Tekla Tedds	Project Bents Villa				Job no.	
Jrbdesigns Ltd. 1 Saville Street	Calcs for Raft foundation				Start page no./Revision 1	
Barnsley	Calcs by JRB	Calcs date 06/02/2023	Checked by	Checked date	Approved by	Approved date

RAFT FOUNDATION DESIGN (BS8110 : PART 1 : 1997)

Tedds calculation version 1.0.12



Soil and raft definition

Soil definition	
Allowable bearing pressure	q _{allow} = 50.0 kN/m ²
Number of types of soil forming sub-soil	One type only
Soil density	Firm to loose
Depth of hardcore beneath slab	$h_{hcoreslab} = 150 \text{ mm}$ (Dispersal allowed for bearing pressure check)
Density of hardcore	$\gamma_{hcore} = 20.0 \text{ kN/m}^3$
Basic assumed diameter of local depression	φ _{depbasic} = 2000 mm
Diameter under slab modified for hardcore	$\phi_{depslab} = \phi_{depbasic} - h_{hcoreslab} = 1850 \text{ mm}$
Raft slab definition	
Max dimension/max dimension between joint	s I _{max} = 20.000 m
Slab thickness	h _{slab} = 250 mm
Concrete strength	$f_{cu} = 40 \text{ N/mm}^2$
Poissons ratio of concrete	ν = 0.2
Slab mesh reinforcement strength	f _{yslab} = 500 N/mm ²
Partial safety factor for steel reinforcement	$\gamma_{\rm S} = 1.15$
From C&CA document 'Concrete ground floo	rs' Table 5
Minimum mesh required in top for shrinkage	A252
Actual mesh provided in top	A393 (A _{sslabtop} = 393 mm ² /m)
Mesh provided in bottom	A393 (A _{sslabbtm} = 393 mm ² /m)
Top mesh bar diameter	$\phi_{\text{slabtop}} = 10 \text{ mm}$
Bottom mesh bar diameter	$\phi_{slabbtm} = 10 \text{ mm}$
Cover to top reinforcement	c _{top} = 20 mm
Cover to bottom reinforcement	$c_{btm} = 40 \text{ mm}$
Average effective depth of top reinforcement	$d_{tslabav} = h_{slab} - c_{top} - \phi_{slabtop} = 220 \text{ mm}$
Average effective depth of bottom reinforcem	nent d _{bslabav} = h _{slab} - C _{btm} - ϕ _{slabbtm} = 200 mm
Overall average effective depth	$d_{slabav} = (d_{tslabav} + d_{bslabav})/2 = 210 \text{ mm}$
Minimum effective depth of top reinforcemen	t $d_{tslabmin} = d_{tslabav} - \phi_{slabtop}/2 = 215 \text{ mm}$
Minimum effective depth of bottom reinforcer	nent $d_{bslabmin} = d_{bslabav} - \phi_{slabbtm}/2 = 195 \text{ mm}$
Slab edge reinforcement	
Mesh provided in top	A393 (A _{sedgetop} = 393 mm ² /m)
Mesh provided in bottom	A393 (A _{sedgebtm} = 393 mm ² /m)

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Internal slab design checks						
Slab calf weight		w	$N/m^3 \times h \dots = 6$	0 kNl/m ²		
Hardcore	$w_{\text{stab}} = 24 \text{ KeV} \Pi^{-} \times \Pi_{\text{stab}} = 0.0 \text{ KeV} \Pi^{-}$					
		Wilcoresiab - 1	ncore × rincoresiab -	- 0.0 101/111		
Applied loading		W 0 0 1	/M/m ²			
Uniformly distributed live load		$W_{\text{Dudl}} = 0.0$	(N/m^2)			
Internal slab bearing pressure	e cneck			14.0	Al/m ²	
	evei		+ Whooreslab + WDi - a-u	udi + WLudi = 14.0 r	ure is less t	han allowahle
				ed bearing press	<i>bure 13 1633 1</i>	
Internal slab bending and she	ar check					
Applied bending moments						
Span of slab		$I_{slab} = \phi_{depslab}$	$b + d_{tslabav} = 207$	70 mm		
Ultimate self weight udl		$W_{swult} = 1.4$	\times W _{slab} = 8.4 kN	/m²		
Self weight moment at centre	Self weight moment at centre $M_{csw} = w_{swult} \times l_{slab}^2 \times (1 + v) / 64 = 0.7 \text{ kNm/m}$					
Self weight moment at edge	eage $M_{esw} = W_{swult} \times I_{slab}^2 / 32 = 1.1 \text{ kNm/m}$					
Self weight shear force at edge	$V_{sw} = w_{swult} \times I_{slab} / 4 = 4.3 \text{ kN/m}$					
Moments due to applied unifo	rmly distribute	ed loads				
Ultimate applied udl		$w_{udlult} = 1.4$	\times W _{Dudl} + 1.6 \times V	$w_{Ludl} = 8.0 \text{ kN/m}^2$		
Moment at centre		$M_{cudl} = W_{udlu}$	$I_{\rm slab}^2 \times (1 + v)$	/) / 64 = 0.6 kNm	/m	
Moment at edge	$M_{eudl} = w_{udlult} \times I_{slab}^2 / 32 = 1.1 \text{ kNm/m}$					
Shear force at edge		$V_{udl} = W_{udlult}$	\times I _{slab} / 4 = 4.1	kN/m		
Resultant moments and shear	rs					
Total moment at edge		M _{Σe} = 2.2 k	Nm/m			
Total moment at centre		M _{Σc} = 1.3 k	Nm/m			
Total shear force		V _Σ = 8.5 kN	/m			
Reinforcement required in top						
K factor		$K_{slabtop} = M_{\Sigma}$	$d_{e}/(f_{cu} \times d_{tslabav}^2)$	= 0.001		
Lever arm		$z_{slabtop} = d_{tslabtop}$	$_{abav} imes min(0.95,$	0.5 + √(0.25 - K _s	labtop/(0.9)) = 20	09.0 mm
Area of steel required for bendir	ng	Asslabtopbend =	= $M_{\Sigma e}/((1.0/\gamma_s) \times$	$f_{yslab} \times Z_{slabtop} = 2$	24 mm²/m	
Minimum area of steel required		$A_{sslabmin} = 0$	$.0013 \times h_{slab} = 3$	325 mm²/m		
Area of steel required		A _{sslabtopreq} =	max(Asslabtopbend	$A_{sslabmin}) = 325$ I	mm²/m	
PASS - Asslabtopreq <= :	Asslabtop - Area	of reinforcemer	nt provided in	top to span loca	l depression	s is adequate
Reinforcement required in bot	ttom					
K factor		$K_{slabbtm} = M_{slabbtm}$	$_{\rm Ec}/({\rm f}_{\rm cu} imes {\rm d}_{\rm bslabav}^2)$	= 0.001		
Lever arm		$z_{slabbtm} = d_{bs}$	$_{\rm slabav} imes min(0.95)$, 0.5 + √(0.25 - K	slabbtm/0.9)) = 1	190.0 mm
Area of steel required for bendir	ng	Asslabbtmbend	$= M_{\Sigma c}/((1.0/\gamma_s) >$	$(f_{yslab} \times Z_{slabbtm}) =$	16 mm²/m	
Area of steel required	. .	A _{sslabbtmreq} =	max(A _{sslabbtmber}	hd, $A_{sslabmin}$) = 325	mm²/m	
PASS - Asslabbtmreq <= Assla	bbtm - Area of re	einforcement pr	ovided in bott	om to span loca	depression	s is adequate
Shear check				_		
Applied shear stress		$v = V_{\Sigma}/d_{tslabe}$	min = 0.039 N/m	m ²		
Tension steel ratio		$\rho = 100 \times A$	$a_{sslabtop}/d_{tslabmin} =$	0.183		

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Barnsley	JRB	06/02/2023					
	-		•		*	•	
From BS8110-1:1997 - Table 3.8							
Design concrete snear strength		$V_{c} = 0.490$		Chaor conco	ity of the ele	h io odoguata	
			PA55 - V <= V	c - Snear capac	ing of the sia	o is adequate	
Internal slab deflection check							
Basic allowable span to depth r	atio	Ratio _{basic} =	26.0				
Moment factor		$M_{factor} = M_{\Sigma c}$	$M_{factor} = M_{\Sigma c}/d_{bslabav}^2 = 0.033 \text{ N/mm}^2$				
Steel service stress		$f_s = 2/3 \times f_{ys}$	$f_{s}=2/3\times f_{yslab}\times A_{sslabbtmbend}/A_{sslabbtm}=\textbf{13.528}\ N/mm^{2}$				
Modification factor		$MF_{slab} = mi$	n(2.0, 0.55 + [(4	77N/mm ² - f _s)/(12	20 × (0.9N/mr	n ² + M _{factor}))])	
		$MF_{slab} = 2.0$	000				
Modified allowable span to dept	h ratio	Ratio _{allow} =	$Ratio_{basic} imes MF_{slat}$	ab = 52.000			
Actual span to depth ratio		Ratio _{actual} =	$I_{slab}/d_{bslabav} = 10$).350			
		PASS - Rat	ioactual <= Ratio	allow - Slab span	to depth rati	o is adequate	
Slab edge design checks							
Basic loading							
Hardcore		$W_{hcoreslab} = \gamma$	$h_{\text{hcore}} \times h_{\text{hcoreslab}} =$	3.0 kN/m ²			
Slab self weight		w _{slab} = 24 k	$w_{slab} = 24 \text{ kN/m}^3 \times h_{slab} = 6.0 \text{ kN/m}^2$				
Edge load number 1							
Load type		Longitudir	al line load				
Dead load		WDedge1 = 6.	0 kN/m				
Live load		$W_{Ledge1} = 0.$	0 kN/m				
Ultimate load		$w_{ultedge1} = 1$	$.4 \times w_{\text{Dedge1}} + 1.6$	6 × w _{Ledge1} = 8.4	kN/m		
Longitudinal line load width		b _{edge1} = 100) mm				
Centroid of load from outside fa	ce of raft	X _{edge1} = 50	mm				
Edge load number 2							
Load type		Longitudir	al line load				
Dead load		WDedge2 = 12	2 .0 kN/m				
Live load		W _{Ledge2} = 2.	0 kN/m				
Ultimate load		W _{ultedge2} = 1	$.4 imes w_{Dedge2} + 1.6$	$6 \times W_{Ledge2} = 20.0$) kN/m		
Longitudinal line load width		b _{edge2} = 100	b _{edge2} = 100 mm				
Centroid of load from outside fa	ce of raft	x _{edge2} = 250 mm					
Slab edge bearing pressure c	heck						
Total uniform load at formation	evel	Wudledge = W	Dudl + WLudl + Wsla	$b + W_{hcoreslab} = 14$.0 kN/m ²		
Centroid of longitudinal and e	quivalent line lo	oads from outs	side face of raf	t			
Load x distance for edge load 1		Moment ₁ =	$W_{ultedge1} \times X_{edge1}$	= 0.4 kN			
Load x distance for edge load 2		Moment ₂ =	$W_{ultedge2} imes X_{edge2}$	= 5.0 kN			
Sum of ultimate longitud'l and e	quivalent line loa	ds ΣUDL = 28	.4 kN/m				
Sum of load x distances		ΣMoment =	ΣMoment = 5.4 kN				
Centroid of loads	$x_{bar} = \Sigma Mor$	$x_{\text{bar}} = \Sigma Moment / \Sigma UDL = 191 \text{ mm}$					
Initially assume no moment to	ansferred into s	lab due to loa	d/reaction ecce	entricity			
Sum of unfactored longitud'l an	d eff'tive line load	s ΣUDLsls =	20.0 kN/m	-			
Allowable bearing width		$b_{allow} = 2 \times 2$	$x_{bar} + 2 \times h_{hcoresta}$	ub × tan(30) = 555	5 mm		
Bearing pressure due to line/po	int loads	$Q_{\text{linepoint}} = \Sigma I$	JDLsls/ ballow = 3	36.0 kN/m ²			
Total applied bearing pressure		$Q_{\text{edge}} = \Omega_{\text{linear}}$	$Q_{\text{interpoint}} = 2002337 \text{ ballow} = 50.0 \text{ kN/m}^2$				
state apparent accounty proceeding	dge > q allow - Th	_{le} > q _{allow} - The slab is required to resist a moment due to eccentricity					
Now assume moment due to	oad/reaction ec	centricity is re	esisted by slab				

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De enire en cidite de encire d			-l-//				
Bearing width required	-1-1-	Dreq = 20DI	_SIS/(Qallow - Wudle	dge) = 556 MM			
Effective bearing width at u/s of	SIAD	Dreqeff = Dreq	- 2 × Nhcoreslab ×	$\tan(30) = 382 \text{ mm}$	n		
Load/reaction eccentricity	by alab	$e = D_{reqeff}/2$	$- x_{bar} = 0$ mm				
From alah bonding abook	by slab	$W_{ecc} = 20D$	$\mathbf{L} \times \mathbf{e} = 0.0 \text{ kinif}$	1/111			
Moment due to depression under	ar slah (hoqqinq)) Mr. – 22 k	Nm/m				
Total moment to be resisted by	slab ton steel	$M_{\text{slabton}} = M$	$a_{2} + M_{\Sigma a} = 2.2 \text{ k}$	Nm/m			
K factor		$K_{slab} = M_{slab}$	$top/(f_{cu} \times d_{tslabmin}^2)$) = 0.001			
l ever arm		$Z_{\text{slab}} = \mathbf{d}_{\text{tslab}}$	$m \times min(0.95, 0)$, e.ee. 5 + √(0 25 - K _{elak}	_/0 9)) = 204 r	nm	
Area of steel required		$\Delta_{\rm coloburget} = M_{\rm coloburget}$	Lishan/((1.0/%) ×	$f_{\rm u} \times z_{\rm obs} = 25 {\rm mm}$	m^{2}/m		
PASS - Assister	<- Assistan - Ar	rea of reinforce	ment provided	to transfer mor	ment into sla	h is adequate	
TACC Assiabled	The	allowable bea	rina pressure u	nder the edge b	nem will not	be exceeded	
				Library iter	m - B pressure wit	h moment transfer	
Slab edge bending check							
Considering a 1.0m width of sla	b						
Divider for moments due to udl's	3	$\beta_{\text{udl}} = 10.0$					
Applied bending moments							
Span of slab		$e_{dqe} = \Phi_{densi}$	ah + dislahmin = 20	65 mm			
Ultimate self weight udl		$W_{edgeult} = 1$	$4 \times W_{\text{slab}} = 8.4 \text{ kl}$	V/m ²			
Self weight bending moment	lf weight bending moment			= 3 .6 kNm/m			
Self weight shear force	Vodgosw = W	$d_{acult} \times l_{adac}/2 = 8$	3.7 kN/m				
			sugeuit / leuge/ -				
Moments due to applied unito	ormly distribute	d loads	0.0 kbl/m2				
Dilimate udi		Wedgeudl = W	udlult = 8.0 KIN/III^2	2.4 kNm/m			
		Ivledgeudl = w	edgeudi × ledge-/ puc	= 3.4 KINIII/III			
Moment and shear due to leav	h number 1	Vedgeudl = W	edgeudl × ledge/2 =	0.3 KIN/III			
Effective slab width		h = min(r)	x h/2 .	03×1).b	12 1 0 3 V I 1	– 710 mm	
Bending moment			$\chi_{edge1}, U_{edge1/2} + \chi_{l} = 2/(\beta)$	$(0.5 \times \text{ledge}) + \text{Dedge}$	m/m		
Shoar force				h = 12.0 kN/m	n		
Moment and shear due to loa	d number 2	Vedge1 = VVul	edge1 ^ ledge/ (Z ^	Deff1) = 12.1 KIV/II	1		
Effective slab width		h _{e#2} – min()	Kadaaa hadaaa/2 +	0 3×ladra) + badraa	y/2 ± 0 3 × loda	. – 920 mm	
Bending moment		Madaao - Wu	\times Hadres \times Lades $\frac{2}{B}$	$\nabla = 0 \cdot 0 \cdot 0$	m/m	9 – 320 mm	
Shear force		Vedge2 – Wut	redge2 × ledge / (Put	h_#2) – 22 5 kN/m	ייייייי ר		
		vedgez — vvu			1		
Kesultant moments and sheat	rs Inding)	M 04	O Ichina /ma				
Maximum choor force	ging)	$W_{\Sigma edge} = 21.2 \text{ KNM/m}$					
		$\mathbf{v}_{\Sigma edge} = 51$	4 KIN/III				
Reinforcement required in top)						
		Kedgetop = M	Σedge/(fcu × Ctslabm	in^{-}) = U.U11		004	
Lever arm		$z_{edgetop} = d_{tslabmin} \times min(0.95, 0.5 + \sqrt{(0.25 - K_{edgetop}/0.9)}) = 204 \text{ mm}$				204 mm	
Area of steel required for bendir	ıg	Asedgetopbend	$A_{sedgetopbend} = M_{\Sigma edge} / ((1.0/\gamma_s) \times f_{yslab} \times z_{edgetop}) = 239 \text{ mm}^2/\text{m}$				
Area of steel required		Asedgetopreq =	max(Asedgetopber	nd, Asslabmin) = 325	mm²/m	h io odoauat-	
P/	HJJ - Asedgetopreq	<= A _{sedgetop} - A		ement provided	in top of sla	u is adequate	
Reinforcement required in bo	ttom			0			
K factor		K _{edgebtm} = N	$I_{\Sigma edge}/(f_{cu} imes d_{bslabe})$	$min^2) = 0.014$			
Lever arm		$z_{edgebtm} = d_{t}$	slabmin imes min(0.9)	5, 0.5 + √(0.25 - I	K _{edgebtm} /0.9)) =	= 185 mm	

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Area of steel required for bendin	g	Asedgebtmbend	$= M_{\Sigma edge}/((1.0/\gamma_{edge}))$	$(s) imes f_{yslab} imes z_{edgebb}$	tm) = 264 mm²/	'n	
Area of steel required		A _{sedgebtmreq} =	= max(A _{sedgebtmbe}	end, A _{sslabmin}) = 32	25 mm²/m		
PASS -	Asedgebtmreq <=	Asedgebtm - Area	of reinforceme	ent provided in	bottom of sla	b is adequate	
Applied shear stress		$v_{edge} = V_{\Sigma edg}$	$_{ m ge} imes$ 1.0m/(1000	$mm \times d_{tslabmin}) =$	0.239 N/mm ²		
Tension steel ratio		$\rho_{edge} = 100$	\times A _{sedgetop} \times 1.0	m/(1000mm × d	tslabmin) = 0.183		
From BS8110-1:1997 - Table 3.8	3						
Design concrete shear strength		Vcedge = 0.49	90 N/mm²				
		PASS - Ve	edge <= V _{cedge} - S	Shear capacity	of the slab is	not exceeded	
Slab edge deflection check							
Basic allowable span to depth ra	ıtio	Ratiobasicedge	e = 26.0				
Moment factor		M _{factoredge} =	$M_{\Sigma edge}/d_{bslabmin}^2$:	= 0.559 N/mm ²			
Steel service stress		$f_{sedge} = 2/3$:	$ imes f_{yslab} imes A_{sedgebtn}$	$_{nbend}/A_{sedgebtm} = 2$	223.743 N/mm ²	2	
Modification factor		MF _{edge} =min	(2.0,0.55+[(477	'N/mm²-f _{sedge})/(1	20×(0.9N/mm ²	² +M _{factoredge}))])	
Madified allowable aparts dont	, ratio	IVIFedge = 1.3	Datio	V ME . 51.0	16		
Actual analysis depth vatio	1 ralio	RallOallowedge	e = RallObasicedge		10		
Actual span to depth ratio	D	RallOactualedg	je = ledge/ Otslabmin	= 9.005	n ta danth rati	io io adoguato	
	E A	ASS - Matioactuale	age <= natioallow	ledge - Slab Spar		o is adequate	
Corner design checks							
Basic loading							
Corner bearing pressure chec	k						
Total uniform load at formation le	evel	Wudlcorner = W	/Dudi + WLudi + Ws	hab + Wheoreslab = 1	1 4.0 kN/m ²		
	P	ASS - Wudlcorner <	= q _{allow} - Applie	ed bearing pres	sure is less t	han allowable	
Slab corner bending check							
Cantilever span of slab at corner		$I_{corner} = \phi_{deps}$	$_{\rm slab}/\sqrt{(2)} + d_{\rm tslabav}$	/2 = 1418 mm			
Moment and shear due to self	weight						
Considering triangular loading	•						
Maximum ultimate self weight uc	ł	Wswult = 1.4	$ imes$ Wslab $ imes$ ϕ depslab/	√(2) = 11.0 kN/r	n		
Self weight bending moment		M _{cornersw} = w	$I_{\rm swult} \times I_{\rm corner}^2 / (6 \times 10^{-2})$	$\times \phi_{depslab} / \sqrt{(2)} = 1$	2.8 kNm/m		
Self weight shear force		V _{cornersw} = w	$V_{cornersw} = w_{swult} \times I_{corner} / (2 \times \phi_{depslab} / \sqrt{2}) = 6.0 \text{ kN/m}$				
Moment and shear due to udle							
Maximum ultimate udl	,	Weerperud - ((1 4×w⊳)⊥(1 6	(XWLudi)) X (dapalah	√√(2) – 10 5 kN	J/m	
Bending moment		Meenteruul – V	V2/	$\frac{1}{6} \times \frac{1}{2}$	= 27 kNm/m	v /111	
Shaar force				$2 \times \frac{1}{2} $	-57 kN/m		
Shear loice		v cornerudi = v	/cornerudi × Icorner/ (4	Z X Wdepslab/ V(Z))	= 3.7 KIN/III		
Resultant moments and shear	S						
Total design moment		$M_{\Sigma corner} = M$	cornersw+ Mcornerud	= 5.5 kNm/m			
lotal design shear force		$V_{\Sigma corner} = V_c$	ornersw+ Vcornerud	= 11.6 kN/m			
Reinforcement required in top	of slab at co	rners					
K factor		$K_{corner} = M_{\Sigma corner} / (f_{cu} \times d_{tslabmin}^2) = 0.003$					
Lever arm		$z_{corner} = d_{tsla}$	$z_{corner} = d_{tslabmin} \times min(0.95, 0.5 + \sqrt{(0.25 - K_{corner}/0.9))} = 204 \text{ mm}$				
Area of steel required for bendin	g	A _{scornerbend} =	$A_{scornerbend} = M_{\Sigma corner} / ((1.0/\gamma_s) \times f_{yslab} \times z_{corner}) = \textbf{62} \ mm^2/m$				
Area of steel required		A _{scorner} = ma	$A_{scorner} = max(A_{scornerbend}, A_{sslabmin}) = 325 mm^2/m$				
	ornor <- Acadaat	on - Area of reint	orcement prov	vided in top of s	slab at corner	s is adequate	
PASS - Asc	Johner - A seuger					,	
PASS - Asc Applied shear stress	Joiner \= Aseuger	$v_{corner} = V_{\Sigma co}$	property dtslabmin = 0.0)54 N/mm ²			

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From BS8110-1:1997 - Table 3	.8							
Design concrete shear strength	ו	$V_{ccorner} = 0$.	v _{ccorner} = 0.490 N/mm ²					
		Pass - Vcor	ner <= Vccorner -	Shear capacity	of the slab is	not exceeded		
Slab corner deflection check								
Basic allowable span to depth r	Ratiobasiccor	Ratiobasiccorner = 7.0						
Moment factor	ient factor			$M_{factorcorner} = M_{\Sigma corner}/d_{tslabmin}^2 = 0.119 \text{ N/mm}^2$				
Steel service stress	$f_{scorner} = 2/3 \times f_{yslab} \times A_{scornerbend}/A_{sedgetop} = 52.503 \text{ N/mm}^2$							

Modified allowable span to depth ratio Actual span to depth ratio

Modification factor

$MF_{corner} = min(2.0, 0.55 + [(477N/mm^{2}-f_{scorner})/(120 \times (0.9N/mm^{2}+M_{factorcorner}))])$

MF_{corner} = **2.000**

 $Ratio_{\text{allowcorner}} = Ratio_{\text{basiccorner}} \times MF_{\text{corner}} = \textbf{14.000}$

 $Ratio_{actual corner} = I_{corner} / d_{tslabmin} = 6.596$

PASS - Ratio_{actualcorner} <= Ratio_{allowcorner} - Slab span to depth ratio is adequate