Structural Calculations

for new basement at

10, Downside Crescent Belsize Park, London NW3 2AP

rodriguesassociates

1 Amwell Street London EC1R 1UL Telephone 020 7837 1133 www.rodriguesassociates.com October 2016 **Structural Calculations**

for

10, Downside Crescent Belsize Park, London NW3 for

Bow Tie Construction Ltd Unit 86, Cressex Enterprise Centre, Lincoln Road High Wycombe, Bucks HP12 3RL

Job No 1411

Rev	Date	Notes
-	12.10.16	Structural package

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1. CALCULATION PLAN

This report contains the structural engineering calculations for the proposed new basement for 10, Downside Crescent.

The development consists of an existing semi-detached house rear extension. The extension will be composed by two levels: basement and ground floor. The access from the main building will be provided creating a new opening in the existing building back wall.

1.1. SUMMARY OF STRUCTURE

Proposed plan area – extension

Maximum plan dimensions	6.4m by 6.5m, say
Footprint area	41.6m²
Storeys	Basement and Ground floor
Maximum height	3m over ground level

1.2. IMPOSED LOADS

The following imposed loads have been used

Typical imposed loads on pitched roofs	0.75 kN/m ²
Typical imposed loads on floors	1.50 kN/m ²
Partitions loads on floors (as imposed loads)	1.00 kN/m ²
Typical imposed loads on flat roofs allowing for maintenance	1.50 kN/m ²

1.3. REAR EXTENSION

The basement of the new extension will be realised with new reinforced concrete walls and slabs. Ground floor walls will be realized with cavity block works and the roof will be mainly constructed in timber elements and steel beams.

2. RESOURCES

2.1 CODES & REFERENCES

- BS6399 Pt1 Loadings for buildings. Code of practice for dead and imposed loads.
- BS6399 Pt2 Loadings for buildings. Code of practice for wind loads.
- BS6399 Pt3 Loadings for buildings. Code of practice for imposed roof loads.
- BS5269 Pt2 Structural use of Timber. Code of practice for permissible stress design, materials and workmanship.
- BS5628 Pt1 Use of masonry. Structural use of unreinforced masonry.
- BS5950 Pt1 Structural use of steelwork in building. Code of practice for design in simple and continuous construction hot rolled sections.
- BS8110 Pt1 Structural use of concrete

Manual for the design of plain masonry in building structures – The Institution of Structural Engineers. July 1997.

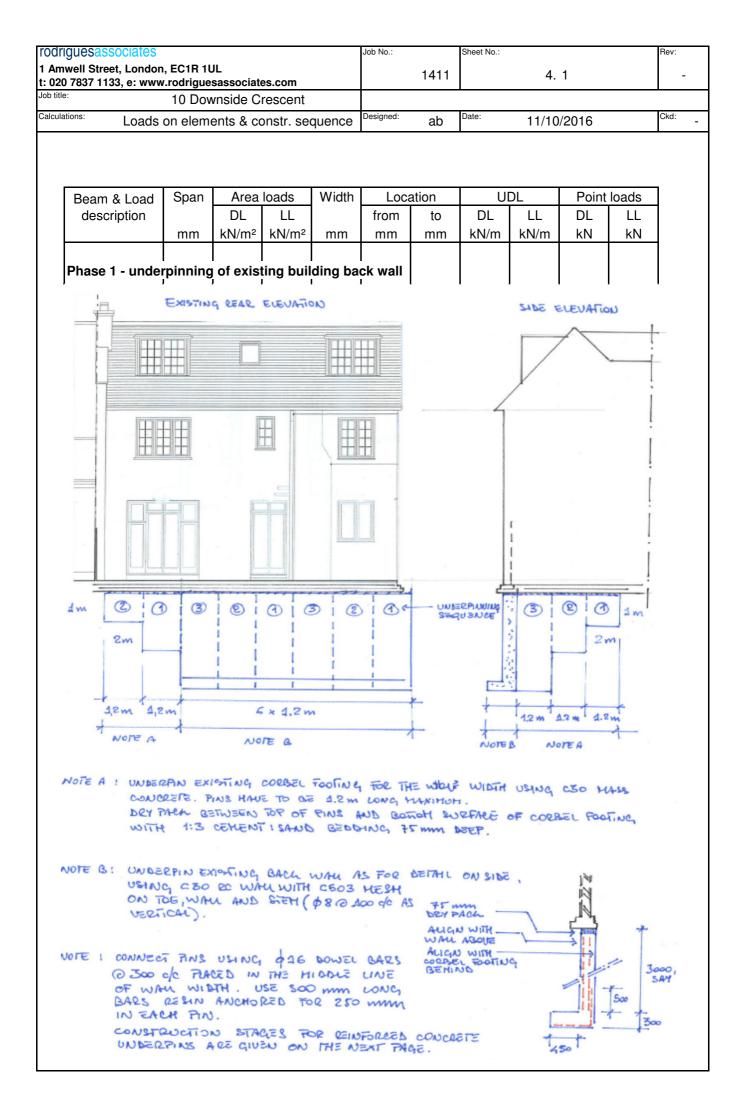
2.2 SOFTWARE

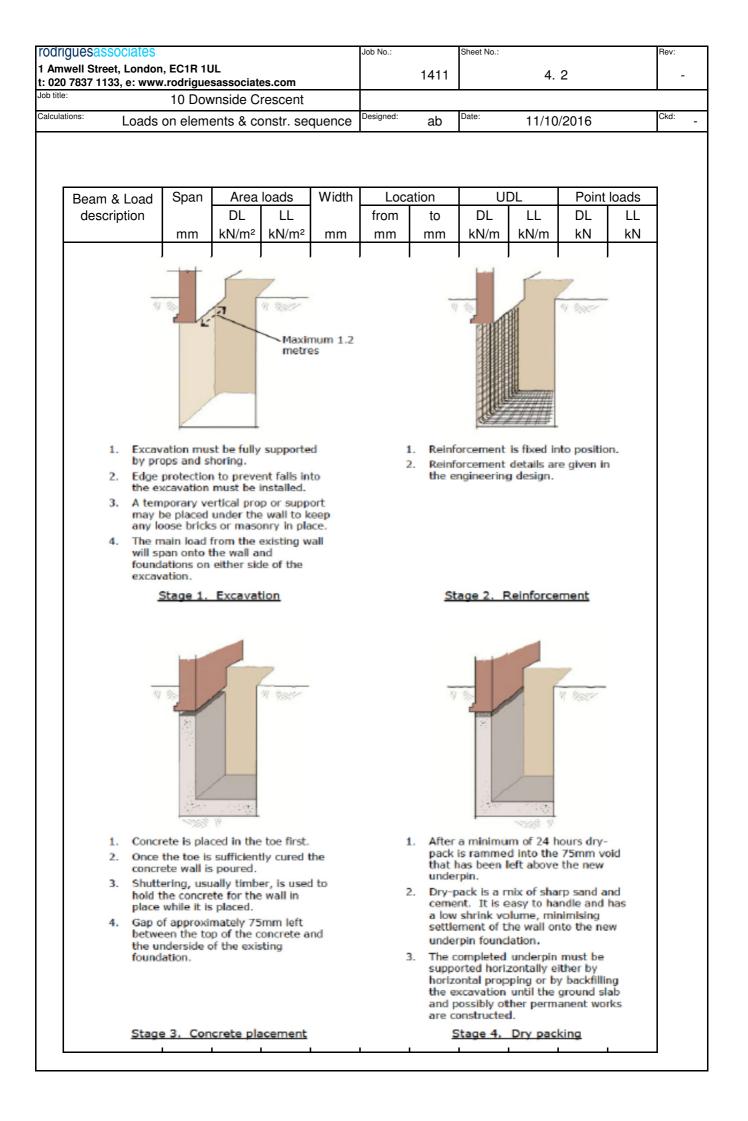
Tekla Structural Designer suite of design and analysis tools.

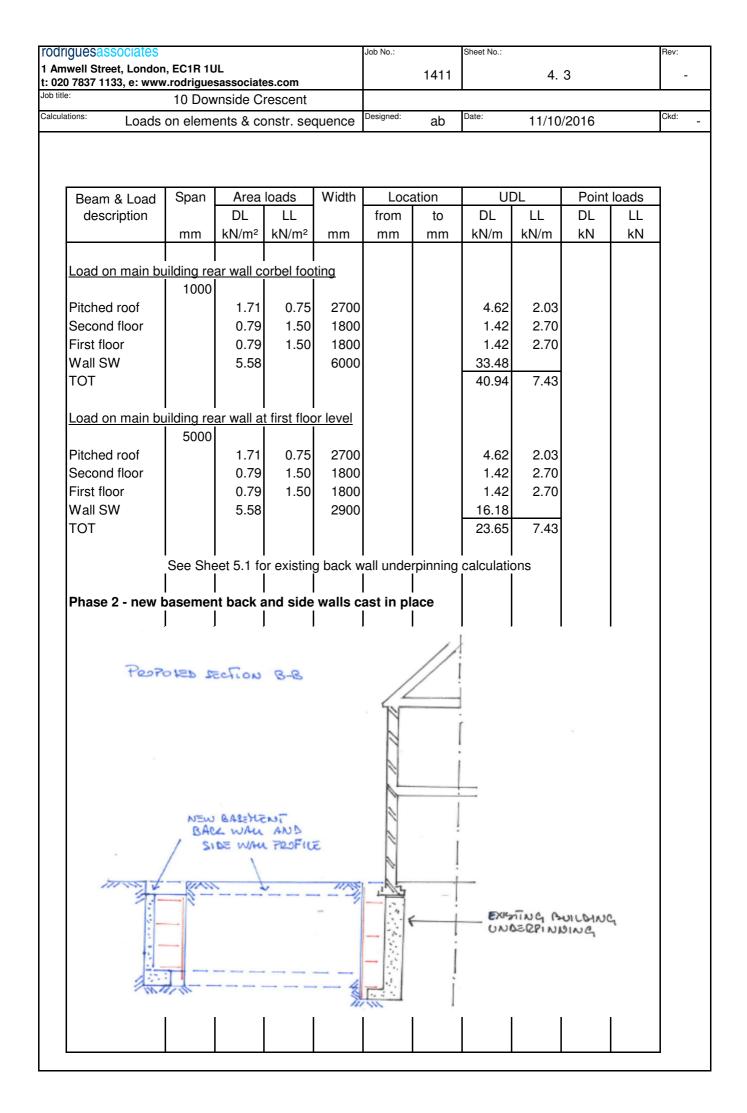
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ns:		Designed: Det		(
	Area loads	Designed: ab	^{te:} 11/10/2016	
xisting pitched	l roof			
Dead	Tiles or slates		0.80 kN/m	
	Battens and felt		0.05 kN/m	
	Rafters		0.15 kN/m	
	Insulation		0.01 kN/m	
	Services		0.05 kN/m	
	Plasterboard and skim coat		0.15 kN/m	2
			1.21 kN/m	2
	Roof Angle 45 °		1.71 kN/m	2
Impose	ed		0.75 kN/m	2
xisting typical	floor			
Dead	Finishes		0.15 kN/m	2
Doud	Boarding		0.14 kN/m	
	Joists		0.15 kN/m	
	Insulation		0.05 kN/m	
	Services		0.05 kN/m	
	Lath and plaster		0.25 kN/m	
			0.79 kN/m	
Impose	ed		1.50 kN/m	2
xternal brick w	vall			
Dead	External render		0.60 kN/m	2
- 044	215mm brickwork		4.73 kN/m	
	Plaster		0.25 kN/m	
			5.58 kN/m	

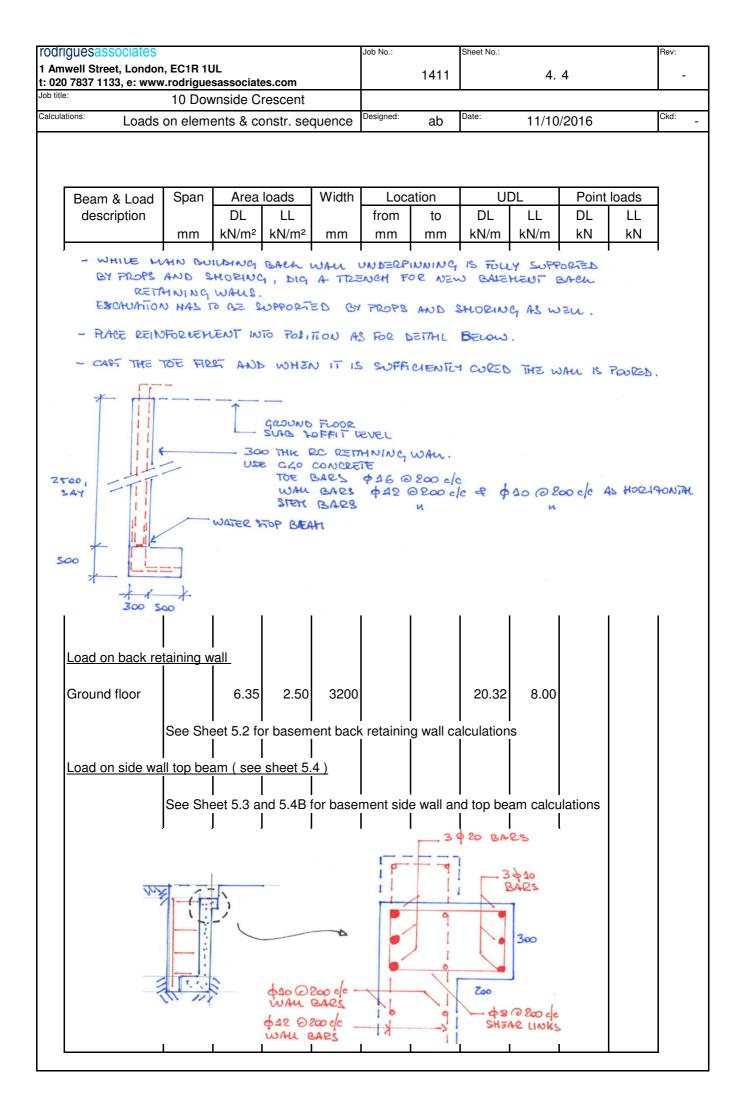
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e:	10 Downside Crescent		-		-
ations:	Area loads	Designed:	ab ^{Date:}	11/10/2016	Ckd:
Proposed gr	ound floor slab				
Dea	d Finishes			0.15 kN/m	2
Dou	Screed			1.80 kN/m	
	Insulation			0.05 kN/m	
	175mm slab			4.20 kN/m	
	Services			0.15 kN/m	
	Gervices			6.35 kN/m	
Imp	aad			1.50 kN/m	2
mp	osed Partitions			1.00 kN/m	
	Parimons			2.50 kN/m	
				2.50 KIN/III	
Proposed ba	sement floor slab				
Dea	d Finishes			0.15 kN/m	2
204	Screed			1.80 kN/m	
	Insulation			0.05 kN/m	
	500mm slab			12.00 kN/m	
	Services			0.15 kN/m	
	Services			14.15 kN/m	
Imp	osed			1.50 kN/m	2
	Partitions			1.00 kN/m	
	1 difficito			2.50 kN/m	
Proposed fla	<u>t roof</u>				
Dea	d Fibre glass waterproofing			0.15 kN/m	2
	Boarding			0.14 kN/m	2
	Insulation			0.05 kN/m	2
	Joists			0.15 kN/m	2
	Services			0.05 kN/m	2
	Plasterboard and skim coa	at		0.15 kN/m	2
				0.69 kN/m	
Imp	osed (allowing for maintenance	e of structure above	e)	1.50 kN/m	2
Glazing					
Dea	d Glazing (Double)			0.65 kN/m	2
200	Framing			0.20 kN/m	
				0.85 kN/m	

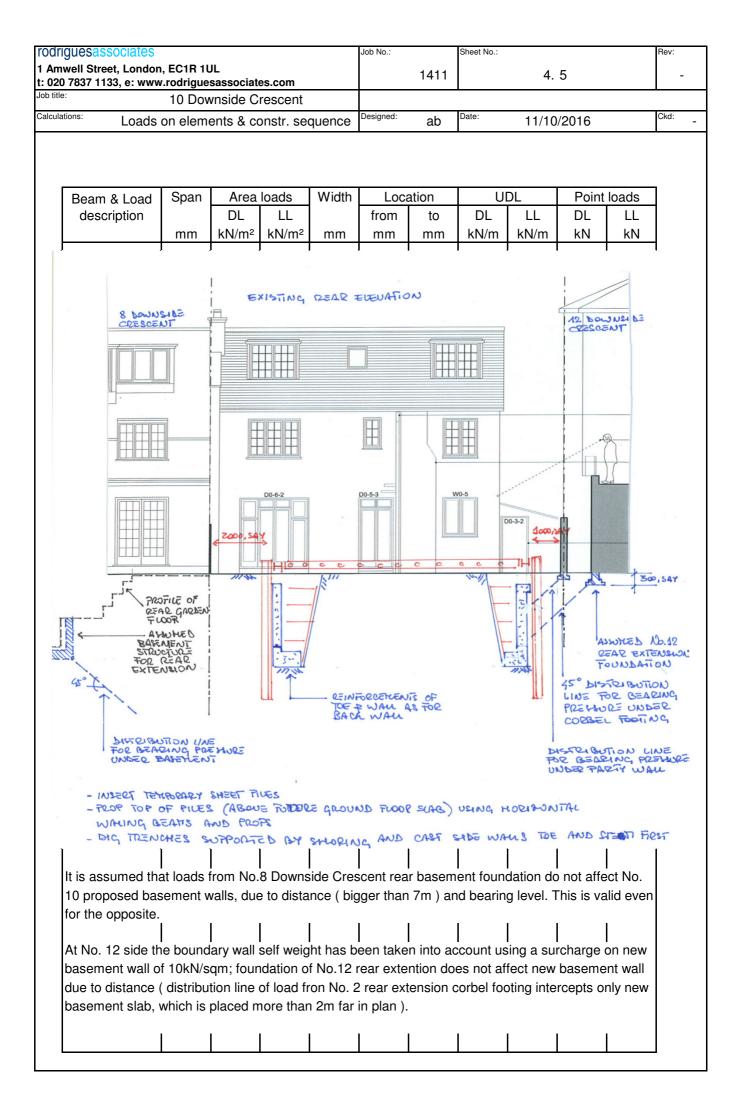
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Job title:	10 Downside Crescent			-	-
Calculations:	Area loads	Designed:	ab	Date: 11/10/2016	6 ^{Ckd:} -
<u>Proposed exte</u> Dead	rnal wall External render 100mm blockwork Insulation 100mm block work Plasterboard and skim coat			1 0 1 0	.60 kN/m ² .50 kN/m ² .05 kN/m ² .50 kN/m ² .15 kN/m ² .80 kN/m ²





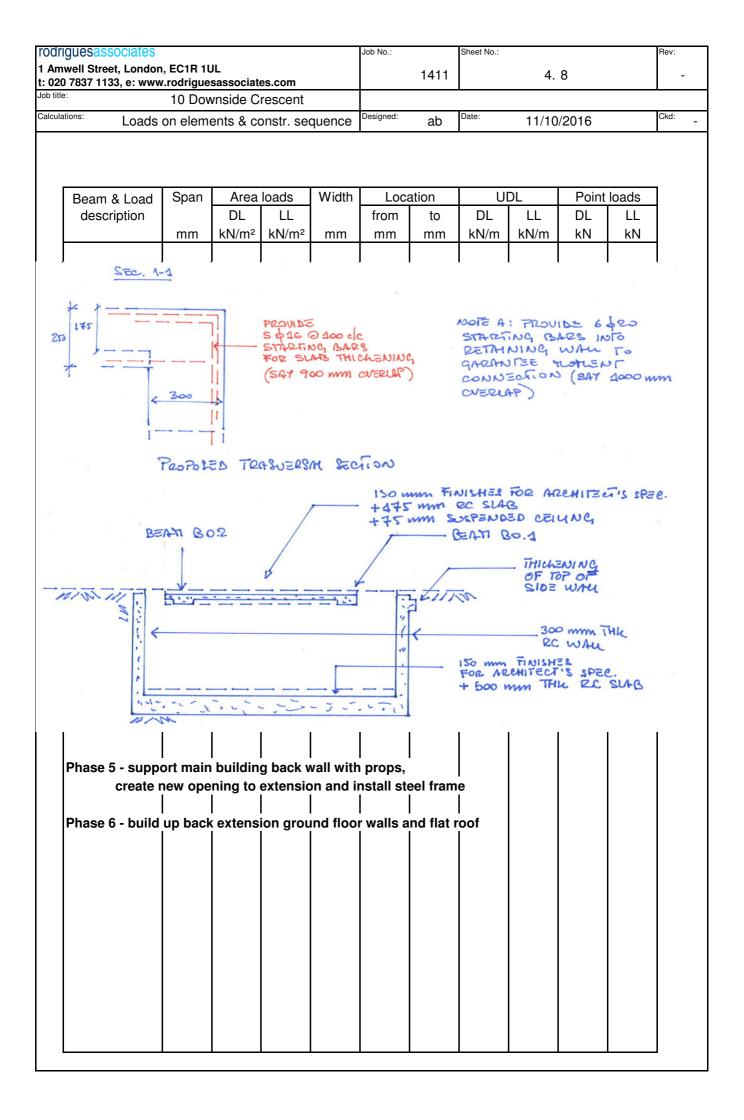






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e:	10 Dov	vnside C	rescent				-				
ations: Loads	on elem	ents & co	onstr. see	quence	Designed:	ab	Date:	11/10	/2016		Ckd:
Beam & Load	Span	Area	loads	Width	Loca	ation	U	DL	Point	loads	
description		DL	LL		from	to	DL	LL	DL	LL	
	mm	kN/m²	kN/m ²	mm	mm	mm	kN/m	kN/m	kN	kN	
Phase 3 - new l) basemer	nt front v	wall and	slab ca	st in pla	се					
71070120	SECTION	B-B					I, ,				l
112107 8			1.2		AREAI	N OR	HIDN W SER TO MUNG	PLACE	TOP		
Hoee	0 0 0	000	•11H		COWER BONDY	EXCAN PROP	UAT10N S.	AGAIN	V is Pa	ARE	
	0 00 0	0 0 0		500	DEINFO	AGAIN RECEVE	U EXCA ENT AN BLAB,	UATION DE CAST	, FUAR	E MNU TH	le
RE WI	TH CHEM	C/C HOE BAR	ERTION		BOIR	2 200 c/c 1 01 2200 2 P 7 B	TONS		NG BAR		
Peopoleso		U B-B	11 11				ot hoe then?			2	
					AND OUTSUD	≠ A2 0 E FAE	RETE FOI 200 cle E), ¢ 3ARS (11	BARS	(INSID 200 clc	E AND	
	ground 1			i place							
Phase 4 - new g	<u>tension c</u>						_	_			
Load on new ex	tension <u>c</u> 6400x3	1					6.35	2.50			1
	6400x3	6.35		1000 I floor sla	ıb calcul	ations					
Load on new ex	6400x3	6.35			ıb calcul	ations					

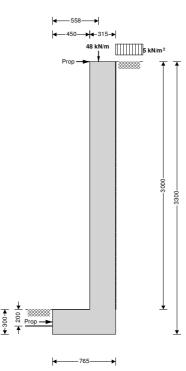
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Calculations:	on eleme				Designed:	ab	Date:	11/10	/2016		Ckd:
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Beam & Load	Span	Area	loade	Width		ation	U	ור	Point I	nade	
description	Opan	DL	LL	WIGUI	from	to	DL		DL	LL	
	mm	kN/m²	kN/m²	mm	mm	mm	kN/m	kN/m	kN	kN	
PROPOSED	SECTION	B-B	11	- 7	esp Agn	IN REM	INING h	Au AT	LOWER		
	====		- H				TOUE				
HLE WATER	4	c e	H	- 0	AST GRE	OND F	LOOP SI	AB 17	5 mm Ti	HILL.	
- BAR			····	WAJER	BARS A	FIOP	AND BO	mon 1	N BOIL	1	
			: :.	GAR	ARECT	ONS.					
A CONTRACTOR	18. C. S.	100									
	י ן	1 1					1		[]		1
Beam B0.1											
	6400										
Ground floor		6.35	2.50		triangula	ar load	11.11	4.38			
Direct load on be	eam	2.15	2.50	500			1.08	1.25			
<u>Beam B0.2</u>											
<u>Boam Boil</u>	6400										
Ground floor		6.35	2.50	1750	triangula	ar load	11.11	4.38			
		6.35	1.50	400				0.60			
Direct load on be	eam	2.15	2.50	500		4400		1.25			
Glazed door Cavity wall abov		0.85 3.80		2300 2500		4400 6400					
Roof	1600	0.69	1.50	2500	4400	0400	0.00		2.76	6.00	
	See She	eet 5.6 ai	nd 5.7 fo	r beam I	B0.1 and	B0.2 ca	lculation	S			
	<u> </u>		PEOF	Poled G	ROUND	floor r	in		×		
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		SHEY EIGH		\				VOID FOR			
			-		+	L ····					
5	500 x 250	AZEP					극가		<i></i>		
6+5	PC BEAL	RS-		1	30.2 145 1	nm THK. SLAB		NISTING			
SHE	AP UNI	rs of BI		-	L BC	slab —		A B			
(200			7 1		V		1	BALEMENT	F		
	2ETA	HNALC HS BELO	1 1 1 1	1	B 0.1			BASETIENT WHUS P	ROFILE		
	0071	- s bell	1-7.			175					
	Soox	250 DEEP	7:			14					
Sts	\$46 BARS	WITH -	ž E	7	×						
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	Calcs for	exist back wal	l underpinning		Start page no./Re 5.	evision I.1
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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

Cantilever propped at both h_{stem} = **3000** mm twall = 315 mm I_{toe} = **450** mm $I_{heel} = \mathbf{0} mm$ $I_{\text{base}} = I_{\text{toe}} + I_{\text{heel}} + t_{\text{wall}} = 765 \text{ mm}$ t_{base} = **300** mm $d_{ds} = 0 \text{ mm}$ lds = **15** mm t_{ds} = **300** mm $h_{wall} = h_{stem} + t_{base} + d_{ds} = 3300 \text{ mm}$ $d_{cover} = \mathbf{0} mm$ d_{exc} = **200** mm $h_{water} = 0 mm$ $h_{sat} = max(h_{water} - t_{base} - d_{ds}, 0 mm) = 0 mm$ $\gamma_{wall} = 23.6 \text{ kN/m}^3$ γ_{base} = 23.6 kN/m³ $\alpha = 90.0 \text{ deg}$ $\beta = 0.0 \text{ deg}$ $h_{eff} = h_{wall} + I_{heel} \times tan(\beta) = 3300 \text{ mm}$

M = **1.5** γ_m = **18.0** kN/m³

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RODRIGUES ASSOCIATES	Calcs for	exist back wa	Start page no./F	Revision 5.1. 2		
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved date
Saturated density of retained n	naterial	γ _s = 21.0 kl				
Design shear strength		φ' = 18.6 de	-			
Angle of wall friction		$\delta = 0.0 \text{ deg}$	1			
Base material details						
Firm clay						
Moist density		γ _{mb} = 18.0				
Design shear strength		φ' _b = 16.5 d	-			
Design base friction		δ _b = 18.6 d	-			
Allowable bearing pressure		P _{bearing} = 10)0 kN/m²			
Using Coulomb theory Active pressure coefficient for $K_a = sin(c)$ Passive pressure coefficient for	$(\alpha + \phi')^2 / (\sin(\alpha)^2)$ r base material	$^{2} \times \sin(\alpha - \delta) \times [1 +]$				
	ιτρ = 5ii	i(θ0 - ψb) / (Siii(θ0) - 06) × [1 - V(8	$\sin(\psi + 0) \times \sin(\psi$	φο) / (Siii(30 +	(00))))) = 2.000
At-rest pressure	-t-stal		- (12) 0 001			
At-rest pressure for retained m	aterial	$\kappa_0 = 1 - \sin^2 \theta$	n(φ') = 0.681			
Loading details Surcharge load on plan Applied vertical dead load on w Applied vertical live load on wa Position of applied vertical load Applied horizontal dead load o Applied horizontal live load on Height of applied horizontal load	ll d on wall n wall wall	Surcharge $W_{dead} = 41$. $W_{live} = 7.4$ $I_{load} = 558$ r $F_{dead} = 0.0$ $F_{live} = 0.0$ k $h_{load} = 0$ mr	kN/m nm kN/m N/m			
0 11		48 ↓ []]]]]				
	م <u>م</u> 4.8 و ع	Prop				
				Loads show	vn in kN/m, pressu	res shown in kN/m ²

Loads shown in kN/m, pressures shown in kN/m²

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1 AMWELL STREET	Calcs for	evist back wa	II underpinning	a	Start page no./I	Revision		
LONDON			-	-				
EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved da		
Vertical forces on wall								
Wall stem		$w_{wall} = h_{stern}$	$x \times t_{wall} \times \gamma_{wall} =$	22.3 kN/m				
Wall base		$W_{base} = I_{base}$	$ imes t_{base} imes \gamma_{base}$	= 5.4 kN/m				
Applied vertical load		$W_v = W_{dead}$	i + Wlive = 48.4	kN/m				
Total vertical load		$W_{total} = W_{wa}$	$H + W_{base} + W_v$	= 76.1 kN/m				
Horizontal forces on wall								
Surcharge		$F_{sur} = K_a \times$	Surcharge \times h	l _{eff} = 8.5 kN/m				
Moist backfill above water tabl	e	$F_{m_a} = 0.5$	$ imes$ Ka $ imes$ γ_{m} $ imes$ (he	$ff - h_{water})^2 = 50.6$	kN/m			
Total horizontal load		$F_{total} = F_{sur} + F_{m_a} = 59.1 \text{ kN/m}$						
Calculate total propping for	ce							
Passive resistance of soil in fr		$F_p = 0.5 \times I$	$K_{p} \times \cos(\delta_{b}) \times \delta_{b}$	(d _{cover} + t _{base} + d _d	s - d_{exc}) ² × γ_{mb} =	• 0.2 kN/m		
Propping force		$F_{prop} = max(F_{total} - F_p - (W_{total} - W_{live}) \times tan(\delta_b), 0 \text{ kN/m})$						
		F _{prop} = 35.8 kN/m						
Overturning moments								
Surcharge		M _{sur} = F _{sur} :	× (h_{eff} - 2 × d_{ds}	s) / 2 = 14.1 kNm	/m			
Moist backfill above water tabl	e			., Nwater - 3 × dds) / 3				
Total overturning moment			Mm_a = 69.7					
Restoring moments			-					
Wall stem		Mwall = Wwall	\times (Itoe + twall / 2	2) = 13.5 kNm/m				
Wall base			$_{se} \times I_{base} / 2 = 2$					
Design vertical dead load			$_{ead} \times I_{load} = 22.9$					
Total restoring moment				_{ad} = 38.5 kNm/m				
Check bearing pressure								
Total vertical reaction		R = W _{total} =	• 76.1 kN/m					
Distance to reaction			2 = 383 mm					
Eccentricity of reaction		$e = abs((I_{ba}$	_{ase} / 2) - x _{bar}) =	0 mm				
			-	Reaction acts	within middle	e third of ba		
Bearing pressure at toe		$p_{toe} = (R / I)$	$_{ m base})$ - (6 $ imes$ R $ imes$	e / I _{base} ²) = 99.5	kN/m²			
Bearing pressure at heel		$p_{heel} = (R /$	I_{base}) + (6 × R \gtrsim	$\times e / I_{base^2}$ = 99.5	kN/m²			
	P	ASS - Maximum L	earing press	ure is less than	allowable bea	aring pressu		
Calculate propping forces to								

Propping force to base of wall

$$\begin{split} F_{prop_top} = (M_{ot} - M_{rest} + R \times I_{base} / 2 - F_{prop} \times t_{base} / 2) / (h_{stem} + t_{base} / 2) = \textbf{17.460} \text{ kN/m} \\ F_{prop_base} = F_{prop} - F_{prop_top} = \textbf{18.299} \text{ kN/m} \end{split}$$

	Project	10 Downsi	de Crescent		Job no. 1	411
RODRIGUES ASSOCIATES	Calcs for				Start page no./F	Revision
1 AMWELL STREET LONDON		exist back wa	II underpinning	9	5	.1. 4
EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved da
RETAINING WALL DESIGN (BS 8002:1994)				
		<u>L</u>			TEDDS calculation	n version 1.2.0
Ultimate limit state load fact	ors					
Dead load factor		$\gamma_{f_d} = 1.4$				
Live load factor		γ _{f_l} = 1.6				
Earth and water pressure facto	or	$\gamma_{f_e} = 1.4$				
Factored vertical forces on v	vall					
Wall stem		-		$\gamma_{wall} = 31.2 \text{ kN/n}$		
Wall base				$< \gamma_{\text{base}} = 7.6 \text{ kN/r}$		
Applied vertical load			-	W _{live} = 69.2 kN/n		
Total vertical load		$W_{total_f} = W_w$	vall_f + Wbase_f +	W _{v_f} = 108 kN/m		
Factored horizontal at-rest fe	orces on wall					
Surcharge		$F_{sur_f} = \gamma_{f_l} >$	$K_0 \times Surcharget$	ge × h _{eff} = 18 kN/	′m	
Moist backfill above water tabl	е	$F_{m_a_f} = \gamma_{f_e}$	$\times ~0.5 \times K_0 \times \gamma_{\rm r}$	$_{\rm m} imes ({\rm h_{eff}} - {\rm h_{water}})^2 =$	= 93.4 kN/m	
Total horizontal load		$F_{total_f} = F_{sur}$	r_f + Fm_a_f = 11	1.4 kN/m		
Calculate total propping for	e					
Passive resistance of soil in fro	ont of wall	$F_{p_f} = \gamma_{f_e} \times$	$0.5 imes K_p imes cos$	$\delta(\delta_b) imes (d_{cover} + t_{bal})$	se + d _{ds} - d _{exc}) ²	$\times \gamma_{mb} = 0.3$
kN/m						
Propping force		$F_{prop_f} = ma$ $F_{prop_f} = 78$.		$(W_{total_f} - \gamma_{f_l} \times W$	$I_{live}) imes tan(\delta_b), 0$	kN/m)
Factored overturning mome	nts					
Surcharge		$M_{sur_f} = F_{sur}$	$_{f} \times (h_{eff} - 2 \times d)$	d _{ds}) / 2 = 29.7 kN	m/m	
Moist backfill above water tabl	e	$M_{m_a_f} = F_m$	_a_f × (h _{eff} + 2 >	imes h _{water} - 3 $ imes$ d _{ds}) /	3 = 102.8 kNm	n/m
Total overturning moment		$M_{ot_f} = M_{sur_f}$	$_{f} + M_{m_a_f} = 13$	2.5 kNm/m		
Restoring moments						
Wall stem		$M_{wall_f} = W_{wall_f}$	$_{\text{all}_{f}} \times (I_{\text{toe}} + t_{\text{wall}})$	/ 2) = 19 kNm/m		
Wall base		$M_{base_f} = w_b$	$_{\rm ase_f} imes I_{ m base}$ / 2 =	= 2.9 kNm/m		
Design vertical load		$M_{v_f} = W_{v_f}$	\times I _{load} = 38.6 k	Nm/m		
Total restoring moment		$M_{rest_f} = M_{w}$	$all_f + M_{base_f} + I$	M _{v_f} = 60.5 kNm/	m	
Factored bearing pressure						
Total vertical reaction		$R_f = W_{total_f}$	= 108.0 kN/m			
Distance to reaction		$x_{bar_f} = I_{base}$	/ 2 = 383 mm			
Eccentricity of reaction		$e_f = abs((I_{ba}$	_{ase} / 2) - x _{bar_f}) :	= 0 mm		
				Reaction acts	within middle	e third of b
Bearing pressure at toe		$p_{toe_f} = (R_f / P_f)$	I_{base}) - (6 × R_{f}	$\times e_{f} / I_{base}^{2} = 141$	I.2 kN/m ²	
Bearing pressure at heel				$R_f \times e_f / I_{base}^2 = 14$		
Rate of change of base reaction				= 0.00 kN/m ² /m		_
Bearing pressure at stem / toe				te \times I _{toe}), 0 kN/m ²		
Bearing pressure at mid stem				$te \times (I_{toe} + t_{wall} / 2)$		
Bearing pressure at stem / hee	el	pstem_heel_f =	max(p _{toe_f} - (ra	ate × ($I_{toe} + t_{wall}$)),	0 kN/m ²) = 14 1	1 .2 kN/m ²
Calculate propping forces to	top and base	e of wall				

Propping force to base of wall

F_{prop_base_f} = F_{prop_f} - F_{prop_top_f} = **46.487** kN/m

Tekla	Project	10 Downoi	de Crescent		Job no.	411
Tedds		TO DOWNS	de Crescent		I	411
RODRIGUES ASSOCIATES	Calcs for				Start page no./F	Revision
1 AMWELL STREET		exist back wa	II underpinnin	g	5	.1. 5
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved date
		1	1	1	-1	
Design of reinforced concre	te retaining wa	all toe (BS 8002:1	<u>994)</u>			
Design of reinforced concre Material properties	te retaining w	all toe (BS 8002:1	<u>994)</u>			
-	-	<u>all toe (BS 8002:1</u> f _{cu} = 30 N/r				

k = 0.13 %

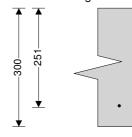
 $c_{toe} = 45 \text{ mm}$

Base details Minimum area of reinforcement Cover to reinforcement in toe Calculate shear for toe design

Shear from bearing pressure Shear from weight of base Total shear for toe design

Calculate moment for toe design

Moment from bearing pressure Moment from weight of base Total moment for toe design



$$\begin{split} & \mathsf{V}_{\text{toe_wt_base}} = \gamma_{f_d} \times \gamma_{\text{base}} \times \mathsf{l}_{\text{toe}} \times \mathsf{t}_{\text{base}} = \textbf{4.5 kN/m} \\ & \mathsf{V}_{\text{toe}} = \mathsf{V}_{\text{toe_bear}} - \mathsf{V}_{\text{toe_wt_base}} = \textbf{59.1 kN/m} \\ & \mathsf{M}_{\text{toe_bear}} = (2 \times p_{\text{toe_f}} + p_{\text{stem_mid_f}}) \times (\mathsf{l}_{\text{toe}} + \mathsf{t}_{\text{wall}} / 2)^2 / 6 = \textbf{26.1 kNm/m} \\ & \mathsf{M}_{\text{toe_wt_base}} = (\gamma_{f_d} \times \gamma_{\text{base}} \times \mathsf{t}_{\text{base}} \times (\mathsf{l}_{\text{toe}} + \mathsf{t}_{\text{wall}} / 2)^2 / 2) = \textbf{1.8 kNm/m} \end{split}$$

 $M_{toe} = M_{toe_bear} - M_{toe_wt_base} = 24.2 \text{ kNm/m}$

 $V_{toe_bear} = (p_{toe_f} + p_{stem_toe_f}) \times I_{toe} / 2 = 63.6 \text{ kN/m}$

▲100-**▶**

Check toe in bending	
Width of toe	b = 1000 mm/m
Depth of reinforcement	$d_{toe} = t_{base} - c_{toe} - (\phi_{toe} / 2) = 251.0 \text{ mm}$
Constant	$K_{toe} = M_{toe} / (b \times d_{toe}^2 \times f_{cu}) = 0.013$
	Compression reinforcement is not required
Lever arm	$z_{toe} = min(0.5 + \sqrt{(0.25 - (min(K_{toe}, 0.225) / 0.9)), 0.95)} \times d_{toe}$

Area of tension reinforcement required Minimum area of tension reinforcement Area of tension reinforcement required Reinforcement provided Area of reinforcement provided

Check shear resistance at toe Design shear stress Allowable shear stress

From BS8110:Part 1:1997 – Table 3.8 Design concrete shear stress
$$\begin{split} K_{toe} &= M_{toe} \ / \ (b \times d_{toe}^2 \times f_{cu}) = \textbf{0.013} \\ \hline & \textit{Compression reinforcement is not require} \\ z_{toe} &= \min(0.5 + \sqrt{(0.25 - (\min(K_{toe}, 0.225) \ / \ 0.9)), 0.95) \times d_{toe}} \\ z_{toe} &= \textbf{238 mm} \\ A_{s_toe_des} &= M_{toe} \ / \ (0.87 \times f_y \times z_{toe}) = \textbf{234 mm}^2 / m \\ A_{s_toe_min} &= k \times b \times t_{base} = \textbf{390 mm}^2 / m \\ A_{s_toe_req} &= Max(A_{s_toe_des}, A_{s_toe_min}) = \textbf{390 mm}^2 / m \\ \textbf{C503 mesh} \end{split}$$

 $A_{s_toe_prov} = 503 \text{ mm}^2/\text{m}$

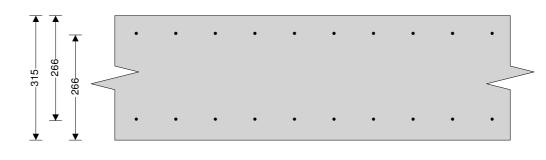
PASS - Reinforcement provided at the retaining wall toe is adequate

$$\label{eq:vtoe} \begin{split} v_{toe} &= V_{toe} \ / \ (b \times d_{toe}) = \textbf{0.235} \ \text{N/mm}^2 \\ v_{adm} &= \min(0.8 \times \sqrt{(f_{cu} \ / \ 1 \ \text{N/mm}^2), \ 5)} \times 1 \ \text{N/mm}^2 = \textbf{4.382} \ \text{N/mm}^2 \\ \textbf{PASS - Design shear stress is less than maximum shear stress} \end{split}$$

vc_toe = 0.441 N/mm²

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

	Project	10 Downsi	de Crescent		Job no. 1	1411
RODRIGUES ASSOCIATES	Calcs for				Start page no./	Revision
1 AMWELL STREET	Calcs IO	exist back wa	II underpinnin	a		5.1.6
LONDON	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved dat
EC1R 1UL	ab	12/10/2016			, pproved by	
Design of reinforced concre	te retaining wa	all stem (BS 8002	::1994)			
Material properties						
Characteristic strength of cond	crete	f _{cu} = 30 N/r	nm²			
Characteristic strength of reint	orcement	$f_y = 500 \text{ N}/$	mm²			
Wall details						
Minimum area of reinforcement	nt	k = 0.13 %				
Cover to reinforcement in ster	n	C _{stem} = 45 r	nm			
Cover to reinforcement in wall		c _{wall} = 45 m	ım			
Factored horizontal at-rest f	orces on stem	I				
Surcharge		$F_{s_sur_f} = \gamma_{f_}$	$_{1} \times K_{0} \times Surcha$	$arge imes (h_{eff} - t_{base} \cdot$	- d _{ds}) = 16.3 kN	√m
Moist backfill above water tabl	е	$F_{s_m_a_f} = 0$	$.5 imes \gamma_{f_e} imes K_0 imes$	$x \gamma_{m} imes (h_{eff} - t_{base} - t_{base})$	d _{ds} - h _{sat}) ² = 77	2.2 kN/m
Calculate shear for stem dea	sign					
Surcharge		$V_{s_sur_f} = 5$	$\times F_{s_{s_{s_{r_{f}}}}} / 8 = $	10.2 kN/m		
Moist backfill above water tabl	е	$V_{s_m_a_f} = F$	$s_{m_a_f} \times b_I \times (($	$5 imes L^2$) - bl ²) / (5 $ imes$	< L ³) = 60.2 kN	/m
Total shear for stem design		$V_{stem} = V_{s_s}$	$ur_f + V_{s_m_a_f} =$	₌ 70.4 kN/m		
Calculate moment for stem	design					
Surcharge		$M_{s_sur} = F_{s_}$	_{sur_f} × L / 8 = 6	5 .4 kNm/m		
Moist backfill above water tabl	е	$M_{s_m_a} = F_s$	$_{m_a_f} \times b_I \times ((5$	$5 imes L^2)$ - (3 $ imes$ bl ²)) /	′ (15 × L²) = 35	5.2 kNm/m
Total moment for stem design		$M_{stem} = M_{s_{-}}$	$sur + M_{s_m_a} = 4$	41.6 kNm/m		
Calculate moment for wall d	esign					
Surcharge		$M_{w_sur} = 9 >$	$< F_{s_sur_f} \times L / 1$	28 = 3.6 kNm/m		
Moist backfill above water tabl	е	$M_{w_m_a} = F_s$	s_m_a_f × 0.577>	$<$ bi \times [(bi ³ +5 \times ai \times L ²)/	/(5×L ³)-0.577 ² /	3] = 14.6
kNm/m						
Total moment for wall design		$M_{wall} = M_{w_s}$	sur + Mw_m_a = 1	18.2 kNm/m		
	∢ -100- >					

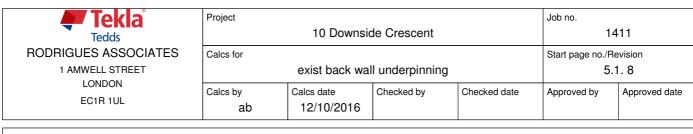


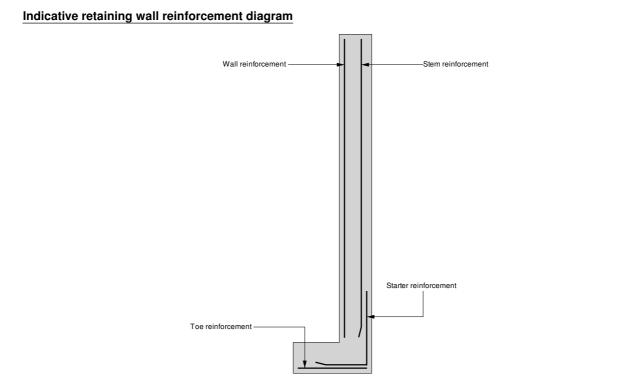
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Check wall stem in bending	
Width of wall stem	b = 1000 mm/m
Depth of reinforcement	d _{stem} = t _{wall} - c _{stem} - (φ _{stem} / 2) = 266.0 mm
Constant	$K_{stem} = M_{stem} / (b \times d_{stem}^2 \times f_{cu}) = 0.020$
	Compression reinforcement 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} = 253 mm
Area of tension reinforcement required	$A_{s_stem_des} = M_{stem} / (0.87 \times f_y \times z_{stem}) = 379 mm^2/m$

	Project	10 Downsi	ide Crescent		Job no. 1	411
RODRIGUES ASSOCIATES	Calcs for				Start page no./	
1 AMWELL STREET LONDON		exist back wa	all underpinnin	g	5	.1. 7
ECIR 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved da
Minimum area of tension reinfo	orcement	A _{s_stem_min} =	= $\mathbf{k} \times \mathbf{b} \times \mathbf{t}_{wall}$ =	410 mm²/m		
Area of tension reinforcement	required	As_stem_req =	Max(As_stem_de	es, As_stem_min) = 4 1	1 0 mm²/m	
Reinforcement provided		C503 mes	h			
Area of reinforcement provide	d	As_stem_prov	= 503 mm²/m			
		PASS - Reinfo	prcement pro	vided at the reta	ining wall ste	m is adequa
Check shear resistance at w	all stem					
Design shear stress		v _{stem} = V _{ster}	$_{\rm m}$ / (b × d _{stem}) =	• 0.265 N/mm ²		
Allowable shear stress		v _{adm} = min	(0.8 × √(f _{cu} / 1	N/mm^2), 5) × 1 N/	/mm ² = 4.382 N	√/mm²
				r stress is less t		
From BS8110:Part 1:1997 -	Table 3.8					
Design concrete shear stress		Vc_stem = 0.4	427 N/mm ²			
			Vsten	n < Vc_stem - No sł	near reinforce	ment requi
Check mid height of wall in	bending					
Depth of reinforcement		d _{wall} = t _{wall} -	- c _{wall} – (¢ _{wall} / 2	2) = 266.0 mm		
Constant		$K_{wall} = M_{wall}$	/ (b × d _{wall} ² × f	cu) = 0.009		
				Compression re	inforcement i	s not requi
Lever arm		z _{wall} = Min(0.5 + √(0.25 -	(min(K _{wall} , 0.225)	/ 0.9)),0.95) ×	dwall
		Z _{wall} = 253				
Area of tension reinforcement	required	A _{s_wall_des} =	M_{wall} / (0.87 \times	$f_y \times z_{wall}$) = 166 m	m²/m	
Minimum area of tension reinfo	orcement	A _{s wall min} =	$k \times b \times t_{wall} = 4$	110 mm²/m		
Area of tension reinforcement	required			$, A_{s_wall_min}) = 410$	mm²/m	
Reinforcement provided		C503 mes				
Area of reinforcement provide	d	$A_{s_wall_prov} =$	503 mm²/m			
	PAS	S - Reinforcemen	t provided to	the retaining wa	ll at mid heig	ht is adequ
Check retaining wall deflect	ion					
Basic span/effective depth rati		ratio _{bas} = 2	0			
-		$f_s = 2 \times f_y \times$	As_stem_req / (3	$\times A_{s_stem_prov}) = 2$	71.6 N/mm ²	
Design service stress				_		
Design service stress Modification factor	factor _{tens} = m	in(0.55 + (477 N/n	1m² - fs)/(120 ×	< (0.9 N/mm² + (N	$I_{\rm stem}/(b \times d_{\rm stem}^2)$)))),2) = 1.70
-			nm² - fs)/(120 > atio _{bas} × factor		/I _{stem} /(b × d _{stem} 2))))),2) = 1.70

PASS - Span to depth ratio is acceptable



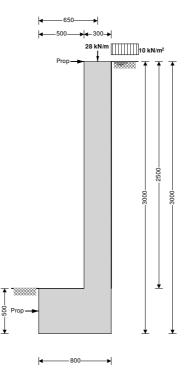


Toe mesh - C503 - (503 mm²/m) Wall mesh - C503 - (503 mm²/m) Stem mesh - C503 - (503 mm²/m)

Tekla Tedds	Project	10 Downsid	de Crescent		Job no. 14	111
RODRIGUES ASSOCIATES 1 AMWELL STREET	Calcs for	new basement b	ack retaining v	wall	Start page no./Re 5.2	evision 2.1
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	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

Cantilever propped at both h_{stem} = **2500** mm twall = 300 mm $I_{toe} = 500 \text{ mm}$ $I_{heel} = \mathbf{0} mm$ $I_{\text{base}} = I_{\text{toe}} + I_{\text{heel}} + t_{\text{wall}} = 800 \text{ mm}$ t_{base} = **500** mm $d_{ds} = 0 \text{ mm}$ lds = **15** mm t_{ds} = **500** mm $h_{wall} = h_{stem} + t_{base} + d_{ds} = 3000 \text{ mm}$ $d_{cover} = 0 mm$ $d_{exc} = 0 mm$ h_{water} = **3000** mm $h_{sat} = max(h_{water} - t_{base} - d_{ds}, 0 mm) = 2500 mm$ $\gamma_{wall} = 23.6 \text{ kN/m}^3$ γ_{base} = 23.6 kN/m³ $\alpha = 90.0 \text{ deg}$ $\beta = 0.0 \text{ deg}$ $h_{eff} = h_{wall} + I_{heel} \times tan(\beta) = 3000 \text{ mm}$

M = **1.5** γ_m = **18.0** kN/m³

	Project	10 Downs	ide Crescent		Job no. 1	411
RODRIGUES ASSOCIATES	Calcs for				Start page no./F	
1 AMWELL STREET LONDON		new basement I	-	wall	5	.2. 2
EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved dat
Saturated density of retained r	material	γ _s = 21.0 k				
Design shear strength		φ' = 18.6 d	-			
Angle of wall friction		$\delta = 0.0 \deg$	g			
Base material details						
Firm clay						
Moist density		$\gamma_{mb} = 18.0$	kN/m³			
Design shear strength		φ' _b = 16.5 α	deg			
Design base friction		$\delta_b = 18.6$ c	leg			
Allowable bearing pressure		P _{bearing} = 1	00 kN/m²			
Using Coulomb theory						
Active pressure coefficient for	retained materi	ial				
$K_a = sin(a)$	$(\alpha + \phi')^2 / (\sin(\alpha))$	$^{2} \times \sin(\alpha - \delta) \times [1 + $	+ $\sqrt{(\sin(\phi' + \delta))}$	< sin(φ' - β) / (sin($(\alpha - \delta) \times \sin(\alpha + \delta)$	$\beta)))]^2) = 0.5$
Passive pressure coefficient for	or base materia	l				
	K _p = sir	n(90 - ¢' _b)² / (sin(9	0 - $\delta_{b}) imes$ [1 - \sqrt{s}	$\sin(\phi_{b}' + \delta_{b}) \times \sin(\phi_{b}')$	φ' _b) / (sin(90 +	$\delta_b)))]^2) = 2.8$
At-rest pressure						
At-rest pressure for retained m	naterial	K ₀ = 1 – si	n(ǫ') = 0.681			
Loading details						
Surcharge load on plan		Surcharge	= 10.0 kN/m ²			
Applied vertical dead load on v	wall	W _{dead} = 20				
Applied vertical live load on wa		W _{live} = 8.0				
Position of applied vertical load		l _{load} = 650	mm			
Applied horizontal dead load of	on wall	F _{dead} = 0.0	kN/m			
Applied horizontal live load on	wall	Flive = 0.0 Å	kN/m			
Height of applied horizontal loa	ad on wall	$h_{load} = 0 m$	m			
		28 ↓ [[]]]]	<u></u> 10			
		Prop -				
2	Prop → 24.2 69.3		5.2 073	29.4		

Tekla Tedds	Project	10 Downsi	de Crescent		Job no. 14	411
RODRIGUES ASSOCIATES	Calcs for	new basement b	ack retaining	wall	Start page no./Re 5.2	evision 2. 3
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved date
Vertical forces on wall Wall stem		$w_{wall} = h_{sterm}$	$\times t_{wall} \times \gamma_{wall} =$	• 17.7 kN/m		

waii stem	Wwall = listem < twall < fwall = 17.7 Kit/in
Wall base	$w_{base} = I_{base} \times t_{base} \times \gamma_{base} = 9.4 \text{ kN/m}$
Applied vertical load	$W_v = W_{dead} + W_{live} = 28.3 \text{ kN/m}$
Total vertical load	$W_{total} = w_{wall} + w_{base} + W_v = 55.5 \text{ kN/m}$
Horizontal forces on wall	
Surcharge	$F_{sur} = K_a \times Surcharge \times h_{eff} = 15.5 \text{ kN/m}$
Saturated backfill	$F_s = 0.5 \times K_a \times (\gamma_{s^-} \gamma_{water}) \times h_{water}^2 = 26 \text{ kN/m}$
Water	$F_{water} = 0.5 \times h_{water}^2 \times \gamma_{water} = 44.1 \text{ kN/m}$
Total horizontal load	$F_{total} = F_{sur} + F_s + F_{water} = 85.6 \text{ kN/m}$
Calculate total propping force	
Passive resistance of soil in front of wall	$F_{p} = 0.5 \times K_{p} \times cos(\delta_{b}) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^{2} \times \gamma_{mb} = \textbf{6} \text{ kN/m}$
Propping force	$F_{prop} = max(F_{total} - F_{p} - (W_{total} - W_{live}) \times tan(\delta_b), 0 \text{ kN/m})$
	F _{prop} = 63.6 kN/m
Overturning moments	
Surcharge	$M_{sur} = F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2 = 23.2 \text{ kNm/m}$
Saturated backfill	$M_s = F_s \times (h_{water} - 3 \times d_{ds}) / 3 = 26 \text{ kNm/m}$
Water	$M_{water} = F_{water} \times (h_{water} - 3 \times d_{ds}) / 3 = 44.1 \text{ kNm/m}$
Total overturning moment	$M_{ot} = M_{sur} + M_s + M_{water} = 93.4 \text{ kNm/m}$
Restoring moments	
Wall stem	$M_{wall} = w_{wall} \times (I_{toe} + t_{wall} / 2) = 11.5 \text{ kNm/m}$
Wall base	$M_{base} = w_{base} \times I_{base} / 2 = 3.8 \text{ kNm/m}$
Design vertical dead load	$M_{dead} = W_{dead} \times I_{load} = 13.2 \text{ kNm/m}$
Total restoring moment	$M_{rest} = M_{wall} + M_{base} + M_{dead} = 28.5 \text{ kNm/m}$
Check bearing pressure	
Total vertical reaction	R = W _{total} = 55.5 kN/m
Distance to reaction	x _{bar} = I _{base} / 2 = 400 mm
Eccentricity of reaction	$e = abs((I_{base} / 2) - x_{bar}) = 0 mm$
	Reaction acts within middle third of base
Bearing pressure at toe	$p_{toe} = (R / I_{base}) - (6 \times R \times e / I_{base}^2) = 69.3 \text{ kN/m}^2$
Bearing pressure at heel	$p_{heel} = (R / I_{base}) + (6 \times R \times e / I_{base}^2) = 69.3 \text{ kN/m}^2$
PA	SS - Maximum bearing pressure is less than allowable bearing pressure
Calculate propping forces to top and base	of wall
Propping force to top of wall	

Propping force to base of wall

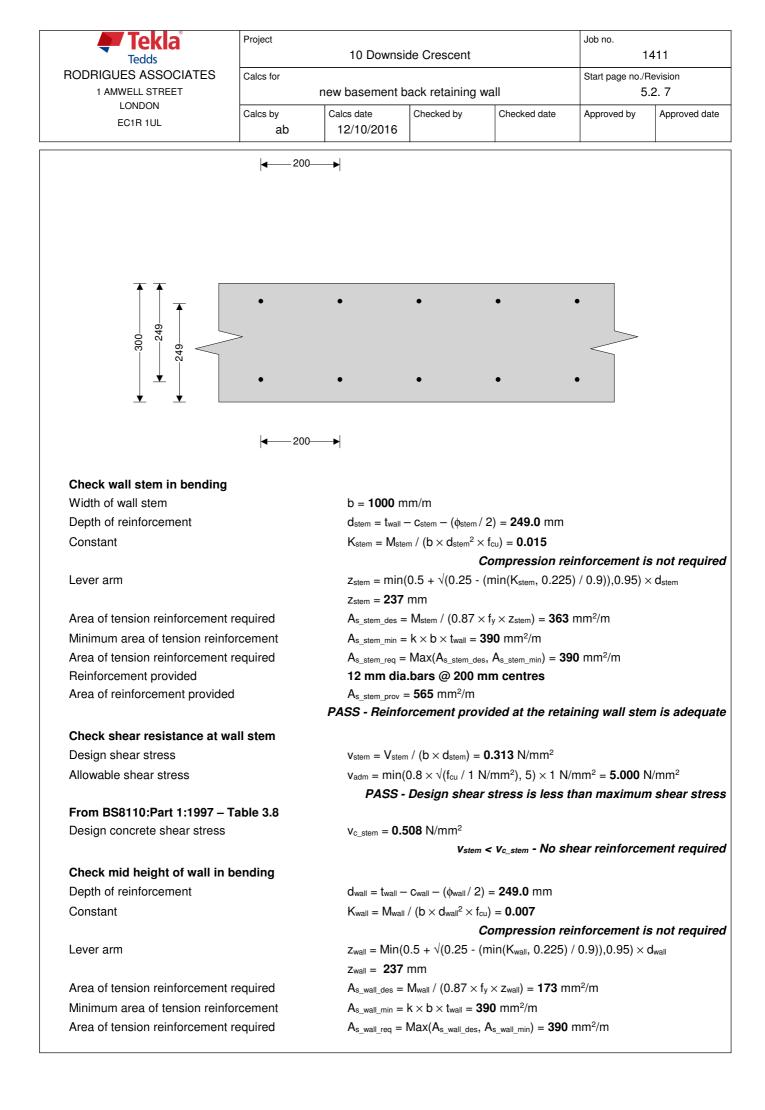
$$\begin{split} F_{prop_top} &= (M_{ot} - M_{rest} + R \times I_{base} / \ 2 - F_{prop} \times t_{base} / \ 2) / (h_{stem} + t_{base} / \ 2) = \textbf{25.881 kN/m} \\ F_{prop_base} &= F_{prop} - F_{prop_top} = \textbf{37.737 kN/m} \end{split}$$

	Project	10 Downsi	de Crescent		Job no. 1	411
RODRIGUES ASSOCIATES	Calcs for				Start page no./I	
1 AMWELL STREET LONDON		new basement b	-			.2. 4
EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved da
RETAINING WALL DESIGN (BS 8002-1994)				
	<u></u>	2			TEDDS calculatio	n version 1.2.0 ⁻
Ultimate limit state load facto	ors					
Dead load factor		$\gamma_{f_d} = 1.4$				
Live load factor		$\gamma_{f_{-}} = 1.6$				
Earth and water pressure facto	or	$\gamma_{f_e} = 1.4$				
Factored vertical forces on v	vall					
Wall stem		$W_{wall_f} = \gamma_{f_d}$	$\timesh_{\text{stem}} \times t_{\text{wall}} \times$	$\gamma_{wall} = 24.8 \text{ kN/r}$	n	
Wall base		$W_{base_f} = \gamma_{f_e}$	$_{ m d} imes {\sf I}_{ m base} imes {\sf t}_{ m base}$	×γ _{base} = 13.2 kN	/m	
Applied vertical load		$W_{v_f} = \gamma_{f_d}$	\times W _{dead} + $\gamma_{f_l} \times$	W _{live} = 41.2 kN/r	n	
Total vertical load		$W_{total_f} = W_v$	vall_f + Wbase_f +	W _{v_f} = 79.2 kN/n	า	
Factored horizontal at-rest for	orces on wall					
Surcharge		$F_{sur f} = \gamma_{f}$	< K₀ × Surchar	ge × h _{eff} = 32.7 k	N/m	
Saturated backfill				γ_{water}) × h_{water}^2 =		
Water				$r^2 \times \gamma_{\text{water}} = 61.8 \text{ k}$		
Total horizontal load				er_f = 142.5 kN/m		
Calculate total propping force	<u>م</u>					
Passive resistance of soil in fro		Fn f = VfeX	$0.5 \times K_{\rm p} \times \cos$	$\mathbf{s}(\delta_{b}) imes (d_{cover} + t_{ball})$	$a_{se} + d_{ds} - d_{exc})^2$	$\times \gamma_{mb} = 8.5$
kN/m		· p_i _ i _c · ·	0.07.147.000			
Propping force		Fprop f = ma	x(Ftotal f - Fp f -	$(W_{total_f} - \gamma_{f_l} \times W)$	$I_{\rm live}) \times \tan(\delta_{\rm b})$. 0	kN/m)
		F _{prop_f} = 11		· _ ·-	, , ,,,	,
Factored overturning mome	nts					
Surcharge		$M_{sur_f} = F_{sur}$	$r_f \times (h_{eff} - 2 \times 0)$	d _{ds}) / 2 = 49 kNm	ı/m	
Saturated backfill		$M_{s_f} = F_{s_f}$	\times (h _{water} - 3 \times d _o	ds) / 3 = 48 kNm/	m	
Water		$M_{water_f} = F_v$	water_f \times (hwater -	$3 \times d_{ds}) / 3 = 61.$	8 kNm/m	
Total overturning moment		$M_{ot_f} = M_{sur}$	$_f + M_{s_f} + M_{wate}$	_{er_f} = 158.8 kNm/	m	
Restoring moments						
Wall stem		$M_{wall_f} = w_{wall_f}$	$_{all_f} imes (I_{toe} + t_{wall})$	/ 2) = 16.1 kNm/	m	
Wall base		$M_{base_f} = W_{b}$	$_{base_f} imes I_{base} / 2 =$	= 5.3 kNm/m		
Design vertical load		$M_{v_f} = W_{v_f}$	\times I _{load} = 26.8 k	Nm/m		
Total restoring moment		$M_{rest_f} = M_w$	$all_f + M_{base_f} + 1$	M _{v_f} = 48.2 kNm/	m	
Factored bearing pressure						
Total vertical reaction		$R_f = W_{total_f}$	= 79.2 kN/m			
Distance to reaction		$x_{bar_f} = I_{base}$	/ 2 = 400 mm			
Eccentricity of reaction		$e_f = abs((I_b$	_{ase} / 2) - x _{bar_f}) :	= 0 mm		
					s within middle	e third of ba
Bearing pressure at toe				$\times e_f / I_{base}^2 = 99.$		
Bearing pressure at heel				$R_f \times e_f / I_{base^2} = 99$		
Rate of change of base reaction			• •	e = 0.00 kN/m ² /m		
Bearing pressure at stem / toe				te \times I _{toe}), 0 kN/m		
Bearing pressure at mid stem				$te \times (I_{toe} + t_{wall} / 2)$		
Bearing pressure at stem / hee		-	/ /		0 kN/m^2) = 99.	A 1 B 1 / 0

Propping force to top of wall

Tedds RODRIGUES ASSOCIATES		10 Downsi	de Crescent			411
1 AMWELL STREET LONDON	Calcs for	new basement b	ack retaining v	vall	Start page no./F	evision 2.5
EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved
Propping force to base of wall	F _{prop_top_f} :	= (M _{ot_f} - M _{rest_f} + R F _{prop_base_f} =		_{op_f} × t _{base} / 2) / (h p_f = 70.070 kN/		= 41.608
Design of reinforced concret	e retaining wa	all toe (BS 8002:1	994)			
Material properties						
Characteristic strength of conci	rete	f _{cu} = 40 N/r	nm²			
Characteristic strength of reinfo	prcement	f _y = 500 N/r	mm²			
Base details						
Minimum area of reinforcement	ł	k = 0.13 %				
Cover to reinforcement in toe	•	$C_{toe} = 45 \text{ m}$				
Calculate shear for toe desig	n					
Shear from bearing pressure		V _{toe bear} = (t	Otoe f + Ostem toe	_f) × I _{toe} / 2 = 49.5	kN/m	
Shear from weight of base				$be \times t_{base} = 8.3 \text{ kN}$		
Total shear for toe design			pear - V _{toe_wt_base}			
Calculate moment for toe des	lan					
Moment from bearing pressure	-	Mara haar — ($2 \times n_{\rm track} + n_{\rm track}$	n_mid_f) × (Itoe + twa	/ 2\ ² / 6 - 20 (kNm/m
Moment from weight of base				$t_{\rm base} \times (t_{\rm toe} + t_{\rm wall})$	-	
woment nom weight of base					(2) / (2) = 3.3 K	INIII/111
Total moment for toe design		M _{toe} = M _{toe} _	bear - Witoe_wt_base	₉ = 17.4 KNm/m		
-	>	M _{toe} = M _{toe}	<u>bear - IVitoe_wt_base</u>	•	•	
Total moment for toe design	► 4 200	•	bear - IVitoe_wt_base	•	•	
Total moment for toe design	► ←200	•	_bear ⁻ ₩itoe_wt_base	•	•	
Total moment for toe design	> • ∢ —_200	•	•	•	•	
Total moment for toe design	 ● 1 200 	• • b = 1000 m	•	•	•	
Total moment for toe design	► 4 200	• b = 1000 m dtoe = tbase -	• 1m/m	• = 447.0 mm	•	
Total moment for toe design	●	• b = 1000 m d _{toe} = t _{base} - K _{toe} = M _{toe} /	$m/m = c_{toe} - (\phi_{toe} / 2)$	• = 447.0 mm = 0.002 Compression re		-
Total moment for toe design	► 4 200	$b = 1000 \text{ m}$ $d_{toe} = t_{base} - K_{toe} = M_{toe} / Z_{toe} = min(C$	• • • • • • • • • • • • • •	• = 447.0 mm = 0.002		-
Total moment for toe design		• b = 1000 m dtoe = tbase - Ktoe = Mtoe / ztoe = min(C ztoe = 425 m		• = 447.0 mm = 0.002 Compression re min(K _{toe} , 0.225) /	′ 0.9)),0.95) × d	-
Total moment for toe design	required	b = 1000 m dtoe = tbase - Ktoe = Mtoe / Ztoe = min(C Ztoe = 425 m As_toe_des =	$f(x) = \frac{1}{2} \int_{-\infty}^{\infty} \frac{1}$	• • • • • • • • • • • • • • • • • • •	′ 0.9)),0.95) × d	-
Total moment for toe design	required	$b = 1000 \text{ m}$ $d_{toe} = t_{base} - K_{toe} = M_{toe} / Z_{toe} = min(C_{toe} = 425 \text{ m})$ $A_{s_toe_des} = (A_{s_toe_min} = 1)$	• • • • • • • • • • • • • •	• = 447.0 mm = 0.002 <i>Compression re</i> min(K _{toe} , 0.225) / × z _{toe}) = 94 mm ² 50 mm ² /m	′′ 0.9)),0.95) × d ²/m	-
Total moment for toe design	required	b = 1000 m dtoe = tbase - Ktoe = Mtoe / ztoe = min(C ztoe = 425 m As_toe_des = As_toe_min = 1 As_toe_req = 1	$ \int \frac{1}{\sqrt{10^{-10} - (\phi_{toe} / 2)}} dt = 0 $	• = 447.0 mm = 0.002 Compression remin(K _{toe} , 0.225) / × Z _{toe}) = 94 mm 50 mm ² /m A _{s_toe_min}) = 650 r	′′ 0.9)),0.95) × d ²/m	-
Total moment for toe design	required rcement required	$b = 1000 \text{ m}$ $d_{toe} = t_{base} - K_{toe} = M_{toe} / Z_{toe} = min(C Z_{toe} = 425 \text{ m})$ $A_{s_toe_des} = A_{s_toe_des} = I$ $A_{s_toe_req} = I$ 16 mm dia	• • • • • • • • • • • • • •	• = 447.0 mm = 0.002 Compression remin(K _{toe} , 0.225) / × Z _{toe}) = 94 mm 50 mm ² /m A _{s_toe_min}) = 650 r	′′ 0.9)),0.95) × d ²/m	-

	Project 10 Downside Crescent			Job no. 1411					
RODRIGUES ASSOCIATES	Calcs for			Start page no./Revision					
1 AMWELL STREET	new basement back retaining wall			5.2.6					
	Calcs by	Calcs by Calcs date Checked by Checked			Approved by	Approved da			
EC1R 1UL	ab	12/10/2016							
Check shear resistance at to	e								
Design shear stress		$v_{toe} = V_{toe}$ /	$(b \times d_{toe}) = 0.0$)92 N/mm²					
Allowable shear stress			N/mm^2), 5) × 1 N/	/mm² = 5.000 l	√/mm²				
				r stress is less t					
From BS8110:Part 1:1997 - 1	Table 3.8		-						
Design concrete shear stress		Vc_toe = 0.4	50 N/mm²						
			Vte	oe < Vc_toe - No sl	near reinforce	ment requii			
Design of reinforced concre	te retaining wa	all stem (BS 8002	2:1994 <u>)</u>						
Material properties									
Characteristic strength of conc	crete	f _{cu} = 40 N/	mm²						
Characteristic strength of reinf	orcement	f _y = 500 N/	mm ²						
Wall details									
Minimum area of reinforcemer	nt	k = 0.13 %)						
Cover to reinforcement in stem	n	Cstem = 45 I	C _{stem} = 45 mm						
Cover to reinforcement in wall		c _{wall} = 45 n	ım						
Factored horizontal at-rest fe	orces on stem								
Surcharge		$F_{s_sur_f} = \gamma_{f_}$	$_{I} \times K_{0} \times Surcha$	$arge imes (h_{eff} - t_{base})$	- d _{ds}) = 27.2 kN	l/m			
Saturated backfill		$F_{s_s_f} = 0.5$	$ imes \gamma_{f_e} imes K_0 imes (\gamma$	$\gamma_{\rm s} - \gamma_{\rm water}) \times h_{\rm sat}^2 = 3$	33.3 kN/m				
Water		$F_{s_water_f} = 0$	$0.5 imes\gamma_{f_e} imes\gamma_{wate}$	er × h _{sat} ² = 42.9 k№	N/m				
Calculate shear for stem des	sign								
Surcharge		$V_{s_sur_f} = 5$	$\times F_{s_sur_f} / 8 = -$	17 kN/m					
Saturated backfill		$V_{s_s_f} = F_{s_f}$	$s_f \times (1 - (a)^2 \times (a)^2)$	((5 × L) - a _l) / (20	× L ³))) = 26.7	≺N/m			
Water		$V_{s_water_f} =$	$V_{s_water_f} = F_{s_water_f} \times (1 - (a_l^2 \times ((5 \times L) - a_l) / (20 \times L^3))) = \textbf{34.3 kN/m}$						
Total shear for stem design		V _{stem} = V _{s_s}	$sur_f + Vs_s_f + V$	's_water_f = 78 kN/m	ı				
Calculate moment for stem of	design								
Surcharge		$M_{s_sur} = F_{s_}$	_sur_f × L / 8 = 9	.4 kNm/m					
Saturated backfill		$M_{s_s} = F_{s_s} + x_{a_1} \times ((3 \times a_1^2) - (15 \times a_1 \times L) + (20 \times L^2))/(60 \times L^2) = 12.2 \text{ kNm/m}$							
Water		$M_{s_water} = F_{s_water_{1}} \times a_{l} \times ((3 \times a_{l}^{2}) - (15 \times a_{l} \times L) + (20 \times L^{2}))/(60 \times L^{2}) = 15.7$							
kNm/m					,				
Total moment for stem design		M _{stem} = M _s	_sur + Ms_s + Ms_	_water = 37.3 kNm/	′m				
Calculate moment for wall de	esign								
Surcharge	-	$M_{w_sur} = 9$:	$\times F_{s_{sur_f}} \times L / 1$	28 = 5.3 kNm/m					
Saturated backfill				L)-a _l)/(20×L ³)-(x-k	$(3 \times a^2) = 5$	5 .5 kNm/m			
	$M_{w \text{ water}} = F_{s \text{ water}} f \times [a_{1}^{2} \times ((5 \times L) - a_{1})/(20 \times L^{3}) - (x - b_{1})^{3} / (3 \times a_{1}^{2})] = 7 \text{ kNm/n}$								
Water		$M_{w water} = H$	$s_{s water_f} \times [a_l^2 \times x]$	((5×L)-a⊨)/(20×L	.°)-(x-bi)° /(3×ai	[_])] = 7 kNm/i			



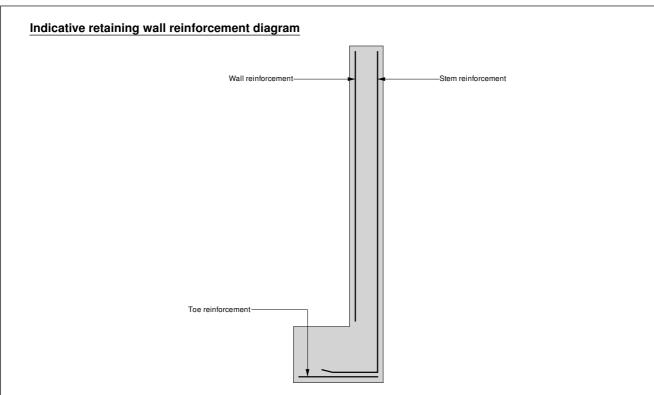
Tekla	Project				Job no.		
Tedds		10 Downsi	de Crescent		1	411	
RODRIGUES ASSOCIATES 1 AMWELL STREET	Calcs for new basement back retaining wall				Start page no./Revision 5.2. 8		
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved date	
Reinforcement provided		12 mm dia	.bars @ 200 i	mm centres			
Area of reinforcement provided		A _{s_wall_prov} =	A _{s_wall_prov} = 565 mm ² /m				
	PASS	S - Reinforcemen	t provided to	the retaining wa	all at mid heig	ht is adequa	
Check retaining wall deflection		S - Reinforcemen	t provided to	the retaining wa	all at mid heig	ht is adequa	
Check retaining wall deflecti Basic span/effective depth ratio	on	5 - Reinforcemen ratio _{bas} = 2		the retaining wa	all at mid heig	ht is adequa	
•	on	ratio _{bas} = 2	0	the retaining wat $\times A_{s_stem_prov}) = 2$	-	ht is adequa	
Basic span/effective depth ratio	on 0	ratio _{bas} = 2	0 : A _{s_stem_req} / (3	× A _{s_stem_prov}) = 2	29.9 N/mm ²	·	

Actual span/effective depth ratio

ratio_{max} = ratio_{bas} × ratio_{tens} = cratio_{act} = h_{stem} / d_{stem} = **10.04**

PASS - Span to depth ratio is acceptable

Tekla Tedds	Project	10 Downsid	de Crescent		Job no. 14	11
RODRIGUES ASSOCIATES	Calcs for r	new basement b	ack retaining wa	all	Start page no./Re 5.2	evision 2. 9
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved date

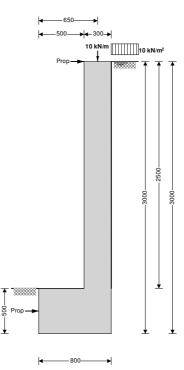


Toe bars - 16 mm dia.@ 200 mm centres - $(1005 \text{ mm}^2/\text{m})$ Wall bars - 12 mm dia.@ 200 mm centres - $(565 \text{ mm}^2/\text{m})$ Stem bars - 12 mm dia.@ 200 mm centres - $(565 \text{ mm}^2/\text{m})$

📕 Tekla	Project				Job no.	
Tedds		10 Downsid	de Crescent		14	11
RODRIGUES ASSOCIATES	Calcs for				Start page no./Re	evision
1 AMWELL STREET	new basement side wall			5.3. 1		
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	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

Cantilever propped at both h_{stem} = **2500** mm twall = 300 mm $I_{toe} = 500 \text{ mm}$ $I_{heel} = \mathbf{0} mm$ $I_{\text{base}} = I_{\text{toe}} + I_{\text{heel}} + t_{\text{wall}} = 800 \text{ mm}$ t_{base} = **500** mm $d_{ds} = 0 \text{ mm}$ lds = **300** mm t_{ds} = **500** mm $h_{wall} = h_{stem} + t_{base} + d_{ds} = 3000 \text{ mm}$ $d_{cover} = 0 mm$ $d_{exc} = 0 mm$ h_{water} = **3000** mm $h_{sat} = max(h_{water} - t_{base} - d_{ds}, 0 mm) = 2500 mm$ $\gamma_{wall} = 23.6 \text{ kN/m}^3$ γ_{base} = 23.6 kN/m³ $\alpha = 90.0 \text{ deg}$ $\beta = 0.0 \text{ deg}$ $h_{eff} = h_{wall} + I_{heel} \times tan(\beta) = 3000 \text{ mm}$

M = **1.5** γ_m = **18.0** kN/m³

1 AMWELL STREET new basement side wall	ob no. 14	411	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Start page no./Revision 5.3. 2		
Design shear strength $\phi' = 18.6 \text{ deg}$ Angle of wall friction $\delta = 0.0 \text{ deg}$ Base material details Firm clay Moist density $\gamma_{peb} = 18.0 \text{ kN/m}^3$ Design shear strength $\phi_b = 16.5 \text{ deg}$ Design base friction $\delta_b = 18.6 \text{ deg}$ Allowable bearing pressure $P_{bearing} = 100 \text{ kN/m}^2$ Using Coulomb theory Active pressure coefficient for retained material $K_a = \sin(\alpha + \phi)^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta) \times [1 + v(\sin(\phi' + \delta) \times \sin(\phi' - \beta) / (\sin(\alpha - \delta))^2]$ Passive pressure coefficient for base material $K_b = \sin(90 - \phi_b)^2 / (\sin(90 - \delta_b) \times [1 - v(\sin(\phi_b + \delta_b) \times \sin(\phi_b) / (1 + 1 + 1)^2]$ At-rest pressure for retained material Loading details Surcharge load on plan Applied vertical load on wall Applied vertical load on wall Applied horizontal load on wall Applied horizontal load on wall Applied horizontal load on wall Applied horizontal load on wall Height of applied horizontal load on wall Height of applied horizontal load on wall $F_{beg} = 0.0 \text{ kN/m}$ $P_{beg} = 0.$	pproved by	Approved dat	
Angle of wall friction $\delta = 0.0 \text{ deg}$ Base material details Firm clay Moist density $\gamma_{mb} = 18.0 \text{ kN/m}^3$ Design shear strength $\phi_b = 16.5 \text{ deg}$ Allowable bearing pressure $P_{\text{tenering}} = 100 \text{ kN/m}^2$ Using Coulomb theory Active pressure coefficient for retained material $K_a = \sin(\alpha + \phi)^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta) \times [1 + (\sin(\phi' + \delta) \times \sin(\phi' - \beta) / (\sin(\alpha - \delta) + \delta) / (\sin(\alpha$			
Base material details Firm clay Moist density Design shear strength Design base friction Allowable bearing pressure Using Coulomb theory Active pressure coefficient for retained material $K_a = \sin(\alpha + \phi)^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta) \times [1 + \sqrt{(\sin(\phi^2 + \delta) \times \sin(\phi^2 - \beta)}) / (\sin(\alpha - \delta))^2$ Passive pressure coefficient for base material $K_p = \sin(90 - \phi_b)^2 / (\sin(90 - \delta_b) \times [1 - \sqrt{(\sin(\phi^2 + \delta) \times \sin(\phi^2)}) / (\frac{1 - 4 + 1}{1 - 4 + 1})^2 + 1 - 4 + 1 - 1 - 1 - 1 + 1 + 1 + 1 + 1 + 1 + 1$			
Firm clay Moist density $\gamma_{mb} = 18.0 \text{ kN/m}^3$ Design shear strength $\phi_b = 16.5 \text{ deg}$ Design base friction $\delta_b = 18.6 \text{ deg}$ Allowable bearing pressure $P_{\text{bearing}} = 100 \text{ kN/m}^2$ Using Coulomb theory Active pressure coefficient for retained material $K_a = \sin(\alpha + \phi)^2 / (\sin(\alpha)^2 \times \sin(\alpha \cdot \delta) \times [1 + \sqrt{(\sin(\phi^2 + \delta) \times \sin(\phi^2 - \beta)}) / (\sin(\alpha - \delta))^2$ Passive pressure coefficient for base material $K_p = \sin(90 - \phi_b)^2 / (\sin(90 - \delta_b) \times [1 - \sqrt{(\sin(\phi^2 + \delta_b) \times \sin(\phi^2)}) / (M + 100 +$			
Moist density $\gamma_{mb} = 18.0 \text{ kN/m}^3$ Design shear strength $\phi_b = 16.5 \text{ deg}$ Design base friction $\delta_b = 18.6 \text{ deg}$ Allowable bearing pressure $P_{\text{bearing}} = 100 \text{ kN/m}^2$ 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 (\alpha - $			
Design shear strength $\psi_b = 16.5 \text{ deg}$ Design base friction $\delta_b = 18.6 \text{ deg}$ Allowable bearing pressure $P_{\text{bearing}} = 100 \text{ kN/m}^2$ Using Coulomb theory Active pressure coefficient for retained material $K_a = \sin(\alpha + \phi)^2 / (\sin(\alpha)^2 \times \sin(\alpha + \delta) \times [1 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta))^2$ Passive pressure coefficient for base material $K_p = \sin(90 - \phi_b)^2 / (\sin(00 - \delta_b) \times [1 - \sqrt{(\sin(\phi_b + \delta_b) \times \sin(\phi_b)}) / (M + 100 + $			
Design base friction $\delta_b = 18.6 \text{ deg}$ Allowable bearing pressure $P_{\text{bearing}} = 100 \text{ kN/m}^2$ 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 [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi)}) / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi)}] / (\sin(\alpha - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi)}] / (\sin(\phi - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi)}] / (\sin(\phi - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi)}] / (\sin(\phi - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi)}] / (\sin(\phi - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi)}] / (\sin(\phi - \delta) \times [2 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi)}] / (\sin(\phi - \delta) \times (\sin(\phi - \delta)) / (\sin(\phi - \delta) \times (\sin(\phi - \delta)) / (\sin(\phi - \delta) \times (\sin(\phi - \delta)) / (\sin(\phi - \delta)) / (\sin(\phi - \delta)) / (\sin(\phi - \delta) \times (\sin(\phi - \delta)) / (\sin(\phi - \delta)) / (\sin(\phi - \delta) \times (\sin(\phi - \delta)) / (\sin(\phi -$			
Allowable bearing pressure $P_{\text{bearing}} = 100 \text{ kN/m}^2$ Using Coulomb theory Active pressure coefficient for retained material $K_a = \sin(\alpha + \phi)^2 / (\sin(\alpha)^2 \times \sin(\alpha \cdot \delta) \times [1 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)}) / (\sin(\alpha \cdot \delta))^2$ Passive pressure coefficient for base material $K_p = \sin(90 - \phi_b)^2 / (\sin(90 - \delta_b) \times [1 - \sqrt{(\sin(\phi_b + \delta_b) \times \sin(\phi_b)}) / (1 - \frac{1}{\sqrt{(\sin(\phi_b + \delta_b) \times \sin(\phi_b)}) / (1 - \frac{1}{(\sin(\phi_b + \delta_$			
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))^2 + \cos(\phi' + \delta)) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta) \times \sin(\phi' + $			
Active pressure coefficient for retained material $K_{a} = \sin(\alpha + \phi)^{2} / (\sin(\alpha)^{2} \times \sin(\alpha \cdot \delta) \times [1 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)} / (\sin(\alpha \cdot \delta))^{2} + \cos(\phi' + \delta)) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta) \times \sin(\phi'$			
Active pressure coefficient for retained material $K_{a} = \sin(\alpha + \phi)^{2} / (\sin(\alpha)^{2} \times \sin(\alpha \cdot \delta) \times [1 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)} / (\sin(\alpha \cdot \delta))^{2} + \cos(\phi' + \delta)) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta) \times \sin(\phi' + \delta)) \times \sin(\phi' + \delta) \times \sin(\phi' $			
$K_{a} = \sin(\alpha + \phi)^{2} / (\sin(\alpha)^{2} \times \sin(\alpha - \delta) \times [1 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta)} / (\sin(\alpha - \delta))]$ Passive pressure coefficient for base material $K_{p} = \sin(90 - \phi_{b})^{2} / (\sin(90 - \delta_{b}) \times [1 - \sqrt{(\sin(\phi_{b} + \delta_{b}) \times \sin(\phi_{b})} / (A + est pressure for retained material]$ Loading details Surcharge load on plan Applied vertical dead load on wall Applied vertical live load on wall Applied horizontal dead load on wall Applied horizontal load on wall $H_{eight of applied horizontal load on wall}$ $F_{low} = 0.0 \text{ kN/m}$ Height of applied horizontal load on wall $F_{low} = 0.0 \text{ kN/m}$ $F_{low} = 0.0 \text{ kN/m}$			
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})} / (M_{b} + \delta_{b}) \times \sin(\phi_{b}) / (M_{b} + \delta_{b}) / (M_{b} + $	δ $\propto \sin(\alpha + 1)$	B)))]2) – 0 5	
$K_{p} = \sin(90 - \phi_{b})^{2} / (\sin(90 - \delta_{b}) \times [1 - \sqrt{(\sin(\phi_{b} + \delta_{b}) \times \sin(\phi_{b}) / (1 - \delta_{b}))^{2}})$ At-rest pressure for retained material Loading details Surcharge load on plan Applied vertical dead load on wall Applied vertical load on wall Applied horizontal live load on wall Height of applied horizontal load on wall $F_{ive} = 0.0 \text{ kN/m}$	$0 \times 3 \prod (\alpha + 1)$	p///] / = 0.0	
At-rest pressure At-rest pressure for retained material Loading details Surcharge load on plan Surcharge = 10.0 kN/m ² Applied vertical live load on wall $W_{tree} = 0.0 kN/m$ Applied horizontal lead load on wall $W_{tree} = 0.0 kN/m$ Applied horizontal load on wall $W_{tree} = 0.0 kN/m$ Height of applied horizontal load on wall $W_{tree} = 0.0 kN/m$ Height of applied horizontal load on wall $W_{tree} = 0.0 kN/m$	$/(\sin(90\pm \delta))$	$\delta_{k}(1)(1^{2}) = 28$	
At-rest pressure for retained material K ₀ = 1 - sin(φ') = 0.681 Loading details Surcharge load on plan Surcharge = 10.0 kN/m ² Applied vertical dead load on wall Applied vertical live load on wall Applied horizontal dead load on wall Applied horizontal load on wall Applied horizontal load on wall Applied horizontal load on wall Height of applied horizontal load on wall Applied horizontal load on wall Height of applied horizontal horizon	/ (511(90 + 0	Jo)))]) = 2.0	
Loading details Surcharge load on plan Applied vertical load on wall Applied horizontal load on wall Applied horizontal load on wall Height of applied horizontal load on wall Height of applie			
Surcharge load on plan Applied vertical dead load on wall Applied vertical live load on wall Applied horizontal load on wall Applied horizontal load on wall Applied horizontal load on wall Height of applied horizontal horizontal horizontal load on wall Height of applied horizontal horizo			
Applied vertical dead load on wall Applied vertical live load on wall Applied horizontal dead load on wall Applied horizontal live load on wall Height of applied horizontal load on wall Height			
Applied vertical live load on wall Position of applied vertical load on wall Applied horizontal dead load on wall Height of applied horizontal load on			
Position of applied vertical load on wall Applied horizontal live load on wall Height of applied horizontal load o			
Applied horizontal dead load on wall Applied horizontal live load on wall Height of applied horizontal load on wall $F_{dead} = 0.0 \text{ kN/m}$ $F_{live} = 0.0 \text{ kN/m}$ $h_{load} = 0 \text{ mm}$			
Applied horizontal live load on wall Height of applied horizontal load on wall			
Height of applied horizontal load on wall $h_{load} = 0 \text{ mm}$			
Loads shown in kN	kN/m pressure	es shown in k	

Tekla Tedds	Project 10 Downside Crescent				Job no. 1411	
RODRIGUES ASSOCIATES 1 AMWELL STREET	Calcs for new basement side wall				Start page no./Revision 5.3. 3	
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/all stem /all base pplied vertical load otal vertical load	$\begin{split} w_{wall} &= h_{stem} \times t_{wall} \times \gamma_{wall} = \textbf{17.7 kN/m} \\ w_{base} &= I_{base} \times t_{base} \times \gamma_{base} = \textbf{9.4 kN/m} \end{split}$
pplied vertical load	$w_{\text{base}} = I_{\text{base}} \times t_{\text{base}} \times \gamma_{\text{base}} = \textbf{9.4} \text{ kN/m}$
otal vertical load	$W_v = W_{dead} + W_{live} = 10.3 \text{ kN/m}$
	$W_{total} = W_{wall} + W_{base} + W_v = 37.4 \text{ kN/m}$
orizontal forces on wall	
urcharge	$F_{sur} = K_a \times Surcharge \times h_{eff} = 15.5 \text{ kN/m}$
aturated backfill	$F_s = 0.5 \times K_a \times (\gamma_{s} - \gamma_{water}) \times h_{water}^2 = 26 \text{ kN/m}$
/ater	$F_{water} = 0.5 \times h_{water}^2 \times \gamma_{water} = 44.1 \text{ kN/m}$
otal horizontal load	$F_{total} = F_{sur} + F_s + F_{water} = 85.6 \text{ kN/m}$
alculate total propping force	
assive resistance of soil in front of wall	$F_{p} = 0.5 \times K_{p} \times cos(\delta_{b}) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^{2} \times \gamma_{mb} = \textbf{6} \text{ kN/m}$
ropping force	$F_{prop} = max(F_{total} - F_p - (W_{total}) \times tan(\delta_b), 0 \text{ kN/m})$
	F _{prop} = 67.0 kN/m
verturning moments	
urcharge	$M_{sur} = F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2 = \textbf{23.2 kNm/m}$
aturated backfill	$M_{s} = F_{s} \times (h_{water} - 3 \times d_{ds}) / 3 = 26 \text{ kNm/m}$
/ater	$M_{water} = F_{water} \times (h_{water} - 3 \times d_{ds}) / 3 = 44.1 \text{ kNm/m}$
otal overturning moment	$M_{ot} = M_{sur} + M_s + M_{water} = 93.4 \text{ kNm/m}$
estoring moments	
/all stem	$M_{wall} = w_{wall} \times (I_{toe} + t_{wall} / 2) = \textbf{11.5} \text{ kNm/m}$
/all base	$M_{\text{base}} = w_{\text{base}} \times I_{\text{base}} / 2 = 3.8 \text{ kNm/m}$
esign vertical dead load	$M_{dead} = W_{dead} \times I_{load} = $ 6.7 kNm/m
otal restoring moment	$M_{rest} = M_{wall} + M_{base} + M_{dead} = \textbf{22} \text{ kNm/m}$
heck bearing pressure	
otal vertical reaction	$R = W_{total} = 37.4 \text{ kN/m}$
istance to reaction	x _{bar} = I _{base} / 2 = 400 mm
ccentricity of reaction	$e = abs((I_{base} / 2) - x_{bar}) = 0 mm$
	Reaction acts within middle third of bas
earing pressure at toe	$p_{toe} = (R / I_{base}) - (6 \times R \times e / I_{base}^2) = 46.8 \text{ kN/m}^2$
earing pressure at heel	$p_{heel} = (R / I_{base}) + (6 \times R \times e / I_{base}^2) = 46.8 \text{ kN/m}^2$
PAS	S - Maximum bearing pressure is less than allowable bearing pressur

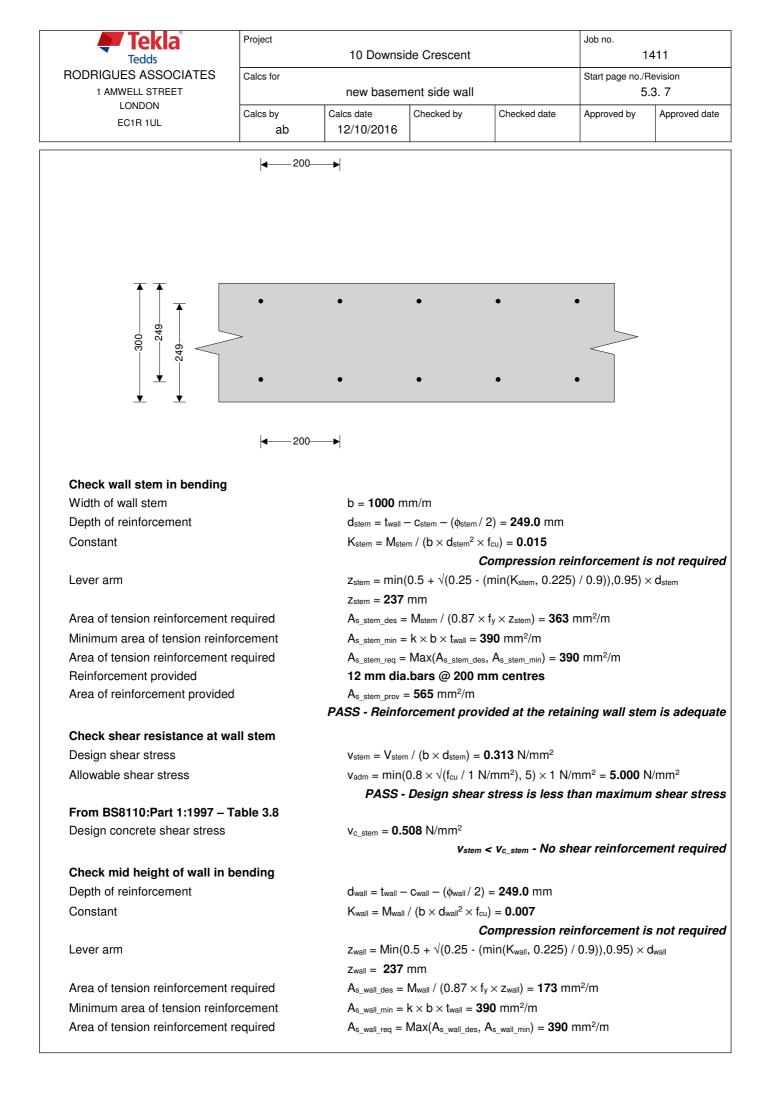
 $F_{prop_top} = (M_{ot} - M_{rest} + R \times I_{base} / 2 - F_{prop} \times t_{base} / 2) / (h_{stem} + t_{base} / 2) = 25.324 \text{ kN/m}$ Propping force to base of wall $F_{prop_base} = F_{prop} - F_{prop_top} = 41.679 \text{ kN/m}$

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1 AMWELL STREET		new basement side wall			5.3. 4	
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved da
	1	1	!		- I	
RETAINING WALL DESIGN (BS 8002:1994	<u>)</u>			TEDDS calculatio	n version 1.2.0 [.]
Ultimate limit state load factor	ors					
Dead load factor		$\gamma_{f_d} = 1.4$				
Live load factor		γ _{f_l} = 1.6				
Earth and water pressure factor	or	$\gamma_{f_e} = 1.4$				
Factored vertical forces on v	vall					
Wall stem		$W_{wall_f} = \gamma_{f_d}$	imes h _{stem} $ imes$ t _{wall} $ imes$	γwall = 24.8 kN/r	n	
Wall base		$W_{base_f} = \gamma_{f_e}$	$1 \times I_{base} \times t_{base} >$	<γ _{base} = 13.2 kN	/m	
Applied vertical load		$W_{v_f} = \gamma_{f_d}$	$\langle W_{dead} + \gamma_{f_l} \times$	W _{live} = 14.4 kN/r	n	
Total vertical load		$W_{total_f} = w_w$	vall_f + Wbase_f +	W _{v_f} = 52.4 kN/n	ı	
Factored horizontal at-rest for	orces on wall					
Surcharge		$F_{sur f} = \gamma_{f}$	$K_0 \times Surcharget$	ge × h _{eff} = 32.7 k	N/m	
Saturated backfill				γ_{water} \times h_{water}^2 =		
Water				$^{2} \times \gamma_{\text{water}} = 61.8 \text{ k}$		
Total horizontal load		F _{total_f} = F _{su}	_f + Fs_f + Fwate	er_f = 142.5 kN/m		
Calculate total propping force	e					
Passive resistance of soil in fro		$F_{p f} = \gamma_{f e} \times$	$0.5 \times K_{p} \times cos$	$s(\delta_b) imes (d_{cover} + t_{ball})$	use + d _{ds} - d _{exc}) ²	$\times \gamma_{\rm mb} = 8.5$
kN/m		r_ •	r		···· · · ,	•
Propping force		$F_{prop_f} = ma$	x(F _{total_f} - F _{p_f} -	$(W_{total_f}) \times tan(\delta_t)$), 0 kN/m)	
		F _{prop_f} = 11	6.4 kN/m			
Factored overturning moment	nts					
Surcharge		$M_{sur_f} = F_{sur}$	$_{f} \times (h_{eff} - 2 \times d)$	d _{ds}) / 2 = 49 kNm	ı/m	
Saturated backfill		$M_{s_f} = F_{s_f}$	\times (h _{water} - 3 \times d _c	ds) / 3 = 48 kNm/	m	
Water		$M_{water_f} = F_w$	$_{water_f} imes (h_{water} -$	$3 \times d_{ds}) / 3 = 61.$	8 kNm/m	
Total overturning moment		$M_{ot_f} = M_{sur_f}$	$_{f} + M_{s_{f}} + M_{wate}$	er_f = 158.8 kNm/	m	
Restoring moments						
Wall stem		$M_{wall_f} = W_{wall_f}$	$_{\text{all}_{f}} \times (I_{\text{toe}} + t_{\text{wall}})$	/ 2) = 16.1 kNm/	m	
Wall base		$M_{base_f} = w_b$	$_{ase_f} \times I_{base} / 2 =$	= 5.3 kNm/m		
Design vertical load		$M_{v_f} = W_{v_f}$	\times I _{load} = 9.3 kN	lm/m		
Total restoring moment		$M_{rest_f} = M_{w}$	$all_f + M_{base_f} + I$	M _{v_f} = 30.7 kNm/	m	
Factored bearing pressure						
Total vertical reaction		$R_f = W_{total_f}$	= 52.4 kN/m			
Distance to reaction			/ 2 = 400 mm			
Eccentricity of reaction		$e_f = abs((I_{ba}$	_{ase} / 2) - X _{bar_f}) =			
Design and the					within middle	e third of ba
Bearing pressure at toe				$\times e_{\rm f} / l_{\rm base}^2 = 65.$		
Bearing pressure at heel				$R_{f} \times e_{f} / I_{base}^{2} = 68$		
Rate of change of base reaction			•	$t = 0.00 \text{ kN/m}^2/\text{m}$ te × I _{toe}), 0 kN/m		2
Bearing pressure at stem / toe Bearing pressure at mid stem						
Bearing pressure at mid stem / hee				$te imes (I_{toe} + t_{wall} / 2)$ ate $ imes (I_{toe} + t_{wall})),$		
DEALING DIESSILE ALSIEUL / DEE	71	Ustem heel f =	IIIAA(Utoe f - (fa	aισ∧(Itoe + lwall)),	$\cup r(N/11) = 00.$	

Propping force to top of wall

		10 Downsi	de Crescent			411	
RODRIGUES ASSOCIATES	Calcs for	new basem	new basement side wall			Start page no./Revision 5.3. 5	
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved	
Propping force to base of wall	F _{prop_top_f} :	= (M _{ot_f} - M _{rest_f} + R F _{prop_base_f} =		_{rop_f} × t _{base} / 2) / (h top_f = 72.797 kN/i		= 43.621	
Design of reinforced concret	te retaining w	all toe (BS 8002:1	994)				
Material properties	<u></u>		<u></u>				
Characteristic strength of conc	rete	f _{cu} = 40 N/r	nm²				
Characteristic strength of reinf		$f_y = 500 \text{ N/}$					
Base details		,					
Minimum area of reinforcemen	ıt	k = 0.13 %					
Cover to reinforcement in toe		c _{toe} = 45 m					
	1 0						
Calculate shear for toe desig Shear from bearing pressure	jn -	V		$() \times [-2, 2, 2, 2, 3, 2, 3, 2, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3,$	'kN/m		
01				_f) × I _{toe} / 2 = 32.7			
Shear from weight of base				$toe \times t_{base} = 8.3 \text{ kN}$	1/111		
Total shear for toe design		$\mathbf{v}_{\text{toe}} = \mathbf{v}_{\text{toe}}$	pear - Vtoe_wt_base	a = 24.3 KIN/III			
Calculate moment for toe de	-		-			/	
Moment from bearing pressure	9			$m_{mid_f} \times (I_{toe} + t_{wa})$	-		
Moment from weight of base				$t_{base} \times (I_{toe} + t_{wall} / $	2) ² / 2) = 3.5 k	Nm/m	
Total moment for toe design		$M_{toe} = M_{toe}$	_bear - M _{toe_wt_bas}	_{se} = 10.3 kNm/m			
₹	•	•	•	•	•		
► 500	► ← _200	•)•	•	•	•		
Check toe in bending	► 200		•	•	•		
Check toe in bending Width of toe	► ← _200	b = 1000 n		•	•		
Check toe in bending Width of toe Depth of reinforcement	► ← _200	b = 1000 n d _{toe} = t _{base} -	- c _{toe} - (φ _{toe} / 2)		•		
Check toe in bending Width of toe	► ← _200	b = 1000 n d _{toe} = t _{base} -	$- c_{toe} - (\phi_{toe} / 2)$ / (b × d _{toe} ² × f _{cu}) = 0.001	•		
Check toe in bending Width of toe Depth of reinforcement Constant	► ← _200	b = 1000 n d _{toe} = t _{base} - K _{toe} = M _{toe} ,	$- c_{toe} - (\phi_{toe} / 2)$ / (b × d _{toe} ² × f _{cu}) = 0.001 Compression re		-	
Check toe in bending Width of toe Depth of reinforcement	► ←200	$b = 1000 \text{ m}$ $d_{\text{toe}} = t_{\text{base}} - K_{\text{toe}} = M_{\text{toe}}$ $z_{\text{toe}} = \min(0)$	$- c_{toe} - (\phi_{toe} / 2)$ / (b × d_{toe} ² × f _{cu}) 0.5 + $\sqrt{(0.25 - (0.25))}$) = 0.001		-	
Check toe in bending Width of toe Depth of reinforcement Constant Lever arm		$b = 1000 \text{ m}$ $d_{\text{toe}} = t_{\text{base}} - K_{\text{toe}} = M_{\text{toe}}$ $Z_{\text{toe}} = min(0)$ $Z_{\text{toe}} = 425 \text{ m}$	$- c_{toe} - (\phi_{toe} / 2)$ / (b × d _{toe} ² × f _{cu}) 0.5 + $\sqrt{0.25}$ - (mm) = 0.001 <i>Compression re</i> min(K _{toe} , 0.225) /	′ 0.9)),0.95) × d	-	
Check toe in bending Width of toe Depth of reinforcement Constant Lever arm Area of tension reinforcement	required	$b = 1000 \text{ m}$ $d_{\text{toe}} = t_{\text{base}} - t_{\text{toe}} = M_{\text{toe}}$ $K_{\text{toe}} = M_{\text{toe}}$ $z_{\text{toe}} = min(0)$ $z_{\text{toe}} = 425 \text{ m}$ $A_{s_\text{toe_des}} = 0$	$- c_{toe} - (\phi_{toe} / 2)$ / (b × d _{toe} ² × f _{cu}) 0.5 + $\sqrt{0.25}$ - (mm M _{toe} / (0.87 × f		′ 0.9)),0.95) × d	-	
Check toe in bending Width of toe Depth of reinforcement Constant Lever arm Area of tension reinforcement Minimum area of tension reinforcement	required	$b = 1000 \text{ m}$ $d_{toe} = t_{base} - t_{toe} = t_{toe} - t_{toe}$ $Z_{toe} = M_{toe} - t_{toe}$ $Z_{toe} = 425 \text{ m}$ $A_{s_toe_des} = t_{s_toe_min} = t_{s_toe_min}$	$-c_{toe} - (\phi_{toe} / 2)$ $/ (b \times d_{toe}^2 \times f_{cu})$ $0.5 + \sqrt{0.25 - (mm)}$ $M_{toe} / (0.87 \times f_{base} = 0)$) = 0.001 <i>Compression re</i> min(K _{toe} , 0.225) / _y × z _{toe}) = 56 mm ² 650 mm ² /m	′ 0.9)),0.95) × d ²/m	-	
Check toe in bending Width of toe Depth of reinforcement Constant Lever arm Area of tension reinforcement Minimum area of tension reinfor Area of tension reinforcement	required	$b = 1000 \text{ m}$ $d_{\text{toe}} = t_{\text{base}} - t_{\text{toe}}$ $K_{\text{toe}} = M_{\text{toe}}$ $z_{\text{toe}} = M_{\text{toe}}$ $z_{\text{toe}} = 425 \text{ m}$ $A_{s_\text{toe_des}} = A_{s_\text{toe_min}} = A_{s_\text{toe_req}} = t_{s_\text{toe_req}}$	$-c_{toe} - (\phi_{toe} / 2)$ $/ (b \times d_{toe}^2 \times f_{cu})$ $0.5 + \sqrt{(0.25 - (mmmm))}$ $M_{toe} / (0.87 \times f_{toe})$ $k \times b \times t_{base} = 0$ $Max(A_{s_toe_des}, -1)$) = 0.001 <i>Compression re</i> min(K _{toe} , 0.225) / _y × z _{toe}) = 56 mm ² 650 mm ² /m A _{s_toe_min}) = 650 m	′ 0.9)),0.95) × d ²/m	-	
Check toe in bending Width of toe Depth of reinforcement Constant Lever arm Area of tension reinforcement Minimum area of tension reinforcement	required prcement required	$b = 1000 \text{ m}$ $d_{\text{toe}} = t_{\text{base}} - t_{\text{toe}}$ $K_{\text{toe}} = M_{\text{toe}}$ $z_{\text{toe}} = M_{\text{toe}}$ $z_{\text{toe}} = 425 \text{ m}$ $A_{\text{s}_\text{toe}_\text{des}} = A_{\text{s}_\text{toe}_\text{min}} = A_{\text{s}_\text{toe}_\text{req}} = 16 \text{ mm dia}$	$-c_{toe} - (\phi_{toe} / 2)$ $/ (b \times d_{toe}^2 \times f_{cu})$ $0.5 + \sqrt{0.25 - (mm)}$ $M_{toe} / (0.87 \times f_{base} = 0)$) = 0.001 <i>Compression re</i> min(K _{toe} , 0.225) / _y × z _{toe}) = 56 mm ² 650 mm ² /m A _{s_toe_min}) = 650 m	′ 0.9)),0.95) × d ²/m	-	

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RODRIGUES ASSOCIATES	Calcs for				Start page no./F	
1 AMWELL STREET	Calcs IO	new basem	ent side wall			.3. 6
LONDON	Calcs by	Calcs date	Calcs date Checked by Checked date			Approved dat
EC1R 1UL	ab	12/10/2016				
Check shear resistance at to	e					
Design shear stress		$v_{toe} = V_{toe}$ /	$(b \times d_{toe}) = 0.0$	55 N/mm²		
Allowable shear stress		v _{adm} = min(0.8 × √(f _{cu} / 1 №	N/mm^2), 5) \times 1 N/	/mm² = 5.000 N	√/mm²
		PASS -	Design sheal	r stress is less t	than maximun	n shear stre
From BS8110:Part 1:1997 - 1	Table 3.8					
Design concrete shear stress		v _{c_toe} = 0.45	0 N/mm²			
			Vto	oe < Vc_toe - No st	hear reinforce	ment requir
Design of reinforced concret	te retaining wa	all stem (BS 8002	:1994 <u>)</u>			
Material properties						
Characteristic strength of conc	crete	f _{cu} = 40 N/n	nm²			
Characteristic strength of reinf	orcement	$f_y = 500 \text{ N/r}$	nm²			
Wall details						
Minimum area of reinforcemen	nt	k = 0.13 %				
Cover to reinforcement in stem	า	Cstem = 45 m	ım			
Cover to reinforcement in wall		c _{wall} = 45 m	m			
Factored horizontal at-rest for	orces on stem	1				
Surcharge		$F_{s_sur_f} = \gamma_{f_i}$	$ imes K_0 imes$ Surcha	$arge imes (h_{eff} - t_{base})$	- d _{ds}) = 27.2 kN	l/m
Saturated backfill		$F_{s_s_f} = 0.5$	$\times \gamma_{f_e} \times K_0 \times (\gamma_{e})$	s- γ_{water}) $ imes$ h _{sat} ² = 3	33.3 kN/m	
Water		$F_{s_water_f} = 0$	$.5 imes\gamma_{f_e} imes\gamma_{wate}$	r × h _{sat} ² = 42.9 k№	N/m	
Calculate shear for stem des	sign					
Surcharge		$V_{s_sur_f} = 5$	$< F_{s_sur_f} / 8 = 1$	1 7 kN/m		
Saturated backfill		$V_{s_s_f} = F_{s_s}$	$_{f} \times (1 - (a)^{2} \times ($	(5 × L) - al) / (20	× L ³))) = 26.7 k	≺N/m
Water		$V_{s_water_f} = F$	$s_{water_f} \times (1 - ($	$a_1^2 \times ((5 \times L) - a_1)$	$(20 \times L^3))) =$	34.3 kN/m
Total shear for stem design		$V_{stem} = V_{s_s}$	$ur_f + Vs_s_f + Vs_s$	s_water_f = 78 kN/m	า	
Calculate moment for stem of	design					
Surcharge		$M_{s_sur} = F_{s_s}$	$sur_f \times L / 8 = 9.$. 4 kNm/m		
Saturated backfill		$M_{s_s} = F_{s_s_}$	$f \times a \times ((3 \times a)^2) - ($	15×a×L)+(20×L²)))/(60×L ²) = 12 .	2 kNm/m
Water		$M_{s_water} = F_s$	s_water_f ×aI×((3×	<ai²)-(15×ai×l)+(2< td=""><td>20×L²))/(60×L²)</td><td>= 15.7</td></ai²)-(15×ai×l)+(2<>	20×L²))/(60×L²)	= 15.7
kNm/m						
Total moment for stem design		$M_{stem} = M_{s_s}$	$sur + Ms_s + Ms_s$	_water = 37.3 kNm/	/m	
Calculate moment for wall de	esign					
Surcharge		$M_{w_sur} = 9 \times$	$F_{s_sur_f} \times L / 1$	28 = 5.3 kNm/m		
Saturated backfill		$M_{w_s} = F_{s_s_}$	$f \times [a_1^2 \times x \times ((5 \times 1)^2)]$	L)-a _l)/(20×L ³)-(x-b	$(3 \times a^2) = 5$	5 .5 kNm/m
Water		M _{w water} = F		×((5×L)-a)/(20×L	. ³)-(x-b _l) ³ /(3×a _l ²	²)] = 7 kNm/r
				((-))		/1



	Project	10 Downsi	de Crescent		Job no. 1	411
RODRIGUES ASSOCIATES 1 AMWELL STREET	Calcs for	new basem	Start page no./Revision 5.3. 8			
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved date
Reinforcement provided Area of reinforcement provided	1		bars @ 200 ⊨ = 565 mm²/m	mm centres		
	PAS	S - Reinforcemen		the retaining wa	all at mid heig	ht is adequat
Check retaining wall deflecti	on					
Basic span/effective depth ratio	D	ratio _{bas} = 2	0			
Design service stress				$\times A_{s \text{ stem prov}} = 2$		

Design service stress Modification factor

 $factor_{tens} = min(0.55 + (477 \text{ N/mm}^2 - f_s)/(120 \times (0.9 \text{ N/mm}^2 + (M_{stem}/(b \times d_{stem}^2)))),2) = 1.92$

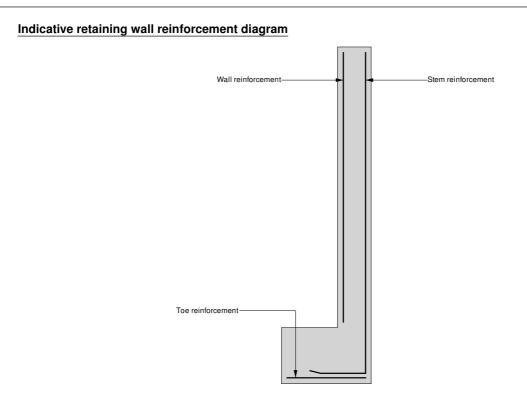
Maximum span/effective depth ratio

Actual span/effective depth ratio

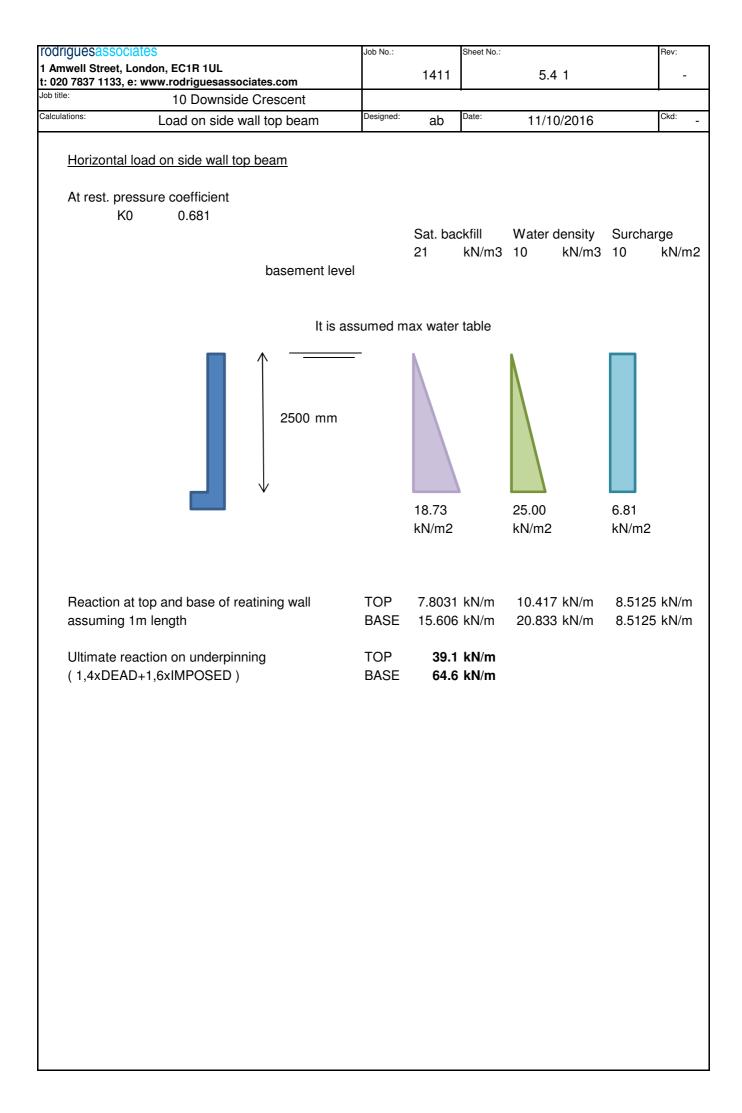
 $ratio_{max} = ratio_{bas} \times factor_{tens} = 38.42$ $ratio_{act} = h_{stem} / d_{stem} = 10.04$

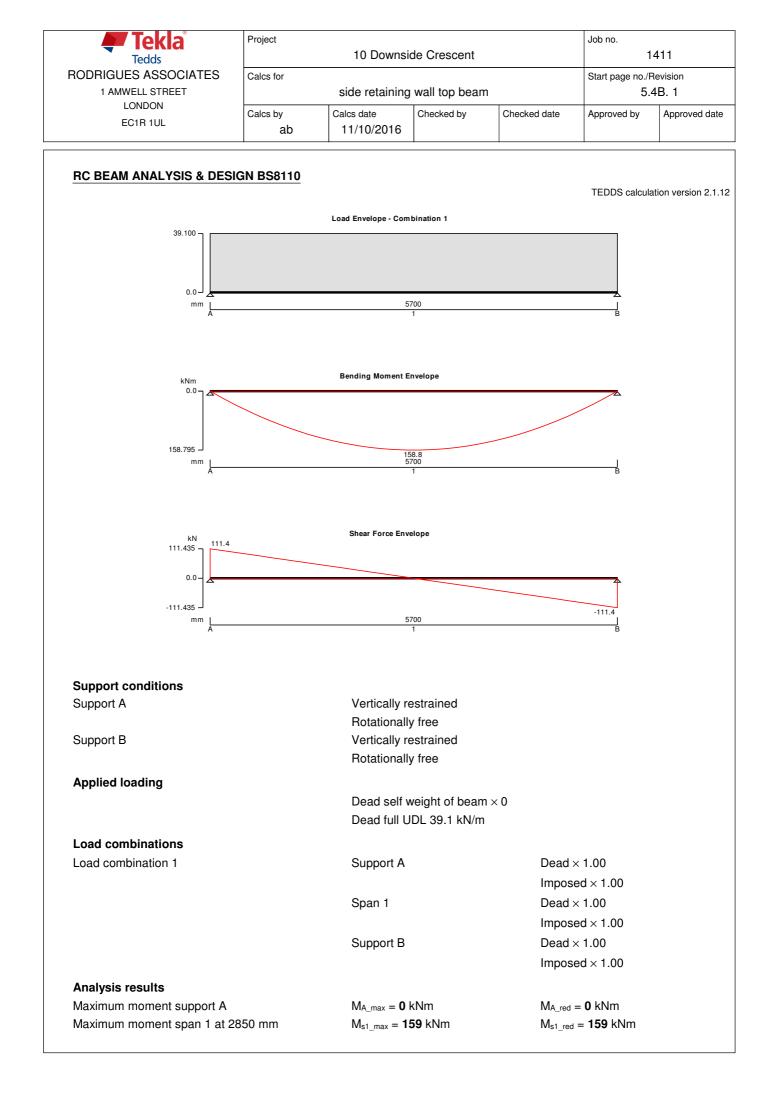
PASS - Span to depth ratio is acceptable

Tekla Tedds	Project	10 Downsid	de Crescent		Job no. 14	11
RODRIGUES ASSOCIATES 1 AMWELL STREET	Calcs for	Start page no./Re 5.3	evision 3. 9			
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved date



Toe bars - 16 mm dia.@ 200 mm centres - $(1005 \text{ mm}^2/\text{m})$ Wall bars - 12 mm dia.@ 200 mm centres - $(565 \text{ mm}^2/\text{m})$ Stem bars - 12 mm dia.@ 200 mm centres - $(565 \text{ mm}^2/\text{m})$





Iekla	Project	10 Downsi	de Crescent		Job no. 1	411
Tedds RODRIGUES ASSOCIATES	Calcs for				Start page no./F	Revision
1 AMWELL STREET LONDON		-	wall top beam	I		4B. 2
EC1R 1UL	Calcs by ab	Calcs date 11/10/2016	Checked by	Checked date	Approved by	Approved d
Maximum moment support B		$M_{B_{max}} = 0$	kNm	M _{B_red} =	■ 0 kNm	
Maximum shear support A		V _{A_max} = 11			111 kN	
Maximum shear support A spa	n 1 at 447 mm	V _{A_s1_max} =			a = 94 kN	
Maximum shear support B Maximum shear support B spa	n 1 at 5252 mm	V _{B_max} = -1		_	-111 kN	
Maximum reaction at support A		V _{B_s1_max} = R _A = 111 k		V B_s1_ree	a = -94 kN	
Unfactored dead load reaction		$R_{A Dead} = 1$				
Maximum reaction at support E	••	R _B = 111 k				
Unfactored dead load reaction	at support B	$R_{B_{Dead}} = 1$	11 kN			
Rectangular section details						
Section width		b = 300 mr	n			
Section depth		h = 500 mr	n			
			0▶			
Concrete details Concrete strength class Characteristic compressive cul Modulus of elasticity of concret	•	C32/40 f _{cu} = 40 N/r E _c = 20kN/r		= 28000 N/mm ²		
Concrete strength class	•	f _{cu} = 40 N/r	mm^2 + 200 × f _{cu}	= 28000 N/mm ²		
Concrete strength class Characteristic compressive cul Modulus of elasticity of concret	reinforcement	$f_{cu} = 40 \text{ N/r}$ $E_c = 20 \text{ kN/r}$ $h_{agg} = 20 \text{ m}$ $f_y = 500 \text{ N/r}$	mm ² + 200 \times f _{cu} mm ²	= 28000 N/mm ²		
Concrete strength class Characteristic compressive cul Modulus of elasticity of concret Maximum aggregate size Reinforcement details Characteristic yield strength of	reinforcement shear reinforcen	$f_{cu} = 40 \text{ N/r}$ $E_c = 20 \text{ kN/r}$ $h_{agg} = 20 \text{ m}$ $f_y = 500 \text{ N/r}$	mm ² + 200 \times f _{cu} mm ²	= 28000 N/mm ²		
Concrete strength class Characteristic compressive cul Modulus of elasticity of concret Maximum aggregate size Reinforcement details Characteristic yield strength of Characteristic yield strength of Nominal cover to reinforcem Nominal cover to top reinforce	reinforcement shear reinforcen ent ment	$f_{cu} = 40 \text{ N/r}$ $E_c = 20 \text{ kN/r}$ $h_{agg} = 20 \text{ m}$ $f_y = 500 \text{ N/r}$ nent $f_{yv} = 500 \text{ N/r}$ $C_{nom_t} = 35$	mm ² + 200 × f _{cu} im mm ² /mm ² mm	= 28000 N/mm ²		
Concrete strength class Characteristic compressive cul Modulus of elasticity of concret Maximum aggregate size Reinforcement details Characteristic yield strength of Characteristic yield strength of Nominal cover to reinforcem Nominal cover to top reinforced	reinforcement shear reinforcen ent ment rcement	$f_{cu} = 40 \text{ N/r}$ $E_c = 20 \text{ kN/r}$ $h_{agg} = 20 \text{ m}$ $f_y = 500 \text{ N/r}$ nent $f_{yv} = 500 \text{ N/r}$ $C_{nom_t} = 35$ $C_{nom_b} = 35$	mm ² + 200 × f _{cu} Im mm ² /mm ² mm	= 28000 N/mm ²		
Concrete strength class Characteristic compressive cul Modulus of elasticity of concret Maximum aggregate size Reinforcement details Characteristic yield strength of Characteristic yield strength of Nominal cover to reinforcem Nominal cover to top reinforce	reinforcement shear reinforcen ent ment rcement	$f_{cu} = 40 \text{ N/r}$ $E_c = 20 \text{ kN/r}$ $h_{agg} = 20 \text{ m}$ $f_y = 500 \text{ N/r}$ nent $f_{yv} = 500 \text{ N/r}$ $C_{nom_t} = 35$	mm ² + 200 × f _{cu} Im mm ² /mm ² mm	= 28000 N/mm ²		
Concrete strength class Characteristic compressive cul Modulus of elasticity of concret Maximum aggregate size Reinforcement details Characteristic yield strength of Characteristic yield strength of Nominal cover to reinforcem Nominal cover to top reinforced	reinforcement shear reinforcen ent ment rcement	f _{cu} = 40 N/r E _c = 20kN/r h _{agg} = 20 m f _y = 500 N/r nent f _{yv} = 500 N/r Cnom_t = 35 Cnom_b = 35 Cnom_s = 35	mm ² + 200 × f _{cu} Im mm ² /mm ² mm			
Concrete strength class Characteristic compressive cul Modulus of elasticity of concret Maximum aggregate size Reinforcement details Characteristic yield strength of Characteristic yield strength of Nominal cover to reinforcem Nominal cover to top reinforced Nominal cover to bottom reinforced	reinforcement shear reinforcen ent ment rcement ement	f _{cu} = 40 N/r E _c = 20kN/r h _{agg} = 20 m f _y = 500 N/r nent f _{yv} = 500 N/r Cnom_t = 35 Cnom_b = 35 Cnom_s = 35	mm ² + 200 × f _{cu} mm /mm ² /mm ² mm mm mm x 10 $_{\phi}$ bars x 8 $_{\phi}$ shear legs at 2			
Concrete strength class Characteristic compressive cul Modulus of elasticity of concret Maximum aggregate size Reinforcement details Characteristic yield strength of Characteristic yield strength of Nominal cover to reinforcem Nominal cover to top reinforced Nominal cover to bottom reinforced	reinforcement shear reinforcem ent ment rcement ement	f _{cu} = 40 N/r E _c = 20kN/r h _{agg} = 20 m f _y = 500 N/r nent f _{yv} = 500 N/r Cnom_t = 35 Cnom_b = 35 Cnom_s = 35	mm ² + 200 × f _{cu} mm /mm ² /mm ² mm mm mm x 10 $_{\phi}$ bars x 8 $_{\phi}$ shear legs at 2			

Tekla Tedds	Project	10 Downsie	de Crescent		Job no. 1411		
RODRIGUES ASSOCIATES 1 AMWELL STREET	Calcs for	side retaining	side retaining wall top beam			Start page no./Revision 5.4B. 3	
LONDON EC1R 1UL	Calcs by ab	Calcs date 11/10/2016	Checked by	Checked date	Approved by	Approved date	

Rectangular section in shear

Design shear force span 1 at 447 mm Design shear stress Design concrete shear stress $(min(f_{cu}, 40) / 25)^{1/3} / \gamma_m$

Allowable design shear stress

Value of v from Table 3.7 Design shear resistance required Area of shear reinforcement required Shear reinforcement provided Area of shear reinforcement provided $V = \max(V_{A_s1_max}, V_{A_s1_red}) = 94 \text{ kN}$ $v = V / (b \times d) = 0.700 \text{ N/mm}^2$ $v_c = 0.79 \times \min(3, [100 \times A_{s, prov} / (b \times d)]^{1/3}) \times \max(1, (400 / d)^{1/4}) \times$ $v_c = 0.657 \text{ N/mm}^2$ $v_{max} = \min(0.8 \text{ N/mm}^2 \times (f_{cu}/1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = 5.000 \text{ N/mm}^2$ PASS - Design shear stress is less than maximum allowable $0.5 \times v_c < v < (v_c + 0.4 \text{ N/mm}^2)$ $v_s = \max(v - v_c, 0.4 \text{ N/mm}^2) = 0.400 \text{ N/mm}^2$ $A_{sv,req} = v_s \times b / (0.87 \times f_{yv}) = 276 \text{ mm}^2/\text{m}$ $2 \times 8\phi \text{ legs at 200 c/c}$

 $A_{sv,prov} = 503 \text{ mm}^2/\text{m}$

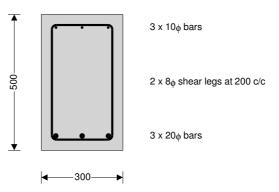
 $s_{vl,max} = 0.75 \times d = 335 \text{ mm}$

PASS - Area of shear reinforcement provided exceeds minimum required

Maximum longitudinal spacing

PASS - Longitudinal spacing of shear reinforcement provided is less than maximum

Mid span 1



Design moment resistance of rectangular section (cl. 3.4.4) - Positive moment

Design moment resistance of rectangular section (cl. 3.4.4) - Positive moment					
Design bending moment	$M = abs(M_{s1_red}) = 159 \text{ kNm}$				
Depth to tension reinforcement	$d = h - c_{nom_b} - \phi_v - \phi_{bot} / 2 = 447 \text{ mm}$				
Redistribution ratio	$\beta_b = min(1 - m_{rs1}, 1) = 1.000$				
	$K = M / (b \times d^2 \times f_{cu}) = 0.066$				
	K' = 0.156				
	K' > K - No compression reinforcement is required				
Lever arm	$z = min(d \times (0.5 + (0.25 - K / 0.9)^{0.5}), 0.95 \times d) = 411 mm$				
Depth of neutral axis	x = (d - z) / 0.45 = 79 mm				
Area of tension reinforcement required	$A_{s,req} = M / (0.87 \times f_y \times z) = 888 \text{ mm}^2$				
Tension reinforcement provided	$3 \times 20\phi$ bars				
Area of tension reinforcement provided	A _{s,prov} = 942 mm ²				
Minimum area of reinforcement	$A_{s,min} = 0.0013 \times b \times h = \textbf{195} \ mm^2$				
Maximum area of reinforcement	$A_{s,max} = 0.04 \times b \times h = 6000 \text{ mm}^2$				
PASS - Area of	reinforcement provided is greater than area of reinforcement required				

Rectangular section in shear	
Shear reinforcement provided	$2 \times 8\phi$ legs at 200 c/c
Area of shear reinforcement provided	$A_{sv,prov} = 503 \text{ mm}^2/\text{m}$

	Project	10 Downsi	de Crescent		Job no.	411
RODRIGUES ASSOCIATES				Start page no./I 5.	Revision 4B. 4	
LONDON EC1R 1UL	Calcs by ab	Calcs date 11/10/2016	Checked by	Checked date	Approved by	Approved da
Minimum area of shear reinforc	ement (Table 3	8.7) A _{sv,min} = 0.4	4N/mm² × b / (0	0.87 × f _{yv}) = 276	mm²/m	
	F	ASS - Area of s	hear reinforce	ement provided	exceeds mini	mum requir
Maximum longitudinal spacing		,	′5 × d = 335 m			
	PASS - Long	itudinal spacing	-	-		
Design concrete shear stress				$(100 \times A_{s,prov} / (b))$ 2) / 25N/mm ²) ^{1/3} /		
Design shear resistance provid	ed		-	/ b = 0.729 N/m	-	
Design shear stress provided			$v_{\rm r} + V_{\rm c} = 1.386$			
Design shear resistance			$ \times (b \times d) = 18 $			
Shear lin	ks provided v	alid between 0 r	nm and 5700	mm with tensio	n reinforceme	ent of 942 m
Spacing of reinforcement (cl	3.12.11)					
Actual distance between bars in	n tension	s = (b - 2 ×	$(C_{nom_s} + \phi_v + \phi_v)$	¢ _{bot} /2)) /(N _{bot} - 1)	- φ _{bot} = 77 mm	
Minimum distance between b	ars in tension	(cl 3.12.11.1)				
Minimum distance between bar	s in tension	$s_{min} = h_{agg}$ -	+ 5 mm = 25 m	ım		
			PA	SS - Satisfies th	e minimum s	pacing crite
Maximum distance between b	oars in tensior	ı (cl 3.12.11.2)				
Design service stress		$f_s = (2 \times f_y)$	imes A _{s,req}) / (3 $ imes$ A	$A_{s,prov} \times \beta_b) = 313.$.9 N/mm²	
Maximum distance between ba	rs in tension	$s_{max} = min($		′ f _s , 300 mm) = 1		
			PAS	SS - Satisfies the	e maximum sj	pacing crite
Span to depth ratio (cl. 3.4.6)	2.0)					
Basic span to depth ratio (Table Design service stress in tensior		•	$epth_{basic} = 20.0$		$0 \text{N}/\text{mm}^2$	
Modification for tension reinforc		$I_s = (2 \times I_y)$	× As,req)/ (3 × A	$_{s,prov} \times \beta_b) = 313.9$	9 N/11111-	
		min(2.0, 0.55 + (477N/mm ² - fs) / (120 × (0.9N/n	nm² + (M / (b ×	$(d^2)))) = 0.9$
Modification for compression re		(,		,, (,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		- ,,,,,
	f _{com}	₀ = min(1.5, 1 + ($100 imes A_{s2,prov}$ /	$(b \times d)) / (3 + (10))$	$00 imes A_{s2,prov}$ / (b	× d)))) = 1.0
Modification for span length		$f_{long} = 1.000$	0			
Allowable span to depth ratio				n_to_depth _{basic} \times	$f_{tens} \times f_{comp} = 19$	9.7
Actual span to depth ratio		•	$epth_{actual} = L_{s1}$			
		PASS	5 - Actual spa	n to depth ratio	is within the a	allowable lii
Support B						
] 3	x 10ø bars			
	-200	2	$x 8_{\phi}$ shear legs at	t 200 c/c		
		3	x 20ø bars			
	<u> </u>					
		_300►				
Rectangular section in shear						
Rectangular section in shear Design shear force span 1 at 52	253 mm	V = abs(mi	$n(V_{B_{s1}_{max}}, V_{B}_{max})$	_s1_red)) = 94 kN		

	Project	^{ject} 10 Downside Crescent				411		
RODRIGUES ASSOCIATES	Calcs for	side retaining	Start page no./Revision 5.4B. 5					
LONDON EC1R 1UL	Calcs by ab	Calcs date 11/10/2016	Checked by	Checked date	Approved by	Approved date		
Design concrete shear stress		$v_c = 0.79 \times$	min(3,[100 × /	$A_{s,prov} / (b \times d)]^{1/3}$	× max(1, (400	0 /d) ^{1/4}) ×		
(min(f _{cu} , 40) / 25) ^{1/3} / γ _m								
		Vc = 0.657						
Allowable design shear stress		v _{max} = min(0.8 N/mm ² × (f _{cu} /1 N/mm ²) ^{0.5} , 5 N/mm ²) = 5.000 N/mm ²						
		PAS	S - Design sh	near stress is le	ss than maxin	num allowab		
Value of v from Table 3.7		$0.5 imes v_c < v$	$< (v_c + 0.4 \text{ N/})$	mm²)				
Design shear resistance requir	red	v _s = max(v	- v _c , 0.4 N/mm	²) = 0.400 N/mm	2			
Area of shear reinforcement re	quired	A _{sv,req} = v _s >	< b / (0.87 × fy) = 276 mm²/m				
Shear reinforcement provided		$2 imes 8\phi$ legs	at 200 c/c					
Area of shear reinforcement pr	rovided	$A_{sv,prov} = 50$	3 mm²/m					
		PASS - Area of sl		ement provided	exceeds mini	mum require		
Maximum longitudinal spacing		$S_{vl,max} = 0.7$	5 × d = 335 m	m				
		gitudinal spacing						

	Project	10 Downsid	Job no. 1411			
RODRIGUES ASSOCIATES 1 AMWELL STREET	Calcs for	Start page no./Revision 5.5. 1				
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved date

RC SLAB DESIGN (BS8110:PART1:1997)	TEDDS calculation version 1.0.0
TWO WAY SPANNING SLAB DEFINITION – SIMPLY SUPPORTED	
Overall depth of slab h = 175 mm	
Outer sagging steel	
Cover to outer tension reinforcement resisting sagging $c_{sag} = 25 \text{ mm}$	
Trial bar diameter D _{tryx} = 12 mm	
Depth to outer tension steel (resisting sagging)	
$d_x = h - c_{sag} - D_{tryx}/2 = 144 \text{ mm}$	
Inner sagging steel	
Trial bar diameter D _{tryy} = 12 mm	
Depth to inner tension steel (resisting sagging)	
$d_y = h - c_{sag} - D_{tryx} - D_{tryy}/2 = 132 \text{ mm}$	
Materials	
Characteristic strength of reinforcement $f_y = 500 \text{ N/mm}^2$	
Characteristic strength of concrete $f_{cu} = 40 \text{ N/mm}^2$	
Asy Nominal 1 m width Asx	
Shorter Span	
h Asy Nominal 1 m width Asx	
Longer Span	
Two-way spanning slab (simple)	
MAXIMUM DESIGN MOMENTS	
Length of shorter side of slab $I_x = 3.500$ m	
Length of longer side of slab $I_y = 6.400 \text{ m}$	
Design ultimate load per unit area $n_s = 12.9 \text{ kN/m}^2$	

	Project	10 Downsid	Job no. 1411			
RODRIGUES ASSOCIATES 1 AMWELL STREET	Calcs for	ground	floor slab		Start page no./Revision 5.5. 2	
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved date

Moment coefficients

 $\alpha_{sx} = (I_y / I_x)^4 / (8 \times (1 + (I_y / I_x)^4)) = 0.115$

 $\alpha_{sy} = (I_y / I_x)^2 / (8 \times (1 + (I_y / I_x)^4)) = 0.034$

Maximum moments per unit width - simply supported slabs

 $m_{sx} = \alpha_{sx} \times n_s \times l_x^2 =$ **18.1** kNm/m

 $m_{sy} = \alpha_{sy} \times n_s \times I_x{}^2 = \textbf{5.4} \text{ kNm/m}$

CONCRETE SLAB DESIGN - SAGGING - OUTER LAYER OF STEEL (CL 3.5.4)

Design sagging moment (per m width of slab) m_{sx} = 18.1 kNm/m

Moment Redistribution Factor $\beta_{bx} = 1.0$

Area of reinforcement required

 $K_x = abs(m_{sx}) / (d_x^2 \times f_{cu}) = 0.022$

 $K'_x = min~(0.156~,~(0.402\times(\beta_{bx}$ - 0.4)) - $(0.18\times(\beta_{bx}$ - $0.4)^2~)) = \textbf{0.156}$

Outer compression steel not required to resist sagging

Slab requiring outer tension steel only - bars (sagging)

 $z_x = min ((0.95 \times d_x), (d_x \times (0.5 + \sqrt{(0.25 - K_x/0.9)}))) = 137 mm$

Neutral axis depth $x_x = (d_x - z_x) / 0.45 = 16 \text{ mm}$

Area of tension steel required

 $A_{sx_req} = abs(m_{sx}) / (1/\gamma_{ms} \times f_y \times z_x) = \textbf{305} \text{ mm}^2/\text{m}$

Tension steel

Provide 12 dia bars @ 200 centres outer tension steel resisting sagging

 $A_{sx_prov} = A_{sx} = 565 \text{ mm}^2/\text{m}$

Area of outer tension steel provided sufficient to resist sagging

Design sagging moment (per m width of slab) $m_{sy} = 5.4 \text{ kNm/m}$

Moment Redistribution Factor $\beta_{by} = 1.0$

Area of reinforcement required

 $K_y = abs(m_{sy}) / (d_{y^2} \times f_{cu}) = 0.008$

 $K'_{y} = min~(0.156$, $(0.402 \times (\beta_{by}$ - 0.4)) - $(0.18 \times (\beta_{by}$ - $0.4)^2$)) = 0.156

Inner compression steel not required to resist sagging

Slab requiring inner tension steel only - bars (sagging)

 $z_y = min ((0.95 \times d_y), (d_y \times (0.5 + \sqrt{(0.25 - K_y/0.9)}))) = 125 mm$

Neutral axis depth $x_y = (d_y - z_y) / 0.45 = 15 \text{ mm}$

Area of tension steel required

Tedds	Project	10 Downsi	de Crescent		Job no. 1	411
RODRIGUES ASSOCIATES 1 AMWELL STREET	Calcs for	Calcs for ground floor slab				Revision .5. 3
LONDON EC1R 1UL	Calcs by	Calcs date	Approved by Approved da			
	ab	12/10/2016	Checked by	Checked date	Approved by	
$A_{sy_{req}} = abs(m_{sy}) / (1/\gamma)$	$V_{\rm ms} \times f_{\rm v} \times Z_{\rm v}) = 9$	9 mm²/m				
Tension steel	,					
Provide 12 dia bars @ 200	<u>centres</u> inner	tension steel res	sisting saggir	ng		
$A_{sy_prov} = A_{sy} = 565 \text{ mm}$	n²/m					
			inner tension	steel provided	sufficient to r	esist saggil
$\frac{Check min and max areas of}{Total area of concrete} A_c = h$						
Minimum % reinforcen						
$A_{st min} = k \times A_c = 228 n$		0				
$A_{st max} = 4 \% \times A_c = 70$						
$A_{st_max} = 4 / 6 \times A_c = 70$ Steel defined:						
Outer steel resisting s	agging A	- 565 mm ² /m				
Outer steer resisting s	ayying Asx_prov	= 303 mm /m		Area of outer s	steel provided	(saqqinq)
Inner steel resisting sa	agging A _{sy_prov} :	= 565 mm²/m				
				Area of inner s	teel provided	(sagging) (
SHEAR RESISTANCE OF CC	NCRETE SLA	BS (CL 3.5.5)				
Outer tension steel resisting	i sagging mom	nents				
Outer tension steer resisting	, cagging men					
Depth to tension steel			mm			
-	from compress	sion face $d_x = 144$		= 565 mm²/m		
Depth to tension steel	from compress	sion face $d_x = 144$ ed (per m width of	slab) A _{sx_prov} :	= 565 mm²/m		
Depth to tension steel Area of tension reinfor	from compress rcement provide force (per m w	sion face $d_x = 144$ ed (per m width of idth of slab) $V_x =$	slab) A _{sx_prov} :	= 565 mm²/m		
Depth to tension steel Area of tension reinfor Design ultimate shear	from compress rcement provide force (per m w	sion face $d_x = 144$ ed (per m width of idth of slab) $V_x =$	slab) A _{sx_prov} :	= 565 mm²/m		
Depth to tension steel Area of tension reinfor Design ultimate shear Characteristic strength	from compress rcement provide force (per m w	sion face $d_x = 144$ ed (per m width of idth of slab) $V_x =$	slab) A _{sx_prov} :	= 565 mm²/m		
Depth to tension steel Area of tension reinfor Design ultimate shear Characteristic strength Applied shear stress	from compress rcement provide force (per m w n of concrete fo	sion face $d_x = 144$ ed (per m width of idth of slab) $V_x =$	slab) A _{sx_prov} :	= 565 mm²/m		
Depth to tension steel Area of tension reinfor Design ultimate shear Characteristic strength Applied shear stress $v_x = V_x / d_x = 0.29 \text{ N/mm}^2$	from compress reement provide force (per m w n of concrete for e 3.5.5.2	sion face $d_x = 144$ ed (per m width of idth of slab) $V_x =$ $u = 40 \text{ N/mm}^2$	slab) A _{sx_prov} :	= 565 mm²/m		
Depth to tension steel Area of tension reinfor Design ultimate shear Characteristic strength Applied shear stress $v_x = V_x / d_x = 0.29 \text{ N/mm}^2$ Check shear stress to clause $v_{allowable} = min ((0.8 \text{ N}^{1/2}/\text{mm}) \times 10^{-1} \text{ mm})$	from compress recement provide force (per m w n of concrete f_c e 3.5.5.2 $\sqrt{(f_{cu})}$, 5 N/mm ²	sion face $d_x = 144$ ed (per m width of idth of slab) $V_x =$ $u = 40 \text{ N/mm}^2$	slab) A _{sx_prov} :	= 565 mm²/m	She	ar stress - (
Depth to tension steel Area of tension reinfor Design ultimate shear Characteristic strength Applied shear stress $v_x = V_x / d_x = 0.29 \text{ N/mm}^2$ Check shear stress to clause $v_{allowable} = min ((0.8 \text{ N}^{1/2}/\text{mm}) \times \text{Shear stresses to clause 3.5})$	from compress recement provide force (per m w n of concrete f_c e 3.5.5.2 $\sqrt{(f_{cu})}$, 5 N/mm ²	sion face $d_x = 144$ ed (per m width of idth of slab) $V_x =$ $u = 40 \text{ N/mm}^2$	slab) A _{sx_prov} :	= 565 mm²/m	She	ar stress - (
Depth to tension steel Area of tension reinfor Design ultimate shear Characteristic strength Applied shear stress $v_x = V_x / d_x = 0.29 \text{ N/mm}^2$ Check shear stress to clause $v_{allowable} = min ((0.8 \text{ N}^{1/2}/\text{mm}) \times \text{Shear stresses to clause 3.5}$ Design shear stress	from compress recement provide force (per m w n of concrete f_c e 3.5.5.2 $\sqrt{(f_{cu})}$, 5 N/mm ² 5.5.3	sion face $d_x = 144$ ed (per m width of idth of slab) $V_x =$ $_u = 40 \text{ N/mm}^2$	slab) A _{sx_prov} : 41 kN/m	= 565 mm²/m	She	ar stress - (
Depth to tension steel Area of tension reinfor Design ultimate shear Characteristic strength Applied shear stress $v_x = V_x / d_x = 0.29 \text{ N/mm}^2$ Check shear stress to clause $v_{allowable} = \min ((0.8 \text{ N}^{1/2}/\text{mm}) \times \text{Shear stresses to clause 3.5})$ Design shear stress $f_{cu_ratio} = \text{if } (f_{cu} > 40 \text{ N/m})$	from compress recement provide force (per m w n of concrete f_c e 3.5.5.2 $\sqrt{(f_{cu})}$, 5 N/mm ² 5.5.3	sion face $d_x = 144$ ed (per m width of idth of slab) $V_x =$ $u = 40 \text{ N/mm}^2$ $^2) = 5.00 \text{ N/mm}^2$ $/(25 \text{ N/mm}^2)) = 1.0$	slab) A _{sx_prov} : 41 kN/m 600			ar stress - (
Depth to tension steel Area of tension reinfor Design ultimate shear Characteristic strength Applied shear stress $v_x = V_x / d_x = 0.29 \text{ N/mm}^2$ Check shear stress to clause $v_{allowable} = min ((0.8 \text{ N}^{1/2}/\text{mm}) \times \text{Shear stresses to clause 3.5}$ Design shear stress	from compress recement provide force (per m w n of concrete f_c e 3.5.5.2 $\sqrt{(f_{cu})}$, 5 N/mm ² 5.5.3	sion face $d_x = 144$ ed (per m width of idth of slab) $V_x =$ $u = 40 \text{ N/mm}^2$ $^2) = 5.00 \text{ N/mm}^2$ $/(25 \text{ N/mm}^2)) = 1.0$	slab) A _{sx_prov} : 41 kN/m 600			ar stress - (
Depth to tension steel Area of tension reinfor Design ultimate shear Characteristic strength Applied shear stress $v_x = V_x / d_x = 0.29 \text{ N/mm}^2$ Check shear stress to clause $v_{allowable} = \min ((0.8 \text{ N}^{1/2}/\text{mm}) \times$ Shear stresses to clause 3.5 Design shear stress $f_{cu_ratio} = \text{if } (f_{cu} > 40 \text{ N/m})$ $v_{cx} = 0.79 \text{ N/mm}^2 \times \min v_{cx} = 0.70 \text{ N/mm}^2$	from compress recement provide force (per m w n of concrete f_c e 3.5.5.2 $\sqrt{(f_{cu})}$, 5 N/mm ² 5.5.3	sion face $d_x = 144$ ed (per m width of idth of slab) $V_x =$ $u = 40 \text{ N/mm}^2$ $^2) = 5.00 \text{ N/mm}^2$ $/(25 \text{ N/mm}^2)) = 1.0$	slab) A _{sx_prov} : 41 kN/m 600			ar stress - (
Depth to tension steel Area of tension reinfor Design ultimate shear Characteristic strength Applied shear stress $v_x = V_x / d_x = 0.29 \text{ N/mm}^2$ Check shear stress to clause $v_{allowable} = min ((0.8 \text{ N}^{1/2}/\text{mm}) \times$ Shear stresses to clause 3.5 Design shear stress $f_{cu_ratio} = if (f_{cu} > 40 \text{ N/m})$ $v_{cx} = 0.79 \text{ N/mm}^2 \times min$	from compress recement provide force (per m w n of concrete f_c e 3.5.5.2 $\sqrt{(f_{cu})}$, 5 N/mm ² 5.5.3	sion face $d_x = 144$ ed (per m width of idth of slab) $V_x =$ $u = 40 \text{ N/mm}^2$ $^2) = 5.00 \text{ N/mm}^2$ $/(25 \text{ N/mm}^2)) = 1.0$	slab) A _{sx_prov} : 41 kN/m 600			ar stress - (

Tedds RODRIGUES ASSOCIATES 1 AMWELL STREET	Project	10 Downsi	Job no. 1411			
	Calcs for	Calcs for ground floor slab				Start page no./Revision 5.5. 4
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved date
		I	1			
SHEAR RESISTANCE OF CO		, <u>,</u>				
SHEAR RESISTANCE OF CO Inner tension steel resisting Depth to tension steel	sagging mor	nents	mm			

Design ultimate shear force (per m width of slab) $V_y = 26 \text{ kN/m}$

Characteristic strength of concrete fcu = 40 N/mm²

Applied shear stress

 $v_y = V_y / d_y = 0.20 \text{ N/mm}^2$

Check shear stress to clause 3.5.5.2

 $v_{allowable} = min ((0.8 \text{ N}^{1/2}/mm) \times \sqrt{(f_{cu})}, 5 \text{ N}/mm^2) = 5.00 \text{ N}/mm^2$

Shear stresses to clause 3.5.5.3

Design shear stress

$$\begin{split} f_{cu_ratio} &= if \; (f_{cu} > 40 \; N/mm^2 \;, \; 40/25 \;, \; f_{cu}/(25 \; N/mm^2)) = \textbf{1.600} \\ v_{cy} &= 0.79 \; N/mm^2 \; \times \; min(3,100 \; \times \; A_{sy_prov} \; / \; d_y)^{1/3} \; \times \; max(0.67,(400 \; mm) \; / \; d_y)^{1/4} \; / \; 1.25 \; \times \; f_{cu_ratio}^{1/3} \\ v_{cy} &= \textbf{0.73} \; N/mm^2 \\ \text{Applied shear stress} \\ v_y &= \textbf{0.20} \; N/mm^2 \end{split}$$

No shear reinforcement required

Shear stress - OK

CONCRETE SLAB DEFLECTION CHECK (CL 3.5.7)

Slab span length $I_x = 3.500 \text{ m}$

Design ultimate moment in shorter span per m width $m_{sx} = 18 \text{ kNm/m}$

Depth to outer tension steel $d_x = 144 \text{ mm}$

Tension steel

Area of outer tension reinforcement provided $A_{sx_prov} = 565 \text{ mm}^2/\text{m}$

Area of tension reinforcement required Asx_req = 305 mm²/m

Moment Redistribution Factor $\beta_{bx} = 1.00$

Modification Factors

Basic span / effective depth ratio (Table 3.9) ratio_{span_depth} = 20

The modification factor for spans in excess of 10m (ref. cl 3.4.6.4) has not been included.

 $f_{s} = 2 \times f_{y} \times A_{sx_req} / (3 \times A_{sx_prov} \times \beta_{bx}) = 179.8 \text{ N/mm}^{2}$

 $factor_{tens} = min (2, 0.55 + (477 \text{ N/mm}^2 - f_s) / (120 \times (0.9 \text{ N/mm}^2 + m_{sx} / d_x^2))) = 1.946$

Calculate Maximum Span

	Project 10 Downside Crescent				Job no. 1411	
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This is a simplified approach and further attention should be given where special circumstances exist. Refer to clauses 3.4.6.4 and 3.4.6.7.

Maximum span $I_{max} = ratio_{span_depth} \times factor_{tens} \times d_x = 5.60 \text{ m}$

Check the actual beam span

Actual span/depth ratio $I_x / d_x = 24.31$

Span depth limit $ratio_{span_depth} \times factor_{tens} = 38.91$

Span/Depth ratio check satisfied

CHECK OF NOMINAL COVER (SAGGING) - (BS8110:PT 1, TABLE 3.4)

Slab thickness h = 175 mm

Effective depth to bottom outer tension reinforcement $d_x = 144.0 \text{ mm}$

Diameter of tension reinforcement $D_x = 12 \text{ mm}$

Diameter of links $L_{diax} = 0 \text{ mm}$

Cover to outer tension reinforcement

 $c_{tenx} = h - d_x - D_x / 2 = 25.0 \text{ mm}$

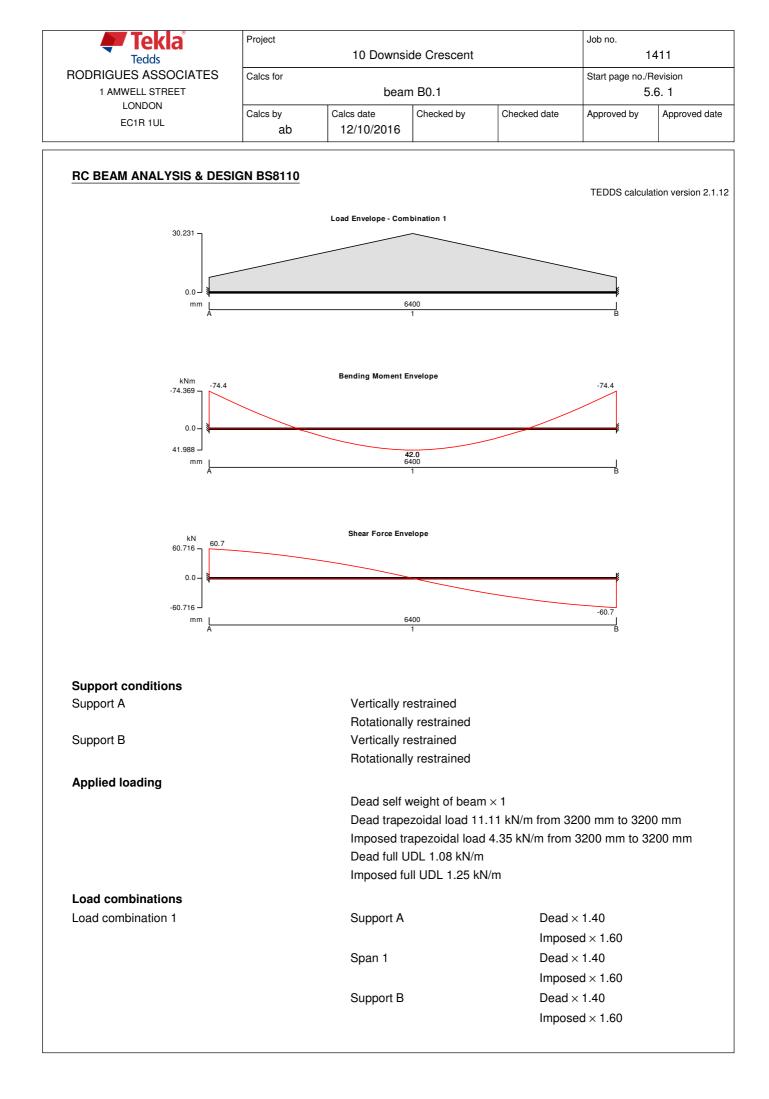
Nominal cover to links steel

 $c_{nomx} = c_{tenx} - L_{diax} = 25.0 \text{ mm}$

Permissable minimum nominal cover to all reinforcement (Table 3.4)

c_{min} = **25** mm

Cover over steel resisting sagging OK



🗾 Tekla	Project				Job no.	
Tedds	10 Downside Crescent				1411	
RODRIGUES ASSOCIATES	Calcs for				Start page no./Re	evision
1 AMWELL STREET		beam	n B0.1		5.6. 2	
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved date

Analysis results

Maximum moment support A	M _{A_max} = -74 kNm	M _{A_red} = -74 kNm
Maximum moment span 1 at 3200 mm	M _{s1_max} = 42 kNm	M _{s1_red} = 42 kNm
Maximum moment support B	M _{B_max} = -74 kNm	M _{B_red} = -74 kNm
Maximum shear support A	$V_{A_{max}} = 61 \text{ kN}$	$V_{A_red} = 61 \text{ kN}$
Maximum shear support A span 1 at 199 mm	$V_{A_s1_max} = 59 \text{ kN}$	$V_{A_s1_red} = 59 \text{ kN}$
Maximum shear support B	$V_{B_{max}} = -61 \text{ kN}$	V _{B_red} = -61 kN
Maximum shear support B span 1 at 6201 mm	$V_{B_s1_max} = -59 \text{ kN}$	$V_{B_s1_red} = -59 \text{ kN}$
Maximum reaction at support A	R _A = 61 kN	
Unfactored dead load reaction at support A	$R_{A_Dead} = 31 \text{ kN}$	
Unfactored imposed load reaction at support A	R _{A_Imposed} = 11 kN	
Maximum reaction at support B	R _B = 61 kN	
Unfactored dead load reaction at support B	$R_{B_{Dead}} = 31 \text{ kN}$	
Unfactored imposed load reaction at support B	$R_{B_Imposed} = 11 \text{ kN}$	

Rectangular section details

Section width Section depth









Concrete details

Concrete strength class Characteristic compressive cube strength Modulus of elasticity of concrete Maximum aggregate size

C32/40

 $\label{eq:fcu} \begin{array}{l} f_{cu} = {\rm 40} \ N/mm^2 \\ E_c = 20 kN/mm^2 + 200 \times f_{cu} = {\rm 28000} \ N/mm^2 \\ h_{agg} = {\rm 20} \ mm \end{array}$

Reinforcement details

 $\begin{array}{ll} \mbox{Characteristic yield strength of reinforcement} & f_y = {\color{black}{500}} \ \mbox{N/mm}^2 \\ \mbox{Characteristic yield strength of shear reinforcement} & f_{yv} = {\color{black}{500}} \ \mbox{N/mm}^2 \end{array}$

Nominal cover to reinforcement

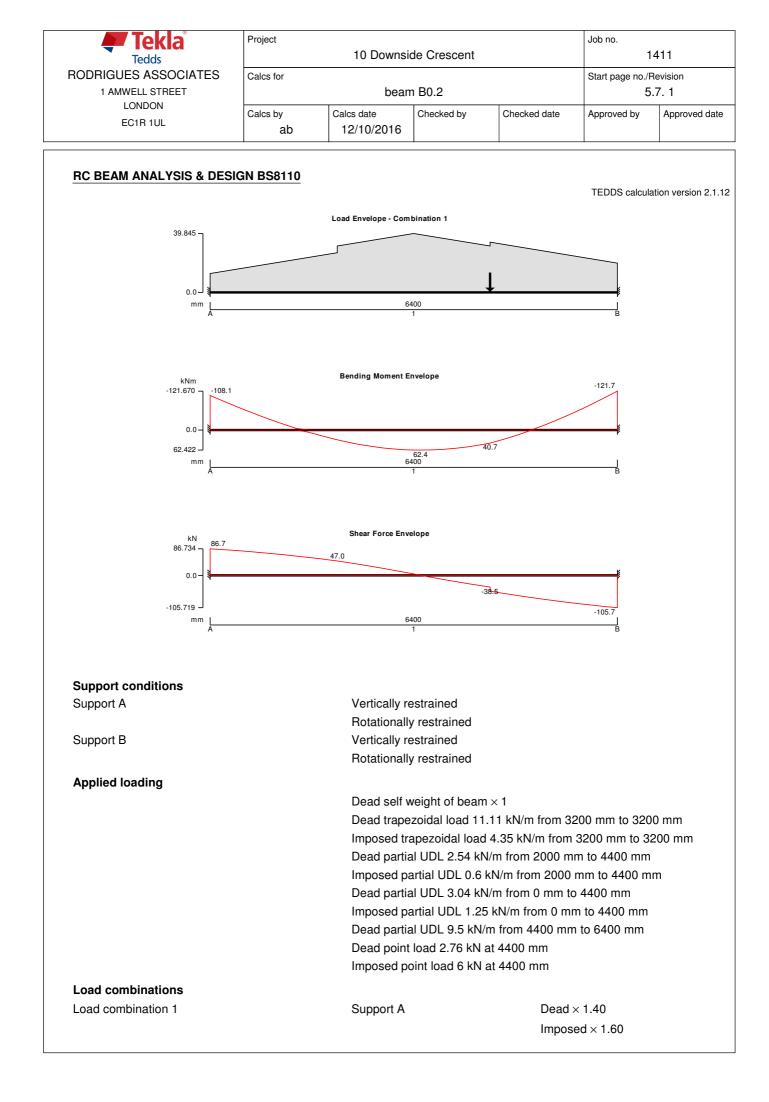
Nominal cover to top reinforcement	$C_{nom_t} = 35 \text{ mm}$
Nominal cover to bottom reinforcement	Cnom_b = 35 mm
Nominal cover to side reinforcement	C _{nom_s} = 35 mm

		10 Downs	1411					
RODRIGUES ASSOCIATES 1 AMWELL STREET	Calcs for beam B0.1				Start page no./I 5	Revision .6. 3		
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved of		
	ab	12/10/2010						
Support A								
	—	• •		$5 imes 16_{\varphi}$ bars 2 x 8_{\varphi} shear legs a	at 100 c/c			
-250								
_	.	• •		$5 \times 16_{\phi}$ bars				
<u> </u>								
←								
Rectangular section in flexu	re (cl.3.4.4)							
Design bending moment	. ,	M = abs(N)	/I _{A_red}) = 74 kNm	n				
Depth to tension reinforcement	t	$d = h - c_{no}$	m_t - φ _v - φ _{top} / 2	= 199 mm				
Redistribution ratio		$\beta_{b} = min(1)$	- m _r A, 1) = 1.0	00				
		K = M / (b	$\times d^2 \times f_{cu}$ = 0.0)94				
		K' = 0.156	5					
			K' > K -	No compressio	on reinforceme	ent is requ		
Lever arm		z = min(d	× (0.5 + (0.25 -	K / 0.9) ^{0.5}), 0.95	× d) = 175 mm	Ì		
Depth of neutral axis		x = (d - z)	/ 0.45 = 52 mm	ı				
Area of tension reinforcement	required	$A_{s,req} = M$	/ (0.87 \times f _y \times z)	= 974 mm ²				
Tension reinforcement provide	d	$5 imes 16\phi$ ba	ars					
Area of tension reinforcement	orovided	$A_{s,prov} = 10$)05 mm²					
Minimum area of reinforcemen	t	$A_{s,min} = 0.0$	$0013 \times b \times h = -$	163 mm²				
Maximum area of reinforcemer			$04 \times b \times h = 50$					
	PASS - Area	of reinforcemer	nt provided is g	greater than are	a of reinforce	ment requ		
Rectangular section in shear								
Design shear force span 1 at 1	99 mm	V = max(\	/A_s1_max, VA_s1_r	_{ed}) = 59 kN				
Design shear stress		v = V / (b	× d) = 0.593 N/	mm²				
Design concrete shear stress (min(f _{cu} , 40) / 25) ^{1/3} / γ_m		$v_c = 0.79$:	< min(3,[100 × /	$A_{s,prov} / (b \times d)]^{1/3}$) × max(1, (400	/d) ^{1/4}) ×		
· · · ·		v _c = 0.883	N/mm ²					
Allowable design shear stress		$v_{max} = min(0.8 \text{ N/mm}^2 \times (f_{cu}/1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = 5.000 \text{ N/mm}^2$ PASS - Design shear stress is less than maximum allowal						
Value of v from Table 3.7			$v < (v_c + 0.4 \text{ N/})$					
Design shear resistance requir	ed	$v_s = max(v - v_c, 0.4 \text{ N/mm}^2) = 0.400 \text{ N/mm}^2$						
Area of shear reinforcement re	quired	$A_{sv,req} = v_s$	\timesb / (0.87 \timesf_{yv}	u) = 460 mm²/m				
Shear reinforcement provided		$2 imes 8\phi$ leg	s at 100 c/c					
Area of shear reinforcement pr		A _{sv,prov} = 1 PASS - Area of s	005 mm²/m shear reinforce	ement provided	exceeds mini	mum reau		
Maximum longitudinal spacing			75 × d = 149 m					
	PASS - Lor	gitudinal spacin			vided is less t	han maxin		
Spacing of rainforcement (al		J						
Spacing of reinforcement (cl	n tension			φ _{top} /2)) /(N _{top} - 1)				

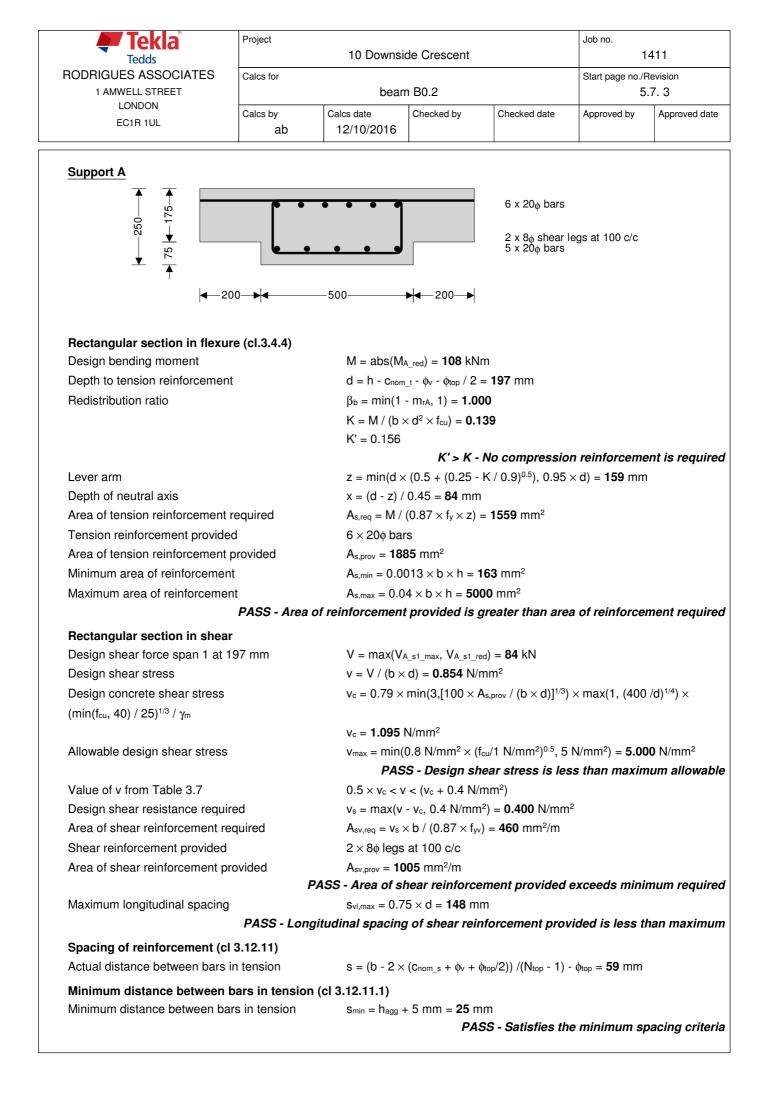
Tedds		10 Downs	ide Crescent		1	411
RODRIGUES ASSOCIATES 1 AMWELL STREET	Calcs for	bear	n B0.1		Start page no./F 5	Revision 6.6.4
LONDON	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved
EC1R 1UL	ab	12/10/2016				
Minimum distance between	bars in tension (cl 3.12.11.1)				
Minimum distance between ba	-	-	+ 5 mm = 25 m	าm		
				SS - Satisfies th	e minimum sp	pacing crit
Maximum distance between	bars in tension (cl 3.12.11.2)				
Design service stress		$f_s = (2 \times f_y)$	imes A _{s,req}) / (3 $ imes$ A	$A_{s,prov} \times \beta_b) = 323$.1 N/mm²	
Maximum distance between ba	ars in tension	s _{max} = min((47000 N/mm /	′ f _s , 300 mm) = 1 4	45 mm	
			PAS	SS - Satisfies the	e maximum s _l	pacing crit
Mid span 1						
 _						
	•••	• •		$5 \times 16_{\varphi}$ bars		
550				$2 \times 8_{\varphi}$ shear legs a	at 100 c/c	
	•	• •		$5 \times 16_{\phi}$ bars		
<u> </u>						
+		500				
Design moment resistance	of rootongular oo	ation (al. 2.4.4)	Desitivo ma	mont		
Design moment resistance of	of rectangular see					
Design bending moment	-	M = abs(M	s1_red) = 42 kNr	n		
Design bending moment Depth to tension reinforcemen	-	$M = abs(M)$ $d = h - c_{non}$	s1_red) = 42 kNr n_b - φ _v - φ _{bot} / 2	m = 199 mm		
Design bending moment	-	$M = abs(M)$ $d = h - c_{non}$ $\beta_b = min(1)$	s1_red) = 42 kNr n_b - φ _v - φ _{bot} / 2 - m _{rs1} , 1) = 1.0	m = 199 mm 000		
Design bending moment Depth to tension reinforcemen	-	$M = abs(M)$ $d = h - c_{non}$ $\beta_b = min(1)$	s1_red) = 42 kNr n_b - φ _v - φ _{bot} / 2	m = 199 mm 000		
Design bending moment Depth to tension reinforcemen	-	$M = abs(M)$ $d = h - c_{non}$ $\beta_b = min(1)$ $K = M / (b)$	$s_{1_red} = 42 \text{ kNr}$ $m_b - \phi_v - \phi_{bot} / 2$ $- m_{rs1}, 1) = 1.0$ $\times d^2 \times f_{cu} = 0.0$	m = 199 mm 000	on reinforceme	ent is requ
Design bending moment Depth to tension reinforcemen	-	$M = abs(M)$ $d = h - C_{non}$ $\beta_b = min(1)$ $K = M / (b)$ $K' = 0.156$	s_{1_red}) = 42 kNr $n_b - \phi_v - \phi_{bot} / 2$ $- m_{rs1}, 1) = 1.0$ $\times d^2 \times f_{cu}$) = 0.0 <i>K' > K -</i>	n = 199 mm 000 053		-
Design bending moment Depth to tension reinforcemen Redistribution ratio	-	$M = abs(M)$ $d = h - c_{non}$ $\beta_b = min(1)$ $K = M / (b)$ $K' = 0.156$ $z = min(d)$	s_{1_red}) = 42 kNr $n_b - \phi_v - \phi_{bot} / 2$ $- m_{rs1}, 1) = 1.0$ $\times d^2 \times f_{cu}$) = 0.0 <i>K' > K -</i>	m = 199 mm 000 053 <i>No compressio</i> K / 0.9) ^{0.5}), 0.95		-
Design bending moment Depth to tension reinforcement Redistribution ratio	ıt	$M = abs(M)$ $d = h - C_{non}$ $\beta_b = min(1)$ $K = M / (b)$ $K' = 0.156$ $z = min(d)$ $x = (d - z) / (d - z)$	$s_{1_red} = 42 \text{ kNr}$ $s_{1_rb} - \phi_V - \phi_{bot} / 2$ $- m_{rs1}, 1) = 1.0$ $\times d^2 \times f_{cu} = 0.0$ K' > K - (0.25 - (0.25 - 0.0))	m = 199 mm 000 053 <i>No compressio</i> K / 0.9) ^{0.5}), 0.95		-
Design bending moment Depth to tension reinforcement Redistribution ratio	required	$M = abs(M)$ $d = h - C_{non}$ $\beta_b = min(1)$ $K = M / (b)$ $K' = 0.156$ $z = min(d)$ $x = (d - z) / (d - z)$	s_{1_red}) = 42 kNr $s_{1_b} - \phi_V - \phi_{bot} / 2$ $- m_{rs1}, 1$) = 1.0 $\times d^2 \times f_{cu}$) = 0.0 $K' > K - \frac{1}{2}$ $(0.5 + (0.25 - \frac{1}{2}) - \frac{1}{2}$ mm $(0.87 \times f_y \times z)$	m = 199 mm 000 053 <i>No compressio</i> K / 0.9) ^{0.5}), 0.95		-
Design bending moment Depth to tension reinforcement Redistribution ratio Lever arm Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement	required ed provided	$M = abs(M)$ $d = h - Cnon$ $\beta_b = min(1)$ $K = M / (b)$ $K' = 0.156$ $z = min(d)$ $x = (d - z) /$ $A_{s,req} = M /$ $5 \times 16\phi ba$ $A_{s,prov} = 10$	$s_{1_{red}} = 42 \text{ kNr}$ $s_{1_{rb}} - \phi_{v} - \phi_{bot} / 2$ $- m_{rs1}, 1) = 1.0$ $\times d^2 \times f_{cu}) = 0.0$ $K' > K - \frac{1}{2}$ $(0.5 + (0.25 - \frac{1}{2}) - (0.45 = 28 \text{ mm})$ $(0.87 \times f_y \times z)$ rs 05 mm^2	m = 199 mm 000 053 <i>No compressio</i> K / 0.9) ^{0.5}), 0.95 1 = 518 mm ²		-
Design bending moment Depth to tension reinforcement Redistribution ratio	required ed provided	$\begin{split} M &= abs(M) \\ d &= h - c_{non} \\ \beta_b &= min(1) \\ K &= M / (b) \\ K' &= 0.156 \\ z &= min(d) \\ x &= (d - z) / \\ A_{s,req} &= M / \\ 5 &\times 16\varphi \ ba \\ A_{s,prov} &= 10 \\ A_{s,min} &= 0.0 \end{split}$	s_{1_red}) = 42 kNr $s_{1_b} - \phi_V - \phi_{bot} / 2$ $- m_{rs1}, 1) = 1.0$ $\times d^2 \times f_{cu}$) = 0.0 $K' > K - \frac{1}{2}$ $(0.45 + (0.25 - \frac{1}{2}))$ (0.45 - 28 mm) $(0.87 \times f_y \times z)$ rs 05 mm^2 $013 \times b \times h = 1$	m = 199 mm 000 053 <i>No compressio</i> K / 0.9) ^{0.5}), 0.95 = 518 mm ²		-
Design bending moment Depth to tension reinforcement Redistribution ratio Lever arm Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement	required ed provided nt nt	M = abs(M) d = h - Cnon $\beta_b = min(1)$ K = M / (b) K' = 0.156 z = min(d) $x = (d - z) / As,req = M / 5 \times 16\phi ba$ $A_{s,prov} = 10$ $A_{s,min} = 0.0$ $A_{s,max} = 0.0$	$s_{1_{red}} = 42 \text{ kNr}$ $s_{1_{red}} - \phi_v - \phi_{bot} / 2$ $- m_{rs1}, 1) = 1.0$ $\times d^2 \times f_{cu}) = 0.0$ K' > K - (0.5 + (0.25 - 0.45 - 28 mm)) $(0.87 \times f_y \times z)$ rs 05 mm^2 $013 \times b \times h = -0.4$	m = 199 mm 000 053 <i>No compressio</i> K / 0.9) ^{0.5}), 0.95 = 518 mm ² 163 mm ² 00 mm ²	× d) = 186 mm	
Design bending moment Depth to tension reinforcement Redistribution ratio	required ed provided nt nt PASS - Area of	M = abs(M) d = h - Cnon $\beta_b = min(1)$ K = M / (b) K' = 0.156 z = min(d) $x = (d - z) / As,req = M / 5 \times 16\phi ba$ $A_{s,prov} = 10$ $A_{s,min} = 0.0$ $A_{s,max} = 0.0$	$s_{1_{red}} = 42 \text{ kNr}$ $s_{1_{red}} - \phi_v - \phi_{bot} / 2$ $- m_{rs1}, 1) = 1.0$ $\times d^2 \times f_{cu}) = 0.0$ K' > K - (0.5 + (0.25 - 0.45 - 28 mm)) $(0.87 \times f_y \times z)$ rs 05 mm^2 $013 \times b \times h = -0.4$	m = 199 mm 000 053 <i>No compressio</i> K / 0.9) ^{0.5}), 0.95 = 518 mm ²	× d) = 186 mm	
Design bending moment Depth to tension reinforcement Redistribution ratio Lever arm Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcement Maximum area of reinforcement	required ed provided nt nt PASS - Area of	$\begin{split} M &= abs(M) \\ d &= h - C_{non} \\ \beta_b &= min(1) \\ K &= M / (b) \\ K' &= 0.156 \\ z &= min(d) \\ z &= (d - z) / \\ A_{s,req} &= M / \\ 5 &\times 16 \phi ba \\ A_{s,prov} &= 10 \\ A_{s,min} &= 0.0 \\ A_{s,max} &= 0.0 \\ reinforcemen \end{split}$	$s_{1_{red}} = 42 \text{ kNr}$ $s_{1_{rb}} - \phi_v - \phi_{bot} / 2$ $- m_{rs1}, 1) = 1.0$ $\times d^2 \times f_{cu}) = 0.0$ K' > K - 0.25 - 0.45 = 28 mm $(0.87 \times f_y \times z)$ rs 05 mm^2 $013 \times b \times h = 50$ t provided is g	m = 199 mm 000 053 <i>No compressio</i> K / 0.9) ^{0.5}), 0.95 = 518 mm ² 163 mm ² 00 mm ²	× d) = 186 mm	
Design bending moment Depth to tension reinforcement Redistribution ratio Lever arm Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcement Maximum area of reinforcement Maximum area of reinforcement	required ed provided nt nt PASS - Area of r	$\begin{split} M &= abs(M) \\ d &= h - c_{non} \\ \beta_b &= min(1) \\ K &= M / (b) \\ K' &= 0.156 \\ z &= min(d) \\ x &= (d - z) / \\ A_{s,req} &= M / \\ 5 &\times 16\phi \ ba \\ A_{s,prov} &= 10 \\ A_{s,min} &= 0.0 \\ A_{s,max} &= 0.0 \\ reinforcemen \\ 2 &\times 8\phi \ legs \end{split}$	s_{1_red}) = 42 kNr $s_{1_b} - \phi_V - \phi_{bot} / 2$ $- m_{rs1}, 1$) = 1.0 $\times d^2 \times f_{cu}$) = 0.0 $K' > K - \frac{1}{2}$ $(0.5 + (0.25 - \frac{1}{2}) - (0.45 - \frac{28}{2}) - (0.45 - \frac{28}{2}$	m = 199 mm 000 053 <i>No compressio</i> K / 0.9) ^{0.5}), 0.95 = 518 mm ² 163 mm ² 00 mm ²	× d) = 186 mm	
Design bending moment Depth to tension reinforcement Redistribution ratio Lever arm Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcement Maximum area of reinforcement Shear reinforcement provided Area of shear reinforcement p	required ed provided nt nt PASS - Area of r rovided	$\begin{split} M &= abs(M) \\ d &= h - C_{non} \\ \beta_b &= min(1) \\ K &= M / (b) \\ K' &= 0.156 \\ z &= min(d) \\ z &= (d - z) / \\ A_{s,req} &= M / \\ 5 \times 16 \phi ba \\ A_{s,prov} &= 10 \\ A_{s,min} &= 0.0 \\ A_{s,max} &= 0.0 \\ reinforcemen \\ 2 \times 8 \phi \ legs \\ A_{sv,prov} &= 10 \\ \end{split}$	$s_{1_{red}} = 42 \text{ kNr}$ $s_{1_{red}} - \phi_v - \phi_{bot} / 2$ $- m_{rs1}, 1) = 1.0$ $\times d^2 \times f_{cu}) = 0.0$ K' > K - (0.5 + (0.25 - 0.45 - 28 mm)) $(0.87 \times f_y \times z)$ rs 05 mm^2 $013 \times b \times h = 50$ t provided is g s at 100 c/c $005 \text{ mm}^2/\text{m}$	m = 199 mm 000 053 <i>No compressio</i> K / 0.9) ^{0.5}), 0.95 = 518 mm ² 163 mm ² 00 mm ² greater than are	× d) = 186 mm	1
Design bending moment Depth to tension reinforcement Redistribution ratio Lever arm Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcement Maximum area of reinforcement Maximum area of reinforcement	required ed provided nt nt PASS - Area of r rovided rcement (Table 3.7	$\begin{split} M &= abs(M \\ d &= h - Cnon \\ \beta_b &= min(1 \\ K &= M / (b \\ K' &= 0.156 \\ z &= min(d \times K') \\ K' &= 0.156 \\ z &= min(d \times K') \\ K' &= 0.156 \\ K' &= 0.156 \\ A_{s,req} &= M / \\ S \times 16 \\ b \\ b \\ A_{s,req} &= M / \\ S \times 16 \\ b \\ b \\ A_{s,prov} &= 10 \\ A_{s,max} &= 0.0 \\ A_{s,max} &= 0.0 \\ reinforcemen \\ 2 \times 8 \\ b \\ legs \\ A_{sv,prov} &= 10 \\ C \\ S \\ S \\ sv,prov &= 10 \\ C \\ S \\$	$s_{1_{red}} = 42 \text{ kNr}$ $s_{1_{rb}} - \phi_v - \phi_{bot} / 2$ $- m_{rs1}, 1) = 1.0$ $\times d^2 \times f_{cu}) = 0.0$ K' > K - (0.5 + (0.25 - 0.45 = 28 mm)) $(0.87 \times f_y \times z)$ rs $013 \times b \times h = 50$ $04 \times b \times h = 50$ $t \ provided \ is g$ $s \ at 100 \ c/c$ $005 \ mm^2/m$ $4N/mm^2 \times b / (0.5 + 0.25 - 0.25)$	m = 199 mm 000 053 No compressio K / 0.9) ^{0.5}), 0.95 = 518 mm ² 163 mm ² 163 mm ² 00 mm ² greater than are 0.87 × f _{yv}) = 460	× d) = 186 mm a of reinforce mm²/m	ment requ
Design bending moment Depth to tension reinforcement Redistribution ratio Lever arm Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcement Maximum area of reinforcement Shear reinforcement provided Area of shear reinforcement p Minimum area of shear reinfor	required ed provided nt nt PASS - Area of r rovided cement (Table 3.7 PA	$\begin{split} M &= abs(M \\ d &= h - c_{non} \\ \beta_b &= min(1 \\ K &= M / (b \\ K' &= 0.156 \\ z &= min(d > \\ X &= (d - z) / \\ A_s,req &= M / \\ 5 \times 16 \phi ba \\ A_s,prov &= 10 \\ A_s,min &= 0.0 \\ A_s,min &= 0.0 \\ A_s,max &= 0.0 \\ reinforcemen \\ 2 \times 8 \phi legs \\ A_sv,prov &= 10 \\ SS - \textit{Area of s} \end{split}$	s_{1_red}) = 42 kNr $s_{1_b} - \phi_{v} - \phi_{bot} / 2$ $- m_{rs1}, 1$) = 1.0 $\times d^{2} \times f_{cu}$) = 0.0 $K' > K - d^{2} \times f_{cu}$ = 0.0 $(0.87 \times f_{v} \times z)$ rs $0.45 = 28 mm^{2}$ $(0.87 \times f_{y} \times z)$ rs $013 \times b \times h = 7$ $04 \times b \times h = 50$ $t \ provided \ is g$ $s \ at 100 \ c/c$ $05 \ mm^{2}/m$ $4N/mm^{2} \times b / (t)$	m = 199 mm 000 053 <i>No compressio</i> K / 0.9) ^{0.5}), 0.95 = 518 mm ² 163 mm ² 164 mm ² 165 mm ² 166 mm ² 167 mm ² 168 mm ² 169 mm ² 160 mm ² 160 mm ² 160 mm ² 161 mm ² 162 mm ² 163 mm ² 163 mm ² 164 mm ² 164 mm ² 165 mm ² 166 mm ² 167 mm ² 168 mm ² 169 mm ² 169 mm ² 160 mm ² 160 mm ² 160 mm ² 161 mm ² 162 mm ² 163 mm ² 164 mm ² 164 mm ² 165 mm ² 166 mm ² 167 mm ² 168 mm ² 169 mm ² 169 mm ² 169 mm ² 160 mm ²	× d) = 186 mm a of reinforce mm²/m	ment requ
Design bending moment Depth to tension reinforcement Redistribution ratio Lever arm Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcement Maximum area of reinforcement Shear reinforcement provided Area of shear reinforcement p	required ed provided nt nt PASS - Area of r rovided cement (Table 3.7 PA (cl. 3.4.5.5)	$\begin{split} M &= abs(M \\ d &= h - Cnon \\ \beta_b &= min(1 \\ K &= M / (b \\ K' &= 0.156 \\ z &= min(d > c \\ x &= (d - z) / \\ A_s,req &= M / \\ 5 \times 16 \varphi ba \\ A_s,prov &= 10 \\ A_s,min &= 0.0 \\ A_s,max &= 0.0 \\ A_s,max &= 0.0 \\ reinforcemen \\ 2 \times 8 \varphi legs \\ A_sv,prov &= 10 \\ SS - Area of s \\ Sv_v,max &= 0.7 \end{split}$	$s_{1_{red}} = 42 \text{ kNr}$ $s_{1_{red}} - \phi_v - \phi_{bot} / 2$ $- m_{rs1}, 1) = 1.0$ $\times d^2 \times f_{cu}) = 0.0$ K' > K - (0.5 + (0.25 - 0.45)) (0.45 = 28 mm) $(0.87 \times f_y \times z)$ rs 05 mm^2 $013 \times b \times h = 50$ t provided is g c at 100 c/c $005 \text{ mm}^2/\text{m}$ $4N/\text{mm}^2 \times b / (0.5)$ hear reinforce $75 \times d = 149 \text{ m}$	m = 199 mm 500 53 No compressio $K / 0.9)^{0.5}$, 0.95 = 518 mm ² 163 mm ² 164 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 175 1	× d) = 186 mm ea of reinforce mm²/m exceeds mini	ment requ mum requ
Design bending moment Depth to tension reinforcement Redistribution ratio	required ed provided nt nt PASS - Area of r rovided cement (Table 3.7 PA (cl. 3.4.5.5)	$\begin{split} \mathbf{M} &= \mathbf{abs}(\mathbf{M} \\ \mathbf{d} &= \mathbf{h} - \mathbf{C_{non}} \\ \mathbf{\beta_b} &= \min(1 \\ \mathbf{K} &= \mathbf{M} / (\mathbf{b} \\ \mathbf{K}' &= 0.156 \\ \mathbf{z} &= \min(\mathbf{d} \times \mathbf{c} \\ \mathbf{z} &= (\mathbf{d} - \mathbf{z}) / \\ \mathbf{A}_{s,req} &= \mathbf{M} / \\ 5 \times 16 \phi \ \mathbf{ba} \\ \mathbf{A}_{s,prov} &= 10 \\ \mathbf{A}_{s,min} &= 0.0 \\ \mathbf{A}_{s,max} &= 0.0 \\ \mathbf{reinforcemen} \\ 2 \times 8 \phi \ \mathbf{legs} \\ \mathbf{A}_{sv,prov} &= 10 \\ \mathbf{S} \cdot \mathbf{Area of s} \\ \mathbf{S}_{vl,max} &= 0.7 \\ \mathbf{udinal spacing} \end{split}$	$s_{1_{red}} = 42 \text{ kNr}$ $s_{1_{red}} - \phi_v - \phi_{bot} / 2$ $- m_{rs1}, 1) = 1.0$ $\times d^2 \times f_{cu}) = 0.0$ K' > K - (0.5 + (0.25 - 0.45 = 28 mm)) $(0.87 \times f_y \times z)$ rs 05 mm^2 $013 \times b \times h = 70$ $04 \times b \times h = 50$ t provided is g s at 100 c/c $005 \text{ mm}^2/\text{m}$ $4N/\text{mm}^2 \times b / (0.5 + 0.25)$ f constants = 100	m = 199 mm 000 053 No compressio $K / 0.9)^{0.5}$, 0.95 = 518 mm ² 163 mm ² 164 mm ² 165 mm ² 166 mm ² 177 mm ² 178 mm ² 179 mm ²	× d) = 186 mm a of reinforce mm²/m exceeds mini. vided is less to	ment requ mum requ han maxin
Design bending moment Depth to tension reinforcement Redistribution ratio Lever arm Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcement Maximum area of reinforcement Shear reinforcement provided Area of shear reinforcement p Minimum area of shear reinfor	required ed provided nt nt PASS - Area of r rovided cement (Table 3.7 PA (cl. 3.4.5.5)	$\begin{split} M &= abs(M \\ d &= h - c_{non} \\ \beta_b &= min(1 \\ K &= M / (b \\ K' &= 0.156 \\ z &= min(d > \\ x &= (d - z) / \\ A_s,req &= M / \\ 5 \times 16 \varphi ba \\ A_s,prov &= 10 \\ A_s,min &= 0.0 \\ A_sv,prov &= 10 \\ K_sv,prov &= 10 \\ S_S - Area of s \\ S_Sv_sv,min &= 0.7 \\ S_S - Area of s \\ S_vl,max &= 0.7 \\ udinal spacing \\ v_c &= 0.79N \end{split}$	s_{1_red}) = 42 kNr s_{1_red} - ϕ_v - ϕ_{bot} / 2 - m_{rs1} , 1) = 1.0 × $d^2 \times f_{cu}$) = 0.0 K' > K - (0.5 + (0.25 - 0.45 = 28 mm)) (0.87 × $f_y \times z$) rs 05 mm ² 013 × b × h = 50 t provided is g at 100 c/c 005 mm ² /m 4N/mm ² × b / (0.45 + 100 m)) (0.87 × $f_y \times z$) rs s = 100 c/c s = 149 m g of shear rein (mm ² × min(3,[m = 199 mm 500 53 No compressio $K / 0.9)^{0.5}$, 0.95 = 518 mm ² 163 mm ² 164 165 mm ² 165 mm ² 166 mm ² 167 mm ² 168 mm ² 169 mm ² 169 mm ² 169 mm ² 160 mm ² 170	× d) = 186 mm <i>ta of reinforcer</i> <i>mm²/m</i> <i>exceeds mini</i> <i>vided is less ti</i> × d)] ^{1/3}) × max(ment requ mum requ han maxin 1, (400mm
Design bending moment Depth to tension reinforcement Redistribution ratio	required ed provided nt nt PASS - Area of r rovided cement (Table 3.7 PA (cl. 3.4.5.5) PASS - Longit	$\begin{array}{l} M = abs(M \\ d = h - Cnon \\ \beta_b = min(1 \\ K = M / (b \\ K' = 0.156 \\ z = min(d > \\ K' = 0.156 \\ z = min(d > \\ K' = 0.156 \\ d \\ as,req = M / \\ 5 \times 16 \phi ba \\ As,prov = 10 \\ As,min = 0.0 \\ As,min = 0.0 \\ As,max = 0.0 \\ Asv,min = 0.4 \\ SS - Area of s \\ sv_v,max = 0.7 \\ sv,max = 0.7 \\$	$s_{1_{red}} = 42 \text{ kNr}$ $r_{b} - \phi_v - \phi_{bot} / 2$ $- m_{rs1}, 1) = 1.0$ $\times d^2 \times f_{cu}) = 0.0$ K' > K - (0.5 + (0.25 - 0.45 = 28 mm)) $(0.87 \times f_y \times z)$ rs 05 mm^2 $013 \times b \times h = 50$ $04 \times b \times h = 50$ t provided is g c at 100 c/c $005 \text{ mm}^2/\text{m}$ $4N/\text{mm}^2 \times b / (0.5 + 0.25)$ f bear reinforce f c	m = 199 mm b00 b53 No compression K / 0.9) ^{0.5}), 0.95 = 518 mm ² 163 mm ² 164 165 mm ² 165 mm ² 166 mm ² 167 mm ² 167 mm ² 168 mm ² 169 mm ² 169 mm ² 169 mm ² 160 mm ² 170	× d) = 186 mm a of reinforce mm ² /m exceeds mini vided is less t × d)] ^{1/3}) × max(/ γ _m = 0.883 N/1	ment requ mum requ han maxin 1, (400mm
Design bending moment Depth to tension reinforcement Redistribution ratio	required ed provided nt nt PASS - Area of r rovided cement (Table 3.7 PA (cl. 3.4.5.5) PASS - Longit	$\begin{split} M &= abs(M \\ d &= h - c_{non} \\ \beta_b &= min(1) \\ K &= M / (b) \\ K' &= 0.156 \\ z &= min(d > c) \\ X &= (d - z) / \\ A_s,req &= M / \\ 5 \times 16 \phi ba \\ A_s,prov &= 10 \\ A_s,min &= 0.0 \\ A$	$s_{1_{red}} = 42 \text{ kNr}$ $r_{b} - \phi_v - \phi_{bot} / 2$ $- m_{rs1}, 1) = 1.0$ $\times d^2 \times f_{cu}) = 0.0$ K' > K - (0.5 + (0.25 - 0.45 = 28 mm)) $(0.87 \times f_y \times z)$ rs 05 mm^2 $013 \times b \times h = 50$ $04 \times b \times h = 50$ t provided is g c at 100 c/c $005 \text{ mm}^2/\text{m}$ $4N/\text{mm}^2 \times b / (0.5 + 0.25)$ f bear reinforce f c	m = 199 mm b00 b53 No compressio $K / 0.9)^{0.5}$, 0.95 = 518 mm ² 163 mm ² 164 165 mm ² 165 mm ² 166 167 mm ² 167 mm ² 168 mm ² 169 mm ² 169 mm ² 169 mm ² 160 mm ² 160 mm ² 160 mm ² 160 mm ² 161 mm ² 161 mm ² 162 mm ² 163 mm ² 164 mm ² 164 mm ² 165 mm ² 165 mm ² 166 mm ² 167 mm ² 168 mm ² 169 mm ² 169 mm ² 169 mm ² 160 mm	× d) = 186 mm a of reinforce mm ² /m exceeds mini vided is less t × d)] ^{1/3}) × max(/ γ _m = 0.883 N/1	ment requ mum requ han maxin 1, (400mm

	Project	10 Downsi	de Crescent		Job no. 1	411
RODRIGUES ASSOCIATES	Calcs for				Start page no./F	
1 AMWELL STREET		bear	n B0.1			.6. 5
LONDON	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved
EC1R 1UL	ab	12/10/2016	,		1-1	
Shear links	s provided va	lid between 0 m	m and 6400 n	nm with tension	reinforcemen	nt of 1005
Spacing of reinforcement (cl 3	3.12.11)					
Actual distance between bars in	tension	s = (b - 2 ×	(Cnom_s + ϕ_v +	φ _{bot} /2)) /(N _{bot} - 1)	- φ _{bot} = 84 mm	
Minimum distance between ba	ars in tension	(c) 3 12 11 1)				
Minimum distance between bars		-	⊦ 5 mm = 25 n	nm		
		Chini — Hayy		SS - Satisfies th	e minimum sı	pacing cri
Maximum distance between b	are in tensior	n (cl 3 12 11 2)				0
Design service stress			$\langle \mathbf{A}_{\alpha} \rangle / (2 \vee 1)$	$A_{s,prov} \times \beta_b) = 171$	6 N/mm ²	
Maximum distance between bar	s in tension	•		$f_{s,prov} \times p_b) = 171$ (f_{s} , 300 mm) = 27		
שמאווועווו טופנמווטב שבנשבבוו שמו				SS - Satisfies th		nacina cri
			r Av		s maximum sp	Caung Ull
Span to depth ratio (cl. 3.4.6)	0.0)					
Basic span to depth ratio (Table	,	·	$epth_{basic} = 20.0$		••••	
Design service stress in tension		t $f_s = (2 \times f_y)$	$<$ A _{s,req})/ (3 \times A	$(s, prov \times \beta_b) = 171.0$	5 N/mm²	
Modification for tension reinforce					0	10)
		min(2.0, 0.55 + (477N/mm² - f₅) / (120 × (0.9N/r	$nm^{2} + (M / (b \times$: d²))))) = 1
Modification for compression rel						
	f _{com}	$p = \min(1.5, 1 + (1.5))$		$(b \times d)) / (3 + (10))$	$00 imes A_{s2,prov} / (b$	× d)))) = 1
Modification for span length		$f_{long} = 1.000$				
Allowable span to depth ratio				n_to_depth _{basic} \times	$f_{tens} \times f_{comp} = 34$	1.9
Actual span to depth ratio		·	$epth_{actual} = L_{s1}$			
		PASS	5 - Actual spa	n to depth ratio	is within the a	allowable
Support B						
▲						
	• •	• •		$5 \times 16_{\varphi}$ bars		
-250				$2 \times 8\phi$ shear legs a	t 100 c/c	
				$5 \times 16_{\phi}$ bars		
				υλισφυαίδ		
_ ▼						
4 —		-500				
Pootongular agation in flamme	(a 2 4 4)					
Rectangular section in flexure Design bending moment	: (01.3.4.4)	M = aba/M		n		
			_{3_red}) = 74 kNn _{_t} - φ _v - φ _{top} / 2			
Depth to tension reinforcement						
Redistribution ratio			$-m_{rB}, 1) = 1.0$			
			$\langle d^2 \times f_{cu} \rangle = 0.0$	J94		
		K' = 0.156	171 17		a and the for	
				No compressio		-
		$z = \min(d x)$: (0.5 + (0.25 -	K / 0.9) ^{0.5}), 0.95	× d) = 175 mm	1
Lever arm			- ·			
Depth of neutral axis		x = (d - z) /	0.45 = 52 mm			
Depth of neutral axis Area of tension reinforcement re	-	x = (d - z) / A _{s,req} = M /	$(0.87 imes f_y imes z)$			
Depth of neutral axis Area of tension reinforcement re Tension reinforcement provided		x = (d - z) / A _{s,req} = M / 5 × 16φ bar	$(0.87 \times f_y \times z)$ is			
Depth of neutral axis Area of tension reinforcement re		x = (d - z) / A _{s,req} = M /	$(0.87 \times f_y \times z)$ is			

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Tedds RODRIGUES ASSOCIATES		10 000013	Start page no./Revision						
1 AMWELL STREET LONDON EC1R 1UL	Calcs for	bear		5.6. 6					
	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved da			
	ab	12/10/2010							
Maximum area of reinforcemen	ıt	$A_{s,max} = 0.0$	04 × b × h = 50	00 mm²					
	PASS - Area	of reinforcemen	t provided is g	greater than are	a of reinforce	ment requii			
Rectangular section in shear									
Design shear force span 1 at 6	201 mm	V = abs(m	in(V _{B_s1_max} , V _B	_ _{s1_red})) = 59 kN					
Design shear stress		$v = V / (b \times$	< d) = 0.593 N/i	mm²					
Design concrete shear stress		$v_c = 0.79 \times$: min(3,[100 × /	$A_{s,prov} / (b \times d)]^{1/3}$	\times max(1, (400) /d) ^{1/4}) ×			
$(min(f_{cu},40)/25)^{1/3}/\gamma_{m}$									
		$v_{c} = 0.883$	N/mm ²						
Allowable design shear stress		$v_{max} = min(0.8 \text{ N/mm}^2 \times (f_{cu}/1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = 5.000 \text{ N/mm}^2$							
		PAS	SS - Design sh	near stress is le	ss than maxin	num allowa			
Value of v from Table 3.7			$v < (v_c + 0.4 \text{ N/})$,					
Design shear resistance requir		$v_s = max(v - v_c, 0.4 \text{ N/mm}^2) = 0.400 \text{ N/mm}^2$							
Area of shear reinforcement re	quired		$A_{sv,req} = v_s \times b \ / \ (0.87 \times f_{yv}) = \textbf{460} \ mm^2/m$						
Shear reinforcement provided			$2 \times 8\phi$ legs at 100 c/c						
Area of shear reinforcement pr)05 mm²/m						
		PASS - Area of s		-	exceeds mini	mum requi			
Maximum longitudinal spacing	B400		75 × d = 149 m						
		gitudinal spacing	g of snear reli	norcement prov	viaea is iess t	nan maximi			
Spacing of reinforcement (cl	•								
Actual distance between bars i	n tension	s = (b - 2 ×	$s = (b - 2 \times (c_{nom_s} + \phi_v + \phi_{top}/2)) / (N_{top} - 1) - \phi_{top} = 84 \text{ mm}$						
Minimum distance between b	oars in tensio								
Minimum distance between bar	rs in tension	$s_{min} = h_{agg}$	+ 5 mm = 25 m						
			PA	SS - Satisfies th	e minimum s	pacing crite			
Maximum distance between	bars in tensio	on (cl 3.12.11.2)							
Design service stress		$f_s = (2 \times f_y)$	imes A _{s,req}) / (3 $ imes$ A	$A_{s,prov} \times \beta_b) = 323$.1 N/mm²				
Maximum distance between ba				′ f _s , 300 mm) = 1 4					



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RODRIGUES ASSOCIATES 1 AMWELL STREET	Calcs for	bear		Start page no./Revision 5.7. 2		
LONDON	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved da
EC1R 1UL	ab	12/10/2016				
		Span 1		Dead	× 1.40	
				Impos	ed × 1.60	
		Support B		Dead	× 1.40	
				Impos	ed imes 1.60	
Analysis results						
Maximum moment support A		MA_max = -1		_	= -108 kNm	
Maximum moment span 1 at 3	309 mm	$M_{s1_max} = 6$		_	= 62 kNm	
Maximum moment support B		M _{B_max} = -1			= -122 kNm	
Maximum shear support A		V _{A_max} = 87			= 87 kN	
Maximum shear support A spa	n 1 at 197 mm	VA_s1_max =			ed = 84 kN	
Maximum shear support B		$V_{B_{max}} = -1$		_	= -106 kN	
Maximum shear support B spa		$V_{B_s1_max} =$		V _{B_s1_re}	ed = -102 kN	
Maximum reaction at support A		R _A = 87 kN				
Unfactored dead load reaction		$R_{A_Dead} = 4$				
Unfactored imposed load reac		R _{A_Imposed} =				
Maximum reaction at support E		R _B = 106 k				
Unfactored dead load reaction		$R_{B_{Dead}} = 6$				
Unfactored imposed load reac	lion at support B	$R_{B_{Imposed}} =$	14 KIN			
Flanged section details						
Section width		b = 500 mr				
Section depth		h = 250 mr				
Maximum flange width		b _f = 900 m				
Flange depth		h _f = 175 m				
T T						
75						
250						
		1				
75						
<u>↓</u> 75 <u>↓</u>						
75	₄ —200—►				-200	
▲ <u>75</u> ▲	∢ —200—►		500		-200►	
Concrete details	∢ —200—►		500	►	-200►	
	∢ —200— ▶	C32/40	500	►	-200►	
Concrete details		C32/40 f _{cu} = 40 N/r		►	-200►	
Concrete details Concrete strength class	be strength	f _{cu} = 40 N/r	nm²	► ► ►		
Concrete details Concrete strength class Characteristic compressive cul	be strength	f _{cu} = 40 N/r	nm² mm² + 200 × fa	► ► ■		
Concrete details Concrete strength class Characteristic compressive cul Modulus of elasticity of concre Maximum aggregate size Reinforcement details	be strength te	$f_{cu} = 40 \text{ N/r}$ $E_c = 20 \text{kN/}$ $h_{agg} = 20 \text{ m}$	nm² mm² + 200 × fa 1m	►		
Concrete details Concrete strength class Characteristic compressive cul Modulus of elasticity of concre Maximum aggregate size Reinforcement details Characteristic yield strength of	be strength te reinforcement	$f_{cu} = 40 \text{ N/r}$ $E_c = 20 \text{kN/}$ $h_{agg} = 20 \text{ m}$ $f_y = 500 \text{ N/}$	mm² mm² + 200 × fa ոտ mm²	► ►		
Concrete details Concrete strength class Characteristic compressive cul Modulus of elasticity of concre Maximum aggregate size Reinforcement details Characteristic yield strength of Characteristic yield strength of	be strength te reinforcement shear reinforcem	$f_{cu} = 40 \text{ N/r}$ $E_c = 20 \text{kN/}$ $h_{agg} = 20 \text{ m}$ $f_y = 500 \text{ N/}$	mm² mm² + 200 × fa ոտ mm²	► ↓		
Concrete details Concrete strength class Characteristic compressive cul Modulus of elasticity of concre Maximum aggregate size Reinforcement details Characteristic yield strength of Characteristic yield strength of Nominal cover to reinforcem	be strength te reinforcement shear reinforcem ent	$f_{cu} = 40 \text{ N/r}$ $E_c = 20 \text{kN/}$ $h_{agg} = 20 \text{ m}$ $f_y = 500 \text{ N/}$ nent $f_{yv} = 500 \text{ N}$	ກm² mm² + 200 × fo າm mm² /mm²	► ► ■		
Concrete details Concrete strength class Characteristic compressive cul Modulus of elasticity of concre Maximum aggregate size Reinforcement details Characteristic yield strength of Characteristic yield strength of Nominal cover to reinforcem Nominal cover to top reinforce	be strength te reinforcement shear reinforcem ent ment	$f_{cu} = 40 N/r$ $E_c = 20kN/$ $h_{agg} = 20 m$ $f_y = 500 N/r$ hent $f_{yv} = 500 N$ $C_{nom_t} = 35$	nm² mm² + 200 × fa ۱m mm² /mm² mm	► 1		
Concrete details Concrete strength class Characteristic compressive cul Modulus of elasticity of concre Maximum aggregate size Reinforcement details Characteristic yield strength of Characteristic yield strength of Nominal cover to reinforcem	be strength te reinforcement shear reinforcem ent ment prcement	$f_{cu} = 40 \text{ N/r}$ $E_c = 20 \text{kN/}$ $h_{agg} = 20 \text{ m}$ $f_y = 500 \text{ N/}$ nent $f_{yv} = 500 \text{ N}$	nm² mm² + 200 × fa nm mm² /mm² mm mm	► 4		



Tedds		10 Downsi	de Crescent			411				
RODRIGUES ASSOCIATES 1 AMWELL STREET	Calcs for		Start page no./Revision 5.7. 4							
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date Approved by Ap						
Maximum distance between	hars in tension	(cl 3 12 11 2)								
Design service stress			$\times A_{s,reg}) / (3 \times A)$	$_{s,prov} \times \beta_b) = 275.$	8 N/mm²					
Maximum distance between ba	ars in tension			f _s , 300 mm) = 1 7						
			PAS	S - Satisfies the	e maximum sp	acing cri				
Mid span 1										
				$6 \times 20_{\Phi}$ bars						
↓ 250 → ↓ 75 ← 175 →		••••		$0 \times 20_{\varphi}$ bars						
250				5 00 1						
75	•••	y		2×80 shear i	egs at 100 c/c					
↑										
← _20	00	_500	▶ - 200 - ▶							
Flanged section in flexure - I	Positive momen	+								
Design bending moment			s1_red) = 62 kNm	ı						
Distance between points of ze	ro moment		L _{s1} = 5440 mn							
Effective flange width			$b_{eff} = min(0.2 \times l_0 + b, b_f) = 900 \text{ mm}$							
Depth to tension reinforcemen	t		$d = h - c_{nom_b} - \phi_v - \phi_{bot} / 2 = 197 mm$							
Percentage redistribution	L .		$m_{rs1} = M_{s1_red} / M_{s1_max} - 1 = 0\%$							
Redistribution ratio		$\beta_{b} = \min(1 - m_{rs1}, 1) = 1.000$								
			$f \times d^2 \times f_{cu}$ = 0.							
		K' = 0.156								
				No compressio	n reinforceme	nt is requ				
					······					
Lever arm		z = min(d ×	(0.5 + (0.25 -	$K / (0.9)^{0.5}$, 0.95	×a) = 18 7 mm					
Lever arm Depth of neutral axis			(0.5 + (0.25 - 0.45 = 23 mm	K / 0.9) ^{0.5}), 0.95	× d) = 187 mm					
	required	x = (d - z) /			× a) = 187 mm					
Depth of neutral axis		x = (d - z) /	0.45 = 23 mm $(0.87 \times f_y \times z) =$		× a) = 187 mm					
Depth of neutral axis Area of tension reinforcement	d		0.45 = 23 mm $(0.87 \times f_y \times z) =$ rs		× a) = 187 mm					
Depth of neutral axis Area of tension reinforcement Tension reinforcement provide	d provided	x = (d - z) / A _{s,req} = M / 5 × 20φ bar A _{s,prov} = 15	0.45 = 23 mm $(0.87 \times f_y \times z) =$ rs	= 769 mm²	× a) = 187 mm					
Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement	d provided t	$x = (d - z) / A_{s,req} = M / 5 \times 20\phi$ ban A _{s,prov} = 15 A _{s,min} = 0.00	0.45 = 23 mm ($0.87 \times f_y \times z$) = rs 71 mm ²	= 769 mm ² 63 mm ²	× a) = 187 mm					
Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcemen	d provided t		0.45 = 23 mm ($0.87 \times f_y \times z$) = rs 71 mm ² $013 \times b \times h = 1$ $4 \times b \times h = 500$	= 769 mm ² 63 mm ²		nent requ				
Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcemen	d provided it nt PASS - Area o		0.45 = 23 mm ($0.87 \times f_y \times z$) = rs 71 mm ² $013 \times b \times h = 1$ $4 \times b \times h = 500$	= 769 mm ² 63 mm ² 00 mm ²		nent requ				
Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcement Maximum area of reinforcement	d provided it nt PASS - Area o		0.45 = 23 mm $(0.87 \times f_y \times z) = 1000 \text{ mm}^2$ 71 mm^2 $0.13 \times b \times h = 1000 \text{ mm}^2$ $14 \times b \times h = 50000 \text{ mm}^2$	= 769 mm ² 63 mm ² 00 mm ²		nent requ				
Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcement Maximum area of reinforcement Rectangular section in shear	d provided It PASS - Area o	$\begin{aligned} x &= (d - z) / \\ A_{s,req} &= M / \\ 5 \times 20\varphi \text{ bar} \\ A_{s,prov} &= 15^{\circ} \\ A_{s,min} &= 0.0^{\circ} \\ A_{s,max} &= 0.0^{\circ} \end{aligned}$	0.45 = 23 mm (0.87 × f _y × z) = rs 71 mm ² 013 × b × h = 1 4 × b × h = 500 t provided is g at 100 c/c	= 769 mm ² 63 mm ² 00 mm ²		nent requ				
Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcement Maximum area of reinforcement Rectangular section in shear Shear reinforcement provided	d provided it PASS - Area o r rovided	$x = (d - z) / A_{s,req} = M / 5 \times 20\phi \text{ bar}$ $A_{s,prov} = 15^{\circ}$ $A_{s,min} = 0.00$ $A_{s,max} = 0.00$ If reinforcements $2 \times 8\phi \text{ legs}$ $A_{sv,prov} = 10^{\circ}$	0.45 = 23 mm $(0.87 \times f_y \times z) =$ rs 71 mm ² $013 \times b \times h = 1$ $4 \times b \times h = 500$ t provided is g at 100 c/c $005 \text{ mm}^2/\text{m}$	= 769 mm ² 63 mm ² 00 mm ²	a of reinforcer	nent requ				
Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcement Maximum area of reinforcement Rectangular section in shear Shear reinforcement provided Area of shear reinforcement provided	d provided it PASS - Area o r rovided cement (Table 3.	$x = (d - z) / A_{s,req} = M / 5 \times 20\phi \text{ ban}$ $A_{s,prov} = 15^{\circ}$ $A_{s,min} = 0.00$ $A_{s,max} = 0.00$ <i>f reinforcement</i> $2 \times 8\phi \text{ legs}$ $A_{sv,prov} = 10$ 7) $A_{sv,min} = 0.4$	0.45 = 23 mm $(0.87 \times f_y \times z) =$ rs 71 mm^2 $013 \times b \times h = 1$ $4 \times b \times h = 500$ t provided is g at 100 c/c $005 \text{ mm}^2/\text{m}$ $IN/\text{mm}^2 \times b / (000)$	= 769 mm² 63 mm² 00 mm² areater than area	a of reinforcer mm²/m					
Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcement Maximum area of reinforcement Rectangular section in shear Shear reinforcement provided Area of shear reinforcement provided	d provided it PASS - Area o r rovided cement (Table 3.	$x = (d - z) / A_{s,req} = M / 5 \times 20\phi \text{ bar}$ $A_{s,prov} = 15^{\circ}$ $A_{s,min} = 0.00$ $A_{s,max} = 0.00$ <i>f reinforcement</i> $2 \times 8\phi \text{ legs}$ $A_{sv,prov} = 10$ 7) $A_{sv,min} = 0.4$ $ASS - Area of states$	0.45 = 23 mm $(0.87 \times f_y \times z) =$ rs 71 mm^2 $013 \times b \times h = 1$ $4 \times b \times h = 500$ t provided is g at 100 c/c $005 \text{ mm}^2/\text{m}$ $IN/\text{mm}^2 \times b / (000)$	= 769 mm ² 63 mm ² 00 mm ² preater than are $0.87 \times f_{yv}$) = 460 m ment provided	a of reinforcer mm²/m					
Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcement Maximum area of reinforcement Rectangular section in shear Shear reinforcement provided Area of shear reinforcement provided Minimum area of shear reinforcement	d provided it PASS - Area o r rovided cement (Table 3. P (cl. 3.4.5.5)	$x = (d - z) / A_{s,req} = M / 5 \times 20\phi bar A_{s,prov} = 15^{\circ} A_{s,min} = 0.00 A_{s,max} = 0.00$ f reinforcements $2 \times 8\phi legs A_{sv,prov} = 10$ 7) Asv,min = 0.4 ASS - Area of sin Svl,max = 0.7	0.45 = 23 mm $(0.87 \times f_y \times z) = 23 \text{ mm}^2$ $(0.87 \times f_y \times z) = 23 \text{ mm}^2$ $(0.13 \times b \times h = 1)^2$ $(0.13 \times b \times h = 500)^2$ $(1.14 \times b \times h = 50)^2$ $(1.14 \times b \times h = 50)^2$ (= 769 mm ² 63 mm ² 00 mm ² preater than are $0.87 \times f_{yv}$) = 460 m ment provided	a of reinforcer mm²/m exceeds minir	num requ				
Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcement Maximum area of reinforcement Rectangular section in shear Shear reinforcement provided Area of shear reinforcement provided Minimum area of shear reinforcement	d provided it PASS - Area o r rovided cement (Table 3. P (cl. 3.4.5.5)	$x = (d - z) / A_{s,req} = M / 5 \times 20\phi bar A_{s,prov} = 15^{\circ} A_{s,min} = 0.00 A_{s,max} = 0.00 A_{sv,prov} = 100 A_{sv,prov} = 100 A_{sv,min} = 0.4 A_{sv,min} = 0.4 A_{sv,min} = 0.4 A_{sv,min} = 0.4 A_{sv,min} = 0.7 A_{sv,min} = 0.7 A_{sv,max} = 0.7 A_{sv,ma$	0.45 = 23 mm $(0.87 \times f_y \times z) =$ rs 71 mm ² $013 \times b \times h = 1$ $4 \times b \times h = 500$ t provided is g at 100 c/c $005 \text{ mm}^2/\text{m}$ $N/mm^2 \times b / (000)$ thear reinforce $5 \times d = 148 \text{ mm}$ g of shear reinforce	= 769 mm ² 63 mm ² 00 mm ² 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 17 1	a of reinforcer mm²/m exceeds minir rided is less th	num requ nan maxir				
Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcement Maximum area of reinforcement Rectangular section in sheat Shear reinforcement provided Area of shear reinforcement provided Minimum area of shear reinforcement provided	d provided it PASS - Area o r rovided cement (Table 3. P (cl. 3.4.5.5)	$x = (d - z) / A_{s,req} = M / 5 \times 20\phi bar A_{s,prov} = 15^{\circ} A_{s,min} = 0.00 A_{s,max} = 0.00 freinforcement 2 \times 8\phi legs A_{sv,prov} = 10^{\circ} A_{sv,min} = 0.4 ASS - Area of si SvI,max = 0.7 itudinal spacing v_c = 0.79 N/ 1000 V_c = 0.79 V_c = 0.79 N/ 1000 V_c = 0.79 V_c = 0.79$	0.45 = 23 mm $(0.87 \times f_y \times z) =$ rs 71 mm ² $013 \times b \times h = 1$ $4 \times b \times h = 500$ t provided is g at 100 c/c $105 \text{ mm}^2/\text{m}$ $N/mm^2 \times b / (00)$ thear reinforce $rs \times d = 148 \text{ mm}$ rg of shear reinf $rm^2 \times min(3, [$	= 769 mm ² 63 mm ² 00 mm ² (reater than are) $0.87 \times f_{yv}$ = 460 m ment provided m forcement prov	a of reinforcer mm²/m exceeds minir rided is less th < d)] ^{1/3}) × max(1	num requ nan maxir				
Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcement Maximum area of reinforcement Rectangular section in sheat Shear reinforcement provided Area of shear reinforcement provided Minimum area of shear reinforcement provided	d provided it PASS - Area o rovided cement (Table 3. P (cl. 3.4.5.5) PASS - Long	$\begin{aligned} x &= (d - z) / \\ A_{s,req} &= M / \\ 5 \times 20\phi \text{ bar} \\ A_{s,prov} &= 15^{\circ} \\ A_{s,min} &= 0.0^{\circ} \\ A_{s,max} &= 0.0^{\circ} \\ A_{s,max} &= 0.0^{\circ} \\ f \text{ reinforcement} \\ 2 \times 8\phi \text{ legs} \\ A_{sv,prov} &= 10^{\circ} \\ 7) A_{sv,min} &= 0.4^{\circ} \\ ASS - Area of stars \\ Svl,max &= 0.7^{\circ} \\ itudinal spacing \\ v_c &= 0.79 \text{N/} \\ /d)^{1/4}) \times (\text{min}) \end{aligned}$	0.45 = 23 mm $(0.87 \times f_y \times z) =$ r_s 71 mm^2 $013 \times b \times h = 1$ $4 \times b \times h = 500$ t provided is g at 100 c/c $005 \text{ mm}^2/\text{m}$ $tN/\text{mm}^2 \times b / (000)$ hear reinforce $5 \times d = 148 \text{ mm}^2$ $r_g of shear reinforce$ $f mm^2 \times min(3, [100)^2 + 100)$	= 769 mm ² 63 mm ² 00 mm ² preater than area 0.87 × f_{yv}) = 460 m ment provided m forcement provided 100 × $A_{s,prov}$ / (b >	a of reinforcer mm²/m exceeds minir vided is less th < d)] ^{1/3}) × max(1 γm = 1.031 N/n	num requ nan maxir				
Depth of neutral axis Area of tension reinforcement Tension reinforcement provide Area of tension reinforcement Minimum area of reinforcement Maximum area of reinforcement Rectangular section in shear Shear reinforcement provided Area of shear reinforcement provided Minimum area of shear reinforcement Maximum longitudinal spacing Design concrete shear stress	d provided it PASS - Area o rovided cement (Table 3. P (cl. 3.4.5.5) PASS - Long	$x = (d - z) / A_{s,req} = M / 5 \times 20\phi bar A_{s,prov} = 15^{\circ} A_{s,min} = 0.00 A_{s,max} $	0.45 = 23 mm $(0.87 \times f_y \times z) =$ r_s 71 mm^2 $013 \times b \times h = 1$ $4 \times b \times h = 500$ t provided is g at 100 c/c $005 \text{ mm}^2/\text{m}$ $tN/\text{mm}^2 \times b / (000)$ hear reinforce $5 \times d = 148 \text{ mm}^2$ $r_g of shear reinforce$ $f mm^2 \times min(3, [100)^2 + 100)$	= 769 mm ² 63 mm ² 00 mm ² preater than area 0.87 × f_{yv}) = 460 m ment provided m forcement provided 100 × $A_{s,prov}$ / (b > 2) / 25N/mm ²) ^{1/3} / b = 0.875 N/mm	a of reinforcer mm²/m exceeds minir vided is less th < d)] ^{1/3}) × max(1 γm = 1.031 N/n	num requ nan maxir				

Tedds		10 Downs	ide Crescent			411			
1 AMWELL STREET	Calcs for	Start page no./Revision 5.7. 5							
LONDON EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked by	Checked date	Approved by	Approved of			
Spacing of reinforcement (cl 3	.12.11)								
Actual distance between bars in	tension	s = (b - 2 >	$(C_{nom_s} + \phi_v + \phi_v)$	\$bot/2)) /(Nbot - 1)	- φ _{bot} = 79 mm				
Minimum distance between ba	rs in tension	(cl 3.12.11.1)							
Minimum distance between bars	in tension	$s_{min} = h_{agg}$	+ 5 mm = 25 m	ım					
			PA	SS - Satisfies th	e minimum sj	pacing crit			
Maximum distance between ba	ars in tensior	n (cl 3.12.11.2)							
Design service stress		$f_s = (2 \times f_y)$	imes A _{s,req}) / (3 $ imes$ A	$\Lambda_{s,prov} \times \beta_b) = 163.$	1 N/mm²				
Maximum distance between bars	in tension	s _{max} = min	(47000 N/mm /	f _s , 300 mm) = 28	38 mm				
			PAS	SS - Satisfies the	e maximum sj	pacing crit			
Span to depth ratio (cl. 3.4.6)									
Basic span to depth ratio (Table	3.9)	span to d	epth _{basic} = 17.5						
Design service stress in tension		• – –	•	$_{s,prov} \times \beta_b) = 163.$	1 N/mm ²				
Modification for tension reinforce				- / - 1 - 7					
	f _{tens} = n	nin(2.0, 0.55 + (4	77N/mm² - fs) /	′ (120 × (0.9N/mr	m^2 + (M / (b _{eff} ×	(d ²))))) = 1 .			
Modification for compression reir			- ,	· · ·		,,,,,			
		min(1.5, 1 + (100	$0 \times A_{s2,prov} / (b_{ef})$	_f × d)) / (3 + (100	imes A _{s2,prov} / (b _{eff}	× d)))) = 1 .			
Modification for span length		$f_{long} = 1.00$	0						
Allowable span to depth ratio		span_to_d	span_to_depth _{allow} = span_to_depth _{basic} \times f _{tens} \times f _{comp} = 33.6						
Actual span to depth ratio		span_to_d	epthactual = Ls1	/ d = 32.5					
		PAS	S - Actual spa	n to depth ratio	is within the a	allowable l			
Support B									
	• •	• • • •		$6 ext{ x 20}_{eeth}$ bars					
- 17									
75 <u>1</u> 28		•••		5 x 80 shers	legs at 100 c/c				
				- 4	-9				
↓ 200		—500———	▶ - 200						
- 200		300							
Rectangular section in flexure	(cl.3.4.4)								
Design bending moment		-	B_red) = 122 kN						
Depth to tension reinforcement			$d = h - c_{nom_t} - \phi_v - \phi_{top} / 2 = 197 mm$						
Redistribution ratio	$\beta_{b} = min(1 - m_{rB}, 1) = 1.000$								
		-	$\times d^2 \times f_{cu}) = 0.1$	57					
		K' = 0.156							
				K' - Compressio		ent is requ			
Lever arm			-	0.9) ^{0.5}) = 153 mm	1				
Depth of neutral axis	4		0.45 = 98 mm						
Depth of compression reinforcen		_	$+\phi_v + \phi_{bot} / 2 =$			- 2			
Area of compression reinforceme	-		-	d^2 / (0.87 × f _y ×	(a - a ₂)) = 9 mr	n-			
Compression reinforcement prov		5 × 20¢ ba							
Area of compression reinforceme	-	$A_{s2,prov} = 1$		00					
		,			a af mainte a				
			-	-		-			
Maximum area of reinforcement Area of tension reinforcement re	PASS - Area	of reinforcemen	-	00 mm² greater than are 0.87 × f _y × z) + A					

	Project	Job no. 1	Job no. 1411							
	Calcs for	10 Downsi	Start page no./Revision 5.7. 6							
1 AMWELL STREET		bear								
LONDON - (EC1R 1UL	Calcs by ab	Calcs date 12/10/2016	Checked date	Approved by	Approved da					
Tension reinforcement provided		6 × 20ø ba	rs							
Area of tension reinforcement pro	A _{s,prov} = 18	85 mm²								
Minimum area of reinforcement ($A_{s,min} = 0.0$	$013 \times b \times h = 1$	163 mm²						
F	ASS - Area	of reinforcemen	t provided is g	greater than are	a of reinforce	ment requii				
Rectangular section in shear										
Design shear force span 1 at 620	3 mm	V = abs(mi	in(VB s1 max, VB	_s1_red)) = 102 kN						
Design shear stress			(d) = 1.032 N/i							
Design concrete shear stress		-	-	$A_{s,prov} / (b \times d)]^{1/3}$	× max(1, (400	/d) ^{1/4})×				
(min(f _{cu} , 40) / 25) ^{1/3} / γ _m					(, (,)	, _, , , .				
		v _c = 1.095	N/mm ²							
Allowable design shear stress			$v_{max} = min(0.8 \text{ N/mm}^2 \times (f_{cu}/1 \text{ N/mm}^2)^{0.5}, 5 \text{ N/mm}^2) = 5.000 \text{ N/mm}^2$							
· · · · · · · · · · · · · · · · · · ·				near stress is les						
Value of v from Table 3.7			/ < (v _c + 0.4 N/							
Design shear resistance required			,	n²) = 0.400 N/mm	2					
Area of shear reinforcement requ	ired	$A_{sv,req} = v_s$	imes b / (0.87 $ imes$ f _{yv}	<i>y</i>) = 460 mm ² /m						
Shear reinforcement provided		2 × 8¢ legs	at 100 c/c							
Area of shear reinforcement prov	ided)05 mm²/m							
		PASS - Area of s		ement provided	exceeds minii	mum requii				
Maximum longitudinal spacing		$S_{vl,max} = 0.7$	′5×d = 148 m	m						
	PASS - Long	gitudinal spacing	g of shear reir	nforcement prov	vided is less tl	han maximi				
Spacing of reinforcement (cl 3.	12.11)									
Actual distance between bars in t	-	s = (b - 2 ×	$(C_{nom_s} + \phi_v + \phi_v)$	¢ _{top} /2)) /(N _{top} - 1)	- φ _{top} = 59 mm					
Minimum distance between bar	s in tensior		•							
Minimum distance between bars			+ 5 mm = 25 m	ım						
		Unin Tagg		SS - Satisfies th	e minimum sp	acing crite				
Maximum distance between ba	rs in tensio	n (cl 3 12 11 2)				-				
Design service stress			× A _{2 rea}) / (3 × A	$A_{s,prov} \times \beta_b) = 323$	3 N/mm ²					
Maximum distance between bars	in tension	, , , , , , , , , , , , , , , , , , ,		$(f_{s}, 300 \text{ mm}) = 14$						
ing and a local too botwoort bard				SS - Satisfies the		acina crite				
					r	J • •				

riguesassociates nwell Street, London, EC1R 1UL 0 7837 1133, e: www.rodriguesassociates.com					Job No.:	1411	Sheet No.:	5.8.	1		Rev:
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tions:	Wate	er uplift c	heck		Designed:	ab	Date:	11/10)/2016		Ckd:
Beam & Load	Span	Aroa	loads	Width		ation		DL	Point	loads	1
description	Opan	DL	LL	VVICUI	from	to	DL		DL	LL	
decomption	mm	kN/m²	kN/m²	mm	mm	mm	kN/m	kN/m	kN	kN	
Water uplift force 3m high water table Gravitational loa Roof dead load Basement slab Basement wall S TOT	<u>∍</u> 7000 <u>d</u> 7000 7000 7000	30.00 0.69 6.35		7300 5000 6300 7300	sqmm				1533.0 24.2 280.0 723.1 514.8 1542.1		