × l_{toe} / 2 = **152.9** kN/m

Shear from weight of base — $V_{toe\_wt\_base}$ = γ_{f_d} × γ_{base} × l_{toe} × t_{base} = **30.1** kN/m

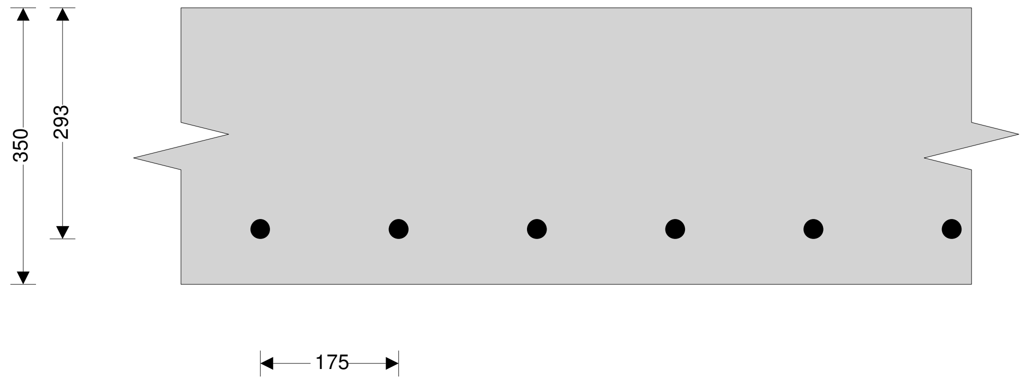
Total shear for toe design — V_{toe} = V_{toe_bear} - $V_{toe\_wt\_base}$ = **122.8** kN/m

Calculate moment for toe design

Moment from bearing pressure — M_{toe_bear} = (2 × p_{toe_f} + $p_{stem\_mid\_f}$) × (l_{toe} + t_{wall} / 2)^2 / 6 = **277.5** kNm/m

Moment from weight of base — $M_{toe\_wt\_base}$ = (γ_{f_d} × γ_{base} × t_{base} × (l_{toe} + t_{wall} / 2)^2 / 2) = **44.9** kNm/m

Total moment for toe design — M_{toe} = M_{toe_bear} - $M_{toe\_wt\_base}$ = **232.5** kNm/m



Check toe in bending

Width of toe — b = **1000** mm/m

Depth of reinforcement — d_{toe} = t_{base} – c_{toe} – (ϕ_{toe} / 2) = **292.5** mm

Constant — K_{toe} = M_{toe} / (b × d_{toe}^2 × f_{cu}) = **0.078**

Compression reinforcement is not required

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

z_{toe} = **265** mm

Area of tension reinforcement required — As_{toe_des} = M_{toe} / (0.87 × f_y × z_{toe}) = **2020** mm^2/m

Minimum area of tension reinforcement — As_{toe_min} = k × b × t_{base} = **455** mm^2/m

Area of tension reinforcement required — As_{toe_req} = Max(As_{toe_des}, As_{toe_min}) = **2020** mm^2/m

Reinforcement provided — **25 mm dia.bars @ 175 mm centres**

Area of reinforcement provided — As_{toe_prov} = **2805** mm^2/m

PASS - Reinforcement provided at the retaining wall toe is adequate

Check shear resistance at toe

Design shear stress $v_{toe} = V_{toe} / (b \times d_{toe}) =$ **0.420** N/mm^2

Allowable shear stress $v_{adm} = \min(0.8 \times \sqrt{(f_{cu} / 1\ N/mm^2)}, 5) \times 1\ N/mm^2 =$ **4.733** 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 $v_{c\_toe} =$ **0.754** N/mm^2

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

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

Material properties

Characteristic strength of concrete $f_{cu} =$ **35** 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 heel $c_{heel} =$ **40** mm

Calculate shear for heel design

Shear from bearing pressure $V_{heel\_bear} = p_{stem\_heel\_f} \times ((3 \times x_{bar\_f}) - l_{toe} - t_{wall}) / 2 =$ **0** kN/m

Shear from weight of base $V_{heel\_wt\_base} = \gamma_{f\_d} \times \gamma_{base} \times l_{heel} \times t_{base} =$ **2.3** kN/m

Shear from weight of saturated backfill $V_{heel\_wt\_s} = w_{s\_f} =$ **18.2** kN/m

Shear from surcharge $V_{heel\_sur} = w_{sur\_f} =$ **0.8** kN/m

Total shear for heel design $V_{heel} = - V_{heel\_bear} + V_{heel\_wt\_base} + V_{heel\_wt\_s} + V_{heel\_sur} =$ **21.3** kN/m

Calculate moment for heel design

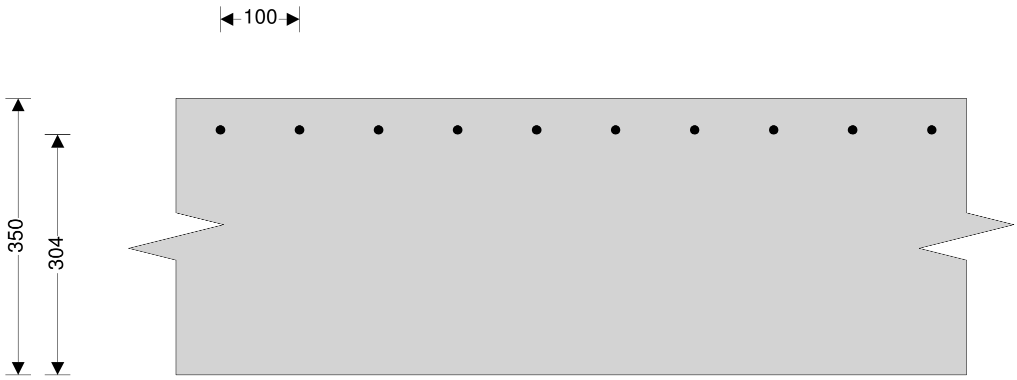
Moment from bearing pressure $M_{heel\_bear} = p_{stem\_mid\_f} \times ((3 \times x_{bar\_f}) - l_{toe} - t_{wall} / 2)^2 / 6 =$ **0.1** kNm/m

Moment from weight of base $M_{heel\_wt\_base} = (\gamma_{f\_d} \times \gamma_{base} \times t_{base} \times (l_{heel} + t_{wall} / 2)^2 / 2) =$ **0.9** kNm/m

Moment from weight of saturated backfill $M_{heel\_wt\_s} = w_{s\_f} \times (l_{heel} + t_{wall}) / 2 =$ **5.2** kNm/m

Moment from surcharge $M_{heel\_sur} = w_{sur\_f} \times (l_{heel} + t_{wall}) / 2 =$ **0.2** kNm/m

Total moment for heel design $M_{heel} = - M_{heel\_bear} + M_{heel\_wt\_base} + M_{heel\_wt\_s} + M_{heel\_sur} =$ **6.3** kNm/m



Check heel in bending

Width of heel $b =$ **1000** mm/m

Depth of reinforcement $d_{heel} = t_{base} - c_{heel} - (\phi_{heel} / 2) =$ **304.0** mm

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

Compression reinforcement is not required

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

$z_{heel} =$ **289** mm

Area of tension reinforcement required $A_{s\_heel\_des} = M_{heel} / (0.87 \times f_y \times z_{heel}) =$ **50** mm^2/m

Minimum area of tension reinforcement $A_{s\_heel\_min} = k \times b \times t_{base} = \mathbf{455}$ mm²/m

Area of tension reinforcement required $A_{s\_heel\_req} = Max(A_{s\_heel\_des}, A_{s\_heel\_min}) = \mathbf{455}$ mm²/m

Reinforcement provided **12 mm dia.bars @ 100 mm centres**

Area of reinforcement provided $A_{s\_heel\_prov} = \mathbf{1131}$ mm²/m

PASS - Reinforcement provided at the retaining wall heel is adequate

Check shear resistance at heel

Design shear stress $v_{heel} = V_{heel} / (b \times d_{heel}) = \mathbf{0.070}$ N/mm²

Allowable shear stress $v_{adm} = min(0.8 \times \sqrt{(f_{cu} / 1\ N/mm^2)}, 5) \times 1\ N/mm^2 = \mathbf{4.733}$ N/mm²

PASS - Design shear stress is less than maximum shear stress

From BS8110:Part 1:1997 – Table 3.8

Design concrete shear stress $v_{c\_heel} = \mathbf{0.545}$ N/mm²

$v_{heel} < v_{c\_heel}$ - No shear reinforcement required

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

Material properties

Characteristic strength of concrete $f_{cu} = \mathbf{35}$ N/mm²

Characteristic strength of reinforcement $f_y = \mathbf{500}$ N/mm²

Wall details

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

Cover to reinforcement in stem $c_{stem} = \mathbf{45}$ mm

Cover to reinforcement in wall $c_{wall} = \mathbf{45}$ mm

Factored horizontal at-rest forces on stem

Surcharge $F_{s\_sur\_f} = \gamma_{f\_l} \times K_0 \times Surcharge \times (h_{eff} - t_{base} - d_{ds}) = \mathbf{7.7}$ kN/m

Saturated backfill $F_{s\_s\_f} = 0.5 \times \gamma_{f\_e} \times K_0 \times (\gamma_s - \gamma_{water}) \times h_{sat}^2 = \mathbf{44.5}$ kN/m

Water $F_{s\_water\_f} = 0.5 \times \gamma_{f\_e} \times \gamma_{water} \times h_{sat}^2 = \mathbf{72.5}$ kN/m

Applied horizontal load $F_{s\_h\_f} = \gamma_{f\_d} \times F_{dead} + \gamma_{f\_l} \times F_{live} = \mathbf{49}$ kN/m

Calculate shear for stem design

Shear at base of stem $V_{stem} = F_{s\_sur\_f} + F_{s\_s\_f} + F_{s\_water\_f} + F_{s\_h\_f} - F_{prop\_f} = \mathbf{29.1}$ kN/m

Calculate moment for stem design

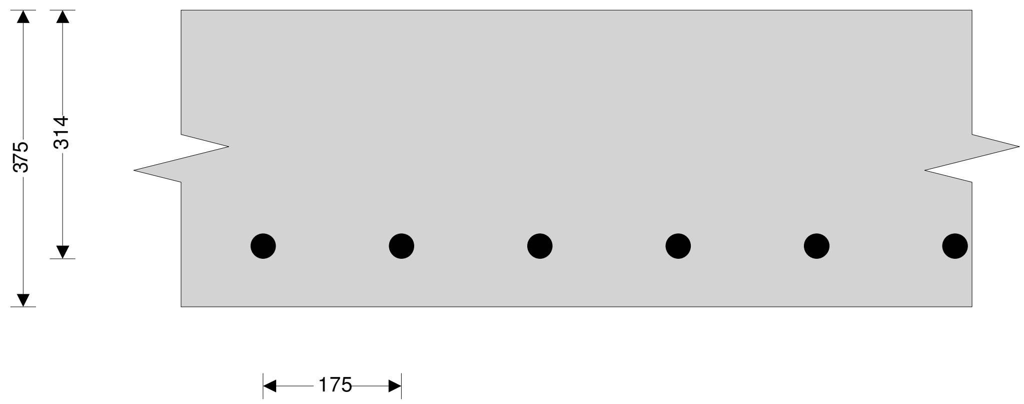
Surcharge $M_{s\_sur} = F_{s\_sur\_f} \times (h_{stem} + t_{base}) / 2 = \mathbf{13.8}$ kNm/m

Saturated backfill $M_{s\_s} = F_{s\_s\_f} \times h_{sat} / 3 = \mathbf{48.2}$ kNm/m

Water $M_{s\_water} = F_{s\_water\_f} \times h_{sat} / 3 = \mathbf{78.6}$ kNm/m

Applied horizontal load $M_{s\_hor} = F_{s\_h\_f} \times (h_{load} - t_{base} / 2) = \mathbf{40.4}$ kNm/m

Total moment for stem design $M_{stem} = M_{s\_sur} + M_{s\_s} + M_{s\_water} + M_{s\_hor} = \mathbf{181}$ kNm/m



Check wall stem in bending

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

Depth of reinforcement — $d_{stem} = t_{wall} - c_{stem} - (\phi_{stem} / 2)$ = **314.0** mm

Constant — $K_{stem} = M_{stem} / (b \times d_{stem}^2 \times f_{cu})$ = **0.052**

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} = **294** mm

Area of tension reinforcement required — $A_{s\_stem\_des} = M_{stem} / (0.87 \times f_y \times z_{stem})$ = **1413** mm²/m

Minimum area of tension reinforcement — $A_{s\_stem\_min} = k \times b \times t_{wall}$ = **488** mm²/m

Area of tension reinforcement required — $A_{s\_stem\_req} = \mathrm{Max}(A_{s\_stem\_des}, A_{s\_stem\_min})$ = **1413** mm²/m

Reinforcement provided — **32 mm dia.bars @ 175 mm centres**

Area of reinforcement provided — $A_{s\_stem\_prov}$ = **4596** mm²/m

PASS - Reinforcement provided at the retaining wall stem is adequate

Check shear resistance at wall stem

Design shear stress — $v_{stem} = V_{stem} / (b \times d_{stem})$ = **0.093** N/mm²

Allowable shear stress — $v_{adm} = \min(0.8 \times \sqrt{(f_{cu} / 1\ \mathrm{N/mm^2})}, 5) \times 1\ \mathrm{N/mm^2}$ = **4.733** N/mm²

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} = **0.853** N/mm²

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

Check retaining wall deflection

Basic span/effective depth ratio — $ratio_{bas}$ = **7**

Design service stress — $f_s = 2 \times f_y \times A_{s\_stem\_req} / (3 \times A_{s\_stem\_prov})$ = **102.5** N/mm²

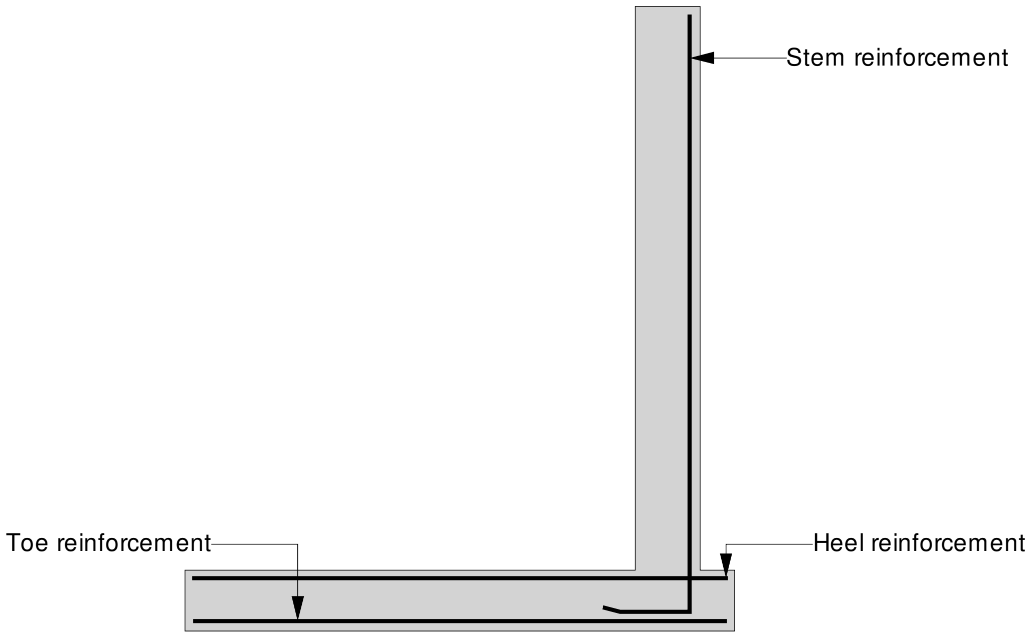
Modification factor — $factor_{tens} = \min(0.55 + (477\ \mathrm{N/mm^2} - f_s)/(120 \times (0.9\ \mathrm{N/mm^2} + (M_{stem}/(b \times d_{stem}^2)))),2)$ = **1.69**

Maximum span/effective depth ratio — $ratio_{max} = ratio_{bas} \times factor_{tens}$ = **11.84**

Actual span/effective depth ratio — $ratio_{act} = h_{stem} / d_{stem}$ = **10.35**

PASS - Span to depth ratio is acceptable

Indicative retaining wall reinforcement diagram



Toe bars - 25 mm dia.@ 175 mm centres - (2805 mm^2/m)
Heel bars - 12 mm dia.@ 100 mm centres - (1131 mm^2/m)
Stem bars - 32 mm dia.@ 175 mm centres - (4596 mm^2/m)