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Sheet no. 1	Rev. A
Prepared by: **BD**	Date: **OCT '18**
Checked by: **MP**	Date: **OCT '18**
Title of Scheme: **ORCHARD COURT – RETAINING WALL**	Job no: **A3174**

STRUCTURAL CALCULATIONS
FOR THE
PERMANENT RETAINING WALL FOR
ORCHARD COURT,
LEEK,
ST13 8LA

PREPARED IN ACCORDANCE WITH THE RELEVANT PARTS OF THE FOLLOWING CODES OF PRACTICE:-

DMRB BD 37/01 LOADS FOR HIGHWAY BRIDGES

BS 8002:1994 EARTH RETAINING STRUCTURES

DATE: OCT 2018

REF: A3174 Rev A

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BRIEF

The calculations are for the design of a permanent retaining wall to Orchard Court, Leek. We have been informed by the contractor that it is the intention to position the wall on the taper with one end 6m away from the boundary with a maximum height at the boundary of 5m and the other end 4.5m away with a maximum height of 4m. It is proposed to bank the ground at 33 degrees from the site boundary to give a maximum height retained of 1.275m.

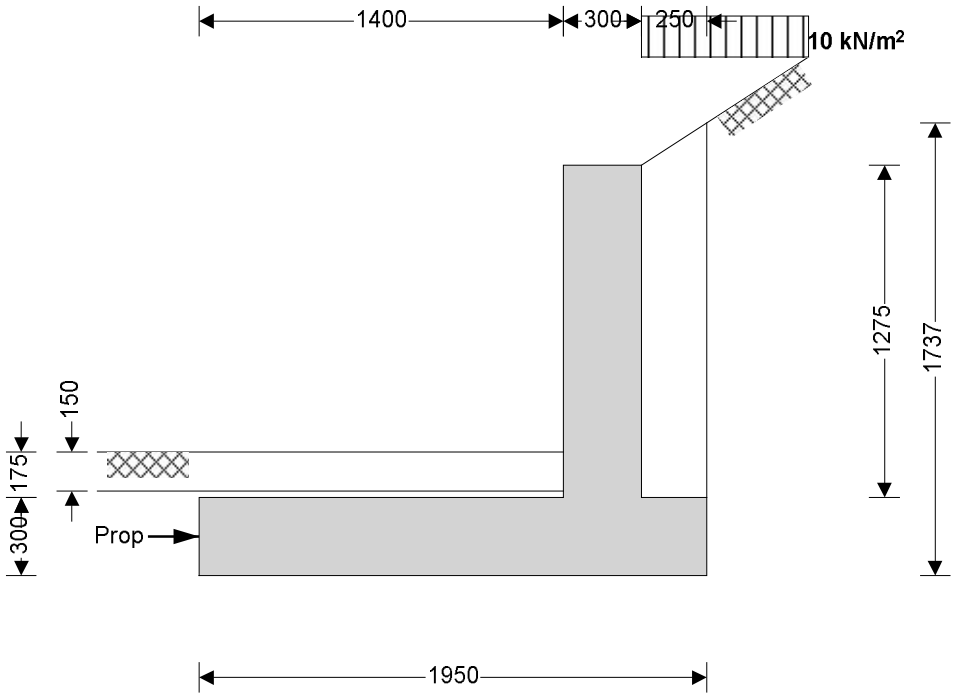
The retaining wall has been designed with the base propped by the ground floor of the dwelling.

CONSIDER 1.275M HIGH RETAINING WALL

Applied vertical load from dwelling construction ignored from this calculation to take account of construction stage.

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} = **1275** mm
Thickness of wall stem	t_{wall} = **300** mm
Length of toe	l_{toe} = **1400** mm
Length of heel	l_{heel} = **250** mm
Overall length of base	$l_{base} = l_{toe} + l_{heel} + t_{wall}$ = **1950** mm
Thickness of base	t_{base} = **300** mm
Depth of downstand	d_{ds} = **0** mm
Position of downstand	l_{ds} = **300** mm
Thickness of downstand	t_{ds} = **300** mm
Height of retaining wall	$h_{wall} = h_{stem} + t_{base} + d_{ds}$ = **1575** mm
Depth of cover in front of wall	d_{cover} = **175** mm
Depth of unplanned excavation	d_{exc} = **150** 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	$\gamma_{wall} =$ **23.6** kN/m^3
Density of base construction	$\gamma_{base} =$ **23.6** kN/m^3
Angle of rear face of wall	$\alpha =$ **90.0** deg
Angle of soil surface behind wall	$\beta =$ **33.0** deg
Effective height at virtual back of wall	$h_{eff} = h_{wall} + l_{heel} \times \tan(\beta) =$ **1737** mm

Retained material details

Mobilisation factor	M = **1.5**
Moist density of retained material	$\gamma_m =$ **21.0** kN/m^3
Saturated density of retained material	$\gamma_s =$ **23.0** kN/m^3
Design shear strength	$\phi' =$ **33.0** deg
Angle of wall friction	$\delta =$ **26.0** deg

Base material details

Moist density	$\gamma_{mb} =$ **17.5** kN/m^3
Design shear strength	$\phi'_b =$ **30.1** deg
Design base friction	$\delta_b =$ **23.5** deg
Allowable bearing pressure	$P_{bearing} =$ **250** kN/m^2

Using Coulomb theory

Active pressure coefficient for retained material

$$K_a = \sin(\alpha + \phi')^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta) \times [1 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta) / (\sin(\alpha - \delta) \times \sin(\alpha + \beta)))}]^2) = \mathbf{0.783}$$

Passive pressure coefficient for base material

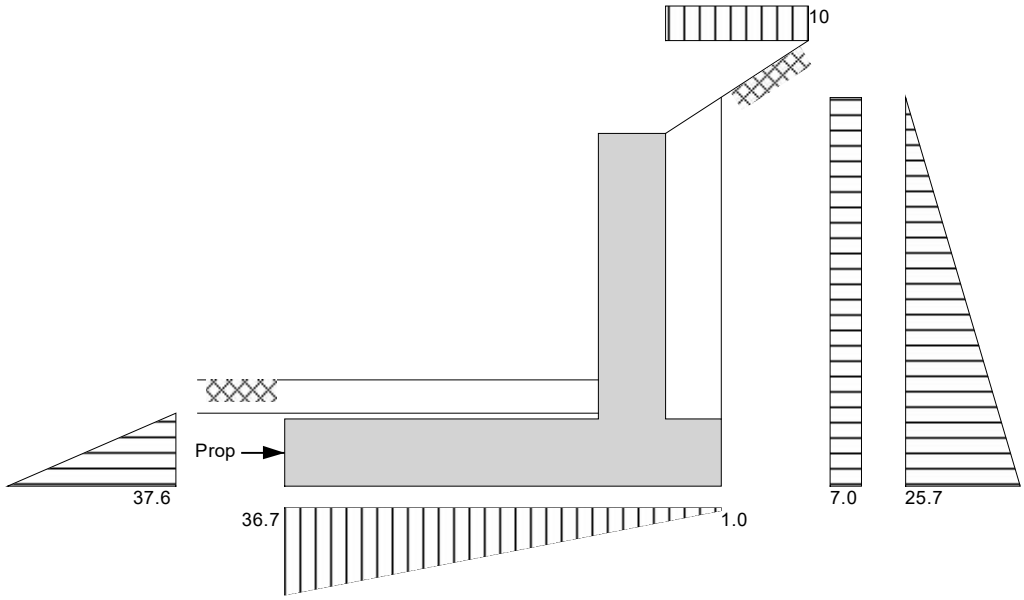
$$K_p = \sin(90 - \phi'_b)^2 / (\sin(90 - \delta_b) \times [1 - \sqrt{(\sin(\phi'_b + \delta_b) \times \sin(\phi'_b) / (\sin(90 + \delta_b)))}]^2) = \mathbf{7.206}$$

At-rest pressure

At-rest pressure for retained material	$K_0 = 1 - \sin(\phi') =$ **0.455**

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	$w_{wall} = h_{stem} \times t_{wall} \times \gamma_{wall}$ = **9** kN/m
Wall base	$w_{base} = l_{base} \times t_{base} \times \gamma_{base}$ = **13.8** kN/m
Surcharge	w_{sur} = Surcharge $\times$ l_{heel} = **2.5** kN/m
Moist backfill to top of wall	$w_{m_w} = l_{heel} \times (h_{stem} - h_{sat}) \times \gamma_m$ = **6.7** kN/m
Moist backfill above top of wall	$w_{m_s} = 0.5 \times l_{heel}^2 \times \tan(\beta) \times \gamma_m$ = **0.4** kN/m
Soil in front of wall	$w_p = l_{toe} \times d_{cover} \times \gamma_{mb}$ = **4.3** kN/m
Total vertical load	$W_{total} = w_{wall} + w_{base} + w_{sur} + w_{m_w} + w_{m_s} + w_p$ = **36.7** kN/m

Horizontal forces on wall

Surcharge	$F_{sur} = K_a \times \cos(90 - \alpha + \delta) \times$ Surcharge $\times h_{eff}$ = **12.2** kN/m
Moist backfill above water table	$F_{m_a} = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water})^2$ = **22.3** kN/m
Total horizontal load	$F_{total} = F_{sur} + F_{m_a}$ = **34.5** kN/m

Calculate propping force

Passive resistance of soil in front of wall	$F_p = 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb}$ = **6.1** kN/m
Propping force	$F_{prop} = \max(F_{total} - F_p - (W_{total} - w_{sur} - w_p) \times \tan(\delta_b), 0$ kN/m)
	F_{prop} = **15.4** kN/m

Overturning moments

Surcharge	$M_{sur} = F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2$ = **10.6** kNm/m
Moist backfill above water table	$M_{m_a} = F_{m_a} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3$ = **12.9** kNm/m
Total overturning moment	$M_{ot} = M_{sur} + M_{m_a}$ = **23.5** kNm/m

Restoring moments

Wall stem	$M_{wall} = w_{wall} \times (l_{toe} + t_{wall} / 2)$ = **14** kNm/m
Wall base	$M_{base} = w_{base} \times l_{base} / 2$ = **13.5** kNm/m

Moist backfill	$M_{m_r} = (w_{m_w} \times (l_{base} - l_{heel} / 2) + w_{m_s} \times (l_{base} - l_{heel} / 3)) =$ **13** kNm/m
Total restoring moment	$M_{rest} = M_{wall} + M_{base} + M_{m_r} =$ **40.5** kNm/m
Check bearing pressure	
Surcharge	$M_{sur_r} = w_{sur} \times (l_{base} - l_{heel} / 2) =$ **4.6** kNm/m
Soil in front of wall	$M_{p_r} = w_p \times l_{toe} / 2 =$ **3** kNm/m
Total moment for bearing	$M_{total} = M_{rest} - M_{ot} + M_{sur_r} + M_{p_r} =$ **24.5** kNm/m
Total vertical reaction	$R = W_{total} =$ **36.7** kN/m
Distance to reaction	$x_{bar} = M_{total} / R =$ **667** mm
Eccentricity of reaction	$e = abs((l_{base} / 2) - x_{bar}) =$ **308** mm
	Reaction acts within middle third of base
Bearing pressure at toe	$p_{toe} = (R / l_{base}) + (6 \times R \times e / l_{base}^2) =$ **36.7** kN/m^2
Bearing pressure at heel	$p_{heel} = (R / l_{base}) - (6 \times R \times e / l_{base}^2) =$ **1** kN/m^2
	PASS - Maximum bearing pressure is less than allowable bearing pressure

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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 $w_{wall_f} = \gamma_{f_d} \times h_{stem} \times t_{wall} \times \gamma_{wall}$ = **12.6** kN/m

Wall base $w_{base_f} = \gamma_{f_d} \times l_{base} \times t_{base} \times \gamma_{base}$ = **19.3** kN/m

Surcharge $w_{sur_f} = \gamma_{f_l} \times \text{Surcharge} \times l_{heel}$ = **4** kN/m

Moist backfill to top of wall $w_{m_w_f} = \gamma_{f_d} \times l_{heel} \times (h_{stem} - h_{sat}) \times \gamma_m$ = **9.4** kN/m

Moist backfill above top of wall $w_{m_s_f} = \gamma_{f_d} \times 0.5 \times l_{heel}^2 \times \tan(\beta) \times \gamma_m$ = **0.6** kN/m

Soil in front of wall $w_{p_f} = \gamma_{f_d} \times l_{toe} \times d_{cover} \times \gamma_{mb}$ = **6** kN/m

Total vertical load $W_{total_f} = w_{wall_f} + w_{base_f} + w_{sur_f} + w_{m_w_f} + w_{m_s_f} + w_{p_f}$ = **51.9** kN/m

Factored horizontal active forces on wall

Surcharge $F_{sur_f} = \gamma_{f_l} \times K_a \times \cos(90 - \alpha + \delta) \times \text{Surcharge} \times h_{eff}$ = **19.6** kN/m

Moist backfill above water table $F_{m_a_f} = \gamma_{f_e} \times 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water})^2$ = **31.2** kN/m

Total horizontal load $F_{total_f} = F_{sur_f} + F_{m_a_f}$ = **50.8** kN/m

Calculate propping force

Passive resistance of soil in front of wall $F_{p_f} = \gamma_{f_e} \times 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb}$ = **8.6** kN/m

Propping force $F_{prop_f} = \max(F_{total_f} - F_{p_f} - (W_{total_f} - w_{sur_f} - w_{p_f}) \times \tan(\delta_b), 0 \text{ kN/m})$

F_{prop_f} = **24.0** kN/m

Factored overturning moments

Surcharge $M_{sur_f} = F_{sur_f} \times (h_{eff} - 2 \times d_{ds}) / 2$ = **17** kNm/m

Moist backfill above water table $M_{m_a_f} = F_{m_a_f} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3$ = **18.1** kNm/m

Total overturning moment $M_{ot_f} = M_{sur_f} + M_{m_a_f}$ = **35.1** kNm/m

Restoring moments

Wall stem $M_{wall_f} = w_{wall_f} \times (l_{toe} + t_{wall} / 2)$ = **19.6** kNm/m

Wall base $M_{base_f} = w_{base_f} \times l_{base} / 2$ = **18.8** kNm/m

Surcharge $M_{sur_r_f} = w_{sur_f} \times (l_{base} - l_{heel} / 2)$ = **7.3** kNm/m

Moist backfill $M_{m_r_f} = (w_{m_w_f} \times (l_{base} - l_{heel} / 2) + w_{m_s_f} \times (l_{base} - l_{heel} / 3))$ = **18.2** kNm/m

Soil in front of wall $M_{p_r_f} = w_{p_f} \times l_{toe} / 2$ = **4.2** kNm/m

Total restoring moment $M_{rest_f} = M_{wall_f} + M_{base_f} + M_{sur_r_f} + M_{m_r_f} + M_{p_r_f}$ = **68.2** kNm/m

Factored bearing pressure

Total moment for bearing $M_{total_f} = M_{rest_f} - M_{ot_f}$ = **33.1** kNm/m

Total vertical reaction $R_f = W_{total_f}$ = **51.9** kN/m

Distance to reaction $x_{bar_f} = M_{total_f} / R_f$ = **637** mm

Eccentricity of reaction $e_f = \text{abs}((l_{base} / 2) - x_{bar_f})$ = **338** mm

Reaction acts outside middle third of base

Bearing pressure at toe $p_{toe_f} = R_f / (1.5 \times x_{bar_f})$ = **54.3** 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}) = **28.43** 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) = **10.3** 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) = **6** 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

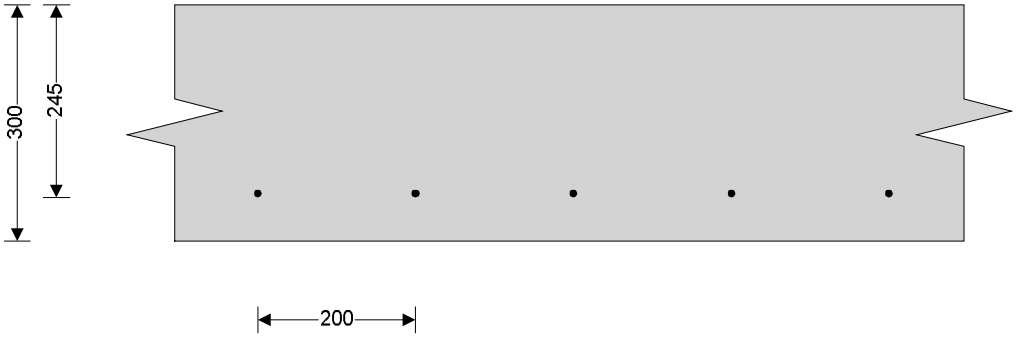
Minimum area of reinforcement	k = **0.13** %
Cover to reinforcement in toe	c_{toe} = **50** mm

Calculate shear for toe design

Shear from bearing pressure	V_{toe_bear} = (p_{toe_f} + $p_{stem_toe_f}$) × l_{toe} / 2 = **48.2** kN/m
Shear from weight of base	$V_{toe_wt_base}$ = γ_{f_d} × γ_{base} × l_{toe} × t_{base} = **13.9** kN/m
Total shear for toe design	V_{toe} = V_{toe_bear} - $V_{toe_wt_base}$ = **34.3** 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 = **47.6** 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) = **11.9** kNm/m
Total moment for toe design	M_{toe} = M_{toe_bear} - $M_{toe_wt_base}$ = **35.7** 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) = **245.0** mm
Constant	K_{toe} = M_{toe} / (b × d_{toe}^2 × f_{cu}) = **0.017**
	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} = **233** mm
Area of tension reinforcement required	$A_{s_toe_des}$ = M_{toe} / (0.87 × f_y × z_{toe}) = **353** mm^2/m
Minimum area of tension reinforcement	$A_{s_toe_min}$ = k × b × t_{base} = **390** mm^2/m
Area of tension reinforcement required	$A_{s_toe_req}$ = Max($A_{s_toe_des}$, $A_{s_toe_min}$) = **390** mm^2/m
Reinforcement provided	**A393 mesh**

Area of reinforcement provided — $A_{s_toe_prov}$ = **393** mm²/m

PASS - Reinforcement provided at the retaining wall toe is adequate

Check shear resistance at toe

Design shear stress — $v_{toe} = V_{toe} / (b \times d_{toe})$ = **0.140** N/mm²

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/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_toe} = **0.434** N/mm²

$v_{toe} < v_{c_toe}$ - No shear reinforcement required

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

Material properties

Characteristic strength of concrete — f_{cu} = **35** N/mm²

Characteristic strength of reinforcement — f_y = **500** N/mm²

Base details

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

Cover to reinforcement in heel — c_{heel} = **50** mm

Calculate shear for heel design

Shear from bearing pressure — $V_{heel_bear} = p_{stem_heel_f} \times ((3 \times x_{bar_f}) - l_{toe} - t_{wall}) / 2$ = **0.6** kN/m

Shear from weight of base — $V_{heel_wt_base} = \gamma_{f_d} \times \gamma_{base} \times l_{heel} \times t_{base}$ = **2.5** kN/m

Shear from weight of moist backfill — $V_{heel_wt_m} = w_{m_w_f} + w_{m_s_f}$ = **10** kN/m

Shear from surcharge — $V_{heel_sur} = w_{sur_f}$ = **4** kN/m

Total shear for heel design — $V_{heel} = -V_{heel_bear} + V_{heel_wt_base} + V_{heel_wt_m} + V_{heel_sur}$ = **15.8** kN/m

Calculate moment for heel design

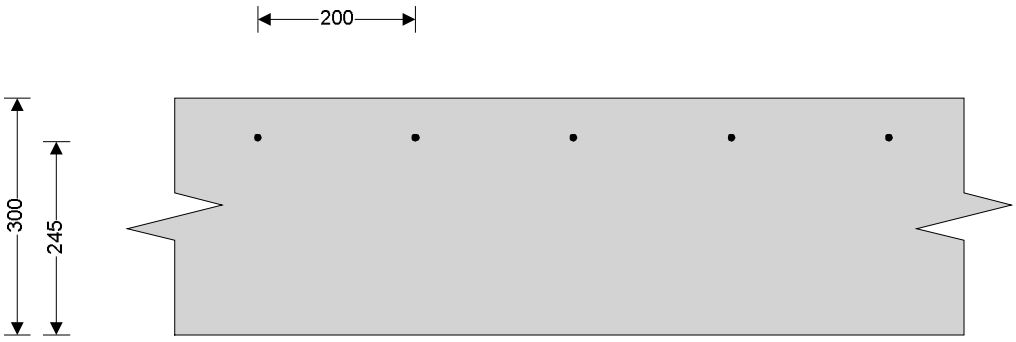
Moment from bearing pressure — $M_{heel_bear} = p_{stem_mid_f} \times ((3 \times x_{bar_f}) - l_{toe} - t_{wall} / 2)^2 / 6$ = **0.2** kNm/m

Moment from weight of base — $M_{heel_wt_base} = (\gamma_{f_d} \times \gamma_{base} \times t_{base} \times (l_{heel} + t_{wall} / 2)^2 / 2)$ = **0.8** kNm/m

Moment from weight of moist backfill — $M_{heel_wt_m} = w_{m_w_f} \times (l_{heel} + t_{wall}) / 2 + w_{m_s_f} \times (2 \times l_{heel} / 3 + t_{wall} / 2)$ = **2.8** kNm/m

Moment from surcharge — $M_{heel_sur} = w_{sur_f} \times (l_{heel} + t_{wall}) / 2$ = **1.1** kNm/m

Total moment for heel design — $M_{heel} = -M_{heel_bear} + M_{heel_wt_base} + M_{heel_wt_m} + M_{heel_sur}$ = **4.4** kNm/m



Check heel in bending

Width of heel — b = **1000** mm/m

Depth of reinforcement — $d_{heel} = t_{base} - c_{heel} - (\phi_{heel} / 2)$ = **245.0** 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} = **233** mm
Area of tension reinforcement required	$A_{s_heel_des} = M_{heel} / (0.87 \times f_y \times z_{heel})$ = **44** mm²/m
Minimum area of tension reinforcement	$A_{s_heel_min} = k \times b \times t_{base}$ = **390** mm²/m
Area of tension reinforcement required	$A_{s_heel_req} = \max(A_{s_heel_des}, A_{s_heel_min})$ = **390** mm²/m
Reinforcement provided	**A393 mesh**
Area of reinforcement provided	$A_{s_heel_prov}$ = **393** mm²/m
	PASS - Reinforcement provided at the retaining wall heel is adequate

Check shear resistance at heel

Design shear stress	$v_{heel} = V_{heel} / (b \times d_{heel})$ = **0.065** N/mm²
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/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} = **0.434** 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} = **35** N/mm²
Characteristic strength of reinforcement	f_y = **500** N/mm²

Wall details

Minimum area of reinforcement	k = **0.13** %
Cover to reinforcement in stem	c_{stem} = **50** mm
Cover to reinforcement in wall	c_{wall} = **50** mm

Factored horizontal active forces on stem

Surcharge	$F_{s_sur_f} = \gamma_{f_l} \times K_a \times \cos(90 - \alpha + \delta) \times$ Surcharge $\times (h_{eff} - t_{base} - d_{ds})$ = **16.2** kN/m
Moist backfill above water table	$F_{s_m_a_f} = 0.5 \times \gamma_{f_e} \times K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - t_{base} - d_{ds} - h_{sat})^2$ = **21.4** kN/m

Calculate shear for stem design

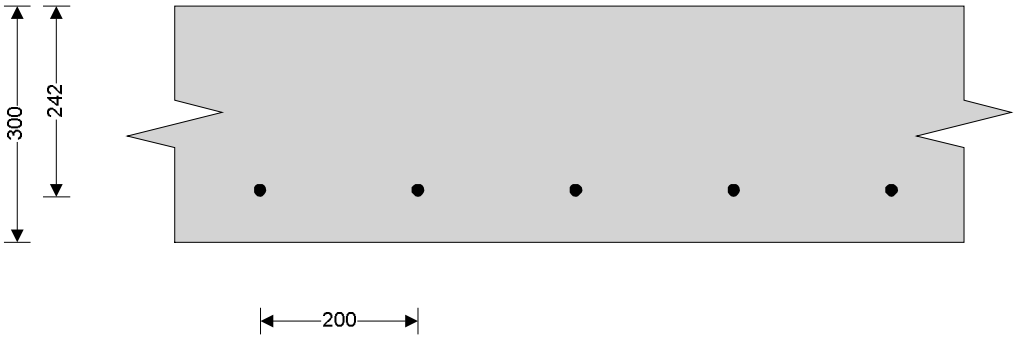
Shear at base of stem	$V_{stem} = F_{s_sur_f} + F_{s_m_a_f} - F_{prop_f}$ = **13.6** kN/m

Calculate moment for stem design

Surcharge	$M_{s_sur} = F_{s_sur_f} \times (h_{stem} + t_{base}) / 2$ = **12.7** kNm/m
Moist backfill above water table	$M_{s_m_a} = F_{s_m_a_f} \times (2 \times h_{sat} + h_{eff} - d_{ds} + t_{base} / 2) / 3$ = **13.4** kNm/m
Total moment for stem design	$M_{stem} = M_{s_sur} + M_{s_m_a}$ = **26.2** kNm/m

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Check wall stem in bending

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

Depth of reinforcement — $d_{stem} = t_{wall} - c_{stem} - (\phi_{stem} / 2)$ = **242.0** mm

Constant — $K_{stem} = M_{stem} / (b \times d_{stem}^2 \times f_{cu})$ = **0.013**

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} = **230** mm

Area of tension reinforcement required — $A_{s_stem_des} = M_{stem} / (0.87 \times f_y \times z_{stem})$ = **262** mm²/m

Minimum area of tension reinforcement — $A_{s_stem_min} = k \times b \times t_{wall}$ = **390** mm²/m

Area of tension reinforcement required — $A_{s_stem_req} = \max(A_{s_stem_des}, A_{s_stem_min})$ = **390** mm²/m

Reinforcement provided — **16 mm dia.bars @ 200 mm centres**

Area of reinforcement provided — $A_{s_stem_prov}$ = **1005** mm²/m

PASS - Reinforcement provided at the retaining wall stem is adequate

Check shear resistance at wall stem

Design shear stress — $v_{stem} = V_{stem} / (b \times d_{stem})$ = **0.056** N/mm²

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/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} = **0.598** 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 — $f_s = 2 \times f_y \times A_{s_stem_req} / (3 \times A_{s_stem_prov})$ = **129.3** N/mm²

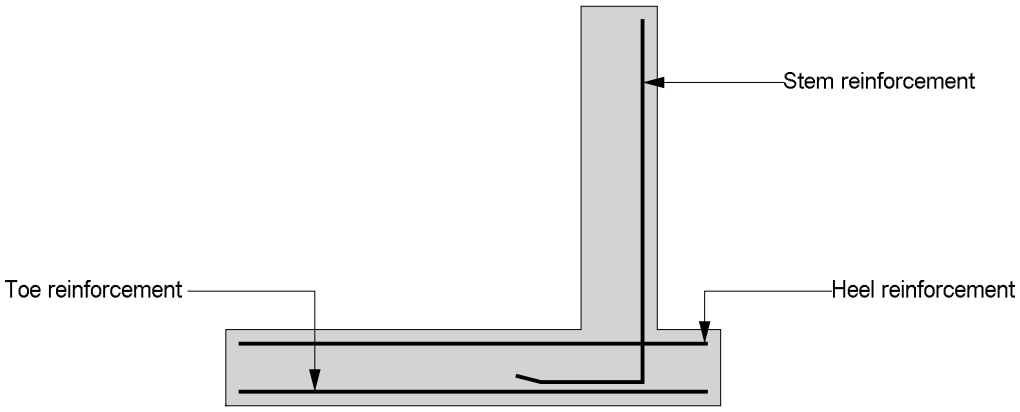
Modification factor — $factor_{tens} = \min(0.55 + (477\ N/mm^2 - f_s)/(120 \times (0.9\ N/mm^2 + (M_{stem}/(b \times d_{stem}^2)))),2)$ = **2.00**

Maximum span/effective depth ratio — $ratio_{max} = ratio_{bas} \times factor_{tens}$ = **14.00**

Actual span/effective depth ratio — $ratio_{act} = h_{stem} / d_{stem}$ = **5.27**

PASS - Span to depth ratio is acceptable

Indicative retaining wall reinforcement diagram



Toe mesh - A393 - (393 mm^2/m)
Heel mesh - A393 - (393 mm^2/m)
Stem bars - 16 mm dia.@ 200 mm centres - (1005 mm^2/m)