# Structural Scheme for Planning

Property Details: 8A Belmont Street London NW1 8HJ

Client Information: Francis Williams Ground and Water Limited

Revision	Date	Comment
-	03.03.2016	Issue for planning
LABC Regional winner 2013 awards		TheInstitution of Structural Engineers



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	1. Structural Design Information
Structural Summary	The existing property is a single storey storage building.
	Firsting property
	Proposed works:
	The storage within the site boundary will be demolished to give way for a new residential property. The new building will be two storeys high above ground level and will also include a basement. For further details of the architectural design, refer to Architectural drawings
Intended use of structure and user requirements	Family/domestic use
Loading (BS 6399-	UDL Concentrated
1)	kN/m <sup>2</sup> Loads kN
	Domestic Single Dwellings1.51.4
	Is Live Load Reduction included in design No

Number of Storeys	Progressive Collapse Two storeys above basement
ls the Building Multi Occupancy?	Yes



Part A3	EN 1991-1-7:1996 Table A1
Progressive collapse	Class 2A Flats, apartments and other residential buildings not exceeding 4 storeys
Additional Design Requirements to Comply with Progressive Collapse	<u>Class 2A – Design provision of effective horizontal ties or , or effective</u> <u>anchorage of suspended floor to walls.</u> Check requirements in EN 1991- 1-7 clauses A.5.1 and A.5.2
	Lateral Stability
Exposure and wind loading conditions	0.6 kN/m²
Stability Design	Lateral stability in the basement is provided by the reinforced retaining walls and slabs which form a complete box.
Lateral Actions	Lateral Forces applied from; Wind on to super structure Soil pressure, Hydro static pressure and surcharge on basement



	Basement Design and Construction Impacts and Initial Design Considerations					
Structural Scheme	A reinforced concrete slab and a contiguous piled wall will form the new foundation of the property. The piled wall, to be designed at detailed design stage, will resist the lateral pressures on the side of the basement.					
	The investigations highlight that water is not present. The walls are designed to cope with the hydrostatic pressure. It is possible that a water main may break causing a local high water table. To account for this, the wall is designed for water at full height.					
	The detailed design should consider floatation as a risk. However, by inspection, the weight of the building is likely to be greater than the uplift forces from the water, resulting in a stable structure.					
	The site is within 5m of a road surface; the basement wall is further away. However, to account for the possibility of emergency services vehicles occupying the pavement, highways loading should be allowed for.					
	Drawings are appended. The details given on these should not be used for construction: detailed design will follow after the planning application process.					
Water Table	Has a soil investigation been carried out Yes No water is present in the borehole. Design permanent condition for water table level: If deeper than existing, design reinforcement for water table at full basement depth to allow for local failure of water mains, drainage and storm water. Global uplift forces can be ignored when the groundwater table is lower than the basement. BS8102 only indicates guidance.					
Retained soil Parameters	Design overall stability to $K_a \& K_p$ values. Lateral movement necessary to achieve $K_a$ mobilisation is height/500 (from Tomlinson). This is tighter than the deflection limits of the concrete wall.					
Temporary Works	Where possible walls are designed to be temporarily stable. Temporary propping details will be required for the ground and soil and this must be					



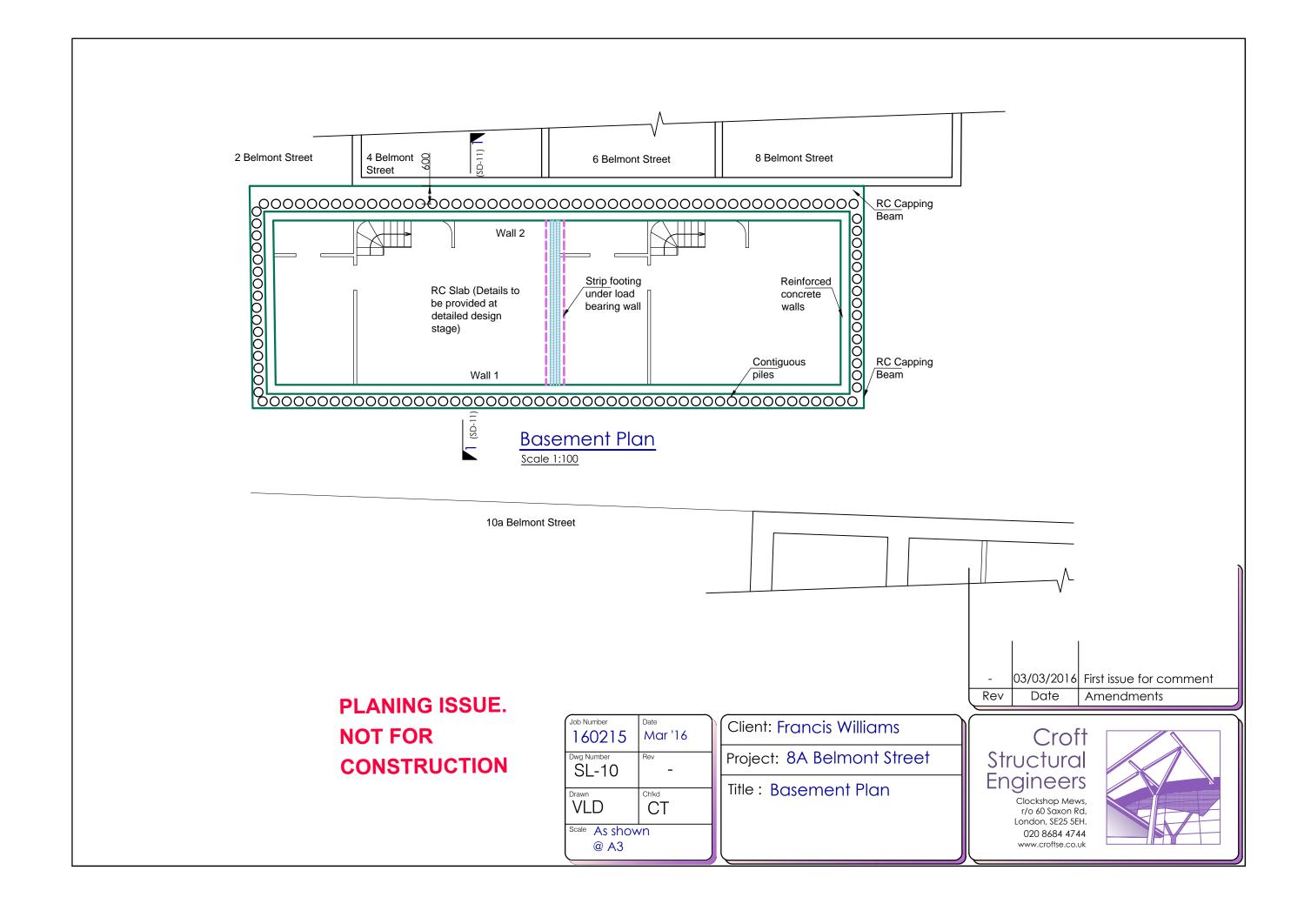
provided by the contractor. Their details should be forwarded to the Engineers responsible for the permanent design.

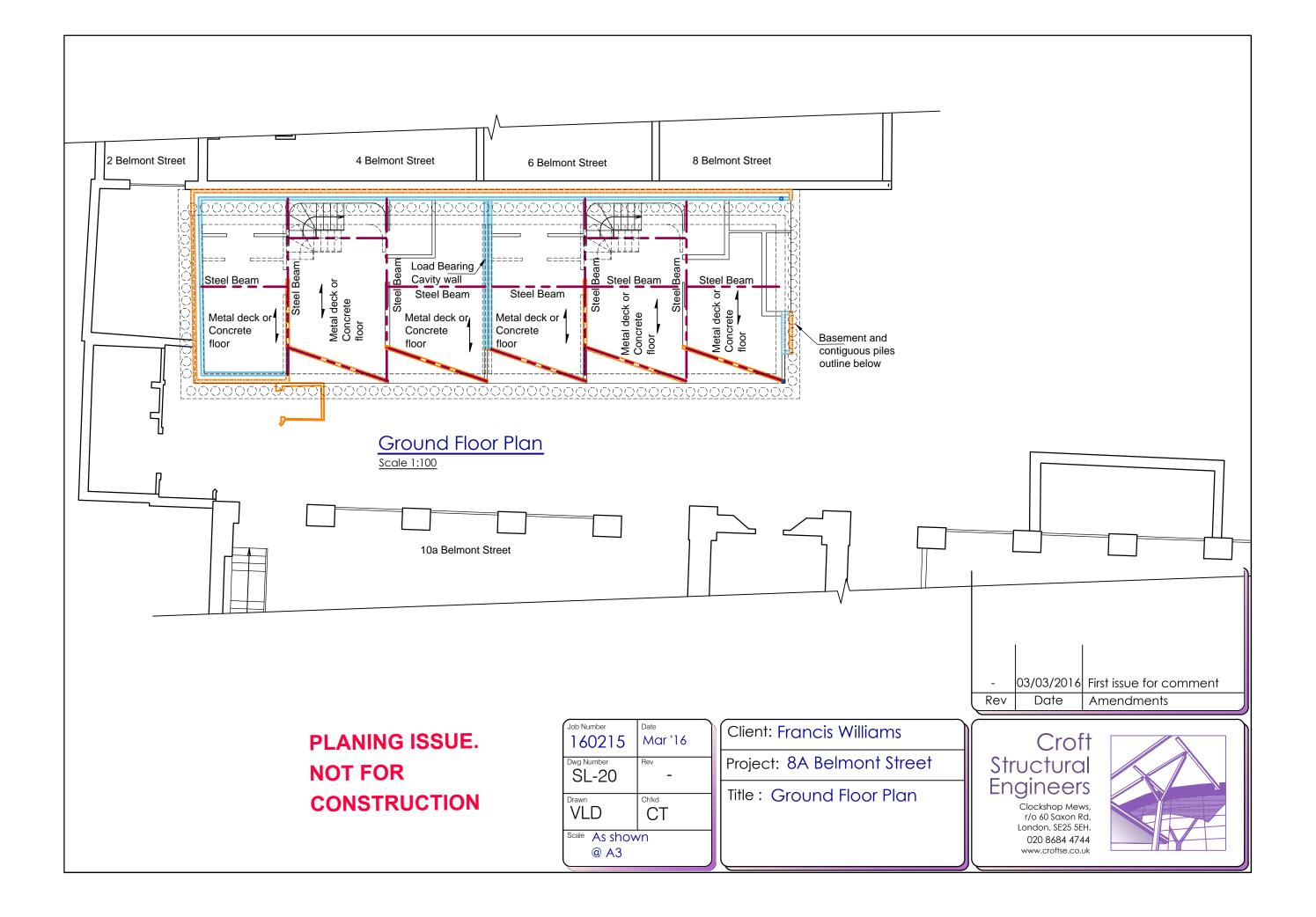
The contractor must provide calculations, drawings and method statements of their temporary works proposals prior to beginning work.

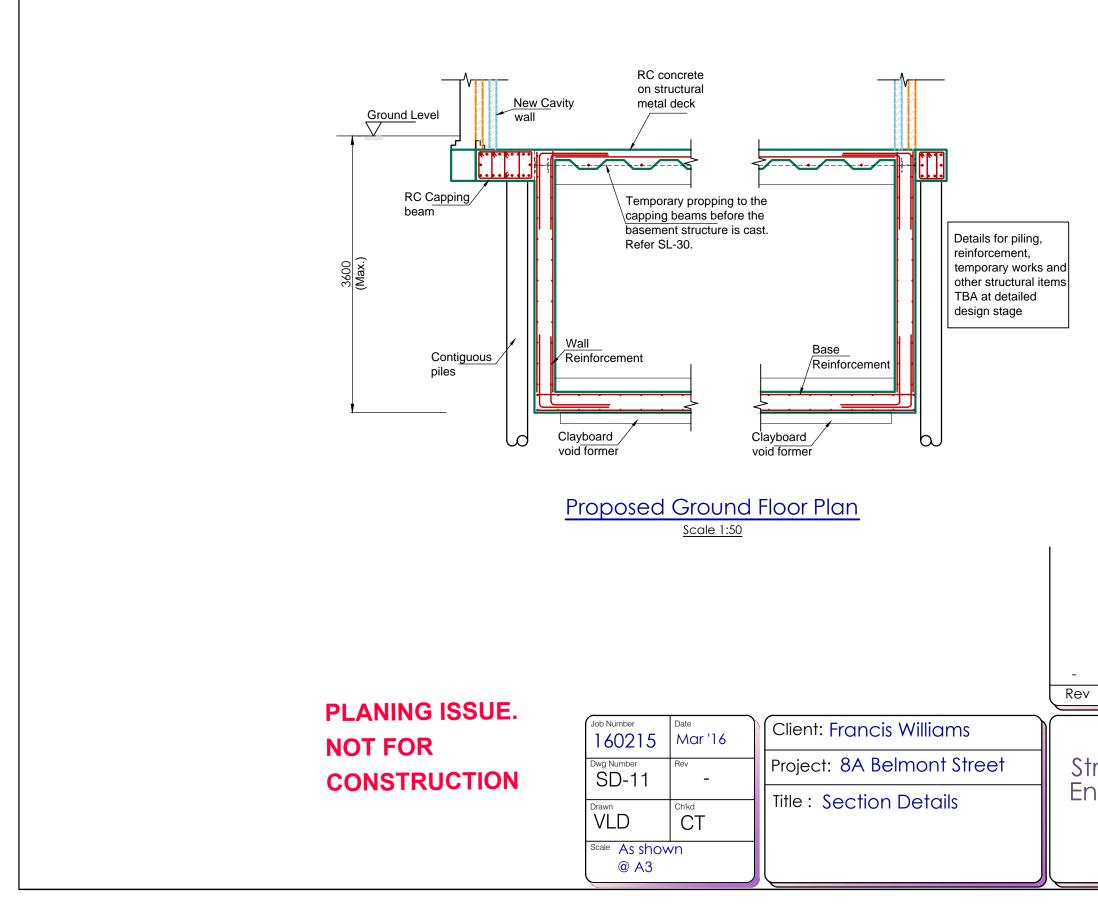


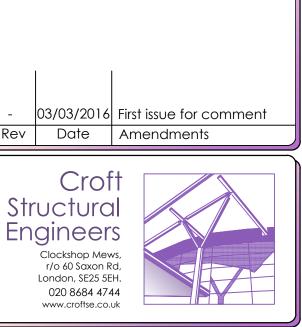
# 2. Structural Drawings

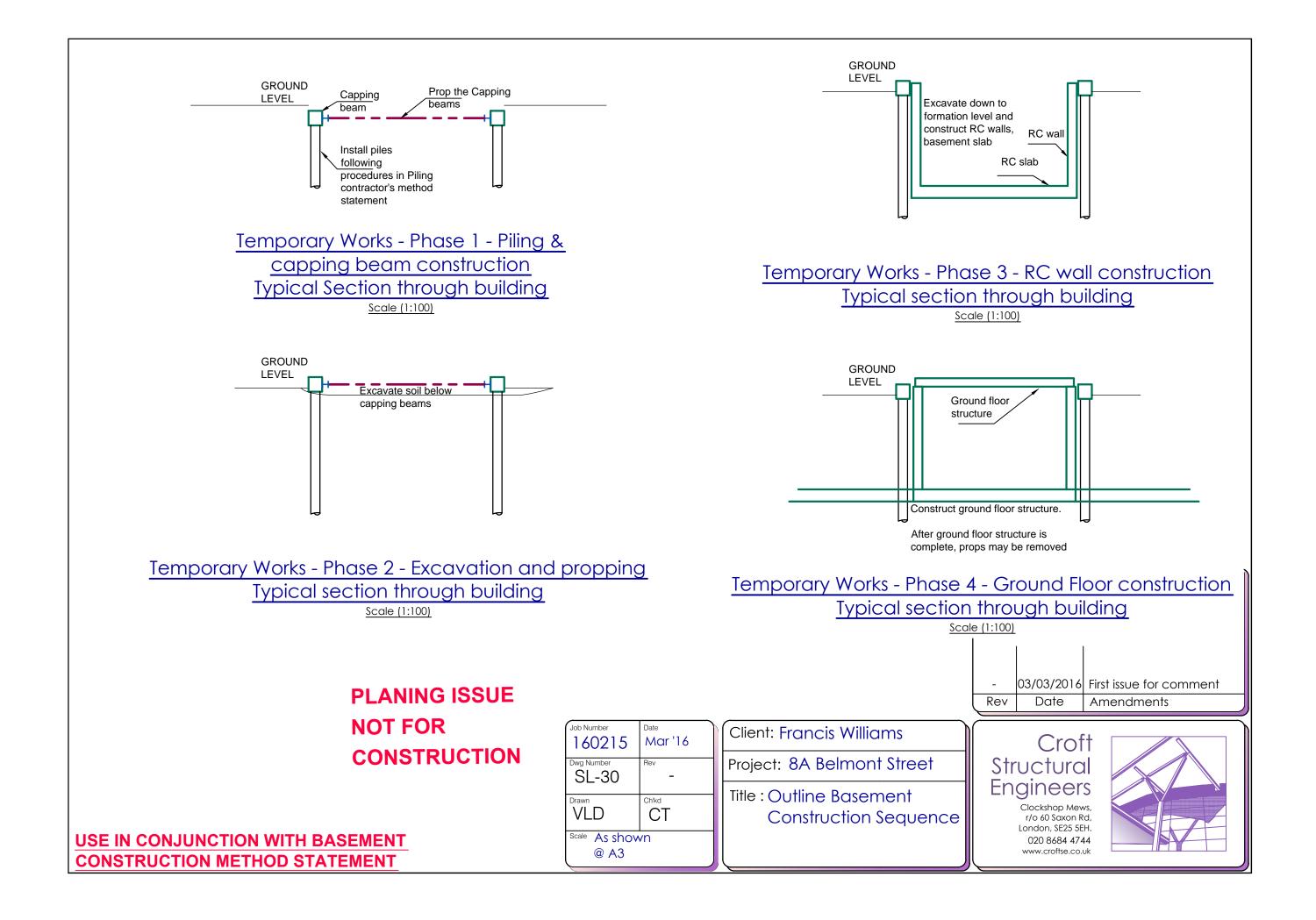
(The attached drawings in this section are for use at planning stage. They are not expect to be the final construction. Do not use these drawings as the construction issue.)













3. Loadings

Gravity Loads

Load Run Down Tables



	CROFT		Project:			<u></u>		Section	0.1	Sheet	01
	STRUCI	<b>IURAL</b>			Selmont Street		1		01		01
<b>MAX</b>	ENGIN	EERS .	Date	Mar-16		Rev	Date	Descriptio	on		
			Ву	VLD							
Enquiries	@croftse.co	o.uk	Cheked	CT							
Tel 0208 68	84 4744		Job Numbe			Status				Rev	
				1602	15						
Reference		_									
	Genera	al Loa	dings								
					C	avity Walls					
	Sloped Roof				100 Fac	ing Brick =	2.2		Timbe	r Partitions	
	Slate =	0.6	kN/m²		100 Block (1	16kN/m3)=	1.6		50x100 Stu	ds @ 400 =	0.15
	Battens =	0.02			Plaste	er & Skim =	0.18		Ir	nsulation =	0.04
	Rafers	0.1125			Dea	ad Load =	3.98	kN/m2	Plaste	er & Skim =	0.36
	Felt =	0.02							De	ad Load =	0.55
	Insulation =	0.02			Inte	rnal Walls					
	Plaster=	0.18		1	00 Block (2	20kN/m3)=	2				
ļ		0.9525	kN/m2			er & Skim =	0.36		Existing E	Brick Walls	
F	oof Angle =	25	deg		De	ad Load =	2.36	kN/m2		ing Brick =	4.5
Plan [	Dead load =	1.051	kN/m2	E	xisting Inte	rnal Walls					
	Live Load =	0.6	kN/m2	-	100 Brick (2		2.1		Plaster	& Lathe =	0.15
					•	er & Skim =	0.36		De	ad Load =	4.65
	Flat Roof				De	ad Load =	2.46	kN/m2			
20m	m Asphalt =	0.46			-			Beam &	Block Gro	und Floors	
	underlay =	0.02			Tim	ber Floors				am & Block	3.1
	insulation =	0.04				18mm Ply				Screed	1.4
	/ Sheeting =	0.1			Joists 50x2	225@400 =	0.16875			Insulation	0.07
,	Firring =	0.1				sulation =	0.05			Finishes	0.05
of joists 50	x200@400 =	0.15				er & Skim =	0.18		De	ad Load =	4.62
	ster & Skim =	0.18				ad Load =	0.54875	kN/m2		ive Load =	1.5
	Dead load =		kN/m2			ive Load =	1.5	kN/m2			
	Live Load =		kN/m2			race Floor			Stand	ling Seam	
		0.70				ade Tiles =	0.4			Roof Sheet	0.08
	Green roof					Asphalt =	0.46			Insulation	0.07
ooil		0.00				inderlay =	0.02			Decking	0.2
	ing (plaster)=	0.20 5.00				nsulation =	0.02			Steelwork	0.2
									Do		
	mm screed=	1.30			Fiy 3	Sheeting = Firring =	0.1			ad Load = ive Load =	0.95
2001	n insulation = Membrane=	1.20 0.03		Dor	of joists 50x2	-	0.175		L L		0.0
Green P	oof(sedum)=	2.50		KU	,	200@400 = er & Skim =	0.175		Filler	joist Floor	
	$perm., g_k =$	10.23	kN/m²			ad Load =		kN/m2	<u>- mer</u>	Finishes	1.2
	n Var., q <sub>k</sub> =		kN/m <sup>2</sup>			ive Load =		kN/m2	Eillo	r Joist Floor	2.5
Fial	, va∷, Yk ≓	1.50	131 <b>1</b> 7 (11						Fille	Ceiling	2.5 0.18
	Poof Angla	45	dog		FOUT	Ceiling	0.075			0	0.18
	Roof Angle =		deg			100 Joists = nsulation =			D-	Steel	
Piant		2.122	kN/m2				0.06			ad Load =	4.18
ļ	Live Load =	0.3	kN/m2			er & Skim =	0.18			ive Load =	3.5
N.4 - 4	al dook Elec	r on Stock				ad Load = ive Load =		kN/m2			
	al deck Floo		2 7 2 4					kN/m2			
	150dp Ribe		2.736				veLoadR				0%
	60	Screed =	1.2			Area		0%	Floors		0%
		Finishes =	0.1					5%			10%
		eelwork =	0.6					10%			20%
		ad Load =		kN/m²				15%			30%
	Liv	ve Load =	3.5	kN/m <sup>-</sup>			200	20%		5 to 10	40%



# 4. Structural Design

5. Contiguous piles around the perimeter of the building will resist lateral loading from the retained soil. This should include full height hydrostatic pressures. The piled wall will be propped at the head by temporary props in the temporary condition (as indicated in drawing SL-50, appended) and by the ground floor structure in the permanent case (refer to drawings SL-10 and SL-30, appended). The ground floor structure will transfer theses horizontal loads to the opposite wall.

6.

 At detailed design stage, the contiguous piled wall should resist highways surcharge loads (10kN/m<sup>2</sup>).



### WALL 1(TEMPORARY CONDITION-NO WATER)

Wall	1
vvall	- 1

Wall 1									
Roof	2.9	1	2.9	Яĸ	10.23	29.7	kN/m		
				qĸ	1.50			4.4	kN/m
First Floor	2.9	1	2.9	Яĸ	4.64	13.4	kN/m		
				qĸ	2.12			6.2	kN/m
Ground Floor	2.9	1	2.9	Яĸ	4.64	13.4	kN/m		
				Qk	3.50			10.2	kN/m
Cavity wall	7	1	7	Яĸ	3.98	27.9	kN/m		
						84.4	kN/m	20.7	kN/m

Retaining wall analysis in accordance with EN1997-1:2004 incorporating Corrigendum dated February 2009 and the UK National Annex incorporating Corrigendum No.1

Tedds calculation version 2.6.05

Retaining wall details

Ne	canning wan details			
	Stem type	Propped cantilever		
	Stem height	h <sub>stem</sub> = <b>3300</b> mm		
	Prop height	h <sub>prop</sub> = <b>3200</b> mm		
	Stem thickness	t <sub>stem</sub> = <b>300</b> mm		
	Angle to rear face of stem	α = <b>90</b> deg		
	Stem density	$\gamma_{\text{stem}} = 25 \text{ kN/m}^3$		
	Toe length	l <sub>toe</sub> = <b>1000</b> mm		
	Base thickness	t <sub>base</sub> = <b>300</b> mm		
	Base density	γ <sub>base</sub> = <b>25</b> kN/m <sup>3</sup>		
	Height of retained soil	h <sub>ret</sub> = <b>3300</b> mm	Angle of soil surface	$\beta = 0 \deg$
	Depth of cover	d <sub>cover</sub> = 0 mm		
Re	etained soil properties			
	Soil type	Medium dense well graded sa	nd	
	Moist density	γmr = <b>21</b> kN/m <sup>3</sup>		
	Saturated density	γ <sub>sr</sub> = <b>23</b> kN/m <sup>3</sup>		
	Characteristic effective shear r	esistance angle	φ' <sub>r.k</sub> = <b>30</b> deg	
	Characteristic wall friction angl	$e \delta_{r,k} = 0 deg$		
Ba	ase soil properties			
	Soil type	Medium dense well graded sa	nd	
	Soil density	γ <sub>b</sub> = <b>18</b> kN/m <sup>3</sup>		
	Characteristic effective shear r	esistance angle	φ' <sub>b.k</sub> = <b>30</b> deg	
	Characteristic wall friction angl	e δ <sub>b.k</sub> = <b>15</b> deg		
	Characteristic base friction and	le	δ <sub>bb.k</sub> = <b>30</b> deg	
	Presumed bearing capacity	$P_{\text{bearing}} = 125 \text{ kN/m}^2$	5	
Lo	ading details	-		
-0	Variable surcharge load	Surcharge <sub>Q</sub> = <b>10</b> kN/m <sup>2</sup>		
	Vertical line load at 1150 mm	-		

Vertical line load at 1150 mm  $P_{G1} = 85 \text{ kN/m}$ 



	P <sub>Q1</sub> = <b>20</b> kN/m ∣←─── <sup>1000</sup> ──→ ◆ <sup>300</sup> ▶		
	الحــــــــــــــــــــــــــــــــــــ		
▲ 3300 3300 100 100 100 100 100 100 100 1		28.5 kN/m <sup>2</sup>	
	107.3 kN/m²	) kN/m²	
Calculate retaining wall geo Base length Moist soil height Length of surcharge load Vertical distance Effective height of wall Horizontal distance Area of wall stem Area of wall base	metry $l_{base} = 1300 \text{ mm}$ $h_{moist} = 3300 \text{ mm}$ $l_{sur} = 0 \text{ mm}$ $x_{sur_v} = 1300 \text{ mm}$ $h_{eff} = 3600 \text{ mm}$ $x_{sur_h} = 1800 \text{ mm}$ $A_{stem} = 0.99 \text{ m}^2$ $A_{base} = 0.39 \text{ m}^2$	Vertical distance Vertical distance	x <sub>stem</sub> = <b>1150</b> mm x <sub>base</sub> = <b>650</b> mm
Using Coulomb theory			
Active pressure coefficient Bearing pressure check Vertical forces on wall	K <sub>A</sub> = <b>0.333</b>	Passive pressure coefficient	K <sub>P</sub> = <b>4.977</b>
Total	$F_{total_v} = F_{stem} + F_{base} + F_{P_v} = 1$	<b>39.5</b> kN/m	
Horizontal forces on wall Total	Ftotal_h = Fmoist_h + Fpass_h + Fsur_	<sub>h</sub> = <b>53.5</b> kN/m	
Moments on wall Total	$M_{total} = M_{stem} + M_{base} + M_{moist} +$	M <sub>sur</sub> + M <sub>P</sub> = <b>79.5</b> kNm/m	
Check bearing pressure Propping force to stem kN/m	F <sub>prop_stem</sub> = <b>3.2</b> kN/m	Propping force to base	F <sub>prop_base</sub> = <b>50.3</b>
Bearing pressure at toe Factor of safety	$q_{toe} = 107.3 \text{ kN/m}^2$ FoS <sub>bp</sub> = 1.165	Bearing pressure at heel	q <sub>heel</sub> = <b>107.3</b> kN/m <sup>2</sup>
	PASS - Allowable bearing pres	ssure exceeds maximum appl	ied bearing pressure

Wall 1

Job Number: 160215 Date:03.03.2016



Retaining wall design in accordance with EN1992-1-1:2004 incorporating Corrigendum dated January 2008 and the UK National Annex incorporating National Amendment No.1 Tedds calculation version 2.6.05

Concrete details - Table 3.1 -	Strength and deformation C28/35	n characteristics for concre	te
Concrete strength class Char.comp.cylinder strength	$f_{ck} = 28 \text{ N/mm}^2$	Mean axial tensile strength	f <sub>ctm</sub> = <b>2.8</b> N/mm <sup>2</sup>
Secant modulus of elasticity	$E_{cm} = 32308 \text{ N/mm}^2$	Maximum aggregate size	h <sub>agg</sub> = <b>20</b> mm
Design comp.concrete strength		Partial factor	γ <sub>C</sub> = <b>1.50</b>
Reinforcement details			70 <b>– 1100</b>
Characteristic yield strength	f <sub>yk</sub> = <b>500</b> N/mm <sup>2</sup>	Modulus of elasticity	E <sub>s</sub> = <b>200000</b> N/mm <sup>2</sup>
Design yield strength	$f_{yd} = 435 \text{ N/mm}^2$	Partial factor	γs = <b>1.15</b>
Cover to reinforcement			75 - 1110
Front face of stem	c <sub>sf</sub> = <b>40</b> mm	Rear face of stem	c <sub>sr</sub> = <b>50</b> mm
Top face of base	$c_{bt} = 50 \text{ mm}$	Bottom face of base	<sub>Cbb</sub> = <b>75</b> mm
Check stem design at 1690 m			
Depth of section	h = <b>300</b> mm		
Rectangular section in flexure			
Design bending moment	M = <b>13.4</b> kNm/m	K = <b>0.008</b>	K' = <b>0.207</b>
Design bending moment	M = 10.4 KKM/M	K' > K - No compression reinf	
Tens.reinforcement required	A <sub>sfM.req</sub> = <b>132</b> mm <sup>2</sup> /m		or ochient to required
Tens.reinforcement provided	10 dia.bars @ 200 c/c	Tens.reinforcement provided	AsfM.prov = <b>393</b>
mm²/m		· · · · · · · · · · · · · · · · · · ·	
Min.area of reinforcement	A <sub>sfM.min</sub> = <b>352</b> mm <sup>2</sup> /m	Max.area of reinforcement	A <sub>sfM.max</sub> = <b>12000</b>
mm²/m			
PASS	S - Area of reinforcement prov	vided is greater than area of re	inforcement required
Deflection control - Section 7	.4		
Limiting span to depth ratio	795.6	Actual span to depth ratio	13.1
	PASS - Spa	nn to depth ratio is less than de	eflection control limit
Crack control - Section 7.3			
Limiting crack width	w <sub>max</sub> = <b>0.3</b> mm	Maximum crack width	w <sub>k</sub> = <b>0.15</b> mm
PASS - Maximum crac	ck width is less than limiting o	crack widthCheck stem desig	gn at base of stem
Depth of section	h = <b>300</b> mm		-
Rectangular section in flexure	e - Section 6.1		
Design bending moment	M = <b>28.2</b> kNm/m	K = <b>0.017</b>	K' = <b>0.207</b>
		K' > K - No compression reinf	orcement is required
Tens.reinforcement required	A <sub>sr.req</sub> = <b>280</b> mm <sup>2</sup> /m		
Tens.reinforcement provided	12 dia.bars @ 200 c/c	Tens.reinforcement provided	A <sub>sr.prov</sub> = <b>565</b> mm <sup>2</sup> /m
Min.area of reinforcement mm <sup>2</sup> /m	A <sub>sr.min</sub> = <b>351</b> mm <sup>2</sup> /m	Max.area of reinforcement	A <sub>sr.max</sub> = <b>12000</b>
PASS	S - Area of reinforcement prov	vided is greater than area of re	inforcement required
Library item: Rectangular sing	gle summary		
Deflection control - Section 7	<sup>7</sup> .4		
Limiting span to depth ratio	245.4	Actual span to depth ratio	13.1
		nn to depth ratio is less than de	
Crack control - Section 7.3		-	
Limiting crack width	w <sub>max</sub> = <b>0.3</b> mm	Maximum crack width	w <sub>k</sub> = <b>0.212</b> mm
	h is loss than limiting areak u	vidthRectangular section in	
	n is less ulan illillilliu clack w		

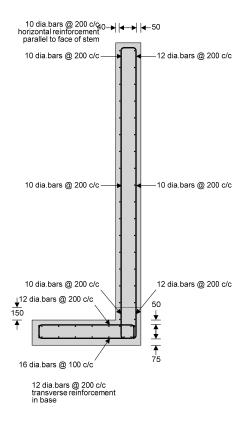


Check stem design at prop Depth of section	h = <b>300</b> mm		
Rectangular section in flexure			
Design bending moment	M = 0  kNm/m	K = 0.000	K' = <b>0.207</b>
		K' > K - No compression reinfo	
Tens.reinforcement required	$A_{sr1.req} = 0 \text{ mm}^2/\text{m}$		
Tens.reinforcement provided mm <sup>2</sup> /m	12 dia.bars @ 200 c/c	Tens.reinforcement provided	A <sub>sr1.prov</sub> = 565
Min.area of reinforcement mm <sup>2</sup> /m	A <sub>sr1.min</sub> = <b>351</b> mm <sup>2</sup> /m	Max.area of reinforcement	A <sub>sr1.max</sub> = <b>12000</b>
PAS	S - Area of reinforcement p	rovided is greater than area of rei	nforcement required
Deflection control - Section 7	<i>'</i> .4		
Limiting span to depth ratio	3503242.6	Actual span to depth ratio	0.4
	PASS - S	Span to depth ratio is less than de	eflection control limit
Crack control - Section 7.3			
Limiting crack width	w <sub>max</sub> = <b>0.3</b> mm	Maximum crack width	$w_k = 0 mm$
PASS - Maximum crack widt	th is less than limiting crac	<b>k width</b> Rectangular section in s	shear - Section 6.2
Design shear force	V = <b>16.8</b> kN/m	Design shear resistance	V <sub>Rd.c</sub> = <b>118.9</b> kN/m
	PASS	- Design shear resistance exceed	s design shear force
Horizontal reinforcement par	allel to face of stem - Se	ection 9.6	
Min.area of reinforcement	A <sub>sx.req</sub> = <b>300</b> mm <sup>2</sup> /m	Max.spacing of reinforcement	s <sub>sx_max</sub> = <b>400</b> mm
Trans.reinforcement provided mm <sup>2</sup> /m	10 dia.bars @ 200 c/c	Trans.reinforcement provided	A <sub>sx.prov</sub> = <b>393</b>
PAS	S - Area of reinforcement p	rovided is greater than area of rei	nforcement required
Check base design at toe			
Depth of section	h = <b>300</b> mm		
Rectangular section in flexure	e - Section 6.1		
Design bending moment	M = <b>68.5</b> kNm/m	K = <b>0.052</b>	K' = <b>0.207</b>
		K' > K - No compression reinfo	orcement is required
Tens.reinforcement required	A <sub>bb.req</sub> = <b>765</b> mm <sup>2</sup> /m		
Tens.reinforcement provided mm <sup>2</sup> /m	16 dia.bars @ 100 c/c	Tens.reinforcement provided	Abb.prov = 2011
Min.area of reinforcement mm <sup>2</sup> /m	A <sub>bb.min</sub> = <b>312</b> mm <sup>2</sup> /m	Max.area of reinforcement	Abb.max = <b>12000</b>
PAS	S - Area of reinforcement p	rovided is greater than area of rei	nforcement required
Crack control - Section 7.3			
Limiting crack width	w <sub>max</sub> = <b>0.3</b> mm	Maximum crack width	w <sub>k</sub> = <b>0.137</b> mm
PASS - Maximum crack widt	th is less than limiting crac	<b>k width</b> Rectangular section in s	shear - Section 6.2
Design shear force	V = <b>137</b> kN/m	Design shear resistance	V <sub>Rd.c</sub> = <b>151.1</b> kN/m
	PASS	- Design shear resistance exceed	s design shear force
Secondary transverse reinfore	cement to base - Sectio	n 9.3	
Min.area of reinforcement	A <sub>bx.req</sub> = <b>402</b> mm <sup>2</sup> /m	Max.spacing of reinforcement	S <sub>bx_max</sub> = <b>450</b> mm
Trans.reinforcement provided mm <sup>2</sup> /m	12 dia.bars @ 200 c/c	Trans.reinforcement provided	A <sub>bx.prov</sub> = <b>565</b>
PAS	S - Area of reinforcement p	rovided is greater than area of rei	nforcement required

PASS - Area of reinforcement provided is greater than area of reinforcement required

Job Number: 160215 Date:03.03.2016





#### WALL 1 (PERMANENT CONDITION)

Location		Area		Туре	L	Load		Load kN		
	L	W	m2			kN/m2	Dead	%	Live	Total
Wall 1										
Roof	2.9	1	2.9	g <sub>k</sub>		10.23	29.7	kN/m		
				q <sub>k</sub>		1.50			4.4	kN/m
First Floor	2.9	1	2.9	<u></u> gk		4.64	13.4	kN/m		
				qĸ		2.12			6.2	kN/m
Ground Floor	2.9	1	2.9	Яĸ		4.64	13.4	kN/m		
				Qĸ		3.50			10.2	kN/m
Cavity wall	7	1	7	g <sub>k</sub>		3.98	27.9	kN/m		
							84.4	kN/m	20.7	kN/m

Retaining wall analysis

In accordance with EN1997-1:2004 incorporating Corrigendum dated February 2009 and the UK National Annex incorporating Corrigendum No.1

Retaining wall details

Tedds calculation version 2.6.05

Job Number: 160215 Date:03.03.2016



Stem heightPropher cantilieverStem height $h_{stem} = 3300 \text{ mm}$ Prop height $h_{prop} = 3200 \text{ mm}$ Stem thicknesstarem = 300 mmAngle to rear face of stem $\alpha = 90 \text{ deg}$ Stem density $\gamma_{stem} = 25 \text{ kN/m^3}$ Toe length $h_{oe} = 1000 \text{ mm}$ Base thicknesstasse = 20 mmBase density $\gamma_{base} = 25 \text{ kN/m^3}$ Height of retained soil $h_{ret} = 3300 \text{ mm}$ Base density $\gamma_{base} = 25 \text{ kN/m^3}$ Height of retained soil $h_{ret} = 3300 \text{ mm}$ Water density $\gamma_{W} = 9.8 \text{ kN/m^3}$ Retained soil propertiesSoil typeSoil typeMedium dense well graded sandMoist density $\gamma_{ter} = 21 \text{ kN/m^3}$ Characteristic effective shear resistance angle $\phi_{1:k} = 30 \text{ deg}$ Characteristic ffective shear resistance angle $\phi_{1:k} = 30 \text{ deg}$ Soil typeMedium dense well graded sandSoil typeMedium dense well graded sa		Champ turn a	Drenned contilever		
Prop height Stem thicknesshprop = 3200 mmStem thicknesstsem = 300 mmAngle to rear face of stemα = 90 degStem densityyatem = 25 kN/m³Toe lengthhoe = 1000 mmBase thicknesstoes = 300 mmBase thicknesstoes = 25 kN/m³Base densityyatem = 25 kN/m³Base densityyatem = 25 kN/m³Base densitytoes = 300 mmBase densitytoes = 25 kN/m³Base densitythret = 3300 mmAngle of cover0 mmHeight of retained soilhret = 3300 mmWater densityyw = 9.8 kN/m³Retained soil propertiesSoil typeSoil typeMedium dense well graded sandMoist densityym = 21 kN/m³Staturated densityym = 22 kN/m³Characteristic effective shear resistance angle\phi.k = 30 degCharacteristic effective shear resistance angle\phi.k = 30 degCharacteristic effective shear resistance angle\phi.k = 30 degSoil typeMedium dense well graded sandSoil typeMedium dense well graded sandSoil typeSoil densitySoil typeMedium dense well graded sandSoil typeSoil densitySoil typeMedium dense well graded sandSoil typeSoil densitySoil typeSoil densitySoil densityNp = 18 kN/m³Characteristic effective shear resistance angleCharacteristic effective shear resistance angleCharacteristic base friction augleDep		Stem type	Propped cantilever		
Stem thicknesstatem = 300 mmAngle to rear face of stem $\alpha = 90 \text{ deg}$ Stem density $\gamma_{stem} = 25 \text{ kN/m}^3$ Toe length $loe = 1000 \text{ mm}$ Base thickness $toase = 300 \text{ mm}$ Base thickness $toase = 25 \text{ kN/m}^3$ Height of retained soil $hret = 3300 \text{ mm}$ Angle of soil surface $\beta = 0 \text{ deg}$ Depth of cover $d_{cover} = 0 \text{ mm}$ Height of water $hwater = 3300 \text{ mm}$ Water density $\gamma_{w} = 9.8 \text{ kN/m}^3$ Retained soil typeMedium dense well graded sandMoist density $\gamma_{wr} = 21 \text{ kN/m}^3$ Saturated density $\gamma_{sr} = 23 \text{ kN/m}^3$ Characteristic effective shear resistance angle $\phi'_{r.k} = 30 \text{ deg}$ Characteristic effective shear resistance angle $\phi'_{r.k} = 30 \text{ deg}$ Soil typeMedium dense well graded sandSoil typeMedium dense well graded sandSoil typeMedium dense well graded sandCharacteristic effective shear resistance angle $\phi'_{r.k} = 30 \text{ deg}$ Characteristic effective shear resistance angle $\phi'_{b.k} = 30 \text{ deg}$ Characteristic effective shear resistance angle $\phi'_{b.k} = 30 \text{ deg}$ Characteristic effective shear resistance angle $\phi'_{b.k} = 30 \text{ deg}$ Characteristic defective shear resistance angle $\phi'_{b.k} = 30 \text{ deg}$ Characteristic defective shear resistance angle $\phi_{b.k} = 30 \text{ deg}$ Characteristic defective shear resistance angle $\phi_{b.k} = 30 \text{ deg}$ Characteristic defective shear resistance angle $\phi_{b.k$		5			
Angle to rear face of stem $\alpha = 90 deg$ Stem density $\gamma_{stem} = 25 \text{ kN/m^3}$ Toe length $I_{toe} = 1000 \text{ mm}$ Base thickness $t_{base} = 300 \text{ mm}$ Base density $\gamma_{base} = 25 \text{ kN/m^3}$ Height of retained soil $h_{ret} = 3300 \text{ mm}$ Angle of soil surface $\beta = 0 deg$ Depth of cover $d_{cover} = 0 \text{ mm}$ Height of water $h_{water} = 3300 \text{ mm}$ Water density $\gamma_w = 9.8 \text{ kN/m^3}$ Retained soil propertiesSoil typeSoil typeMedium dense well graded sandMoist density $\gamma_{wr} = 21 \text{ kN/m^3}$ Saturated density $\gamma_{orr} = 23 \text{ kN/m^3}$ Characteristic effective shear resistance angle $\phi^{i}_{r.k} = 30 \text{ deg}$ Characteristic wall friction angle $\delta_{r.k} = 0 \text{ deg}$ Base soil propertiesSoil density $\gamma_b = 18 \text{ kN/m^3}$ Characteristic effective shear resistance angle $\phi^{i}_{r.k} = 30 \text{ deg}$ Characteristic wall friction angle $\delta_{b.k} = 15 \text{ deg}$ Characteristic wall friction angle $\delta_{b.k} = 15 \text{ deg}$ Characteristic wall friction angle $\delta_{b.k} = 15 \text{ deg}$ Characteristic wall friction angle $\delta_{b.k} = 15 \text{ deg}$ Characteristic base friction angle $\delta_{b.k} = 15 \text{ deg}$ Characteristic wall friction angle $\delta_{b.k} = 15 \text{ deg}$ Characteristic wall friction angle $\delta_{b.k} = 15 \text{ deg}$ Characteristic wall friction angle $\delta_{b.k} = 15 \text{ deg}$ Characteristic wall friction angle $\gamma = 125 \text{ kN/m^2}$ Loading detailsVariable surcharge loadSurcharge_a = 10  kN			1 1		
NoteYstem = 25 kN/m³Toe lengthhoe = 1000 mmBase thicknessbase = 300 mmBase densityYbase = 25 kN/m³Height of retained soilhret = 3300 mmAngle of soil surface $\beta$ = 0 degDepth of coverdover = 0 mmHeight of waterhwater = 3300 mmWater density $\gamma_w$ = 9.8 kN/m³Retained soil propertiesSoil typeSoil typeMedium dense well graded sandMoist density $\gamma_{rer}$ = 21 kN/m³Saturated density $\gamma_{rer}$ = 23 kN/m³Characteristic effective shear resistance angle $\phi'_{r.k}$ = 30 degCharacteristic ull friction angle $\delta_{r.k}$ = 0 degBase soil propertiesSoil dpoMedium dense well graded sandSoil typeMedium dense well graded sandSoil density $\gamma_b$ = 18 kN/m³Characteristic effective shear resistance angle $\phi'_{r.k}$ = 30 degCharacteristic effective shear resistance angle $\phi'_{b.k}$ = 30 degCharacteristic effective shear resistance angle $\phi'_{b.k}$ = 30 degCharacteristic ull friction angle $\delta_{b.k}$ = 15 degCharacteristic base friction $a_{b.k}$ = 15 degCharacteristic base friction $a_{b.k}$ = 125 kN/m² $\delta_{bb.k}$ = 30 degLoading detailsYariable surcharge loadSurcharge_0 = 10 kN/m²Variable surcharge loadSurcharge_0 = 10 kN/m²Yariable surcharge loadVariable surcharge loadSurcharge_0 = 10 kN/m²Yariable surcharge loadVariable surcharge loadSurcharge_0 = 10 kN/m²Yariable surcharge load <td></td> <td>Stem thickness</td> <td>t<sub>stem</sub> = <b>300</b> mm</td> <td></td> <td></td>		Stem thickness	t <sub>stem</sub> = <b>300</b> mm		
Toe length $k_{toe} = 1000 \text{ mm}$ Base thickness $b_{tase} = 300 \text{ mm}$ Base density $\gamma_{tasse} = 25 \text{ kN/m^3}$ Height of retained soil $h_{ret} = 3300 \text{ mm}$ Angle of soil surface $\beta = 0 \text{ deg}$ Depth of cover $d_{cover} = 0 \text{ mm}$ Height of water $h_{water} = 3300 \text{ mm}$ Water density $\gamma_{w} = 9.8 \text{ kN/m^3}$ Retained soil propertiesSoil typeSoil typeMedium dense well graded sandMoist density $\gamma_{rer} = 21 \text{ kN/m^3}$ Saturated density $\gamma_{sr} = 23 \text{ kN/m^3}$ Characteristic effective shear resistance angle $\phi^{t}_{r.k} = 30 \text{ deg}$ Base soil propertiesSoil densitySoil typeMedium dense well graded sandSoil density $\gamma_{b} = 18 \text{ kN/m^3}$ Characteristic effective shear resistance angle $\phi^{t}_{r.k} = 30 \text{ deg}$ Base soil propertiesSoil densitySoil density $\gamma_{b} = 18 \text{ kN/m^3}$ Characteristic effective shear resistance angle $\phi^{t}_{b.k} = 30 \text{ deg}$ Characteristic unall friction angle $\delta_{b.k} = 15 \text{ deg}$ Characteristic base friction $angle \delta_{b.k} = 15 \text{ deg}$ Characteristic base friction $angle \delta_{b.k} = 125 \text{ kN/m^2}$ Loading detailsVariable surcharge loadVariable surcharge loadSurcharge_0 = 10 \text{ kN/m^2}Vertical line load at 1150 mmPe_1 = 84 \text{ kN/m}		Angle to rear face of stem	α = <b>90</b> deg		
Base thickness       tbase = 300 mm         Base density       γbase = 25 kN/m³         Height of retained soil       hret = 3300 mm       Angle of soil surface       β = 0 deg         Depth of cover       dcover = 0 mm       Height of water       hwater = 3300 mm       yw = 9.8 kN/m³         Water density       γw = 9.8 kN/m³       Ferstand soil properties       Soil type       Medium dense well graded sand         Soil type       Medium dense well graded sand       Moist density       γmr = 21 kN/m³         Saturated density       γsr = 23 kN/m³       Characteristic effective shear restance angle       \vertice * 10 deg         Base soil properties       Soil type       Medium dense well graded sand       Soil deg         Base soil properties       Soil density       γsr = 23 kN/m³       Soil characteristic effective shear restance angle       \vertice * 10 deg         Base soil properties       Soil density       γs = 18 kN/m³       Soil density       γb = 18 kN/m³         Characteristic effective shear restance angle       \vertice * 18 kN/m³       Sobak = 30 deg       Sobak = 30 deg         Characteristic wall friction angle       Sobak = 15 deg       Sobak = 30 deg       Sobak = 30 deg         Characteristic base friction angle       Sobak = 125 kN/m²       Sobak = 30 deg       Sobak = 30 deg         <		Stem density	γ <sub>stem</sub> = <b>25</b> kN/m <sup>3</sup>		
LateValueState		Toe length	l <sub>toe</sub> = <b>1000</b> mm		
$\begin{tabular}{ c                                   $		Base thickness	t <sub>base</sub> = <b>300</b> mm		
Depth of cover $d_{cover} = 0 \text{ mm}$ Height of water $h_{water} = 3300 \text{ mm}$ Water density $\gamma_w = 9.8 \text{ kN/m^3}$ Retained soil propertiesSoil typeSoil typeMedium dense well graded sandMoist density $\gamma_{mr} = 21 \text{ kN/m^3}$ Saturated density $\gamma_{sr} = 23 \text{ kN/m^3}$ Characteristic effective shear resistance angle $\phi'_{r.k} = 30 \text{ deg}$ Characteristic vall friction angle $\delta_{r.k} = 0 \text{ deg}$ Base soil propertiesSoil typeMedium dense well graded sandSoil density $\gamma_b = 18 \text{ kN/m^3}$ Characteristic effective shear resistance angle $\phi'_{b.k} = 30 \text{ deg}$ Base soil propertiesSoil densitySoil density $\gamma_b = 18 \text{ kN/m^3}$ Characteristic effective shear resistance angle $\phi'_{b.k} = 30 \text{ deg}$ Characteristic base friction angle $\delta_{b.k} = 15 \text{ deg}$ Characteristic base friction angle $\delta_{b.k} = 15 \text{ deg}$ Presumed bearing capacity $P_{bearing} = 125 \text{ kN/m^2}$ Loading detailsVariable surcharge loadVariable surcharge loadSurchargeq = 10 kN/m²Vertical line load at 1150 mm $P_{G_3} = 84 \text{ kN/m}$		Base density	$\gamma_{\text{base}} = 25 \text{ kN/m}^3$		
Height of waterhwater = 3300 mmWater densityγw = 9.8 kN/m³Retained soil propertiesMedium dense well graded sandSoil typeMedium dense well graded sandMoist densityγmr = 21 kN/m³Saturated densityγsr = 23 kN/m³Characteristic effective shear resistance angleφ'r.k = 30 degCharacteristic wall friction angle δr.k = 0 degBase soil propertiesSoil densitySoil densityγb = 18 kN/m³Characteristic effective shear resistance angleφ'r.k = 30 degCharacteristic effective shear resistance angleφ'b.k = 30 degSoil densityγb = 18 kN/m³Characteristic effective shear resistance angleφ'b.k = 30 degCharacteristic base friction angle δb.k = 15 degSoib.k = 30 degCharacteristic base friction angle basing = 125 kN/m²Soib.k = 30 degLoader detailsVariable surcharge loadSurchargea = 10 kN/m²Variable surcharge loadSurchargea = 10 kN/m²Vertical line load at 1150 mmPG1 = 84 kN/m		Height of retained soil	h <sub>ret</sub> = <b>3300</b> mm	Angle of soil surface	$\beta = 0 \deg$
Water density       γw = 9.8 kN/m³         Retained soil properties       Soil type       Medium dense well graded sand         Moist density       γmr = 21 kN/m³         Saturated density       γmr = 21 kN/m³         Saturated density       γmr = 21 kN/m³         Characteristic effective shear resistance angle       φ'r.k = 30 deg         Characteristic wall friction angle δr.k = 0 deg       KN/m³         Base soil properties       Soil density         Soil density       γb = 18 kN/m³         Characteristic effective shear resistance angle       φ'r.k = 30 deg         Base soil properties       Soil density         Soil density       γb = 18 kN/m³         Characteristic effective shear resistance angle       φ'b.k = 30 deg         Characteristic base friction angle δb.k = 15 deg       KD.acteristic base friction angle δb.k = 15 deg         Characteristic base friction angle       δbb.k = 30 deg         Presumed bearing capacity       Pbearing = 125 kN/m²         Loading details       Variable surcharge load       Surchargeo = 10 kN/m²         Variable surcharge load       Surchargeo = 10 kN/m²         Vertical line load at 1150 mm       PG1 = 84 kN/m		Depth of cover	d <sub>cover</sub> = <b>0</b> mm		
Retained soli propertiesSoil typeMedium dense well graded sandMoist density $\gamma_{mr} = 21 \text{ kN/m}^3$ Saturated density $\gamma_{sr} = 23 \text{ kN/m}^3$ Characteristic effective shear resistance angle $\phi'_{r,k} = 30 \text{ deg}$ Characteristic wall friction angle $\delta_{r,k} = 0$ deg $\phi'_{r,k} = 30 \text{ deg}$ Base soil propertiesSoil density $\gamma_{b} = 18 \text{ kN/m}^3$ Soil density $\gamma_{b} = 18 \text{ kN/m}^3$ Characteristic effective shear resistance angle $\phi'_{b,k} = 30 \text{ deg}$ Soil density $\gamma_{b} = 18 \text{ kN/m}^3$ Characteristic effective shear resistance angle $\phi'_{b,k} = 30 \text{ deg}$ Characteristic ffective shear resistance angle $\phi'_{b,k} = 30 \text{ deg}$ Characteristic base friction angle $\delta_{b,k} = 15 \text{ deg}$ $\delta_{bb,k} = 30 \text{ deg}$ Presumed bearing capacity $P_{bearing} = 125 \text{ kN/m}^2$ LOading detailsVariable surcharge loadSurcharge_Q = 10 \text{ kN/m}^2Variable surcharge loadSurcharge_Q = 10 \text{ kN/m}^2Vertical line load at 1150 mm $P_{G_1} = 84 \text{ kN/m}$		Height of water	h <sub>water</sub> = <b>3300</b> mm		
Soil typeMedium dense well graded sandMoist density $\gamma_{mr} = 21 \text{ kN/m^3}$ Saturated density $\gamma_{sr} = 23 \text{ kN/m^3}$ Characteristic effective shear resistance angle $\phi'_{r.k} = 30 \text{ deg}$ Characteristic wall friction angle $\delta_{r.k} = 0 \text{ deg}$ $\phi'_{r.k} = 30 \text{ deg}$ Base soil propertiesSoil density $\gamma_b = 18 \text{ kN/m^3}$ Soil density $\gamma_b = 18 \text{ kN/m^3}$ $\phi'_{b.k} = 30 \text{ deg}$ Characteristic effective shear resistance angle $\phi'_{b.k} = 30 \text{ deg}$ Characteristic effective shear resistance angle $\phi'_{b.k} = 30 \text{ deg}$ Characteristic base friction angle $\delta_{b.k} = 15 \text{ deg}$ $\delta_{bb.k} = 30 \text{ deg}$ Presumed bearing capacity $P_{bearing} = 125 \text{ kN/m^2}$ Loading detailsSurcharge of a 10 kN/m²Variable surcharge loadSurcharge of a 4 kN/mVertical line load at 1150 mm $P_{G1} = 84 \text{ kN/m}$		Water density	γ <sub>w</sub> = <b>9.8</b> kN/m <sup>3</sup>		
Moist density $\gamma_{mr} = 21 \text{ kN/m}^3$ Saturated density $\gamma_{sr} = 23 \text{ kN/m}^3$ Characteristic effective shear resistance angle $\phi'_{r,k} = 30 \text{ deg}$ Characteristic wall friction angle $\delta_{r,k} = 0 \text{ deg}$ $\phi'_{r,k} = 30 \text{ deg}$ Base soil propertiesSoil typeMedium dense well graded sandSoil density $\gamma_b = 18 \text{ kN/m}^3$ $\phi'_{b,k} = 30 \text{ deg}$ Characteristic effective shear resistance angle $\phi'_{b,k} = 30 \text{ deg}$ Characteristic effective shear resistance angle $\phi'_{b,k} = 30 \text{ deg}$ Characteristic base friction angle $\delta_{b,k} = 15 \text{ deg}$ $\delta_{bb,k} = 30 \text{ deg}$ Characteristic base friction angle $\delta_{bb,k} = 30 \text{ deg}$ Presumed bearing capacity $P_{bearing} = 125 \text{ kN/m}^2$ Loading detailsSurcharge_0 = 10 \text{ kN/m}^2Variable surcharge loadSurcharge_0 = 10 \text{ kN/m}^2Vertical line load at 1150 mm $P_{G_1} = 84 \text{ kN/m}$	Re	tained soil properties			
Saturated density $\gamma_{sr} = 23 \text{ kN/m}^3$ Characteristic effective shear resistance angle $\phi'_{r.k} = 30 \text{ deg}$ Characteristic wall friction angle $\delta_{r.k} = 0 \text{ deg}$ Base soil propertiesSoil typeMedium dense well graded sandSoil density $\gamma_b = 18 \text{ kN/m}^3$ Characteristic effective shear resistance angle $\phi'_{b.k} = 30 \text{ deg}$ Characteristic effective shear resistance angle $\phi'_{b.k} = 30 \text{ deg}$ Characteristic vall friction angle $\delta_{b.k} = 15 \text{ deg}$ $\delta_{bb.k} = 30 \text{ deg}$ Characteristic base friction angle $\delta_{bb.k} = 30 \text{ deg}$ Presumed bearing capacity $P_{bearing} = 125 \text{ kN/m}^2$ Loading details $Surcharge_0 = 10 \text{ kN/m}^2$ Vertical line load at 1150 mm $P_{G1} = 84 \text{ kN/m}$		Soil type	Medium dense well graded sar	nd	
$ \begin{array}{c} \mbox{Characteristic effective shear resistance angle} & \phi'_{r.k} = 30 \mbox{ deg} \\ Characteristic wall friction angle $$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$		Moist density	$\gamma_{mr} = 21 \text{ kN/m}^3$		
$\begin{array}{c c c c c c } \mbox{Characteristic wall friction angle $\delta_{r,k}$ = 0 deg} \\ \hline Base soil properties \\ \hline Soil type & Medium dense well graded sand \\ \hline Soil density & $\gamma_b$ = 18 kN/m^3 \\ \hline Characteristic effective shear resistance angle & $\phi'_{b,k}$ = 30 deg \\ \hline Characteristic wall friction angle $\delta_{b,k}$ = 15 deg \\ \hline Characteristic base friction angle $\delta_{b,k}$ = 15 deg \\ \hline Characteristic base friction angle $\delta_{b,k}$ = 15 deg \\ \hline Characteristic base friction angle $\delta_{b,k}$ = 15 deg \\ \hline Presumed bearing capacity $P_{bearing}$ = 125 kN/m^2 \\ \hline Loading details \\ \hline Variable surcharge load $Surcharge_Q$ = 10 kN/m^2 \\ \hline Vertical line load at 1150 mm $P_{G_1}$ = 84 kN/m \\ \hline \end{array}$		Saturated density	$\gamma_{sr} = 23 \text{ kN/m}^3$		
Base soil propertiesSoil typeMedium dense well graded sandSoil density $\gamma_b = 18 \text{ kN/m^3}$ Characteristic effective shear resistance angle $\phi'_{b,k} = 30 \text{ deg}$ Characteristic wall friction angle $\delta_{b,k} = 15 \text{ deg}$ $\delta_{bb,k} = 30 \text{ deg}$ Characteristic base friction angle $\delta_{b,k} = 15 \text{ deg}$ $\delta_{bb,k} = 30 \text{ deg}$ Presumed bearing capacity $P_{bearing} = 125 \text{ kN/m^2}$ Loading detailsSurcharge Q = 10 kN/m²Variable surcharge loadSurchargeQ = 10 kN/m²Vertical line load at 1150 mm $P_{G1} = 84 \text{ kN/m}$		Characteristic effective shear re	esistance angle	¢'r.k = <b>30</b> deg	
		Characteristic wall friction angle	$e \delta_{r,k} = 0 \deg$		
$ \begin{array}{llllllllllllllllllllllllllllllllllll$	Ba	se soil properties			
$\begin{array}{c} \mbox{Characteristic effective shear resistance angle} & \varphi'_{b,k} = 30 \mbox{ deg} \\ \mbox{Characteristic wall friction angle} & b_{b,k} = 15 \mbox{ deg} \\ \mbox{Characteristic base friction angle} & b_{bearing} = 125 \mbox{ kN/m}^2 \\ \mbox{Coading details} & Variable surcharge load & Surcharge_Q = 10 \mbox{ kN/m}^2 \\ \mbox{Vertical line load at 1150 mm} & P_{G1} = 84 \mbox{ kN/m} \end{array}$		Soil type	Medium dense well graded sar	nd	
$\begin{array}{c} \mbox{Characteristic wall friction angle $\delta_{b,k}$ = 15 deg} \\ \mbox{Characteristic base friction angle} & $\delta_{bb,k}$ = 30 deg \\ \mbox{Presumed bearing capacity} & $P_{bearing}$ = 125 kN/m^2 \\ \mbox{Loading details} & $Variable surcharge load & $Surcharge_Q$ = 10 kN/m^2 \\ \mbox{Vertical line load at 1150 mm} & $P_{G1}$ = 84 kN/m \\ \end{array}$		Soil density	γ <sub>b</sub> = <b>18</b> kN/m <sup>3</sup>		
$\begin{array}{c} \mbox{Characteristic base friction angle} & & & & \\ \mbox{Presumed bearing capacity} & \mbox{P}_{bearing} = 125 \ \mbox{kN/m}^2 \\ \mbox{Loading details} & & & \\ \mbox{Variable surcharge load} & & \mbox{Surcharge}_{Q} = 10 \ \mbox{kN/m}^2 \\ \mbox{Vertical line load at 1150 mm} & \mbox{P}_{G1} = 84 \ \mbox{kN/m} \end{array}$		Characteristic effective shear re	esistance angle	φ'b.k = <b>30</b> deg	
Presumed bearing capacity $P_{bearing} = 125 \text{ kN/m}^2$ Loading detailsVariable surcharge loadVertical line load at 1150 mm $P_{G1} = 84 \text{ kN/m}$		Characteristic wall friction angle	eδ <sub>b.k</sub> = <b>15</b> deg		
Loading detailsVariable surcharge loadSurcharge $_Q = 10 \text{ kN/m}^2$ Vertical line load at 1150 mm $P_{G1} = 84 \text{ kN/m}$		Characteristic base friction ang	le	$\delta_{bb.k} = 30 \text{ deg}$	
Variable surcharge loadSurchargeQ = $10 \text{ kN/m}^2$ Vertical line load at 1150 mm $P_{G1} = 84 \text{ kN/m}$		Presumed bearing capacity	P <sub>bearing</sub> = 125 kN/m <sup>2</sup>		
Vertical line load at 1150 mm P <sub>G1</sub> = 84 kN/m	Lo	ading details			
		Variable surcharge load	Surcharge <sub>Q</sub> = 10 kN/m <sup>2</sup>		
P <sub>Q1</sub> = <b>20.7</b> kN/m		Vertical line load at 1150 mm	P <sub>G1</sub> = <b>84</b> kN/m		
			P <sub>Q1</sub> = <b>20.7</b> kN/m		



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	<b> </b> ←────1150────→		
		0000 0000 0000 0000 0000 0000 0000 0000 0000	
	107.1 kN/m <sup>2</sup>	.1 kN/m²	
Calculate retaining wall geo Base length Saturated soil height Moist soil height Length of surcharge load Vertical distance Effective height of wall Horizontal distance Area of wall stem Area of wall base	Dimetry $I_{base} = 1300 \text{ mm}$ $h_{sat} = 3300 \text{ mm}$ $h_{moist} = 0 \text{ mm}$ $I_{sur} = 0 \text{ mm}$ $x_{sur_v} = 1300 \text{ mm}$ $h_{eff} = 3600 \text{ mm}$ $x_{sur_h} = 1800 \text{ mm}$ $A_{stem} = 0.99 \text{ m}^2$ $A_{base} = 0.39 \text{ m}^2$	Vertical distance Vertical distance	x <sub>stem</sub> = <b>1150</b> mm x <sub>base</sub> = <b>650</b> mm
Using Coulomb theory			
Active pressure coefficient Bearing pressure check Vertical forces on wall	K <sub>A</sub> = <b>0.333</b>	Passive pressure coefficient	K <sub>P</sub> = <b>4.977</b>
Total Horizontal forces on wall	$F_{total_v} = F_{stem} + F_{base} + F_{water_v}$	+ F <sub>P_v</sub> = <b>139.2</b> kN/m	
Total	Ftotal_h = Fsat_h + Fmoist_h + Fpass	_h + F <sub>water_h</sub> + F <sub>sur_h</sub> = <b>100.2</b> kN/m	ı
Moments on wall Total	M <sub>total</sub> = M <sub>stem</sub> + M <sub>base</sub> + M <sub>sat</sub> + M	M <sub>moist</sub> + M <sub>water</sub> + M <sub>sur</sub> + M <sub>P</sub> = <b>23.1</b>	kNm/m
Check bearing pressure Propping force to stem	F <sub>prop_stem</sub> = <b>19.2</b> kN/m	Propping force to base	Fprop_base = 80.9
kN/m Bearing pressure at toe Factor of safety	$q_{toe} = 107.1 \text{ kN/m}^2$ FoS <sub>bp</sub> = 1.167 PASS - Allowable bearing pre-	Bearing pressure at heel	q <sub>heel</sub> = <b>107.1</b> kN/m <sup>2</sup>
Potoining wall design	i Auu - Alluwable bearing pre	ssure exceeds maximum appi	ica searing pressure

Retaining wall design

Job Number: 160215 Date:03.03.2016



Tedds calculation version 2.6.05

In accordance with EN1992-1-1:2004 incorporating Corrigendum dated January 2008 and the UK National Annex incorporating National Amendment No.1

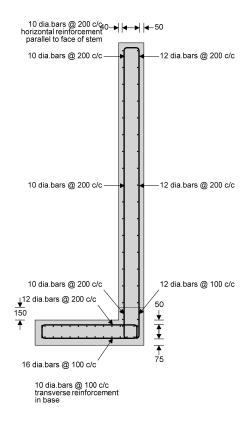
			lds calculation version 2.6.05
	-	ion characteristics for concre	ete
Concrete strength class	C30/37		
Char.comp.cylinder strength	$f_{ck} = 30 \text{ N/mm}^2$	Mean axial tensile strength	f <sub>ctm</sub> = <b>2.9</b> N/mm <sup>2</sup>
Secant modulus of elasticity	E <sub>cm</sub> = <b>32837</b> N/mm <sup>2</sup>	Maximum aggregate size	h <sub>agg</sub> = <b>20</b> mm
Design comp.concrete strengt	h f <sub>cd</sub> = <b>17.0</b> N/mm²	Partial factor	γc = <b>1.50</b>
Reinforcement details			
Characteristic yield strength	f <sub>yk</sub> = <b>500</b> N/mm <sup>2</sup>	Modulus of elasticity	E <sub>s</sub> = <b>200000</b> N/mm <sup>2</sup>
Design yield strength	f <sub>yd</sub> = <b>435</b> N/mm <sup>2</sup>	Partial factor	γs <b>= 1.15</b>
Cover to reinforcement			
Front face of stem	c <sub>sf</sub> = <b>40</b> mm	Rear face of stem	c <sub>sr</sub> = <b>50</b> mm
Top face of base	c <sub>bt</sub> = <b>50</b> mm	Bottom face of base	c <sub>bb</sub> = <b>75</b> mm
Check stem design at 1666 n	nm		
Depth of section	h = <b>300</b> mm		
Rectangular section in flexure	e - Section 6.1		
Design bending moment	M = <b>23.6</b> kNm/m	K = 0.013	K' = <b>0.207</b>
g		K' > K - No compression reinf	orcement is required
Tens.reinforcement required	A <sub>sfM.req</sub> = <b>233</b> mm <sup>2</sup> /m		
Tens.reinforcement provided	10 dia.bars @ 200 c/c	Tens.reinforcement provided	AsfM.prov = 393
mm <sup>2</sup> /m			
Min.area of reinforcement mm <sup>2</sup> /m	A <sub>sfM.min</sub> = <b>369</b> mm <sup>2</sup> /m	Max.area of reinforcement	A <sub>sfM.max</sub> = <b>12000</b>
	S - Area of reinforcement p	rovided is greater than area of re	inforcement required
Deflection control - Section 7			in el content i equilou
Limiting span to depth ratio	360.9	Actual span to depth ratio	13.1
Emiling span to depth failo		Span to depth ratio is less than de	-
Crack control Section 7.2	1 400 - 0		
Crack control - Section 7.3			0.00
Limiting crack width	w <sub>max</sub> = <b>0.3</b> mm	Maximum crack width	w <sub>k</sub> = <b>0.28</b> mm
		<b>ng crack width</b> Check stem desig	gn at base of stem
Depth of section	h = <b>300</b> mm		
Rectangular section in flexure			
Design bending moment	M = <b>50.7</b> kNm/m	K = <b>0.028</b>	K' = <b>0.207</b>
		K' > K - No compression reinf	forcement is required
Tens.reinforcement required	A <sub>sr.req</sub> = <b>503</b> mm <sup>2</sup> /m		
Tens.reinforcement provided mm <sup>2</sup> /m	12 dia.bars @ 100 c/c	Tens.reinforcement provided	Asr.prov = <b>1131</b>
Min.area of reinforcement mm <sup>2</sup> /m	A <sub>sr.min</sub> = <b>368</b> mm <sup>2</sup> /m	Max.area of reinforcement	A <sub>sr.max</sub> = <b>12000</b>
	S - Area of reinforcement p	rovided is greater than area of re	inforcement required
Deflection control - Section 7		· · · · · · · · · · · · · · · · · · ·	
Limiting span to depth ratio	105.2	Actual span to depth ratio	13.1
Emiling span to depth failo		Span to depth ratio is less than de	-
Crack control - Section 7.3	FA33 - 3		
	w _ 0.2 mm	Movimum crock width	$w_{1} = 0.435$ mm
Limiting crack width	w <sub>max</sub> = <b>0.3</b> mm	Maximum crack width	$w_k = 0.135 \text{ mm}$
	-	k widthRectangular section in	
Design shear force	V = <b>92.4</b> kN/m <b>PASS</b>	Design shear resistance - Design shear resistance exceed	V <sub>Rd.c</sub> = <b>134.2</b> kN/m Is design shear force



Check stem design at prop Depth of section	h = <b>300</b> mm		
Rectangular section in flexure Design bending moment	M = 0  kNm/m	K = <b>0.000</b>	K' = <b>0.207</b>
Design bending moment	$W = \mathbf{U} K N \Pi / \Pi$	K' > K - No compression reinfo	
Tens.reinforcement required	A <sub>sr1.req</sub> = <b>0</b> mm <sup>2</sup> /m	K > K - No compression reink	orcement is required
Tens.reinforcement provided	12 dia.bars @ 200 c/c	Tens.reinforcement provided	A <sub>sr1.prov</sub> = <b>565</b>
mm <sup>2</sup> /m			
Min.area of reinforcement	A <sub>sr1.min</sub> = <b>368</b> mm <sup>2</sup> /m	Max.area of reinforcement	A <sub>sr1.max</sub> = <b>12000</b>
	S - Area of reinforcement p	rovided is greater than area of rei	nforcement required
Deflection control - Section 7	-		iner een en er equir eu
Limiting span to depth ratio	3494411.2	Actual span to depth ratio	0.4
		Span to depth ratio is less than de	-
Crack control - Section 7.3			
Limiting crack width	w <sub>max</sub> = <b>0.3</b> mm	Maximum crack width	w <sub>k</sub> = <b>0</b> mm
•		<i>k width</i> Rectangular section in a	
Design shear force	V = 28 kN/m	Design shear resistance	$V_{\rm Rd,c} = 123  \rm kN/m$
Design shear force		- Design shear resistance exceed	
Horizontal reinforcement par		-	g.:
Min.area of reinforcement	$A_{\text{sx.req}} = 300 \text{ mm}^2/\text{m}$	Max.spacing of reinforcement	Ssy may = <b>400</b> mm
Trans.reinforcement provided	10 dia.bars @ 200 c/c	Trans.reinforcement provided	A <sub>sx.prov</sub> = <b>393</b>
mm²/m		· · · · · · · · · · · · · · · · · · ·	
PAS	S - Area of reinforcement p	rovided is greater than area of rei	nforcement required
Check base design at toe		-	
Depth of section	h = <b>300</b> mm		
Rectangular section in flexure	e - Section 6.1		
Design bending moment	M = <b>68.4</b> kNm/m	K = <b>0.048</b>	K' = <b>0.207</b>
		K' > K - No compression reinfo	orcement is required
Tens.reinforcement required	A <sub>bb.req</sub> = <b>763</b> mm <sup>2</sup> /m		
Tens.reinforcement provided	16 dia.bars @ 100 c/c	Tens.reinforcement provided	Abb.prov = 2011
mm²/m			
Min.area of reinforcement	A <sub>bb.min</sub> = <b>327</b> mm <sup>2</sup> /m	Max.area of reinforcement	Abb.max = <b>12000</b>
mm²/m			
PAS	S - Area of reinforcement p	rovided is greater than area of rei	nforcement required
Crack control - Section 7.3			
Limiting crack width	w <sub>max</sub> = <b>0.3</b> mm	Maximum crack width	w <sub>k</sub> = <b>0.136</b> mm
PASS - Maximum crack widt	th is less than limiting crac	<b>k width</b> Rectangular section in s	shear - Section 6.2
Design shear force	V = <b>136.8</b> kN/m	Design shear resistance	V <sub>Rd.c</sub> = <b>154.6</b> kN/m
		<ul> <li>Design shear resistance exceed</li> </ul>	s design shear force
Secondary transverse reinfore	cement to base - Sectio	on 9.3	
Min.area of reinforcement	A <sub>bx.req</sub> = <b>402</b> mm <sup>2</sup> /m	Max.spacing of reinforcement	S <sub>bx_max</sub> = <b>450</b> mm
Trans.reinforcement provided	10 dia.bars @ 100 c/c	Trans.reinforcement provided	A <sub>bx.prov</sub> = <b>785</b>
mm²/m			
PAS	S - Area of reinforcement n	rovided is greater than area of rei	ntorcement required

PASS - Area of reinforcement provided is greater than area of reinforcement required





#### WALL 2 (TEMPORARY CONDITION)

#### Retaining wall analysis

Retaining wall details

In accordance with EN1997-1:2004 incorporating Corrigendum dated February 2009 and the UK National Annex incorporating Corrigendum No.1

Tedds calculation version 2.6.05

ке	lairiiriy wali uelaiis			
	Stem type	Propped cantilever		
	Stem height	h <sub>stem</sub> = <b>3300</b> mm		
	Prop height	h <sub>prop</sub> = <b>3200</b> mm		
	Stem thickness	t <sub>stem</sub> = <b>300</b> mm		
	Angle to rear face of stem	α = <b>90</b> deg		
	Stem density	γ <sub>stem</sub> = <b>25</b> kN/m <sup>3</sup>		
	Toe length	l <sub>toe</sub> = <b>1000</b> mm		
	Base thickness	t <sub>base</sub> = <b>300</b> mm		
	Base density	$\gamma_{\text{base}} = 25 \text{ kN/m}^3$		
	Height of retained soil	h <sub>ret</sub> = <b>3300</b> mm	Angle of soil surface	$\beta = 0 \deg$
	Depth of cover	$d_{cover} = 0 mm$		
Re	tained soil properties			
	Soil type	Medium dense well graded sar	nd	
	Moist density	γmr = <b>21</b> kN/m <sup>3</sup>		
	Saturated density	γ <sub>sr</sub> = <b>23</b> kN/m <sup>3</sup>		
	Characteristic effective shear resistance angle		φ' <sub>r.k</sub> = <b>30</b> deg	
	Characteristic wall friction angle	$e \delta_{r.k} = 0 \deg$		
Ba	se soil properties			



		L	
Soil type	Medium dense well graded sa	Ind	
Soil density	γ <sub>b</sub> = <b>18</b> kN/m <sup>3</sup>		
Characteristic effective shear	•	φ' <sub>b.k</sub> = <b>30</b> deg	
Characteristic wall friction ang		φ b.κ = <b>σσ</b> ασg	
Characteristic base friction an		$\delta_{bb.k} = 30 \text{ deg}$	
Presumed bearing capacity	P <sub>bearing</sub> = <b>125</b> kN/m <sup>2</sup>		
	F bearing - 123 KIWIII		
Loading details	Suraharga <b>10</b> kN/m <sup>2</sup>		
Variable surcharge load	Surcharge <sub>Q</sub> = <b>10</b> kN/m <sup>2</sup>		
₹ 3300 ₹	Prop	5 kN/m <sup>2</sup>	
	┥────1300───		
Calculate retaining wall geo	ometry		
Base length	l <sub>base</sub> = <b>1300</b> mm		
Moist soil height	h <sub>moist</sub> = <b>3300</b> mm		
Length of surcharge load	l <sub>sur</sub> = <b>0</b> mm		
Vertical distance	x <sub>sur_v</sub> = <b>1300</b> mm		
Effective height of wall	h <sub>eff</sub> = <b>3600</b> mm		
Horizontal distance	x <sub>sur_h</sub> = <b>1800</b> mm		
Area of wall stem	A <sub>stem</sub> = <b>0.99</b> m <sup>2</sup>	Vertical distance	x <sub>stem</sub> = <b>1150</b> mm
Area of wall base	A <sub>base</sub> = <b>0.39</b> m <sup>2</sup>	Vertical distance	x <sub>base</sub> = <b>650</b> mm
Using Coulomb theory			
Active pressure coefficient	K <sub>A</sub> = <b>0.333</b>	Passive pressure coefficient	K <sub>P</sub> = <b>4.977</b>
Bearing pressure check			
Vertical forces on wall			
Total	$F_{total_v} = F_{stem} + F_{base} = 34.5 \text{ kM}$	V/m	
Horizontal forces on wall			
Total	F <sub>total_h</sub> = F <sub>moist_h</sub> + F <sub>pass_h</sub> + F <sub>su</sub>	r_h = <b>53.5</b> kN/m	
Moments on wall			
	+ M <sub>moist</sub> + M <sub>sur</sub> = <b>-41.2</b> kNm/1	m	
Total Millolar – Mislem – Mibase			



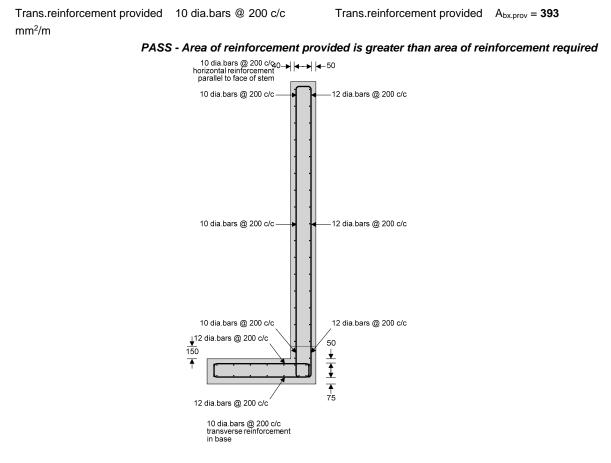
		1	
Check bearing pressure	E 40.0 LN//		
Propping force to stem kN/m	F <sub>prop_stem</sub> = <b>18.2</b> kN/m	Propping force to base	Fprop_base = <b>35.3</b>
Bearing pressure at toe	q <sub>toe</sub> = <b>26.5</b> kN/m <sup>2</sup>	Bearing pressure at heel	q <sub>heel</sub> = <b>26.5</b> kN/m <sup>2</sup>
Factor of safety	$FoS_{bp} = 4.71$	Bearing pressure at neer	Qheel = 20.3 KN/III
		essure exceeds maximum appl	lied bearing pressure
Retaining wall design	The Anomable bearing pro		icu scuring pressure
In accordance with EN1992-	1-1-2004 incorporating Cor	rigendum dated January 2	2008 and the UK
National Annex incorporatin		•	
	g hallonal / interioritent in		ds calculation version 2.6.05
Concrete details - Table 3.1	- Strength and deformation	n characteristics for concre	te
Concrete strength class	C30/37		
Char.comp.cylinder strength	f <sub>ck</sub> = <b>30</b> N/mm <sup>2</sup>	Mean axial tensile strength	f <sub>ctm</sub> = <b>2.9</b> N/mm <sup>2</sup>
Secant modulus of elasticity	E <sub>cm</sub> = <b>32837</b> N/mm <sup>2</sup>	Maximum aggregate size	h <sub>agg</sub> = <b>20</b> mm
Design comp.concrete strengt	h f <sub>cd</sub> = <b>17.0</b> N/mm <sup>2</sup>	Partial factor	γc = <b>1.50</b>
Reinforcement details			
Characteristic yield strength	f <sub>yk</sub> = <b>500</b> N/mm <sup>2</sup>	Modulus of elasticity	E <sub>s</sub> = <b>200000</b> N/mm <sup>2</sup>
Design yield strength	f <sub>yd</sub> = <b>435</b> N/mm <sup>2</sup>	Partial factor	γs = <b>1.15</b>
Cover to reinforcement			
Front face of stem	c <sub>sf</sub> = <b>40</b> mm	Rear face of stem	c <sub>sr</sub> = <b>50</b> mm
Top face of base	c <sub>bt</sub> = <b>50</b> mm	Bottom face of base	c <sub>bb</sub> = <b>75</b> mm
Check stem design at 1690 r	nm		
Depth of section	h = <b>300</b> mm		
Rectangular section in flexur	e - Section 6.1		
Design bending moment	M = <b>13.4</b> kNm/m	K = <b>0.007</b>	K' = <b>0.207</b>
		K' > K - No compression reinf	orcement is required
Tens.reinforcement required	A <sub>sfM.req</sub> = <b>132</b> mm <sup>2</sup> /m		
Tens.reinforcement provided	10 dia.bars @ 200 c/c	Tens.reinforcement provided	AsfM.prov = <b>393</b>
mm²/m	AsfM min = <b>369</b> mm <sup>2</sup> /m		40000
Min.area of reinforcement mm <sup>2</sup> /m	AsfM.min = 309 [[][[] <sup>-</sup> /[]]	Max.area of reinforcement	A <sub>sfM.max</sub> = <b>12000</b>
	S - Area of reinforcement prov	vided is greater than area of re	inforcement required
Deflection control - Section	•	naca is greater than area of rel	
Limiting span to depth ratio	867.8	Actual span to depth ratio	13.1
Emiling span to depin ratio		an to depth ratio is less than de	
Crack control - Section 7.3			
Limiting crack width	w <sub>max</sub> = <b>0.3</b> mm	Maximum crack width	w <sub>k</sub> = <b>0.15</b> mm
6	ck width is less than limiting (	crack widthCheck stem desig	
Depth of section	h = 300 mm		<u>.</u>
Rectangular section in flexur	e - Section 6.1		
Design bending moment	M = <b>28.2</b> kNm/m	K = 0.016	K' = <b>0.207</b>
		K' > K - No compression reinf	orcement is required
Tens.reinforcement required	A <sub>sr.req</sub> = <b>280</b> mm <sup>2</sup> /m		
Tens.reinforcement provided	12 dia.bars @ 200 c/c	Tens.reinforcement provided	A <sub>sr.prov</sub> = 565 mm <sup>2</sup> /m
Min.area of reinforcement	A <sub>sr.min</sub> = <b>368</b> mm <sup>2</sup> /m	Max.area of reinforcement	Asr.max = <b>12000</b>
mm²/m			
PAS	S - Area of reinforcement prov	vided is greater than area of rea	inforcement required
Deflection control - Section	7.4		
Limiting span to depth ratio	267.7	Actual span to depth ratio	13.1



#### PASS - Span to depth ratio is less than deflection control limit

Crack control - Section 7.3		•••	
Limiting crack width	w <sub>max</sub> = <b>0.3</b> mm	Maximum crack width	w <sub>k</sub> = <b>0.212</b> mm
		widthRectangular section in	
Design shear force	V = <b>50.6</b> kN/m	Design shear resistance	V <sub>Rd.c</sub> = <b>123</b> kN/m
	PASS -	Design shear resistance exceed	ls design shear force
Check stem design at prop			
Depth of section	h = <b>300</b> mm		
Rectangular section in flexure	e - Section 6.1		
Design bending moment	M = <b>0</b> kNm/m	K = <b>0.000</b>	K' = <b>0.207</b>
		K' > K - No compression reinf	orcement is required
Tens.reinforcement required	$A_{sr1.req} = 0 \text{ mm}^2/\text{m}$		
Tens.reinforcement provided mm <sup>2</sup> /m	12 dia.bars @ 200 c/c	Tens.reinforcement provided	Asr1.prov = <b>565</b>
Min.area of reinforcement mm <sup>2</sup> /m	A <sub>sr1.min</sub> = <b>368</b> mm <sup>2</sup> /m	Max.area of reinforcement	A <sub>sr1.max</sub> = <b>12000</b>
PAS	S - Area of reinforcement pro	ovided is greater than area of rei	inforcement required
Deflection control - Section 7	'.4		
Limiting span to depth ratio	3818380.7	Actual span to depth ratio	0.4
2	PASS - Sp	oan to depth ratio is less than de	eflection control limit
Crack control - Section 7.3			
Limiting crack width	w <sub>max</sub> = <b>0.3</b> mm	Maximum crack width	w <sub>k</sub> = <b>0</b> mm
-	th is less than limiting crack	widthRectangular section in	shear - Section 6.2
Design shear force	V = <b>16.8</b> kN/m	Design shear resistance	V <sub>Rd.c</sub> = <b>123</b> kN/m
5	PASS -	Design shear resistance exceed	s design shear force
Horizontal reinforcement par		-	-
Min.area of reinforcement	A <sub>sx.req</sub> = <b>300</b> mm <sup>2</sup> /m	Max.spacing of reinforcement	s <sub>sx max</sub> = <b>400</b> mm
Trans.reinforcement provided mm <sup>2</sup> /m	10 dia.bars @ 200 c/c	Trans.reinforcement provided	
PAS	S - Area of reinforcement pro	ovided is greater than area of rei	inforcement required
Check base design at toe		-	
Depth of section	h = <b>300</b> mm		
Rectangular section in flexure	e - Section 6.1		
Design bending moment	M = <b>12.9</b> kNm/m	K = <b>0.009</b>	K' = <b>0.207</b>
Design benang memori		K' > K - No compression reinf	
Tens.reinforcement required	A <sub>bb.req</sub> = <b>142</b> mm <sup>2</sup> /m		
Tens.reinforcement provided	12 dia.bars @ 200 c/c	Tens.reinforcement provided	A <sub>bb.prov</sub> = <b>565</b>
Min.area of reinforcement	A <sub>bb.min</sub> = <b>330</b> mm <sup>2</sup> /m	Max.area of reinforcement	Abb.max = <b>12000</b>
	S - Area of reinforcement pro	ovided is greater than area of rei	inforcement reauired
Crack control - Section 7.3			
Limiting crack width	w <sub>max</sub> = <b>0.3</b> mm	Maximum crack width	w <sub>k</sub> = <b>0.141</b> mm
		<i>width</i> Rectangular section in	
Design shear force	V = 25.7  kN/m	Design shear resistance	$V_{Rd,c} = 114.8 \text{ kN/m}$
Design shear loice		Design shear resistance exceed	
Secondary transverse reinfer		-	o acorgii orical luice
Secondary transverse reinfore Min.area of reinforcement	$A_{bx,req} = 113 \text{ mm}^2/\text{m}$	Max.spacing of reinforcement	Shu 450 mm
		Mar.spacing of remote ment	





#### WALL 2 (PERMANENT CONDITION)

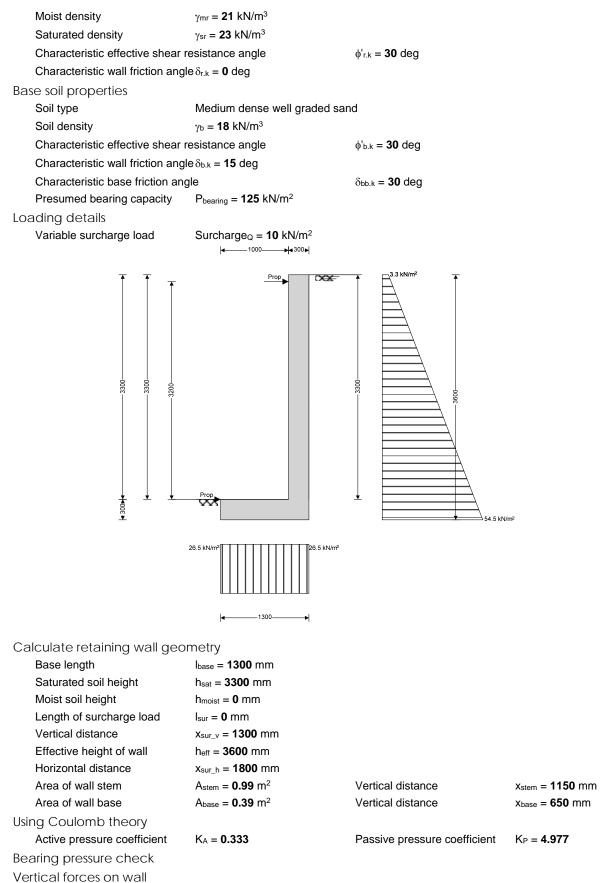
Retaining wall analysis

In accordance with EN1997-1:2004 incorporating Corrigendum dated February 2009 and the UK National Annex incorporating Corrigendum No.1

Tedds calculation version 2.6.05

Retaining wall details			
Stem type	Propped cantilever		
Stem height	h <sub>stem</sub> = <b>3300</b> mm		
Prop height	h <sub>prop</sub> = <b>3200</b> mm		
Stem thickness	t <sub>stem</sub> = <b>300</b> mm		
Angle to rear face of stem	α = <b>90</b> deg		
Stem density	$\gamma_{stem} = 25 \text{ kN/m}^3$		
Toe length	l <sub>toe</sub> = <b>1000</b> mm		
Base thickness	t <sub>base</sub> = <b>300</b> mm		
Base density	$\gamma_{\text{base}} = 25 \text{ kN/m}^3$		
Height of retained soil	h <sub>ret</sub> = <b>3300</b> mm	Angle of soil surface	$\beta = 0 \deg$
Depth of cover	d <sub>cover</sub> = 0 mm		
Height of water	h <sub>water</sub> = <b>3300</b> mm		
Water density	γ <sub>w</sub> = <b>9.8</b> kN/m <sup>3</sup>		
Retained soil properties			
Soil type	Medium dense well graded s	and	







		PY			
Total	F <sub>total_v</sub> = F <sub>stem</sub> + F <sub>base</sub> + F <sub>wa</sub>	<sub>ater_v</sub> = <b>34.5</b> kN/m			
Horizontal forces on wall					
Total	F <sub>total_h</sub> = F <sub>sat_h</sub> + F <sub>moist_h</sub> + I	F <sub>pass_h</sub> + F <sub>water_h</sub> + F <sub>sur_h</sub> = <b>100.2</b> kN/r	n		
Moments on wall					
Total	M <sub>total</sub> = M <sub>stem</sub> + M <sub>base</sub> + M <sub>sa</sub>	at + M <sub>moist</sub> + M <sub>water</sub> + M <sub>sur</sub> = <b>-97.3</b> kNm	ı/m		
Check bearing pressure					
Propping force to stem	F 31 2 kN/m	Propping force to base	Fprop_base = <b>66</b>		
	1 prop_stem - <b>34.2</b> KIV/III	Flopping loice to base	i prop_base – 00		
kN/m	$a = 26.5 \text{ kM/m}^2$	Bearing process at heal	a 26 5 kNl/m2		
Bearing pressure at toe	$q_{toe} = 26.5 \text{ kN/m}^2$	Bearing pressure at heel	$q_{heel} = 26.5 \text{ kN/m}^2$		
Factor of safety	$FoS_{bp} = 4.71$	pressure exceeds maximum app	lind hoaring prossure		
	FASS - Allowable bearing	pressure exceeds maximum app	neu bearing pressure		
Retaining wall design					
	. –	Corrigendum dated January 2	2008 and the UK		
National Annex incorporating	g National Amendmen				
Concrete details Table 2.1			dds calculation version 2.6.05		
	0	tion characteristics for concre	ete		
Concrete strength class	C28/35		6 0 0 N/m m <sup>2</sup>		
Char.comp.cylinder strength	$f_{ck} = 28 \text{ N/mm}^2$	Mean axial tensile strength	f <sub>ctm</sub> = <b>2.8</b> N/mm <sup>2</sup>		
Secant modulus of elasticity	$E_{cm} = 32308 \text{ N/mm}^2$	Maximum aggregate size	h <sub>agg</sub> = <b>20</b> mm		
Design comp.concrete strengt	n f <sub>cd</sub> = <b>15.9</b> N/mm²	Partial factor	γc = <b>1.50</b>		
Reinforcement details					
Characteristic yield strength	f <sub>yk</sub> = <b>500</b> N/mm <sup>2</sup>	Modulus of elasticity	E <sub>s</sub> = <b>200000</b> N/mm <sup>2</sup>		
Design yield strength	f <sub>yd</sub> = <b>435</b> N/mm <sup>2</sup>	Partial factor	γs = <b>1.15</b>		
Cover to reinforcement					
Front face of stem	c <sub>sf</sub> = <b>40</b> mm	Rear face of stem	c <sub>sr</sub> = <b>50</b> mm		
Top face of base	c <sub>bt</sub> = <b>50</b> mm	Bottom face of base	c <sub>bb</sub> = <b>75</b> mm		
Check stem design at 1666 n	าทา				
Depth of section	h = <b>300</b> mm				
Rectangular section in flexure	e - Section 6.1				
Design bending moment	M = <b>23.6</b> kNm/m	K = <b>0.014</b>	K' = <b>0.207</b>		
		K' > K - No compression rein	forcement is required		
Tens.reinforcement required	A <sub>sfM.req</sub> = <b>233</b> mm <sup>2</sup> /m				
Tens.reinforcement provided	10 dia.bars @ 200 c/c	Tens.reinforcement provided	AsfM.prov = 393		
mm²/m					
Min.area of reinforcement	A <sub>sfM.min</sub> = <b>352</b> mm <sup>2</sup> /m	Max.area of reinforcement	AsfM.max = <b>12000</b>		
mm²/m					
PAS	S - Area of reinforcement	provided is greater than area of re	inforcement required		
Deflection control - Section 7	.4				
Limiting span to depth ratio	330.8	Actual span to depth ratio	13.1		
	PASS -	Span to depth ratio is less than d	eflection control limit		
Crack control - Section 7.3					
Limiting crack width	w <sub>max</sub> = <b>0.3</b> mm	Maximum crack width	w <sub>k</sub> = <b>0.28</b> mm		
PASS - Maximum crae	ck width is less than limiti	i <b>ng crack width</b> Check stem desi	gn at base of stem		
Depth of section	h = <b>300</b> mm				
Rectangular section in flexure	e - Section 6.1				
Design bending moment	M = <b>50.7</b> kNm/m	K = <b>0.030</b>	K' = <b>0.207</b>		
		K' > K - No compression rein	forcement is required		
Tens.reinforcement required	A <sub>sr.req</sub> = <b>503</b> mm <sup>2</sup> /m				

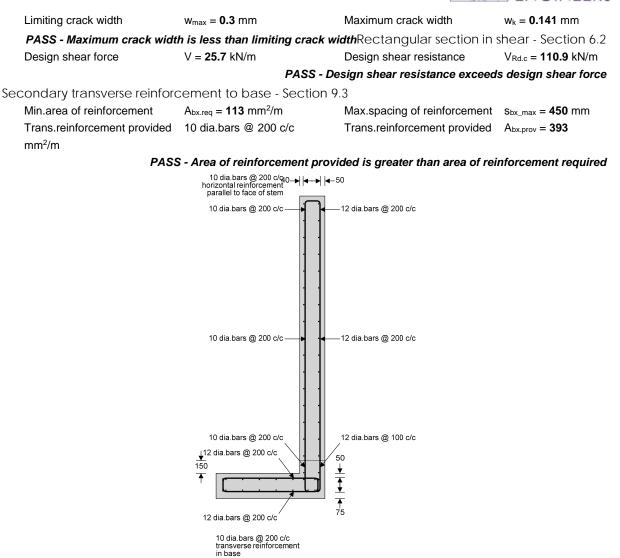


Tens.reinforcement provided mm <sup>2</sup> /m	12 dia.bars @ 100 c/c	Tens.reinforcement provided	A <sub>sr.prov</sub> = <b>1131</b>
Min.area of reinforcement	A <sub>sr.min</sub> = <b>351</b> mm <sup>2</sup> /m	Max.area of reinforcement	A <sub>sr.max</sub> = <b>12000</b>
mm²/m			
	-	rovided is greater than area of rei	nforcement required
Deflection control - Section 7	7.4		
Limiting span to depth ratio	96.7	Actual span to depth ratio	13.1
	PASS - S	Span to depth ratio is less than de	eflection control limit
Crack control - Section 7.3			
Limiting crack width	w <sub>max</sub> = <b>0.3</b> mm	Maximum crack width	w <sub>k</sub> = <b>0.135</b> mm
PASS - Maximum crack wid	th is less than limiting crac	<b>k width</b> Rectangular section in s	shear - Section 6.2
Design shear force	V = <b>92.4</b> kN/m	Design shear resistance	V <sub>Rd.c</sub> = <b>131.1</b> kN/m
0	PASS	- Design shear resistance exceed	s design shear force
Check stem design at prop			U U
Depth of section	h = <b>300</b> mm		
Rectangular section in flexur			
Design bending moment	M = 0  kNm/m	K = <b>0.000</b>	K' = <b>0.207</b>
Design bending moment	$W = \mathbf{U} K W W$		
Topo reinforcement required	Δ <b>0</b> mm <sup>2</sup> /m	K' > K - No compression reinf	orcement is required
Tens.reinforcement required	$A_{sr1.req} = 0 \text{ mm}^2/\text{m}$	Tana asiafana ana ataon idad	
Tens.reinforcement provided	12 dia.bars @ 200 c/c	Tens.reinforcement provided	A <sub>sr1.prov</sub> = <b>565</b>
mm²/m	<b>054</b>		40000
Min.area of reinforcement	A <sub>sr1.min</sub> = <b>351</b> mm <sup>2</sup> /m	Max.area of reinforcement	A <sub>sr1.max</sub> = <b>12000</b>
mm²/m	• • • • • • • • • • • • • • • • • • •		
	-	rovided is greater than area of rei	nforcement required
Deflection control - Section 7			
Limiting span to depth ratio	3206019.9	Actual span to depth ratio	0.4
	PASS - S	Span to depth ratio is less than de	eflection control limit
Crack control - Section 7.3			
Limiting crack width	w <sub>max</sub> = <b>0.3</b> mm	Maximum crack width	w <sub>k</sub> = <b>0</b> mm
PASS - Maximum crack wid	th is less than limiting crac	<b>k width</b> Rectangular section in s	shear - Section 6.2
Design shear force	V = <b>28</b> kN/m	Design shear resistance	V <sub>Rd.c</sub> = <b>118.9</b> kN/m
	PASS	- Design shear resistance exceed	s design shear force
Horizontal reinforcement par	allel to face of stem - Se	ection 9.6	
Min.area of reinforcement	A <sub>sx.req</sub> = <b>300</b> mm <sup>2</sup> /m	Max.spacing of reinforcement	s <sub>sx_max</sub> = <b>400</b> mm
Trans.reinforcement provided	10 dia.bars @ 200 c/c	Trans.reinforcement provided	Asx.prov = <b>393</b>
mm²/m			
PAS	S - Area of reinforcement p	rovided is greater than area of rei	nforcement required
Check base design at toe			
Depth of section	h = <b>300</b> mm		
Rectangular section in flexur	e - Section 6.1		
Design bending moment	M = <b>12.9</b> kNm/m	K = 0.010	K' = <b>0.207</b>
		K' > K - No compression reinfo	
Tens.reinforcement required	A <sub>bb.req</sub> = <b>142</b> mm <sup>2</sup> /m		or volution to required
	Abb.req = 142 mm-/m 12 dia.bars @ 200 c/c	Tone reinforcement provided	Au
Tens.reinforcement provided mm <sup>2</sup> /m	12 UIA.DAIS @ 200 C/C	Tens.reinforcement provided	Abb.prov = <b>565</b>
	$\Lambda_{11} = -215 \text{ mm}^{2}/\text{m}$	May area of reinforcement	A
Min.area of reinforcement mm <sup>2</sup> /m	A <sub>bb.min</sub> = <b>315</b> mm <sup>2</sup> /m	Max.area of reinforcement	Abb.max = <b>12000</b>
	S - Aros of rainforcement -	rovided is greater than area of rei	nforcoment required
PAS	o - Area ur reiniurcement D	ovided is dreater triari area of rel	morcement reduired

PASS - Area of reinforcement provided is greater than area of reinforcement required

Crack control - Section 7.3





#### **RC CAPPING BEAM**

The propping force is 81 kN/m

RC member analysis & design (EN1992-1-1:2004) In accordance with EN1992-1-1:2004 incorporating Corrigenda January 2008 and the UK national

Tedds calculation version 3.0.01

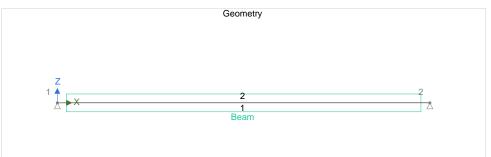
Analysis

annex

Tedds calculation version 1.0.13

Geometry





Nodes

Node	Co-ordinates		Freedom		Coordinate system		Spring			
	Х	Z	Х	Z	Rot.	Name	Angle	Х	Z	Rot.
	(m)	(m)					(°)	(kN/m)	(kN/m)	kNm/°
1	0	0	Fixed	Fixed	Free		0	0	0	0
2	2	0	Fixed	Fixed	Free		0	0	0	0
Materials										

Materials	
-----------	--

Name	Density	Youngs Modulus	Shear Modulus	Thermal Coefficient
	(kg/m³)	kN/mm <sup>2</sup>	kN/mm <sup>2</sup>	°C-1
Concrete (C28 2500 Quartzite)	2500	32.3082497	13.4617707	0.00001

Sections

Name	Area	Moment of inertia		Moment of inertia Shear ar		r area
		Major	Minor	Ay	Az	
	(cm²)	(cm4)	(cm4)	(cm²)	(cm²)	
R 450x450	2025	341719	341719	1688	1688	

Elements

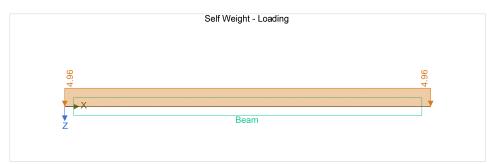
Elemen t	Length	Nodes		Nodes Section		Material		Releases		
	(m)	Start	End			Start momen t	End momen t	Axial		
1	2	1	2	R 450x450	Concrete (C28 2500 Quartzite)	Fixed	Fixed	Fixed		

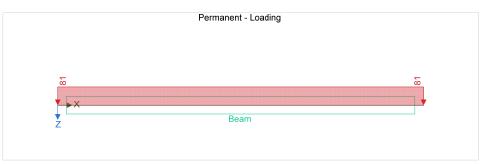
Members

Name	Elem	Elements				
	Start	End				
Beam	1	1				

Loading







Load cases

Name	Enabled	Self weight factor	Patternable
Self Weight	yes	1	no
Permanent	yes	0	no
Imposed	no	0	no

Load combinations

Load combination	Туре	Enabled	Patterned			
LoadCombination1	Quasi	yes	no			
LoadCombination2	Service	yes	no			

Load combination: LoadCombination1 (Quasi)

	Load case	Factor				
	Self Weight	1.35				
	Permanent	1.35				
L	Load combination: LoadCombination2 (Service)					

Load case Factor

Self Weight	1
Permanent	1

Member UDL loads

Member	Load case	Position			Load	Orientatio n
		Туре	Start	End		
					(kN/m)	
Beam	Permanent	Ratio	0	1	81	GlobalZ

Results

Forces

 Concrete details (Table 3.1 - Strength and deformation characteristics for concrete)

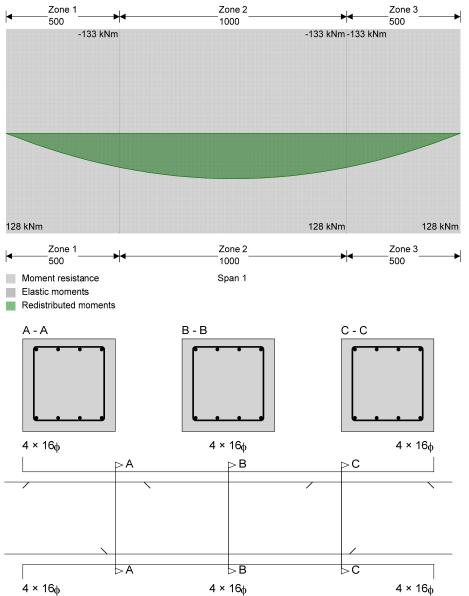
 Concrete strength class
 C28/35

 Char. comp. cylinder strength
 fck = 28 N/mm<sup>2</sup>



Design comp conc. strength	f <sub>cwd</sub> = <b>18.7</b> N/mm <sup>2</sup>	Maximum aggregate size	h <sub>agg</sub> = <b>20</b> mm
Reinforcement details			
Char. yield strength of rinf.	f <sub>yk</sub> = <b>500</b> N/mm <sup>2</sup>	Partial factor for reinf. steel	γs = <b>1.15</b>
Design yield strength of reinf.	f <sub>yd</sub> = <b>435</b> N/mm <sup>2</sup>		
Nominal cover to reinforcem	ent		
Nominal cover to top reinf	Cnom_t = <b>35</b> mm	Nominal cover to bottom reinf	Cnom_b = <b>50</b> mm
Nominal cover to side reinf	C <sub>nom_s</sub> = <b>50</b> mm		
Fire resistance			
Standard fire resistance period	1 R = <b>60</b> min	No. sides exposed to fire	3
Minimum width of beam	b <sub>min</sub> = <b>120</b> mm		
Beam - Span 1			
Rectangular section details			
Section width	b = <b>450</b> mm	Section depth	h = <b>450</b> mm
		PASS - Minimum dimensions fo	r fire resistance met

Moment design



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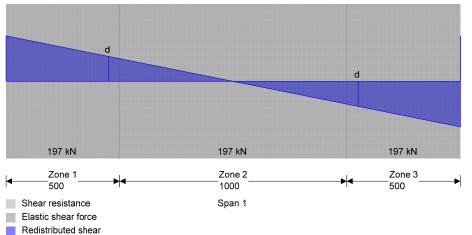


Zone 1 (0 mm - 500 mm) Pos	itive moment - section 6.1		
Design bending moment	M = <b>43.5</b> kNm	Effective depth tension reinf.	d = <b>384</b> mm
Area of tension reinf. req'd	$A_{s,req} = 274 \text{ mm}^2$	Area of tension reinf. prov	$A_{s,prov} = 804 \text{ mm}^2$
Min area of reinf. (exp.9.1N)	$A_{s,min} = 249 \text{ mm}^2$	Max area reinf. (cl.9.2.1.1(3))	$A_{s,max} = 8100 \text{ mm}^2$
		vided is greater than area of re	-,
Crack control - Section 7.3			
Maximum crack width	w <sub>k</sub> = <b>0.3</b> mm	Min area reinf req'd (exp.7.1)	$A_{scmin} = 314 \text{ mm}^2$
		ovided exceeds minimum requi	
Quasi-permanent moment	M <sub>OP</sub> = <b>43.5</b> kNm		
Actual tension bar spacing	s <sub>bar</sub> = <b>106</b> mm	Max bar spacing (Table 7.3N)	Sbar.max = <b>300</b> mm
		pacing exceeds actual bar space	
Zone 1 (0 mm - 500 mm) Neg	-		0
Design bending moment	M = <b>14.5</b> kNm	Effective depth tension reinf.	d = <b>399</b> mm
Area of tension reinf. req'd	$A_{s,req} = 88 \text{ mm}^2$	Area of tension reinf. prov	$A_{s,prov} = 804 \text{ mm}^2$
Min area of reinf. (exp.9.1N)	$A_{s,min} = 258 \text{ mm}^2$	Max area reinf. (cl.9.2.1.1(3))	$A_{s,max} = 8100 \text{ mm}^2$
	- /	vided is greater than area of re	
Crack control - Section 7.3			q
Maximum crack width	wk = <b>0.3</b> mm	Min area reinf req'd (exp.7.1)	$A_{scmin} = 313 \text{ mm}^2$
		ovided exceeds minimum requi	
Quasi-permanent moment	M <sub>QP</sub> = <b>0.0</b> kNm		
Actual tension bar spacing	sbar = <b>106</b> mm	Max bar spacing (Table 7.3N)	Sbar.max = <b>300</b> mm
	PASS - Maximum bar su	acing exceeds actual bar space	
Minimum bar spacing (Secti	-	<b>3</b>	<b>9</b>
Top bar spacing	stop = <b>90.0</b> mm	Min allow. top bar spacing	Stop,min = <b>25.0</b> mm
- op aan op aang		S - Actual bar spacing exceeds	
Bottom bar spacing	s <sub>bot</sub> = <b>90.0</b> mm	Min allow. bottom bar spacing	Sbot,min = <b>25.0</b> mm
Bottom bar spacing		Min allow. bottom bar spacing S - Actual bar spacing exceed	
	PAS	S - Actual bar spacing exceed	
Zone 2 (500 mm - 1500 mm)	PAS	S - Actual bar spacing exceeds	
Zone 2 (500 mm - 1500 mm) Design bending moment	PAS Positive moment - section M = <b>58.0</b> kNm	<b>S - Actual bar spacing exceed</b> 6.1 Effective depth tension reinf.	s <i>minimum allowable</i> d = <b>384</b> mm
Zone 2 (500 mm - 1500 mm) Design bending moment Area of tension reinf. req'd	<b>PAS</b> Positive moment - section	<b>S - Actual bar spacing exceed</b> 6.1 Effective depth tension reinf. Area of tension reinf. prov	s minimum allowable d = 384 mm $A_{s,prov}$ = 804 mm <sup>2</sup>
Zone 2 (500 mm - 1500 mm) Design bending moment Area of tension reinf. req'd Min area of reinf. (exp.9.1N)	PAS Positive moment - section M = 58.0 kNm A <sub>s,req</sub> = 366 mm <sup>2</sup> A <sub>s,min</sub> = 249 mm <sup>2</sup>	<b>S - Actual bar spacing exceeds</b> 5.1 Effective depth tension reinf. Area of tension reinf. prov Max area reinf. (cl.9.2.1.1(3))	s <i>minimum allowable</i> d = <b>384</b> mm A <sub>s,prov</sub> = <b>804</b> mm <sup>2</sup> A <sub>s,max</sub> = <b>8100</b> mm <sup>2</sup>
Zone 2 (500 mm - 1500 mm) Design bending moment Area of tension reinf. req'd Min area of reinf. (exp.9.1N)	PAS Positive moment - section M = 58.0 kNm A <sub>s,req</sub> = 366 mm <sup>2</sup> A <sub>s,min</sub> = 249 mm <sup>2</sup>	<b>S - Actual bar spacing exceed</b> 6.1 Effective depth tension reinf. Area of tension reinf. prov	s <i>minimum allowable</i> d = <b>384</b> mm A <sub>s,prov</sub> = <b>804</b> mm <sup>2</sup> A <sub>s,max</sub> = <b>8100</b> mm <sup>2</sup>
Zone 2 (500 mm - 1500 mm) Design bending moment Area of tension reinf. req'd Min area of reinf. (exp.9.1N) PAS Crack control - Section 7.3	PAS Positive moment - section M = 58.0 kNm A <sub>s,req</sub> = 366 mm <sup>2</sup> A <sub>s,min</sub> = 249 mm <sup>2</sup>	<b>S - Actual bar spacing exceeds</b> 5.1 Effective depth tension reinf. Area of tension reinf. prov Max area reinf. (cl.9.2.1.1(3)) <b>vided is greater than area of re</b>	d = 384 mm A <sub>s,prov</sub> = 804 mm <sup>2</sup> A <sub>s,max</sub> = 8100 mm <sup>2</sup> inforcement required
Zone 2 (500 mm - 1500 mm) Design bending moment Area of tension reinf. req'd Min area of reinf. (exp.9.1N) <b>PAS</b> Crack control - Section 7.3 Maximum crack width	PAS Positive moment - section of M = 58.0  kNm $A_{s,req} = 366 \text{ mm}^2$ $A_{s,min} = 249 \text{ mm}^2$ S - Area of reinforcement prove $w_k = 0.3 \text{ mm}$	<b>S - Actual bar spacing exceeds</b> 5.1 Effective depth tension reinf. Area of tension reinf. prov Max area reinf. (cl.9.2.1.1(3)) <b>vided is greater than area of re</b> Min area reinf req'd (exp.7.1)	s minimum allowable d = 384 mm A <sub>s,prov</sub> = 804 mm <sup>2</sup> A <sub>s,max</sub> = 8100 mm <sup>2</sup> inforcement required A <sub>sc,min</sub> = 314 mm <sup>2</sup>
Zone 2 (500 mm - 1500 mm) Design bending moment Area of tension reinf. req'd Min area of reinf. (exp.9.1N) <b>PAS</b> Crack control - Section 7.3 Maximum crack width <b>PASS - Are</b>	PAS Positive moment - section of M = 58.0  kNm $A_{s,req} = 366 \text{ mm}^2$ $A_{s,min} = 249 \text{ mm}^2$ S - Area of reinforcement prove $w_k = 0.3 \text{ mm}$	<b>S - Actual bar spacing exceeds</b> 5.1 Effective depth tension reinf. Area of tension reinf. prov Max area reinf. (cl.9.2.1.1(3)) <b>vided is greater than area of re</b>	s minimum allowable d = 384 mm A <sub>s,prov</sub> = 804 mm <sup>2</sup> A <sub>s,max</sub> = 8100 mm <sup>2</sup> inforcement required A <sub>sc,min</sub> = 314 mm <sup>2</sup>
Zone 2 (500 mm - 1500 mm) Design bending moment Area of tension reinf. req'd Min area of reinf. (exp.9.1N) <b>PAS</b> Crack control - Section 7.3 Maximum crack width	PAS Positive moment - section of M = 58.0  kNm $A_{s,req} = 366 \text{ mm}^2$ $A_{s,min} = 249 \text{ mm}^2$ S - Area of reinforcement prop $w_k = 0.3 \text{ mm}$ a of tension reinforcement prop	S - Actual bar spacing exceeds 5.1 Effective depth tension reinf. Area of tension reinf. prov Max area reinf. (cl.9.2.1.1(3)) vided is greater than area of reaction Min area reinf req'd (exp.7.1) ovided exceeds minimum required	d = 384 mm A <sub>s,prov</sub> = 804 mm <sup>2</sup> A <sub>s,max</sub> = 8100 mm <sup>2</sup> <i>inforcement required</i> A <sub>sc,min</sub> = 314 mm <sup>2</sup> <i>ired for crack control</i>
Zone 2 (500 mm - 1500 mm) Design bending moment Area of tension reinf. req'd Min area of reinf. (exp.9.1N) <b>PASS</b> Crack control - Section 7.3 Maximum crack width <b>PASS - Are</b> Quasi-permanent moment	PAS Positive moment - section of M = 58.0  kNm $A_{s,req} = 366 \text{ mm}^2$ $A_{s,min} = 249 \text{ mm}^2$ <b>S</b> - Area of reinforcement prod $w_k = 0.3 \text{ mm}$ a of tension reinforcement prod $M_{QP} = 58.0 \text{kNm}$ $S_{bar} = 106 \text{ mm}$	<b>S - Actual bar spacing exceeds</b> 5.1 Effective depth tension reinf. Area of tension reinf. prov Max area reinf. (cl.9.2.1.1(3)) <b>vided is greater than area of re</b> Min area reinf req'd (exp.7.1)	s minimum allowable d = 384 mm A <sub>s,prov</sub> = 804 mm <sup>2</sup> A <sub>s,max</sub> = 8100 mm <sup>2</sup> inforcement required A <sub>sc,min</sub> = 314 mm <sup>2</sup> ired for crack control Sbar,max = 252.8 mm
Zone 2 (500 mm - 1500 mm) Design bending moment Area of tension reinf. req'd Min area of reinf. (exp.9.1N) <i>PAS</i> Crack control - Section 7.3 Maximum crack width <i>PASS - Are</i> Quasi-permanent moment Actual tension bar spacing	PAS Positive moment - section of M = 58.0  kNm $A_{s,req} = 366 \text{ mm}^2$ $A_{s,min} = 249 \text{ mm}^2$ S - Area of reinforcement prove $W_k = 0.3 \text{ mm}$ a of tension reinforcement prove $M_{QP} = 58.0 \text{ kNm}$ $S_{bar} = 106 \text{ mm}$ PASS - Maximum bar spectrum	S - Actual bar spacing exceeds 5.1 Effective depth tension reinf. Area of tension reinf. prov Max area reinf. (cl.9.2.1.1(3)) vided is greater than area of reac Min area reinf req'd (exp.7.1) ovided exceeds minimum requinant Max bar spacing (Table 7.3N)	s minimum allowable d = 384 mm A <sub>s,prov</sub> = 804 mm <sup>2</sup> A <sub>s,max</sub> = 8100 mm <sup>2</sup> inforcement required A <sub>sc,min</sub> = 314 mm <sup>2</sup> ired for crack control Sbar,max = 252.8 mm
Zone 2 (500 mm - 1500 mm) Design bending moment Area of tension reinf. req'd Min area of reinf. (exp.9.1N) <b>PASS</b> Crack control - Section 7.3 Maximum crack width <b>PASS - Are</b> Quasi-permanent moment Actual tension bar spacing Deflection control - Section	PAS Positive moment - section of M = 58.0  kNm $A_{s,req} = 366 \text{ mm}^2$ $A_{s,min} = 249 \text{ mm}^2$ <b>S</b> - Area of reinforcement prod $w_k = 0.3 \text{ mm}$ <b>a of tension reinforcement prod</b> $M_{QP} = 58.0 \text{ kNm}$ $S_{bar} = 106 \text{ mm}$ <b>PASS - Maximum bar sp</b> 7.4	S - Actual bar spacing exceeds 5.1 Effective depth tension reinf. Area of tension reinf. prov Max area reinf. (cl.9.2.1.1(3)) vided is greater than area of reach Min area reinf req'd (exp.7.1) ovided exceeds minimum requi- Max bar spacing (Table 7.3N) pacing exceeds actual bar space	d = 384 mm A <sub>s,prov</sub> = 804 mm <sup>2</sup> A <sub>s,max</sub> = 8100 mm <sup>2</sup> <i>inforcement required</i> A <sub>sc,min</sub> = 314 mm <sup>2</sup> <i>ired for crack control</i> S <sub>bar,max</sub> = 252.8 mm <i>iring for crack control</i>
Zone 2 (500 mm - 1500 mm) Design bending moment Area of tension reinf. req'd Min area of reinf. (exp.9.1N) <i>PAS</i> Crack control - Section 7.3 Maximum crack width <i>PASS - Are</i> Quasi-permanent moment Actual tension bar spacing	PAS Positive moment - section of M = 58.0  kNm $A_{s,req} = 366 \text{ mm}^2$ $A_{s,min} = 249 \text{ mm}^2$ S - Area of reinforcement prove $W_k = 0.3 \text{ mm}$ a of tension reinforcement prove $M_{QP} = 58.0 \text{ kNm}$ $S_{bar} = 106 \text{ mm}$ PASS - Maximum bar spectrum	S - Actual bar spacing exceeds 5.1 Effective depth tension reinf. Area of tension reinf. prov Max area reinf. (cl.9.2.1.1(3)) vided is greater than area of reac Min area reinf req'd (exp.7.1) ovided exceeds minimum requinant Max bar spacing (Table 7.3N)	s minimum allowable d = 384 mm A <sub>s,prov</sub> = 804 mm <sup>2</sup> A <sub>s,max</sub> = 8100 mm <sup>2</sup> inforcement required A <sub>sc,min</sub> = 314 mm <sup>2</sup> ired for crack control Sbar,max = 252.8 mm
Zone 2 (500 mm - 1500 mm) Design bending moment Area of tension reinf. req'd Min area of reinf. (exp.9.1N) PAS Crack control - Section 7.3 Maximum crack width PASS - Area Quasi-permanent moment Actual tension bar spacing Deflection control - Section Allow. span to depth ratio	PAS Positive moment - section of M = 58.0  kNm $A_{s,req} = 366 \text{ mm}^2$ $A_{s,min} = 249 \text{ mm}^2$ S - Area of reinforcement produces $w_k = 0.3 \text{ mm}$ a of tension reinforcement produces $M_{QP} = 58.0 \text{ kNm}$ $S_{bar} = 106 \text{ mm}$ PASS - Maximum bar sp 7.4 span_to_depth <sub>allow</sub> = 40.000	S - Actual bar spacing exceeds 5.1 Effective depth tension reinf. Area of tension reinf. prov Max area reinf. (cl.9.2.1.1(3)) vided is greater than area of reach Min area reinf req'd (exp.7.1) ovided exceeds minimum requi- Max bar spacing (Table 7.3N) pacing exceeds actual bar space	s minimum allowable d = 384 mm A <sub>s,prov</sub> = 804 mm <sup>2</sup> A <sub>s,max</sub> = 8100 mm <sup>2</sup> inforcement required A <sub>sc,min</sub> = 314 mm <sup>2</sup> ired for crack control Sbar,max = 252.8 mm iring for crack control span_to_depthactual
Zone 2 (500 mm - 1500 mm) Design bending moment Area of tension reinf. req'd Min area of reinf. (exp.9.1N) <b>PAS</b> Crack control - Section 7.3 Maximum crack width <b>PASS - Are</b> Quasi-permanent moment Actual tension bar spacing Deflection control - Section Allow. span to depth ratio = <b>5.208</b>	PAS Positive moment - section $K$ M = 58.0 kNm A <sub>s,req</sub> = 366 mm <sup>2</sup> A <sub>s,min</sub> = 249 mm <sup>2</sup> S - Area of reinforcement prod $W_k = 0.3$ mm a of tension reinforcement prod MQP = 58.0kNm Sbar = 106 mm PASS - Maximum bar sp 7.4 span_to_depth <sub>allow</sub> = 40.000 PASS - Ac	S - Actual bar spacing exceeds 5.1 Effective depth tension reinf. Area of tension reinf. prov Max area reinf. (cl.9.2.1.1(3)) vided is greater than area of reac Min area reinf req'd (exp.7.1) by ided exceeds minimum require Max bar spacing (Table 7.3N) bacing exceeds actual bar space Actual span to depth ratio	s minimum allowable d = 384 mm A <sub>s,prov</sub> = 804 mm <sup>2</sup> A <sub>s,max</sub> = 8100 mm <sup>2</sup> inforcement required A <sub>sc,min</sub> = 314 mm <sup>2</sup> ired for crack control Sbar,max = 252.8 mm iring for crack control span_to_depthactual
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Min area of reinf. (exp.9.1N)	A <sub>s,min</sub> = <b>249</b> mm <sup>2</sup>	Max area reinf. (cl.9.2.1.1(3))	A <sub>s,max</sub> = <b>8100</b> mm <sup>2</sup>			
PASS - Area of reinforcement provided is greater than area of reinforcement required						
Crack control - Section 7.3						
Maximum crack width	w <sub>k</sub> = <b>0.3</b> mm	Min area reinf req'd (exp.7.1)	A <sub>sc,min</sub> <b>= 314</b> mm <sup>2</sup>			
PASS - Area of tension reinforcement provided exceeds minimum required for crack control						
Quasi-permanent moment	M <sub>QP</sub> = <b>43.5</b> kNm					
Actual tension bar spacing	s <sub>bar</sub> = <b>106</b> mm	Max bar spacing (Table 7.3N)	s <sub>bar,max</sub> = 300 mm			
	PASS - Maximum bar s	pacing exceeds actual bar spac	ing for crack control			
Zone 3 (1500 mm - 2000 mm)	) Negative moment - sect	ion 6.1				
Design bending moment	M = <b>14.5</b> kNm	Effective depth tension reinf.	d = <b>399</b> mm			
Area of tension reinf. req'd	A <sub>s,req</sub> = 88 mm <sup>2</sup>	Area of tension reinf. prov	A <sub>s,prov</sub> = 804 mm <sup>2</sup>			
Min area of reinf. (exp.9.1N)	A <sub>s,min</sub> = <b>258</b> mm <sup>2</sup>	Max area reinf. (cl.9.2.1.1(3))	A <sub>s,max</sub> = 8100 mm <sup>2</sup>			
PAS	S - Area of reinforcement pro	wided is greater than area of rel	inforcement required			
Crack control - Section 7.3						
Maximum crack width	w <sub>k</sub> = <b>0.3</b> mm	Min area reinf req'd (exp.7.1)	A <sub>sc,min</sub> <b>= 313</b> mm <sup>2</sup>			
PASS - Area of tension reinforcement provided exceeds minimum required for crack control						
Quasi-permanent moment	M <sub>QP</sub> = <b>0.0</b> kNm					
Actual tension bar spacing	s <sub>bar</sub> = <b>106</b> mm	Max bar spacing (Table 7.3N)	s <sub>bar,max</sub> = <b>300</b> mm			
PASS - Maximum bar spacing exceeds actual bar spacing for crack control						
Minimum bar spacing (Section 8.2)						
Top bar spacing	stop = <b>90.0</b> mm	Min allow. top bar spacing	Stop,min = <b>25.0</b> mm			
PASS - Actual bar spacing exceeds minimum allowable						
Bottom bar spacing	s <sub>bot</sub> = <b>90.0</b> mm	Min allow. bottom bar spacing	S <sub>bot,min</sub> = <b>25.0</b> mm			
	PAS	SS - Actual bar spacing exceeds	s minimum allowable			
Shoor design						

Shear design





→ 2 × 8 legs @ 25	50 c/c	2 × 8 legs @ 250 c			
Zone 1 500	Zone 2	Zone 3	<b>→</b>		
Angle of comp. shear strut	$\theta_{max} = 45 \text{ deg}$	Strength reduction factor	V <sub>1</sub> = <b>0.533</b>		
Compression chord coefficient	α <sub>cw</sub> = <b>1.00</b>	Minimum area of shear reinf.	A <sub>sv,min</sub> <b>= 381</b> mm <sup>2</sup> /m		
Zone 1 (0 mm - 500 mm) shea	ar - section 6.2				
Shear force at support	V <sub>Ed,max</sub> = <b>116</b> kN	Max design shear resistance	V <sub>Rd,max</sub> = <b>1007</b> kN		
PAS	S - Design shear force at sup	port is less than maximum de	sign shear resistance		
Design shear force	V <sub>Ed</sub> = <b>64</b> kN	Area shear reinf. req'd	A <sub>sv,req</sub> = <b>381</b> mm <sup>2</sup> /m		
Area of shear reinf prov.	Asv,prov = <b>402</b> mm <sup>2</sup> /m				
	PASS - Area of shear i	reinforcement provided excee	ds minimum required		
Max. long. spacing - exp.9.6N					
PAS	SS - Longitudinal spacing of s	hear reinforcement provided i	s less than maximum		
Zone 2 (500 mm - 1500 mm) s	shear - section 6.2				
Design shear force	V <sub>Ed</sub> = <b>58</b> kN	Area shear reinf. req'd	A <sub>sv,req</sub> = <b>381</b> mm <sup>2</sup> /m		
Area of shear reinf prov.	A <sub>sv,prov</sub> = <b>402</b> mm <sup>2</sup> /m				
		reinforcement provided excee	ds minimum required		
Max. long. spacing - exp.9.6N					
		hear reinforcement provided i	s less than maximum		
Zone 3 (1500 mm - 2000 mm)					
Shear force at support	V <sub>Ed,max</sub> = <b>116</b> kN	Max design shear resistance	V <sub>Rd,max</sub> = <b>1007</b> kN		
		port is less than maximum de	-		
Design shear force	V <sub>Ed</sub> = <b>64</b> kN	Area shear reinf. req'd	A <sub>sv,req</sub> = <b>381</b> mm <sup>2</sup> /m		
Area of shear reinf prov.	A <sub>sv,prov</sub> = <b>402</b> mm <sup>2</sup> /m	• •			
PASS - Area of shear reinforcement provided exceeds minimum required					
Max. long. spacing - exp.9.6N		<b>, ,,</b> , ,. ,.			
PASS - Longitudinal spacing of shear reinforcement provided is less than maximum					



# 8. Basement Method Statement



## Contents

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# 1. Basement Formation Suggested Method Statement.

- 1.1. This method statement provides an approach which will allow the basement design to be correctly considered during construction, and the temporary support to be provided during the works. <u>The Contractor is responsible for the works on site and the final temporary works methodology and design on this site and any adjacent sites.</u>
- 1.2. This method statement for the development of 8A Belmont Street. It has been written by a Chartered Engineer. The overall sequence is shown on drawing SL-30.
- 1.3. This proposed method has been developed to allow for improved costings and for inclusion in the Party Wall Award. Should the contractor provide alternative methodology the changes shall be at their own costs, and an Addendum to the Party Wall Award will be required.
- 1.4. Contact party wall surveyors to inform them of any changes to this method statement.
- 1.5. Contact the developers of any adjacent or nearby sites to inform them of the proposed works.
- 1.6. The approach followed in this design is:
  - i. demolish the existing structures (Storage building)
  - ii. install a contiguous piled wall with capping beam around the perimeter
  - iii. excavate within the contiguous piled walls;
  - iv. provide adequate propping, with propping to the head and include mass concrete thrust blocks for prop support at base
  - v. construct the new building from basement level upwards.
- 1.7. A soil investigation has been undertaken. The soil conditions are London Clay formation
- 1.8. No ground water encountered in the borehole taken at site. Local dewatering may be required. Following piling around the perimeter, and during the subsequent excavations, dewater locally (create sumps from which water can be pumped out of).
- 1.9. The structural water proofer (not Croft) must comment on the proposed design and ensure that this will provide adequate water proofing.
- 1.1. Provide engineers with concrete mix, supplier, deliver and placement methods 2 weeks prior to first pour. Site mixing of concrete should not be employed apart from in small sections <1m<sup>3</sup>. Contractor must provide method on how to achieve site mixing to the correct specification; the contractor must undertake tool box talks with staff to ensure site quality is maintained.



## 2. Enabling Works

- 2.1. The site is to be hoarded with ply sheet to 2.2m to prevent unauthorised public access.
- 2.2. Demolish the storage building. Refer to Section 4 for demolition proposals.
- 2.3. Licences for skips and conveyors to be posted on hoarding
- 2.4. On commencement of construction, the contractor should report any discrepancies to the structural engineer in order that the detailed design may be modified as necessary.

## 3. Piling Sequencing

For general piling procedures, refer to the piling contractor's method statement. The anticipated sequence is as follows:

- 3.1. Piles are to be installed at different levels and positions around the development. All piles are installed from the same level and cut down as required.
  - 3.1.1.Prior to bringing the piling rig on site, check with the piling contractor the requirements of a working platform and install to their design and specification if required.
  - 3.1.2. Mark out datum line to determine various surface heights
  - 3.1.3. Mark out pile sequence locations as specified by Engineer's detailed design stage drawings.
  - 3.1.4. Following the sequencing guidance from the Engineers detailed design stage drawings, mark out proposed pile position with a pair of reference markers at 1.0m from the pile pin, each forming a line to the pile, mutually rotated at 90 degrees.
  - 3.1.5.Rig operator to set up over the pile pin position and position auger relative to reference marks. Directed and checked by banks man.
  - 3.1.6. The flap at the tip of the auger is closed and secured. Auger tip lowered to ground level and position rechecked. Drilling to commence upon banks man approval.
  - 3.1.7. Concrete is prepared while piling operatives grout up concrete pump, hoses and flight, concrete pump operator to check concrete complies with design mix. Concrete held in agitator.
  - 3.1.8.Rig operator augers to require design depth. Reference makers are to be used to check pile position during the first few metres of drilling.
  - 3.1.9. If obstruction encountered, Engineer to be notified of pile number and depth. Move rig to next pile position whilst obstruction removal is dealt with. Contractor to be advised on procedure should obstruction not be removable. If necessary, pile bores to be backfilled and made safe. Open excavation to be protected when open.



- 3.1.10. When design depth reached, the auger is to be kept rotating to allow spoil in the bore to rise.
- 3.1.11. Concrete can be pumped to rig while rig operator monitors instrumentation and adjust auger rate of withdrawal accordingly.
- 3.1.12. Pressure, concrete flow and over-break to be monitored throughout operation.
- 3.1.13. During the withdrawal the rig operator is to activate the flight cleaner. If an automatic cleaner is not fitted to the rig then the piling gang must clean the flight manually to prevent spoil/arising travelling above head height this will be controlled by the piling foreman who must ensure the auger is not rotating when it is manually cleaned.
- 3.1.14. When auger tip reaches platform level, concrete pumping is stopped.
- 3.1.15. Attendant excavator as directed by the banks man clears spoil and concrete slurry from pile heap.
- 3.1.16. Banks man to check position of the cage in the pile, centring where necessary. Reinforcement generally to be installed flush with Piling Platform Level (PPL). Anchor pile reinforcement or threaded bars that project above piling platform to have protective caps.
- 3.1.17. Concrete testing cube samples to be taken as per engineering specification.
- 3.1.18. Rig is moved onto next pile in the sequence and positioned as above, with piles installed as per points 3.1.5 3.1.12
- 3.1.19. Equipment to be cleaned and maintained as per normal methods.
- 3.1.20. This sequence of piling is to continue until all perimeter piles have been installed. As piling progresses wound perimeter, construct reinforced concrete capping beam to piles.
- 3.1.21. Excavate within the contiguous piled wall perimeter, and install props as excavations progress.
  - 3.1.21.1. <u>The piled wall should be propped until the permanent structure is complete</u> (refer to item 3.2). Propping should include props to the head, ie to the capping beam. The contractor should provide proposals for propping to the structural engineer who is responsible for the detailed design of the permanent structure at least two weeks before the excavations commence.
- 3.2. Once all piles have been installed propped, complete the excavation. Cast bases for internal load bearing walls. The next step sequence is to install the steelwork at ground level. In the permanent condition, this will prop the external perimeter of the basement.
- 3.3. When steelwork has been set up, the cross props may be removed.



# 4. Demolition, Recycling, Dust/Noise Control and Site Hoarding

- 4.1. Demolition work is to take place within the hoarded confines of the materials such as stock bricks, timber etc. are to be recycled where possible. To minimise dust and dirt from demolition the following measures shall be implemented:
  - 4.1.1. Any debris or dust or dirt falling on the street and public highway will be cleared as it occurs by designated cleaners and washed down fully every night.
  - 4.1.2. Demolished materials are to be removed to a skip placed in front of the site which will be emptied regularly as required.
  - 4.1.3. All brickwork and concrete demolition work is to be constantly watered to reduce airborne dust
- 4.2. Building work which can be heard at the boundary of the site will not be carried out on Sundays or bank holidays and will be carried out within working hours as agreed by the council.