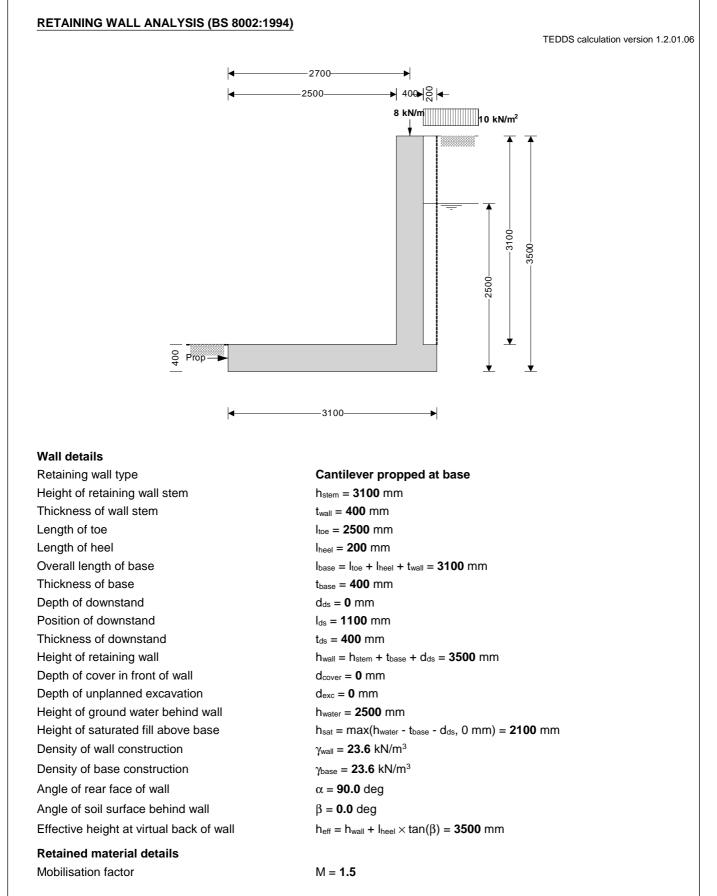
14 ELDON GROVE LONDON NW3

Job No 3791

APPENDIX II





Tedds	Project	14 ELDON GRO	VE, LONDON	NW3	Job no.	3791		
Ian Drummond Consulting Engineers	Calcs for	LIGHTWELL R	GHTWELL RETAINING WALL			Start page no./Revision C 2		
90 Cowcross Street London	Calcs by AB	Calcs date 04/07/2014	Checked by	Checked date	Approved by	Approved date		
Moist density of retained mate		γ _m = 21.0 k						
Saturated density of retained r	natenai	γ _s = 23.0 k						
Design shear strength		φ' = 25.0 de	0					
Angle of wall friction Base material details		δ = 9.9 deg)					
Stiff clay			_					
Moist density		γ _{mb} = 19.0						
Design shear strength		φ' _b = 18.0 c	-					
Design base friction		$\delta_{\rm b} = 18.6 {\rm d}$	-					
Allowable bearing pressure		Pbearing = 1	50 kN/m²					
Using Coulomb theory								
Active pressure coefficient for								
		$^{2} \times sin(\alpha - \delta) \times [1 - \delta]$	+ √(sin(φ' + δ) >	< sin(φ' - β) / (sin(α - δ) × sin(α +	$(\beta)))]^{2}) = 0.37$		
Passive pressure coefficient for						0.111-01		
	$K_p = sin$	n(90 - φ'♭)² / (sin(90	Ο - δ _b) × [1 - √(s	$\sin(\phi_{\rm b} + \delta_{\rm b}) \times \sin(\phi_{\rm b})$	φ' _b) / (sin(90 +	$\delta_{\rm b})))]^2) = 3.0$		
At-rest pressure								
At-rest pressure for retained m	naterial	$K_0 = 1 - si$	∩(∲') = 0.577					
Loading details Surcharge load on plan Applied vertical dead load on wa Applied vertical live load on wa Position of applied vertical load Applied horizontal dead load on Applied horizontal live load on Height of applied horizontal load	all d on wall n wall wall	Surcharge $W_{dead} = 7.7$ $W_{live} = 0.0$ $I_{load} = 2700$ $F_{dead} = 0.0$ $F_{live} = 0.0$ k $h_{load} = 0$ min	kN/m) mm kN/m kN/m					
Prop- 22.0 45.3			8 ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓		2.1 24.5			

Tedds	Project 14	Job no. 3791				
lan Drummond Consulting Engineers	Calcs for	LIGHTWELL RE	TAINING WAL	L	Start page no./Re	evision 3
90 Cowcross Street London	Calcs by AB	Calcs date 04/07/2014	Checked by	Checked date	Approved by	Approved date

Loads shown in kN/m, pressures shown in $k\text{N/m}^2$

	Loads shown in kN/m, pressures shown in kN/
Vertical forces on wall	
Wall stem	$w_{wall} = h_{stem} \times t_{wall} \times \gamma_{wall} = \textbf{29.3 kN/m}$
Wall base	$w_{base} = I_{base} \times t_{base} \times \gamma_{base} = 29.3 \text{ kN/m}$
Surcharge	$w_{sur} = Surcharge \times I_{heel} = 2 \text{ kN/m}$
Moist backfill to top of wall	$w_{m_w} = I_{heel} \times (h_{stem} - h_{sat}) \times \gamma_m = 4.2 \text{ kN/m}$
Saturated backfill	$w_s = I_{heel} \times h_{sat} \times \gamma_s = 9.7 \text{ kN/m}$
Applied vertical load	$W_v = W_{dead} + W_{live} = 7.7 \text{ kN/m}$
Total vertical load	$W_{total} = w_{wall} + w_{base} + w_{sur} + w_{m_w} + w_s + W_v = 82.1 \text{ kN/m}$
Horizontal forces on wall	
Surcharge	$F_{sur} = K_a \times cos(90 - \alpha + \delta) \times Surcharge \times h_{eff} = 12.9 \text{ kN/m}$
Moist backfill above water table	$F_{m_a} = 0.5 \times K_a \times cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water})^2 = 3.9 \text{ kN/m}$
Moist backfill below water table	$F_{m_b} = K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water} = 19.3 \text{ kN/m}$
Saturated backfill	$F_s = 0.5 \times K_a \times cos(90 - \alpha + \delta) \times (\gamma_{s-} \gamma_{water}) \times h_{water}^2 = 15.1 \text{ kN/m}$
Water	$F_{water} = 0.5 \times h_{water}^2 \times \gamma_{water} = 30.7 \text{ kN/m}$
Total horizontal load	F _{total} = F _{sur} + F _{m_a} + F _{m_b} + F _s + F _{water} = 81.8 kN/m
Calculate propping force	
Passive resistance of soil in front of wall	$F_p = 0.5 \times K_p \times cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb} = 4.4 \text{ kN/m}$
Propping force	$F_{prop} = max(F_{total} - F_p - (W_{total} - w_{sur}) \times tan(\delta_b), 0 \text{ kN/m})$
	$F_{\text{prop}} = 50.4 \text{ kN/m}$
Overturning moments	
Surcharge	$M_{sur} = F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2 = 22.5 \text{ kNm/m}$
Moist backfill above water table	$M_{m_a} = F_{m_a} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3 = 10.9 \text{ kNm/m}$
Moist backfill below water table	$M_{m_b} = F_{m_b} \times (h_{water} - 2 \times d_{ds}) / 2 = 24.1 \text{ kNm/m}$
Saturated backfill	$M_{s} = F_{s} \times (h_{water} - 3 \times d_{ds}) / 3 = 12.6 \text{ kNm/m}$
Water	$M_{water} = F_{water} \times (h_{water} - 3 \times d_{ds}) / 3 = 25.5 \text{ kNm/m}$
Total overturning moment	$M_{ot} = M_{sur} + M_m a + M_m b + M_s + M_{water} = 95.7 kNm/m$
Restoring moments	
Wall stem	$M_{wall} = w_{wall} \times (I_{toe} + t_{wall} / 2) = 79 \text{ kNm/m}$
Wall base	$M_{\text{base}} = w_{\text{base}} \times I_{\text{base}} / 2 = 45.4 \text{ kNm/m}$
Moist backfill	$M_{m_r} = (w_{m_w} \times (l_{base} - l_{heel} / 2) + w_{m_s} \times (l_{base} - l_{heel} / 3)) = 12.6 \text{ kNm/m}$
Saturated backfill	$M_{s,r} = w_s \times (I_{base} - I_{heel} / 2) = 29 kNm/m$
Design vertical dead load	$M_{dead} = W_{dead} \times I_{load} = 20.8 \text{ kNm/m}$
Total restoring moment	$M_{\text{rest}} = M_{\text{wall}} + M_{\text{base}} + M_{\text{m}_{r}} + M_{\text{s}_{r}} + M_{\text{dead}} = 186.7 \text{ kNm/m}$
-	
Check bearing pressure	$M \rightarrow (1 + 1) = (2) = G(k) m/m$
Surcharge	$M_{sur_r} = w_{sur} \times (I_{base} - I_{heel} / 2) = 6 \text{ kNm/m}$
Total moment for bearing Total vertical reaction	$M_{\text{total}} = M_{\text{rest}} - M_{\text{ot}} + M_{\text{sur}_r} = 97.1 \text{ kNm/m}$ $R = W_{\text{total}} = 82.1 \text{ kN/m}$
Distance to reaction	$R = VV_{\text{total}} = 62.1 \text{ kN/m}$ $x_{\text{bar}} = M_{\text{total}} / R = 1182 \text{ mm}$
Eccentricity of reaction	$e = abs((l_{base} / 2) - x_{bar}) = 368 \text{ mm}$
	Reaction acts within middle third of ba
Bearing pressure at toe	$p_{toe} = (R / I_{base}) + (6 \times R \times e / I_{base}^2) = 45.3 \text{ kN/m}^2$
Bearing pressure at heel	$p_{\text{heel}} = (\text{R} / \text{I}_{\text{base}}) \cdot (6 \times \text{R} \times \text{e} / \text{I}_{\text{base}}^2) = 7.6 \text{ kN/m}^2$
	ASS Meximum bearing pressure is loss than allowable bearing pressure

PASS - Maximum bearing pressure is less than allowable bearing pressure

Tedds	Project	14 ELDON GRO	VE, LONDON	Job no. 3791						
Ian Drummond Consulting	Calcs for	LIGHTWELL R			Start page no./	Revision C 4				
Engineers										
90 Cowcross Street London	Calcs by AB	Calcs date 04/07/2014	Checked by	Checked date	Approved by	Approved da				
RETAINING WALL DESIGN (BS 8002:1994)	2								
Ultimate limit state load fact	ors				TEDDS calculatio	n version 1.2.0'				
Dead load factor		γ _{f d} = 1.4								
Live load factor		γ _{f_l} = 1.6								
Earth and water pressure factor	or	γ _{f_e} = 1.4								
Factored vertical forces on v		·								
Wall stem	- Tun	Wwall $f = \gamma f$ d	$1 \times h_{stem} \times t_{wall} \times$	γ _{wall} = 41 kN/m						
Wall base				$\times \gamma_{\text{base}} = 41 \text{ kN/m}$	ı					
Surcharge		-		I _{heel} = 3.2 kN/m						
Moist backfill to top of wall		•	•	$-h_{sat}$ × $\gamma_m = 5.9$	kN/m					
Saturated backfill			$\langle I_{heel} \times h_{sat} \times \gamma_s$							
Applied vertical load		-	-	W _{live} = 10.8 kN/r	n					
Total vertical load		•	•	$W_{sur_f} + W_{m_w_f} + V_{m_w_f}$		5 3 kN/m				
					vs_i i vvv_i – i i	0.0 ((1)/11)				
Factored horizontal at-rest fo	orces on wall	Г.,		ao y h	NI/m					
5	Surcharge			$\begin{aligned} F_{sur_{-}f} &= \gamma_{f_1} \times K_0 \times Surcharge \times h_{eff} = \textbf{32.3 kN/m} \\ F_{m_a_f} &= \gamma_{f_e} \times 0.5 \times K_0 \times \gamma_m \times (h_{eff} - h_{water})^2 = \textbf{8.5 kN/m} \end{aligned}$						
Moist backfill above water tabl	-	-								
Moist backfill below water table	9	$\begin{aligned} F_{m_b_f} &= \gamma_{f_e} \times K_0 \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water} = \textbf{42.4 kN/m} \\ F_{s_f} &= \gamma_{f_e} \times 0.5 \times K_0 \times (\gamma_{s-} \gamma_{water}) \times h_{water}^2 = \textbf{33.3 kN/m} \end{aligned}$								
Saturated backfill										
Water		$F_{water_f} = \gamma_{f_e} \times 0.5 \times h_{water}^2 \times \gamma_{water} = 42.9 \text{ kN/m}$ $F_{total_f} = F_{sur_f} + F_{m_a_f} + F_{m_b_f} + F_{s_f} + F_{water_f} = 159.5 \text{ kN/m}$								
Total horizontal load		Γ total_f = Γ su	ır_f + ⊏ m_a_f + ⊏ r	n_b_f + F s_f + F wate	r_f = 139.3 KIN/f	n				
Calculate propping force		_								
Passive resistance of soil in fro	ont of wall	$F_{p_f} = \gamma_{f_e} \times$	$\times 0.5 \times K_{p} \times \cos \theta$	$s(\delta_b) imes (d_{cover} + t_{back})$	$_{\rm ase}$ + d _{ds} - d _{exc}) ²	$\times \gamma_{mb} = 6.2$				
kN/m		_			(2) 01 11	`				
Propping force		$F_{prop_f} = ma$ $F_{prop_f} = 11$		• (W _{total_f} - W _{sur_f}) >	< tan(ðb), 0 kn/i	m)				
Factored overturning mome	nts									
Surcharge		$M_{sur_f} = F_{su}$	$_{r_f} \times (h_{eff} - 2 \times$	d _{ds}) / 2 = 56.6 kN	lm/m					
Moist backfill above water tabl	е	$M_{m_a_f} = F_m$	n_a_f × (h _{eff} + 2 >	\times h _{water} - 3 \times d _{ds}) /	′ 3 = 24 kNm/m	l				
Moist backfill below water table	9	$M_{m_b_f} = F_n$	$h_{b_f} \times (h_{water} - 2)$	$2 \times d_{ds}$) / 2 = 53 k	Nm/m					
Saturated backfill		$M_{s_f} = F_{s_f}$	imes (h _{water} - 3 $ imes$ d	_{ds}) / 3 = 27.8 kNn	n/m					
Water		$M_{water_f} = F_{f}$	$_{water_f} \times (h_{water} -$	$3 \times d_{ds}) / 3 = 35.$	8 kNm/m					
Total overturning moment		$M_{ot_f} = M_{sur}$	$r_f + M_{m_a_f} + M$	m_b_f + Ms_f + Mwa	_{ter_f} = 197.2 kNi	m/m				
Restoring moments										
Wall stem		$M_{wall_f} = w_w$	$_{\rm vall_f} imes (I_{ m toe} + t_{ m wall})$	/ 2) = 110.6 kNm	n/m					
Wall base		$M_{base_f} = W_{base_f}$	$_{\rm base_f} imes I_{ m base}$ / 2	= 63.5 kNm/m						
Surcharge		$M_{sur_r_f} = w$	$_{\rm sur_f} imes$ (I _{base} - I _{he}	_{el} / 2) = 9.6 kNm/	m					
Moist backfill		$M_{m_r_f} = (w$	$_{m_w_f} imes (I_{base} - I_h)$	$_{eel}$ / 2) + $w_{m_s_f} \times$	(I _{base} - I _{heel} / 3))	= 17.6 kNm				
Saturated backfill		$M_{s_r_f} = w_{s_r}$	$_{\rm f} imes ({\sf I}_{\rm base} - {\sf I}_{\rm heel} /$	2) = 40.6 kNm/m	ı					
Design vertical load		$M_{v_f} = W_{v_f}$	\times I _{load} = 29.1 k	:Nm/m						
Total restoring moment		$M_{rest_f} = M_w$	_{vall_f} + M _{base_f} +	$M_{sur_r_f} + M_{m_r_f} +$	$M_{s_r_f} + M_{v_f} = 2$	271 kNm/m				
Factored bearing pressure										
Total moment for bearing		$M_{total_f} = M_r$	est_f - M _{ot_f} = 73	3 .8 kNm/m						
Total vertical reaction			f = 115.3 kN/m							

Tedds	Project	14 ELDON GRO	/E, LONDON I	NW3	Job no. 3791		
lan Drummond Consulting	Calcs for				Start page no./	Revision	
Engineers		LIGHTWELL R	ETAINING WA	ALL		C 5	
90 Cowcross Street London	Calcs by AB	Calcs date 04/07/2014	Checked by	Checked date	Approved by	Approved da	
Distance to reaction		x _{bar_f} = M _{tota}	_{l_f} / R _f = 640 m	าท			
Eccentricity of reaction		$e_f = abs((I_{ba}$	_{ase} / 2) - x _{bar_f}) :	= 910 mm			
				Reaction acts	outside middle	e third of ba	
Bearing pressure at toe		-	$(1.5 \times X_{bar_f}) =$				
Bearing pressure at heel		• -	N/m ² = 0 kN/m				
Rate of change of base reaction	n	-		62.53 kN/m²/m			
Bearing pressure at stem / toe		-		te \times I _{toe}), 0 kN/m	-		
Bearing pressure at mid stem		p _{stem_mid_f} =	max(p _{toe_f} - (ra	$te \times (I_{toe} + t_{wall} / 2)$	2)), 0 kN/m²) =	0 kN/m ²	
Bearing pressure at stem / hee		p _{stem_heel_f} =	max(p _{toe_f} - (ra	ate × (I_{toe} + t_{wall})),	0 kN/m²) = 0 k	κN/m²	
Design of reinforced concret	e retaining w	all toe (BS 8002:1	994 <u>)</u>				
Material properties							
Characteristic strength of conc		f _{cu} = 40 N/n					
Characteristic strength of reinfo	orcement	f _y = 500 N/r	nm²				
Base details							
Minimum area of reinforcemen	t	k = 0.13 %					
Cover to reinforcement in toe		c _{toe} = 50 m	m				
Calculate shear for toe desig	n						
Shear from bearing pressure		$V_{toe_bear} = 3$	$\times p_{\text{toe}_f} \times x_{\text{bar}_f}$	/ 2 = 115.3 kN/n	n		
Shear from weight of base		V _{toe_wt_base} =	= $\gamma_{f_d} \times \gamma_{base} \times I_t$	$toe \times t_{base} = 33 \text{ kN}$	l/m		
Total shear for toe design		$V_{toe} = V_{toe_b}$	ear - V _{toe_wt_base}	= 82.3 kN/m			
Calculate moment for toe de	sign						
Moment from bearing pressure)	$M_{toe_bear} = 3$	$B \times p_{toe_f} \times x_{bar_f}$	$_{\rm f} imes (I_{ m toe} - x_{ m bar_f} + t_{ m w})$	_{vall} / 2) / 2 = 237	7.5 kNm/m	
Moment from weight of base		M _{toe_wt_base} =	= ($\gamma_{f_d} \times \gamma_{base} \times$	$t_{\text{base}} imes (I_{\text{toe}} + t_{\text{wall}})$	/ 2) ² / 2) = 48.2	kNm/m	
Total moment for toe design		$M_{toe} = M_{toe}$	_{bear} - M _{toe_wt_bas}	_{se} = 189.4 kNm/n	n		
▲ ● 400 ● 340	•	•	•	• •			
	 4 −−−2	00►					
Check toe in bending							
Width of toe		b = 1000 m					
Depth of reinforcement			- c _{toe} - (φ _{toe} / 2)				
Constant		$K_{toe} = M_{toe}$ /	$(b \times d_{toe}^2 \times f_{cu})$	-		_	
				Compression re		-	
Lever arm		z _{toe} = min(0 z _{toe} = 323 n		min(K _{toe} , 0.225)	/ 0.9)),0.95) × (D _{toe}	
Area of tension reinforcement	required	$A_{s_toe_des} =$	M_{toe} / (0.87 $ imes$ fy	y × z _{toe}) = 1348 m	nm²/m		
		•		500 2/			

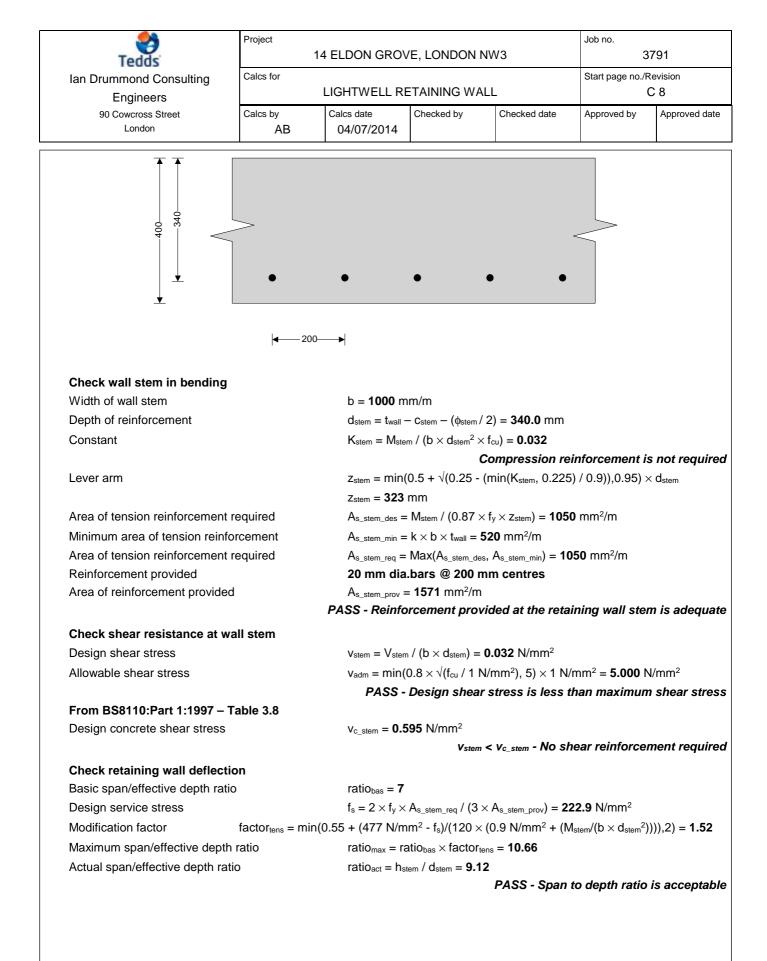
 $A_{s_toe_min} = k \times b \times t_{base} = \textbf{520} \text{ mm}^2/\text{m}$

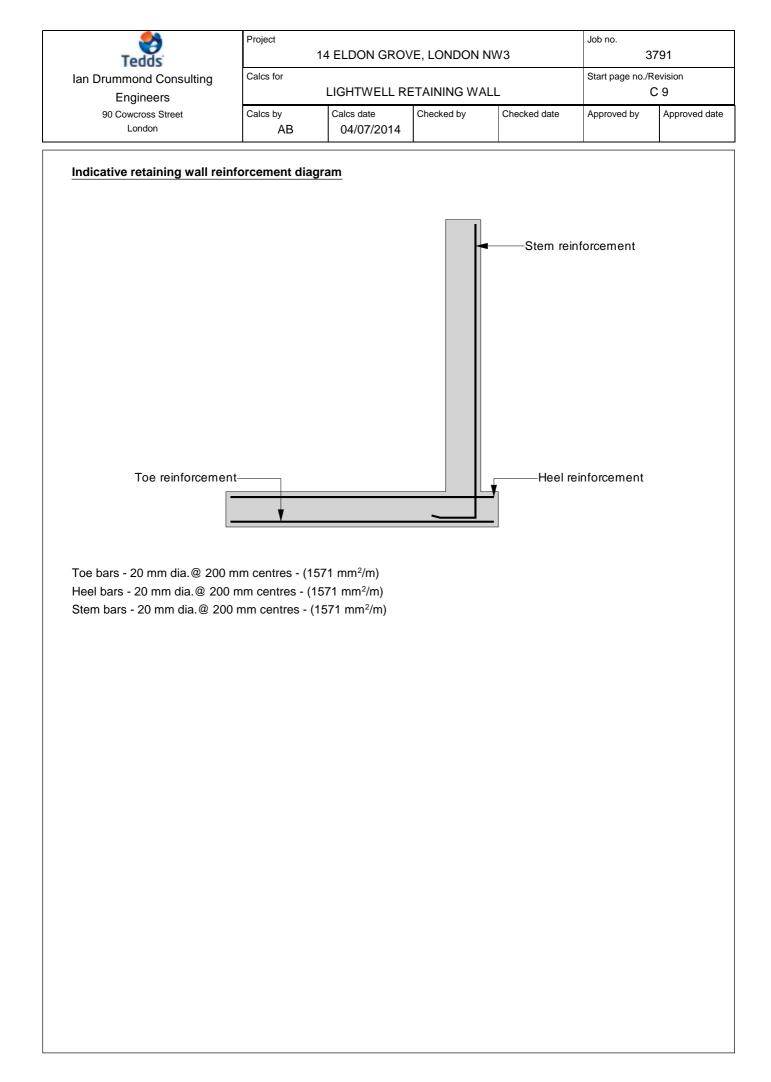
Minimum area of tension reinforcement

Tedds	Project	14 ELDON GROV	Job no. 3	3791		
lan Drummond Consulting Engineers	Calcs for	LIGHTWELL RE	ETAINING WA	LL	Start page no./F	Revision C 6
90 Cowcross Street London	Calcs by AB	Calcs date 04/07/2014	Checked by	Checked date	Approved by	Approved dat
Area of tension reinforcement re Reinforcement provided	quired		Max(A _{s_toe_des} , <i>J</i> .bars @ 200 r	A _{s_toe_min}) = 1348 nm centres	mm²/m	
Area of reinforcement provided		$A_{s_toe_prov} =$	1571 mm²/m			
		PASS - Rein	forcement pr	ovided at the re	taining wall to	e is adequa
Check shear resistance at toe Design shear stress		Vice - Vice /	(b × d _{toe}) = 0.2	42 N/mm ²		
Allowable shear stress				N/mm²), 5) × 1 N/	/mm ² = 5 000 N	l/mm ²
				r stress is less t		
From BS8110:Part 1:1997 – Ta	ble 3.8		U			
Design concrete shear stress		Vc_toe = 0.59				
			Vto	be < Vc_toe - No sh	near reinforce	ment requir
Design of reinforced concrete	retaining wa	all heel (BS 8002:	1994 <u>)</u>			
Material properties						
Characteristic strength of concre		f _{cu} = 40 N/n				
Characteristic strength of reinfor	cement	f _y = 500 N/r	nm²			
Base details						
Minimum area of reinforcement		k = 0.13 %	~			
Cover to reinforcement in heel		C _{heel} = 50 m	IM			
Calculate shear for heel desig	n	M			NI/m	
Shear from weight of base Shear from weight of moist back	fill		$W_{m_w_f} = 5.9 \text{ kN}$	$I_{heel} imes t_{base} = 2.6 ext{ k}$	AN/111	
Shear from weight of saturated b			wm_w_r = 3.5 kN/			
Shear from surcharge			sur_f = 3.2 kN/n			
Total shear for heel design		V _{heel} = V _{heel}	_wt_base + Vheel_v	wt_m + V _{heel_wt_s} + '	V _{heel_sur} = 25.2	kN/m
Calculate moment for heel des	sign					
Moment from weight of base		$M_{heel_wt_base}$	= ($\gamma_{f_d} \times \gamma_{base} \times$	$t_{ ext{base}} imes (I_{ ext{heel}} + t_{ ext{wal}})$	(/ 2) ² / 2) = 1.1	kNm/m
Moment from weight of moist ba	ckfill	M _{heel_wt_m} =	$w_{m_w_f} \times (I_{heel} +$	- t _{wall}) / 2 = 1.8 kN	lm/m	
Moment from weight of saturated	d backfill	$M_{heel_wt_s} = v$	$W_{s_f} \times (I_{heel} + t_w)$	all) / 2 = 4.1 kNm/	/m	
Moment from surcharge				_{vall}) / 2 = 1 kNm/m		
Total moment for heel design		$M_{heel} = M_{heel}$	I_wt_base + Mheel	_wt_m + M _{heel_wt_s} +	• M _{heel_sur} = 7.8	kNm/m
	◄ ───20	00►				
400	•	•	•	• •		
↓ ↓						

Width of heel Depth of reinforcement b = 1000 mm/m $d_{\text{heel}} = t_{\text{base}} - c_{\text{heel}} - (\phi_{\text{heel}} / 2) = 340.0 \text{ mm}$

Tedds		14 ELDON GRO	NW3		3791	
Ian Drummond Consulting Engineers	Calcs for	LIGHTWELL R	ETAINING WA	ALL.	Start page no./	Revision C 7
90 Cowcross Street London	Calcs by AB	Calcs date 04/07/2014	Checked by	Checked date	Approved by	Approved
Constant		K _{heel} = M _{he}	_{el} / (b × d _{heel} ² ×	-		
				Compression re		=
Lever arm		Z _{heel} = MIN Z _{heel} = 323		(min(K _{heel} , 0.225)	(/ 0.9)),0.95) ×	COheel
Area of tension reinforcement	required			$f_y \times z_{heel}$) = 56 mi	m²/m	
Minimum area of tension reinfo	-		= $k \times b \times t_{base} =$			
Area of tension reinforcement				s, As_heel_min) = 520) mm²/m	
Reinforcement provided			a.bars @ 200 r	-		
Area of reinforcement provided	d	As_heel_prov =	= 1571 mm²/m			
		PASS - Rein	forcement pro	vided at the reta	aining wall he	el is adeq
Check shear resistance at he	eel					
Design shear stress		$v_{\text{heel}} = V_{\text{hee}}$	h / (b × d _{heel}) = ().074 N/mm²		
Allowable shear stress		v _{adm} = min	(0.8 × √(f _{cu} / 1 ľ	N/mm²), 5) × 1 N/	′mm² = 5.000 l	N/mm ²
		PASS	- Design shea	r stress is less t	han maximur	n shear s
From BS8110:Part 1:1997	Table 3.8					
Design concrete shear stress		Vc_heel = 0.	595 N/mm²			
			Vhee	el < Vc_heel - No sh	near reinforce	ment req
						-
Design of reinforced concre	te retaining w	all stem (BS 8002	2:1994)			_
Design of reinforced concre Material properties	te retaining w	all stem (BS 8002	2:1994)			-
Material properties		all stem (BS 8002 f _{cu} = 40 N/				
	crete		mm ²			
Material properties Characteristic strength of conc Characteristic strength of reinf	crete	f _{cu} = 40 N/	mm ²			
Material properties Characteristic strength of conc	crete forcement	f _{cu} = 40 N/	mm² /mm²			
Material properties Characteristic strength of cond Characteristic strength of reinf Wall details	crete forcement	f _{cu} = 40 N/ f _y = 500 N/	mm² /mm²			
Material properties Characteristic strength of cond Characteristic strength of reinf Wall details Minimum area of reinforcemer	crete forcement nt	f _{cu} = 40 N/ f _y = 500 N/ k = 0.13 %	mm² /mm² 5 mm			
Material properties Characteristic strength of cond Characteristic strength of reinf Wall details Minimum area of reinforcement Cover to reinforcement in sten	crete forcement nt n	f _{cu} = 40 N/ f _y = 500 N/ k = 0.13 % C _{stem} = 50 f C _{wall} = 35 n	mm² /mm² 5 mm			
Material properties Characteristic strength of cond Characteristic strength of reinf Wall details Minimum area of reinforcemer Cover to reinforcement in sten Cover to reinforcement in wall	crete forcement nt n	f _{cu} = 40 N/ f _y = 500 N/ k = 0.13 % C _{stem} = 50 I C _{wall} = 35 n	mm² /mm² 5 mm nm	arge $ imes$ (h _{eff} - t _{base} -		١/m
Material properties Characteristic strength of cond Characteristic strength of reinf Wall details Minimum area of reinforcement Cover to reinforcement in sten Cover to reinforcement in wall Factored horizontal at-rest fe	crete forcement nt n orces on sten	$f_{cu} = 40 \text{ N/}$ $f_y = 500 \text{ N/}$ k = 0.13 % $C_{stem} = 50 \text{ I}$ $C_{wall} = 35 \text{ m}$ $F_{s_sur_f} = \gamma_f$	mm² /mm² 5 mm nm _ı × K₀ × Surcha		• d _{ds}) = 28.6 kN	
Material properties Characteristic strength of cond Characteristic strength of reinf Wall details Minimum area of reinforcemer Cover to reinforcement in stem Cover to reinforcement in wall Factored horizontal at-rest for Surcharge	crete forcement nt n orces on sterr e	$f_{cu} = 40 \text{ N/}$ $f_y = 500 \text{ N/}$ $k = 0.13 \%$ $C_{stem} = 50 \text{ f}$ $C_{wall} = 35 \text{ n}$ $F_{s_sur_f} = \gamma_f$ $F_{s_m_a_f} = 0$	mm ² /mm ² 5 mm nm _1 × K ₀ × Surcha).5 × $\gamma_{f=e}$ × K ₀ ×	arge × (h _{eff} - t _{base} -	• d _{ds}) = 28.6 kN d _{ds} - h _{sat}) ² = 8. 3	5 kN/m
Material properties Characteristic strength of cond Characteristic strength of reinf Wall details Minimum area of reinforcemer Cover to reinforcement in sten Cover to reinforcement in wall Factored horizontal at-rest for Surcharge Moist backfill above water tabl	crete forcement nt n orces on sterr e	$f_{cu} = 40 \text{ N/}$ $f_y = 500 \text{ N/}$ $k = 0.13 \%$ $C_{stem} = 50 \text{ H}$ $C_{wall} = 35 \text{ m}$ $F_{s_sur_f} = \gamma_{f}$ $F_{s_m_a_f} = 0$ $F_{s_m_b_f} = \gamma$	mm ² /mm ² 5 mm nm JI × K ₀ × Surcha J.5 × γ_{f_e} × K ₀ × γ_m × (arge × (h _{eff} - t _{base} - γ _m × (h _{eff} - t _{base} - α 'h _{eff} - t _{base} - d _{ds} - h	• d _{ds}) = 28.6 kM d _{ds} - h _{sat}) ² = 8. _{sat}) × h _{sat} = 35.	5 kN/m
Material properties Characteristic strength of cond Characteristic strength of reinf Wall details Minimum area of reinforcemer Cover to reinforcement in stem Cover to reinforcement in wall Factored horizontal at-rest for Surcharge Moist backfill above water table	crete forcement nt n orces on sterr e	$f_{cu} = 40 \text{ N/}$ $f_y = 500 \text{ N/}$ $k = 0.13 \%$ $C_{stem} = 50 \text{ f}$ $C_{wall} = 35 \text{ m}$ $F_{s_sur_f} = \gamma_f$ $F_{s_m_a_f} = 0$ $F_{s_s_f} = 0.5$	mm ² /mm ² /mm nm 1.5 × γ_{f_e} × K ₀ × γ_{f_e} × K ₀ × γ_m × (j_5 × γ_{f_e} × K ₀ × (γ	arge × (h _{eff} - t _{base} - γ _m × (h _{eff} - t _{base} - α h _{eff} - t _{base} - d _{ds} - h r _s - γ _{water}) × h _{sat} ² = 2	- d _{ds}) = 28.6 kN d _{ds} - h _{sat}) ² = 8. _{sat}) × h _{sat} = 35. 23.5 kN/m	5 kN/m
Material properties Characteristic strength of cond Characteristic strength of reinf Wall details Minimum area of reinforcemer Cover to reinforcement in stem Cover to reinforcement in wall Factored horizontal at-rest for Surcharge Moist backfill above water table Moist backfill below water table Saturated backfill Water	crete forcement nt n orces on sterr e	$f_{cu} = 40 \text{ N/}$ $f_y = 500 \text{ N/}$ $k = 0.13 \%$ $C_{stem} = 50 \text{ f}$ $C_{wall} = 35 \text{ m}$ $F_{s_sur_f} = \gamma_f$ $F_{s_m_a_f} = 0$ $F_{s_s_f} = 0.5$	mm ² /mm ² /mm nm 1.5 × γ_{f_e} × K ₀ × γ_{f_e} × K ₀ × γ_m × (j_5 × γ_{f_e} × K ₀ × (γ	arge × (h _{eff} - t _{base} - γ _m × (h _{eff} - t _{base} - α 'h _{eff} - t _{base} - d _{ds} - h	- d _{ds}) = 28.6 kN d _{ds} - h _{sat}) ² = 8. _{sat}) × h _{sat} = 35. 23.5 kN/m	5 kN/m
Material properties Characteristic strength of cond Characteristic strength of reinf Wall details Minimum area of reinforcemen Cover to reinforcement in sten Cover to reinforcement in wall Factored horizontal at-rest for Surcharge Moist backfill above water table Moist backfill below water table	crete forcement nt n orces on sterr e	$f_{cu} = 40 \text{ N/} \\ f_y = 500 \text{ N/} \\ k = 0.13 \% \\ C_{stem} = 50 \text{ f} \\ C_{wall} = 35 \text{ n} \\ C_{wall} = 35 \text{ n} \\ F_{s_sur_f} = \gamma_f \\ F_{s_m_a_f} = 0 \\ F_{s_m_b_f} = \gamma \\ F_{s_s_f} = 0.5 \\ F_{s_water_f} = 0.5 \\ F_{$	mm ² /mm ² /mm nm $_1 \times K_0 \times Surcha0.5 \times \gamma_{f_e} \times K_0 \times K_0 \times K_0 \times K_0 \times \gamma_m \times (5 \times \gamma_{f_e} \times K_0 \times (\gamma 0.5 \times \gamma_{f_e} \times \gamma_{wate})$	arge × ($h_{eff} - t_{base} - \gamma_m × (h_{eff} - t_{base} - \alpha_{ds} - h_{cff} - t_{base} - d_{ds} - h_{st}$ $(h_{eff} - t_{base} - d_{ds} - h_{st}) × h_{sat}^2 = 2$ $(h_{eff} - t_{base} - d_{ds} - h_{st}) × h_{sat}^2 = 30.3 \text{ kN}$	- d _{ds}) = 28.6 kN d _{ds} - h _{sat}) ² = 8. _{sat}) × h _{sat} = 35. 23.5 kN/m √m	5 kN/m 6 kN/m
Material properties Characteristic strength of cond Characteristic strength of reinf Wall details Minimum area of reinforcemer Cover to reinforcement in stem Cover to reinforcement in wall Factored horizontal at-rest for Surcharge Moist backfill above water table Moist backfill below water table Saturated backfill Water Calculate shear for stem des Shear at base of stem	crete forcement nt n orces on sten le e sign	$f_{cu} = 40 \text{ N/} \\ f_y = 500 \text{ N/} \\ k = 0.13 \% \\ C_{stem} = 50 \text{ f} \\ C_{wall} = 35 \text{ n} \\ C_{wall} = 35 \text{ n} \\ F_{s_sur_f} = \gamma_f \\ F_{s_m_a_f} = 0 \\ F_{s_m_b_f} = \gamma \\ F_{s_s_f} = 0.5 \\ F_{s_water_f} = 0.5 \\ F_{$	mm ² /mm ² /mm nm $_1 \times K_0 \times Surcha0.5 \times \gamma_{f_e} \times K_0 \times K_0 \times K_0 \times K_0 \times \gamma_m \times (5 \times \gamma_{f_e} \times K_0 \times (\gamma 0.5 \times \gamma_{f_e} \times \gamma_{wate})$	arge × (h _{eff} - t _{base} - γ _m × (h _{eff} - t _{base} - α h _{eff} - t _{base} - d _{ds} - h r _s - γ _{water}) × h _{sat} ² = 2	- d _{ds}) = 28.6 kN d _{ds} - h _{sat}) ² = 8. _{sat}) × h _{sat} = 35. 23.5 kN/m √m	5 kN/m 6 kN/m
Material properties Characteristic strength of cond Characteristic strength of reinf Wall details Minimum area of reinforcemen Cover to reinforcement in sten Cover to reinforcement in wall Factored horizontal at-rest for Surcharge Moist backfill above water table Saturated backfill Water Calculate shear for stem des Shear at base of stem Calculate moment for stem des	crete forcement nt n orces on sten le e sign	$f_{cu} = 40 \text{ N/} \\ f_y = 500 \text{ N/} \\ k = 0.13 \% \\ C_{stem} = 50 \text{ f} \\ C_{wall} = 35 \text{ n} \\ C_{wall} = 35 \text{ n} \\ F_{s_sur_f} = \gamma_{f} \\ F_{s_m_a_f} = 0 \\ F_{s_m_b_f} = \gamma \\ F_{s_s_f} = 0.5 \\ F_{s_water_f} = \\ V_{stem} = F_{s_s}$	mm ² /mm ² /mm nm nm $j_1 \times K_0 \times Surchators(j_1 \times K_0 \times Surchators) (j_2 \times \gamma_{f_0} \times K_0 \times \gamma_m \times (j_2 \times \gamma_{f_0} \times K_0 \times (\gamma_0 \times \gamma_{f_0} \times \gamma_{f$	$arge \times (h_{eff} - t_{base} - q_m \times (h_{eff} - t_{base} - q_{ds} - h_{ds} - q_{ds} - h_{sat}^2 = 2$ $h_{eff} - t_{base} - d_{ds} - h_{sat}^2 = 2$ $h_{eff} - t_{bsat}^2 = 30.3 \text{ kN}$ $F_{s_m_b_f} + F_{s_s_f} + $	• d _{ds}) = 28.6 kN d _{ds} - h _{sat}) ² = 8. _{sat}) × h _{sat} = 35. 23.5 kN/m V/m F _{s_water_f} - Fprop	5 kN/m 6 kN/m
Material properties Characteristic strength of cond Characteristic strength of reinf Wall details Minimum area of reinforcemer Cover to reinforcement in stem Cover to reinforcement in wall Factored horizontal at-rest for Surcharge Moist backfill above water table Moist backfill below water table Saturated backfill Water Calculate shear for stem des Shear at base of stem Calculate moment for stem of Surcharge	crete forcement nt n orces on stem e e sign design	$f_{cu} = 40 \text{ N/} \\ f_y = 500 \text{ N/} \\ k = 0.13 \% \\ c_{stem} = 50 \text{ H} \\ c_{wall} = 35 \text{ m} \\ c_{wall} = 35 \text{ m} \\ F_{s_sur_f} = \gamma_f \\ F_{s_m_a_f} = 0 \\ F_{s_m_b_f} = \gamma \\ F_{s_s_f} = 0.5 \\ F_{s_water_f} = \\ V_{stem} = F_{s_i} \\ M_{s_sur} = F_{s_i} \\ \end{cases}$	mm ² /mm ² /mm nm nm $(J_1 \times K_0 \times Surchat)$ $(J_1 \times K_0 \times Surchat)$ $(J_2 \times \gamma_{f_e} \times K_0 \times \gamma_m \times (J_2 \times \gamma_{f_e} \times K_0 \times (\gamma_{e} \times \gamma_{e} \times K_0 \times (\gamma_{e} \times \gamma_{e} \times K_0 \times (\gamma_{e} \times \gamma_{e} \times \gamma_$	$arge \times (h_{eff} - t_{base} - \gamma_m \times (h_{eff} - t_{base} - d_{ds} - h_{ds} - d_{ds} - h_{st}^2 - 2 q_{water}) \times h_{sat}^2 = 2 q_{sr} \times h_{sat}^2 = 30.3 \text{ kN}$ $F_{s_m_b_f} + F_{s_s_f} + q_{base}) / 2 = 50.1 \text{ kN}$	• d _{ds}) = 28.6 kN d _{ds} - h _{sat}) ² = 8. sat) × h _{sat} = 35. 23.5 kN/m V/m F _{s_water_f} - F _{prop}	5 kN/m 6 kN/m o_f = 11 kN
Material properties Characteristic strength of cond Characteristic strength of reinf Wall details Minimum area of reinforcemen Cover to reinforcement in stem Cover to reinforcement in wall Factored horizontal at-rest for Surcharge Moist backfill above water table Saturated backfill Water Calculate shear for stem des Shear at base of stem Calculate moment for stem of Surcharge Moist backfill above water table	crete forcement nt n orces on stem e e sign design e	$f_{cu} = 40 \text{ N/} \\ f_y = 500 \text{ N/} \\ k = 0.13 \% \\ C_{stem} = 50 \text{ f} \\ C_{wall} = 35 \text{ n} \\ C_{wall} = 35 \text{ n} \\ F_{s_sur_f} = \gamma_{f} \\ F_{s_m_a_f} = 0 \\ F_{s_m_b_f} = \gamma \\ F_{s_s_f} = 0.5 \\ F_{s_water_f} = \\ V_{stem} = F_{s_i} \\ M_{s_sur} = F_{s_i} \\ M_{s_m_a} = F_{s_i} \\ M_{s_m$	mm ² /mm ² /mm nm nm $j \times K_0 \times Surcha).5 \times \gamma_{f_e} \times K_0 \times K_0 \times K_0 \times Y_{f_e} \times K_0 \times Y_m \times (j_{5} \times \gamma_{f_e} \times K_0 \times (\gamma_{0.5} \times \gamma_{f_e} \times K_0 \times (\gamma_{0.5} \times \gamma_{f_e} \times K_0 \times (\gamma_{0.5} \times \gamma_{f_e} \times (\gamma_{0.5} \times (\gamma_{0.5$	arge × ($h_{eff} - t_{base} - q_m × (h_{eff} - t_{base} - d_{ds} - h_{ds} - q_{ds} - h_{sat}^2 = 2$ $h_{eff} - t_{base} - d_{ds} - h_{sat}^2 = 2$ $h_{eff} - y_{water} × h_{sat}^2 = 30.3 \text{ kN}$ $F_{s_m_b_f} + F_{s_s_f} + h_{base}$ $h_{at} + h_{eff} - d_{ds} + t_{base}$	• d _{ds}) = 28.6 kN d _{ds} - h _{sat}) ² = 8. sat) × h _{sat} = 35. 23.5 kN/m V/m F _{s_water_f} - F _{prop}	5 kN/m 6 kN/m o_f = 11 kN
Material properties Characteristic strength of cond Characteristic strength of reinf Wall details Minimum area of reinforcemen Cover to reinforcement in stem Cover to reinforcement in wall Factored horizontal at-rest for Surcharge Moist backfill above water table Moist backfill below water table Saturated backfill Water Calculate shear for stem des Shear at base of stem Calculate moment for stem of Surcharge Moist backfill above water table Moist backfill above water table	crete forcement nt n orces on stem e e sign design e	$f_{cu} = 40 \text{ N/} \\ f_y = 500 \text{ N/} \\ k = 0.13 \% \\ C_{stem} = 50 \text{ H} \\ C_{wall} = 35 \text{ m} \\ C_{wall} = 35 \text{ m} \\ F_{s_sur_f} = \gamma_f \\ F_{s_m_a_f} = 0.5 \\ F_{s_m_a_f} = 0.5 \\ F_{s_water_f} = \\ V_{stem} = F_{s_i} \\ M_{s_sur} = F_{s_i} \\ M_{s_m_a} = F_{s_i} \\ M_{s_m_b} = F_{s_i} \\ M_{s_i} = F_{s_i} \\ M_{s_i} \\ M_{s_i} = F_{s$	mm ² /mm ² /mm nm nm $J_1 \times K_0 \times Surchators(f_e \times K_0 \times \gamma_{f_e} \times K_0 \times (\gamma_{f_e} \times K_0 \times \gamma_{m} \times (\gamma_{f_e} \times K_0 \times (\gamma_{f_e} \times \gamma_{f_e} \times \gamma_{f_e} \times \gamma_{mater}))))))))))))))))))))))))))))))))))))$	arge × $(h_{eff} - t_{base} - \gamma_m × (h_{eff} - t_{base} - d_{ds} - h_{ds} - d_{ds} - h_{ds} - \gamma_{water}) × h_{sat}^2 = 2$ or × h_{sat}^2 = 30.3 kN F_s_m_b_f + F_s_s_f + base) / 2 = 50.1 kN at + h_{eff} - d_ds + t_base = 37.4 kNm/m	• d _{ds}) = 28.6 kN d _{ds} - h _{sat}) ² = 8. sat) × h _{sat} = 35. 23.5 kN/m V/m F _{s_water_f} - F _{prop}	5 kN/m 6 kN/m o_f = 11 kN
Material properties Characteristic strength of cond Characteristic strength of reinf Wall details Minimum area of reinforcemen Cover to reinforcement in stem Cover to reinforcement in wall Factored horizontal at-rest for Surcharge Moist backfill above water table Saturated backfill Water Calculate shear for stem des Shear at base of stem Calculate moment for stem of Surcharge Moist backfill above water table	crete forcement nt n orces on stem e e sign design e	$f_{cu} = 40 \text{ N/} \\ f_y = 500 \text{ N/} \\ k = 0.13 \% \\ C_{stem} = 50 \text{ f} \\ C_{wall} = 35 \text{ m} \\ C_{wall} = 35 \text{ m} \\ F_{s_sur_f} = \gamma_{f} \\ F_{s_m_a_f} = 0 \\ F_{s_m_b_f} = \gamma \\ F_{s_s_f} = 0.5 \\ F_{s_water_f} = \\ V_{stem} = F_{s_i} \\ M_{s_sur} = F_{s_i} \\ M_{s_m_a} = F \\ M_{s_m_b} = F_{s_s} \\ M_{s_s} = F_{s_s} \\ M_{s_s} = F_{s_s} \\ \end{bmatrix}$	mm ² /mm ² /mm nm nm $1 \times K_0 \times Surcha).5 \times \gamma_{f_e} \times K_0 \times f_{f_e} \times K_0 \times \gamma_m \times (f_e \times K_0 \times \gamma_m \times (f_e \times \gamma_{f_e} \times K_0 \times (f_e \times f_e \times f_e$	arge × $(h_{eff} - t_{base} - \gamma_m × (h_{eff} - t_{base} - d_{ds} - h_{ds} - d_{ds} - h_{ds} - \gamma_{water}) × h_{sat}^2 = 2$ or × h_{sat}^2 = 30.3 kN F_s_m_b_f + F_s_s_f + base) / 2 = 50.1 kN at + h_{eff} - d_ds + t_base = 37.4 kNm/m	• d _{ds}) = 28.6 kN d _{ds} - h _{sat}) ² = 8. sat) × h _{sat} = 35. 23.5 kN/m V/m F _{s_water_f} - F _{prop}	5 kN/m 6 kN/m o_f = 11 kN





<u></u>	Project	Job no.				
Tedds	14 ELDON GROVE, LONDON NW3				3791	
Ian Drummond Consulting	Calcs for	Start page no./Revision				
Engineers	P	ARTY FENCE R	ETAINING WAI		C	10
90 Cowcross Street London	Calcs by AB	Calcs date 04/07/2014	Checked by	Checked date	Approved by	Approved date

TEDDS calculation version 1.2.01.06

RETAINING WALL ANALYSIS (BS 8002:1994)

Wall details

Retaining wall type Height of retaining wall stem Thickness of 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 **Retained material details** Mobilisation factor

Moist density of retained material

Unpropped cantilever

h_{stem} = 650 mm t_{wall} = 225 mm I_{toe} = **300** mm I_{heel} = **50** mm $I_{\text{base}} = I_{\text{toe}} + I_{\text{heel}} + t_{\text{wall}} = 575 \text{ mm}$ t_{base} = **300** mm $d_{ds} = 0 \text{ mm}$ l_{ds} = **225** mm t_{ds} = **300** mm $h_{wall} = h_{stem} + t_{base} + d_{ds} = 950 \text{ mm}$ $d_{cover} = 0 mm$ $d_{exc} = 0 mm$ h_{water} = **500** mm $h_{sat} = max(h_{water} - t_{base} - d_{ds}, 0 mm) = 200 mm$ γ_{wall} = 23.6 kN/m³ γ_{base} = 23.6 kN/m³ α = **90.0** deg $\beta = 0.0 \deg$ $h_{eff} = h_{wall} + I_{heel} \times tan(\beta) = 950 \text{ mm}$ M = 1.5

γ_m = **21.0** kN/m³

edds	Project	14 ELDON GRO	VE, LONDON I	NW3	Job no.	3791
Ian Drummond Consulting Engineers	Calcs for	PARTY FENCE RETAINING WALL				Revision C 11
90 Cowcross Street London	Calcs by AB	Calcs date 04/07/2014	Checked by	Checked date	Approved by	Approved date
Saturated density of retained r Design shear strength	naterial	γ _s = 23.0 k φ' = 25.0 d	eg			
Angle of wall friction		δ = 9.9 deg	9			
Base material details						
Stiff clay						
Moist density		γ _{mb} = 19.0				
Design shear strength		φ' _b = 18.0 α	-			
Design base friction		δ _b = 18.6 d	-			
Allowable bearing pressure		P _{bearing} = 1	50 kN/m²			
Using Coulomb theory						
Active pressure coefficient for					s, s), -:(0)))12)
$K_a = sin(a)$ Passive pressure coefficient for			+ v(sin(\$ + 8)>	< sin(φ' - β) / (sin(α - 0) × SIN(α +	· p)))] ²) = 0.37 3
rassive pressure coefficient to			$(1 - \delta_{\rm L}) \sim [1 - \sqrt{\ell_{\rm L}}]$	$\sin(\phi_{\rm b} + \delta_{\rm b}) \times \sin(\phi_{\rm b})$	h'L) / (cin/00 ·	δ _L)))]2) _ 2 0 5'
	$\kappa_p = \sin \theta$	(90 - φ _B)- / (Sin(9)	U - Ob) × [1 - V(S	$\sin(\psi_{\rm b} + o_{\rm b}) \times \sin(\psi_{\rm b})$	φb) / (Sill(90 +	$O_{\rm D})))]^{-}) = 3.03$
At-rest pressure			(
At-rest pressure for retained m	naterial	$K_0 = 1 - SI$	n(φ') = 0.577			
Loading details						
Surcharge load on plan		-	= 10.0 kN/m ²			
Applied vertical dead load on v		W _{dead} = 9.8				
Applied vertical live load on wa		W _{live} = 0.0 I _{load} = 410				
Position of applied vertical loa Applied horizontal dead load of		$F_{dead} = 410$				
Applied horizontal live load on		Flive = 0.0				
Height of applied horizontal los		$h_{load} = 0 m$				
5		1040				
		10	1			
				10		
					1	
					Λ	
/						
	16.5 49.6		14.7	3.7 3.5 2.4	4.9	
	16.5 49.6		14.7	3.7 3.5 2.4	4.9	
	16.5 49.6		14.7	3.7 3.5 2.4	4.9	

_ 💝	Project	14 ELDON GRO		NW3	Job no.	3791
Tedds Ian Drummond Consulting Engineers	Calcs for	PARTY FENCE I			Start page no./F	
90 Cowcross Street London	Calcs by AB	Calcs date 04/07/2014	Checked by	Checked date	Approved by	Approved date
Vertical forces on wall						
Wall stem		$w_{wall} = h_{stem}$	$\times t_{wall} \times \gamma_{wall} =$	3.5 kN/m		
Wall base		Wbase = Ibase	$ imes$ t _{base} $ imes$ γ _{base}	= 4.1 kN/m		

 $w_{sur} = Surcharge \times I_{heel} = 0.5 \text{ kN/m}$

 $w_{s} = I_{heel} \times h_{sat} \times \gamma_{s} = 0.2 \text{ kN/m}$ $W_{v} = W_{dead} + W_{live} = 9.8 \text{ kN/m}$

 $w_{m_w} = I_{heel} \times (h_{stem} - h_{sat}) \times \gamma_m = 0.5 \text{ kN/m}$

 $F_{water} = 0.5 \times h_{water}^2 \times \gamma_{water} = 1.2 \text{ kN/m}$

 $F_{total} = F_{sur} + F_{m_a} + F_{m_b} + F_s + F_{water} = 7.8 \text{ kN/m}$

 $W_{total} = W_{wall} + W_{base} + W_{sur} + W_{m_w} + W_s + W_v = 18.5 \text{ kN/m}$

 $F_{sur} = K_a \times cos(90 - \alpha + \delta) \times Surcharge \times h_{eff} = 3.5 \text{ kN/m}$

 $F_{m_a} = 0.5 \times K_a \times cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water})^2 = 0.8 \text{ kN/m}$

 $F_{m_b} = K_a \times cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water} = 1.7 \text{ kN/m}$

 $F_s = 0.5 \times K_a \times cos(90 - \alpha + \delta) \times (\gamma_s - \gamma_{water}) \times h_{water}^2 = 0.6 \text{ kN/m}$

Wall base Surcharge Moist backfill to top of wall Saturated backfill Applied vertical load Total vertical load

Horizontal forces on wall

Surcharge Moist backfill above water table Moist backfill below water table Saturated backfill Water Total horizontal load

Calculate stability against sliding

Passive resistance of soil in front of wall Resistance to sliding

Overturning moments

Surcharge Moist backfill above water table Moist backfill below water table Saturated backfill Water Total overturning moment

Restoring moments

Wall stem Wall base Moist backfill Saturated backfill Design vertical dead load Total restoring moment

Check stability against overturning

Total overturning moment Total restoring moment

Check bearing pressure

Surcharge Total moment for bearing Total vertical reaction Distance to reaction Eccentricity of reaction
$$\begin{split} F_{p} &= 0.5 \times K_{p} \times cos(\delta_{b}) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^{2} \times \gamma_{mb} = \textbf{2.5 kN/m} \\ F_{res} &= F_{p} + (W_{total} - w_{sur}) \times tan(\delta_{b}) = \textbf{8.5 kN/m} \end{split}$$

PASS - Resistance force is greater than sliding force

$$\begin{split} M_{sur} &= F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2 = \textbf{1.7 kNm/m} \\ M_{m_a} &= F_{m_a} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3 = \textbf{0.5 kNm/m} \\ M_{m_b} &= F_{m_b} \times (h_{water} - 2 \times d_{ds}) / 2 = \textbf{0.4 kNm/m} \\ M_{s} &= F_{s} \times (h_{water} - 3 \times d_{ds}) / 3 = \textbf{0.1 kNm/m} \\ M_{water} &= F_{water} \times (h_{water} - 3 \times d_{ds}) / 3 = \textbf{0.2 kNm/m} \\ M_{ot} &= M_{sur} + M_{m_a} + M_{m_b} + M_{s} + M_{water} = \textbf{2.9 kNm/m} \end{split}$$

$$\begin{split} M_{wall} &= w_{wall} \times (I_{toe} + t_{wall} / 2) = \textbf{1.4 kNm/m} \\ M_{base} &= w_{base} \times I_{base} / 2 = \textbf{1.2 kNm/m} \\ M_{m_r} &= (w_{m_w} \times (I_{base} - I_{heel} / 2) + w_{m_s} \times (I_{base} - I_{heel} / 3)) = \textbf{0.3 kNm/m} \\ M_{s_r} &= w_s \times (I_{base} - I_{heel} / 2) = \textbf{0.1 kNm/m} \\ M_{dead} &= W_{dead} \times I_{load} = \textbf{4 kNm/m} \\ M_{rest} &= M_{wall} + M_{base} + M_{m_r} + M_{s_r} + M_{dead} = \textbf{7 kNm/m} \end{split}$$

M_{ot} = **2.9** kNm/m M_{rest} = **7.0** kNm/m **PASS - Restoring moment is greater than overturning moment**

$$\begin{split} M_{sur_r} &= w_{sur} \times (I_{base} - I_{heel} / 2) = \textbf{0.3 kNm/m} \\ M_{total} &= M_{rest} - M_{ot} + M_{sur_r} = \textbf{4.3 kNm/m} \\ R &= W_{total} = \textbf{18.5 kN/m} \\ x_{bar} &= M_{total} / R = \textbf{235 mm} \\ e &= abs((I_{base} / 2) - x_{bar}) = \textbf{52 mm} \\ \textbf{Reaction acts within middle third of base} \end{split}$$

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Engineers	PARTY FENCE RETAINING WALL					C 13	
90 Cowcross Street London	Calcs by AB	Calcs date 04/07/2014	Checked by	Checked date	Approved by	Approved	
				(1			
Bearing pressure at toe				e / I_{base^2} = 49.6			
Bearing pressure at heel	DA	/ p _{heel} = (R I SS - Maximum I		$(e / I_{base}^2) = 14.7$		vina nroo	
	17		scaring press			ing pics.	

Tedds		14 ELDON GRO	VE, LONDON	NW3	3791		
lan Drummond Consulting	Calcs for				Start page no./F		
Engineers		PARTY FENCE	RETAINING W	/ALL	(C 14	
90 Cowcross Street London	Calcs by AB	Calcs date 04/07/2014	Checked by	Checked date	Approved by	Approved of	
RETAINING WALL DESIGN (BS 8002:1994)	1					
		-			TEDDS calculatio	n version 1.2.0	
Ultimate limit state load fact Dead load factor	ors	γ _{f_d} = 1.4					
Live load factor		γ _L a – 1.4 γ _{f_l} = 1.6					
Earth and water pressure facto	or	γ _{f_e} = 1.4					
Factored vertical forces on v		<u>h-</u> o					
Wall stem	vali	We walk $f = \sqrt{f} d$	$\times h_{ctom} \times t_{wall} \times$	γ _{wall} = 4.8 kN/m			
Wall base				$\times \gamma_{\text{base}} = 5.7 \text{ kN/r}$	n		
Surcharge		-		$h_{\text{beel}} = 0.8 \text{ kN/m}$			
Moist backfill to top of wall		-	-	$(h_{sat}) \times \gamma_m = 0.7$	kN/m		
Saturated backfill			$\langle I_{heel} \times h_{sat} \times \gamma_s$				
Applied vertical load		•	•	W _{live} = 13.7 kN/n	n		
Total vertical load		•	•	$W_{sur_f} + W_{m_w_f} + V$		kN/m	
Factored horizontal at-rest f	orces on wall	_					
Surcharge		$F_{sur} f = \gamma_{f}$	× K₀ × Surchar	ge × h _{eff} = 8.8 kN	/m		
Moist backfill above water tabl	e	•		$m \times (h_{eff} - h_{water})^2 =$			
Moist backfill below water table	8			$_{\rm eff}$ - $h_{\rm water}$) \times $h_{\rm water}$			
Saturated backfill		-	• •	γ_{water}) × h_{water}^2 =			
Water				$^{2} \times \gamma_{\text{water}} = 1.7 \text{ kN}$			
Total horizontal load				, n_b_f + Fs_f + Fwater			
Passive resistance of soil in fr	ont of wall	$F_{p_f} = \gamma_{f_e} \times$	$0.5 imes K_p imes costs$	$\delta(\delta_{b}) imes (d_{cover} + t_{bal})$	_{se} + d _{ds} - d _{exc}) ²	$\times \gamma_{mb} = 3.5$	
kN/m							
Factored overturning mome	nts						
Surcharge		$M_{sur_f} = F_{su}$	$_{r_f} \times (h_{eff} - 2 \times)$	d _{ds}) / 2 = 4.2 kNn	n/m		
Moist backfill above water tabl	e	$M_{m_a_f} = F_m$	n_a_f × (h _{eff} + 2 >	imes h _{water} - 3 $ imes$ d _{ds}) /	3 = 1.1 kNm/n	า	
Moist backfill below water table	e	$M_{m_b_f} = F_m$	$h_b_f \times (h_{water} - 2)$	$\times d_{ds}) / 2 = 1 kN$	m/m		
Saturated backfill			-	_{ds}) / 3 = 0.2 kNm/			
Water				$3 \times d_{ds}) / 3 = 0.3$			
Total overturning moment		$M_{ot_f} = M_{sur}$	$f_{f} + M_{m_a_f} + M$	$m_{b_f} + M_{s_f} + M_{wat}$	_{er_f} = 6.7 kNm/r	m	
Restoring moments							
Wall stem			-	/ 2) = 2 kNm/m			
Wall base			$_{base_f} \times I_{base} / 2$				
Surcharge				_{el} / 2) = 0.4 kNm/			
Moist backfill				$_{eel}$ / 2) + $W_{m_s_f} \times$	(I _{base} - I _{heel} / 3))	= 0.4 kNm/	
Saturated backfill				2) = 0.2 kNm/m			
Design vertical load			\times l _{load} = 5.6 kN				
Total restoring moment		$M_{rest_f} = M_w$	_{/all_f} + M _{base_f} +	$M_{sur_r_f} + M_{m_r_f} +$	$M_{s_r_f} + M_{v_f} = '$	1 0.2 kNm/n	
Factored bearing pressure							
Total moment for bearing			$m_{est_f} - M_{ot_f} = 3.5$	5 kNm/m			
Total vertical reaction			f = 26.0 kN/m				
Distance to reaction Eccentricity of reaction			_{al_f} / R _f = 133 m _{ase} / 2) - x _{bar_f})				
Looenmony of readiion			ase / ∠) = ∧bar_f)	- 134 11111			

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90 Cowcross Street London	Calcs by AB	Calcs date 04/07/2014	Checked by	Checked date	Approved by	Approved			
Bearing pressure at toe		$p_{toe_f} = R_f /$	$(1.5 \times x_{bar_f}) =$	129.9 kN/m ²					
Bearing pressure at heel		$p_{\text{heel}_f} = 0 \text{ k}$	N/m² = 0 kN/m	1 ²					
Rate of change of base reaction	on	rate = p _{toe_1}	$(3 \times x_{bar_f}) =$	324.88 kN/m²/m					
Bearing pressure at stem / toe	;	$p_{stem_toe_f} =$	max(p _{toe_f} - (ra	te \times I _{toe}), 0 kN/m ²	²) = 32.4 kN/m ²	2			
Bearing pressure at mid stem		$p_{stem_mid_f} =$	max(p _{toe_f} - (ra	ate \times (I _{toe} + t _{wall} / 2	2)), 0 kN/m²) =	0 kN/m ²			
Bearing pressure at stem / he	el	Pstem_heel_f =	max(p _{toe_f} - (ra	ate × (I_{toe} + t_{wall})),	0 kN/m²) = 0 k	⟨N/m²			
Design of reinforced concre	te retaining wa	all toe (BS 8002:1	994)						
Material properties									
Characteristic strength of cond	crete	$f_{cu} = 35 \text{ N/r}$	nm²						
Characteristic strength of reinf	orcement	f _y = 500 N/	mm²						
Base details									
Minimum area of reinforcement	nt	k = 0.13 %							
Cover to reinforcement in toe		c _{toe} = 50 m	m						
Calculate shear for toe desig	gn								
Shear from bearing pressure		$V_{toe_bear} = (p_{toe_f} + p_{stem_toe_f}) \times I_{toe} / 2 = 24.3 \text{ kN/m}$							
Shear from weight of base			$V_{toe_wt_base} = \gamma_{f_d} \times \gamma_{base} \times I_{toe} \times t_{base} = \textbf{3} \text{ kN/m}$						
Total shear for toe design		$V_{toe} = V_{toe_{-}}$	$V_{toe} = V_{toe_bear} - V_{toe_wt_base} = 21.4 \text{ kN/m}$						
Calculate moment for toe de	esign								
Moment from bearing pressure	e	$M_{toe_bear} = ($	$2 \times p_{toe_f} + p_{ster}$	$m_{m_{d_f}} \times (I_{toe} + t_{wa})$	$(12)^2 / 6 = 7.4$	kNm/m			
Moment from weight of base		$M_{toe_wt_base}$	= ($\gamma_{f_d} \times \gamma_{base} \times$	$t_{\text{base}} imes (I_{\text{toe}} + t_{\text{wall}})$	(2) ² / 2) = 0.8	kNm/m			
Total moment for toe design		$M_{toe} = M_{toe}$	_bear - M _{toe_wt_bas}	_e = 6.5 kNm/m					
→ 300 → 245		•	•	• •					
	 ⊲ —20	0►							
Check toe in bending									
Width of toe		b = 1000 mm/m							
	Depth of reinforcement			$d_{toe} = t_{base} - c_{toe} - (\phi_{toe} / 2) = 245.0 \text{ mm}$					
Constant	$K_{toe} = M_{toe} / (b \times d_{toe}^2 \times f_{cu}) = 0.003$ Compression reinforcement is not requ								
Lever arm		$z_{toe} = min(0)$ $z_{toe} = 233$ r		min(K _{toe} , 0.225) /	0.9)),0.95) × (Jtoe			
Area of tension reinforcement	required	$A_{s_toe_des} =$	M_{toe} / (0.87 $ imes$ fy	$y \times z_{\text{toe}}$) = 64 mm ²	²/m				
	-		$\mathbf{k} \times \mathbf{b} \times \mathbf{t}_{\text{base}} = 3$	-					
Minimum area of tension reinf	required			A _{s_toe_min}) = 390 r	nm²/m				
Minimum area of tension reinf Area of tension reinforcement									
	- 1	10 mm dia	.bars @ 200 r	nm centres					
Area of tension reinforcement			.bars @ 200 r 393 mm²/m	nm centres					

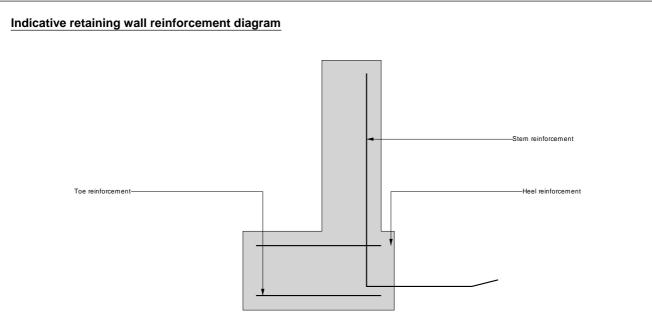
Tedds	14 ELDON GROVE, LONDON NW3			Job no. 3791				
Ian Drummond Consulting Engineers	Calcs for	PARTY FENCE RETAINING WALL				Start page no./Revision C 16		
90 Cowcross Street London	Calcs by AB	Calcs date Checked by Checked date Approved by						
Check shear resistance at to	20							
Design shear stress		v _{toe} = V _{toe} /	$(b \times d_{toe}) = 0.0$	87 N/mm ²				
Allowable shear stress		v _{adm} = min((0.8 × √(f _{cu} / 1 ľ	N/mm²), 5) × 1 N/	/mm ² = 4.733 N	√mm²		
		PASS -	Design shea	r stress is less t	han maximun	n shear str		
From BS8110:Part 1:1997 -	Table 3.8							
Design concrete shear stress		Vc_toe = 0.4 3						
			Vte	oe < Vc_toe - No sł	iear reinforce	ment requi		
Design of reinforced concre	te retaining wa	all heel (BS 8002:	1994)					
Material properties								
Characteristic strength of cond		f _{cu} = 35 N/r						
Characteristic strength of reinf	orcement	f _y = 500 N/	mm²					
Base details								
Minimum area of reinforcemen		k = 0.13 %						
Cover to reinforcement in hee		Cheel = 50 n	nm					
Calculate shear for heel des	ign							
Shear from weight of base		$V_{\text{heel_wt_base}} = \gamma_{f_d} \times \gamma_{\text{base}} \times I_{\text{heel}} \times t_{\text{base}} = \textbf{0.5 kN/m}$						
Shear from weight of moist ba	$V_{\text{heel}_wt_m} = w_{m_w_f} = 0.7 \text{ kN/m}$							
Shear from weight of saturated backfill		$V_{heel_wt_s} = W_{s_f} = 0.3 \text{ kN/m}$						
Shear from surcharge			/ _{sur_f} = 0.8 kN/r			1/22		
Total shear for heel design		Vheel = Vhee	I_wt_base + Vheel_v	wt_m + V _{heel_wt_s} + `	V heel_sur = 2.3 kl	N/II)		
Calculate moment for heel d	esign		(10)210)	LAL Inter for		
Moment from weight of base	ookfill			$\langle t_{\text{base}} \times (l_{\text{heel}} + t_{\text{wal}})$		KININ/M		
Moment from weight of moist I				+ t _{wall}) / 2 = 0.1 kN				
Moment from weight of satura	ieu dackfill	$M_{\text{heel}_wt_s} = w_{s_f} \times (I_{\text{heel}} + t_{\text{wall}}) / 2 = 0 \text{ kNm/m}$ $M_{\text{heel}_wt_s} = w_{s_f} \times (I_{\text{heel}} + t_{\text{wall}}) / 2 = 0 \text{ kNm/m}$						
Moment from surcharge		M _{heel_sur} = w _{sur_f} × (I _{heel} + t _{wall}) / 2 = 0.1 kNm/m M _{heel} = M _{heel_wt_base} + M _{heel_wt_m} + M _{heel_wt_s} + M _{heel_sur} = 0.4 kNm/m						
Total moment for heel design		Wheel = Mhe	el_wt_base + Mheel	_wt_m + IVIheel_wt_s +	· IVIheel_sur = 0.4	KINM/M		
	∢ —_20	0						
Ť								
				•				
300-	\geq							
30 245								
<u> </u>								
Check heel in bending								
Width of heel		b = 1000 n	nm/m					
Depth of reinforcement		$d_{\text{heel}} = t_{\text{base}}$	- Cheel - (¢heel /	2) = 245.0 mm				
Constant		K _{heel} = M _{hee}	el / (b $ imes$ d _{heel} ² $ imes$	-				
				Compression re		-		
Lever arm				(min(K _{heel} , 0.225)	/ 0.9)),0.95) ×	dheel		
A () · · · · · ·		Zheel = 233		, <u> </u>	21			
Area of tension reinforcement			$A_{s_heel_des} = M_{heel} / (0.87 \times f_y \times z_{heel}) = 4 \text{ mm}^2/\text{m}$					
Minimum area of tension reinf		$A_{s_heel_min} = k \times b \times t_{base} = 390 \text{ mm}^2/\text{m}$						

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90 Cowcross Street London	Calcs by AB	Calcs date 04/07/2014	Checked by	Checked date	Approved by	Approved date			
Area of tension reinforcement re	equired	As_heel_req =	Max(As_heel_des	, As_heel_min) = 390) mm²/m				
Reinforcement provided		10 mm dia	.bars @ 200 r	nm centres					
Area of reinforcement provided		As_heel_prov =	393 mm²/m						
		PASS - Reinf	orcement pro	vided at the reta	aining wall he	el is adequa			
Check shear resistance at hee	əl								
Design shear stress		v _{heel} = V _{heel}	/ (b × d _{heel}) = 0).009 N/mm ²					
Allowable shear stress		$v_{adm} = min($	0.8 × √(f _{cu} / 1 №	N/mm²), 5) × 1 N/	mm² = 4.733 ۱	N/mm ²			
		PASS -	Design shea	r stress is less t	han maximun	n shear stres			
From BS8110:Part 1:1997 – Ta	able 3.8								
Design concrete shear stress		Vc heel = 0.4	34 N/mm ²						
				l < Vc heel - No sh	near reinforce	ment require			
Design of sainfaces designed		-II etem (DC 0002	.4004)			-			
Design of reinforced concrete	e retaining wa	all stem (BS 8002	:1994)						
Material properties			0						
Characteristic strength of concre		$f_{cu} = 35 \text{ N/mm}^2$							
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} = 50 n	nm						
Cover to reinforcement in wall		c _{wall} = 35 mm							
Factored horizontal at-rest for	rces on stem	1							
Surcharge		$F_{s_sur_f} = \gamma_{f_i}$	$ imes K_0 imes$ Surcha	arge imes (h _{eff} - t _{base} -	- d _{ds}) = 6 kN/m				
Moist backfill above water table		$F_{smaf} = 0$	$.5 imes \gamma_{\rm fe} imes {\sf K}_0 imes$	$\gamma_{\rm m} imes (h_{\rm eff} - t_{\rm base} - c)$	d _{ds} - h _{sat}) ² = 1.7	∕ kN/m			
Moist backfill below water table		$F_{s_m_b_f} = \gamma_{f_e} \times K_0 \times \gamma_m \times (h_{eff} - t_{base} - d_{ds} - h_{sat}) \times h_{sat} = \textbf{1.5} \text{ kN/m}$							
Saturated backfill		$F_{s_s_f} = 0.5 \times \gamma_{f_e} \times K_0 \times (\gamma_{s} - \gamma_{water}) \times h_{sat}^2 = 0.2 \text{ kN/m}$							
Water		$F_{s_water_f} = 0.5 \times \gamma_{f_e} \times \gamma_{water} \times h_{sat}^2 = 0.3 \text{ kN/m}$							
Calculate shear for stem desig	an								
Shear at base of stem	gn	VE		$F_{s_m_b_f} + F_{s_s_f} +$	E	kN/m			
		v stem – 1 s_s	ur_t 〒 I S_M_A_t Ŧ		I s_water_t - 3.1				
Calculate moment for stem de	esign								
Surcharge		$M_{s_sur} = F_{s_sur_f} \times (h_{stem} + t_{base}) / 2 = 2.9 \text{ kNm/m}$							
Moist backfill above water table		$M_{s_m_a} = F_{s_m_a_f} \times (2 \times h_{sat} + h_{eff} - d_{ds} + t_{base} / 2) / 3 = 0.9 \text{ kNm/m}$							
Moist backfill below water table		$M_{s_m_b} = F_{s_m_b_f} \times h_{sat} / 2 = 0.2 \text{ kNm/m}$							
Saturated backfill	$M_{s_s} = F_{s_s_f} \times h_{sat} / 3 = 0 \text{ kNm/m}$								
Water	$M_{s_water} = F_{s_water_f} \times h_{sat} / 3 = 0 \text{ kNm/m}$								
Total moment for stem design		$M_{stem} = M_{s_{-}}$	_{sur} + M _{s_m_a} + N	$M_{s_m_b} + M_{s_s} + M_{s_s}$	s_water = 3.9 kNr	m/m			
	•	•	•	• •					

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lan Drummond Consulting Engineers	PARTY FENCE RETAINING WALL				Start page no./Revision C 18				
90 Cowcross Street London	Calcs by AB	Calcs date 04/07/2014			Approved by	Approved da			
Check wall stem in bending Width of wall stem		b = 1000 r	nm/m						
Depth of reinforcement				(2) = 170.0 mm					
Constant			(ϕ_{stem})	,					
oonstant		rtstem – Wist		Compression re	inforcement i	s not requir			
Lever arm		Z _{stem} = min		-		-			
		z _{stem} = min(0.5 + √(0.25 - (min(K _{stem} , 0.225) / 0.9)),0.95) × d _{stem} z _{stem} = 161 mm							
Area of tension reinforcement r	eauired		$A_{s_stem_des} = M_{stem} / (0.87 \times f_y \times z_{stem}) = 55 \text{ mm}^2/\text{m}$						
Minimum area of tension reinforcement			$A_{s_stem_min} = k \times b \times t_{wall} = 293 \text{ mm}^2/\text{m}$						
Area of tension reinforcement required			As_stem_req = Max(As_stem_des, As_stem_min) = 293 mm ² /m						
Reinforcement provided			a.bars @ 200 r	-					
Area of reinforcement provided		As_stem_prov	= 393 mm²/m						
		PASS - Reinf	orcement prov	vided at the reta	ining wall ste	m is adequa			
Check shear resistance at wa	all stem								
Design shear stress		v _{stem} = V _{ste}	m / (b × d _{stem}) =	0.057 N/mm ²					
Allowable shear stress			v_{adm} = min(0.8 × $\sqrt{(f_{cu} / 1 N/mm^2)}$, 5) × 1 N/mm ² = 4.733 N/mm ²						
				r stress is less i					
From BS8110:Part 1:1997 - T	able 3.8		-						
Design concrete shear stress		$V_{c_{stem}} = 0.$	537 N/mm ²						
			V _{stem}	o < ∨ _{c_stem} - No sl	hear reinforce	ment requir			
Check retaining wall deflection	on								
Basic span/effective depth ratio		ratio _{bas} = 7	ratio _{bas} = 7						
Design service stress	$f_s = 2 \times f_y >$	$f_{s} = 2 \times f_{y} \times A_{s_stem_req} / (3 \times A_{s_stem_prov}) = \textbf{248.3 N/mm}^{2}$							
Modification factor	factor _{tens} = mi	in(0.55 + (477 N/r	nm² - fs)/(120 $ imes$	(0.9 N/mm ² + (N	$A_{\rm stem}/(b \times d_{\rm stem}^2)$)))),2) = 2.00			
Maximum span/effective depth	ratio	ratio _{max} = r	$atio_{bas} imes factor_{t}$	tens = 14.00					
Actual span/effective depth rati	0	ratio _{act} = h	_{stem} / d _{stem} = 3.8	32					
				PASS - Span	to depth ratio	is acceptal			

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Toe bars - 10 mm dia.@ 200 mm centres - (393 mm²/m) Heel bars - 10 mm dia.@ 200 mm centres - (393 mm²/m) Stem bars - 10 mm dia.@ 200 mm centres - (393 mm²/m)