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Job Title	Job Number	Sheet Number	Revision
Calculation/sketch Title	Date	Author	Checked

Loading to the side elevation

Assume the party walls support the roof and the timber floors.

Dead load of solid brick wall	G_{k1} = 6.21kN/m^2
Dead load of timber floors	G_{k2} = 0.85kN/m^2
Dead load of roof	G_{k3} = 1.25kN/m^2
Roof load (no access)	Q_{k1} = 0.70kN/m^2
Cat A occupancy	Q_{k2} = 1.50kN/m^2
Height of party wall	H = 11.00m
Loaded width of floor	L_F = 5.50m
Span of roof supported	L_R = 5.50m
Dead load from wall	W_{Gk1} = 6.21kN/m2 x 11.00m = 68.31kN/m
Dead load from floors	W_{Gk2} = 0.85kN/m2 x 5.50m x 2 floors = 9.35kN/m
Dead load from roof	W_{Gk3} = 1.25kN/m2 x 5.50m = 6.88kN/m
Total dead load	**W_{Gk} = 84.54kN/m**
Imposed load from floors	W_{Qk1} = 1.50kN/m2 x 5.50m x 2 floors = 16.50kN/m
Imposed load from roof	W_{Qk2} = 0.70 x 5.50m = 3.85kN/m
Total imposed load	**W_{Qk} = 20.35kN/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 2.9.12

Retaining wall details

Stem type	Propped cantilever
Stem height	h_{stem} = **2800** mm
Prop height	h_{prop} = **2800** mm
Stem thickness	t_{stem} = **300** mm
Angle to rear face of stem	α = **90** deg
Stem density	γ_{stem} = **25** kN/m^3
Toe length	l_{toe} = **1000** mm
Base thickness	t_{base} = **350** mm
Base density	γ_{base} = **25** kN/m^3
Height of retained soil	h_{ret} = **2800** mm
Angle of soil surface	β = **0** deg
Depth of cover	d_{cover} = **0** mm
Height of water	h_{water} = **1550** mm
Water density	γ_w = **9.8** kN/m^3

Retained soil properties

Soil type	Firm silty clay
Moist density	γ_{mr} = **19.5** kN/m^3
Saturated density	γ_{sr} = **19.5** kN/m^3
Characteristic effective shear resistance angle	$\phi'_{r.k}$ = **24** deg
Characteristic wall friction angle	$\delta_{r.k}$ = **12** deg

Base soil properties

Soil type	Firm silty clay
Soil density	γ_b = **19.5** kN/m^3
Characteristic effective shear resistance angle	$\phi'_{b.k}$ = **24** deg
Characteristic wall friction angle	$\delta_{b.k}$ = **12** deg
Characteristic base friction angle	$\delta_{bb.k}$ = **16** deg
Presumed bearing capacity	$P_{bearing}$ = **150** kN/m^2

Loading details

Variable surcharge load	$Surcharge_Q$ = **10** kN/m^2
Vertical line load at 1150 mm	P_{G1} = **85** kN/m
	P_{Q1} = **21** kN/m

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	Section Propped underpin analysis and design for party wall			Sheet no./rev. 2	
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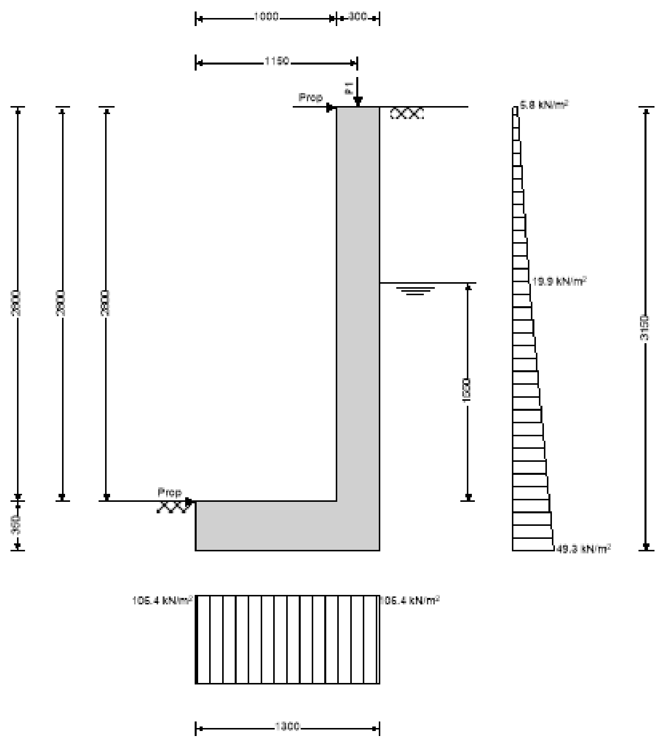


General arrangement

Calculate retaining wall geometry

Base length $l_{base} = l_{toe} + t_{stem} = \mathbf{1300}$ mm

Saturated soil height $h_{sat} = h_{water} + d_{cover} = \mathbf{1550}$ mm

Moist soil height $h_{moist} = h_{ret} - h_{water} = \mathbf{1250}$ mm

Length of surcharge load $l_{sur} = l_{heel} = \mathbf{0}$ mm

- Distance to vertical component $x_{sur\_v} = l_{base} - l_{heel} / 2 = \mathbf{1300}$ mm

Effective height of wall $h_{eff} = h_{base} + d_{cover} + h_{ret} = \mathbf{3150}$ mm

- Distance to horizontal component $x_{sur\_h} = h_{eff} / 2 = \mathbf{1575}$ mm

Area of wall stem $A_{stem} = h_{stem} \times t_{stem} = \mathbf{0.84}$ m^2

- Distance to vertical component $x_{stem} = l_{toe} + t_{stem} / 2 = \mathbf{1150}$ mm

Area of wall base $A_{base} = l_{base} \times t_{base} = \mathbf{0.455}$ m^2

- Distance to vertical component $x_{base} = l_{base} / 2 = \mathbf{650}$ mm

Using Coulomb theory

At rest pressure coefficient $K_0 = 1 - \sin(\phi'_{r.k}) = \mathbf{0.593}$

Passive pressure coefficient $K_P = \sin(90 - \phi'_{b.k})^2 / (\sin(90 + \delta_{b.k}) \times [1 - \sqrt{[\sin(\phi'_{b.k} + \delta_{b.k}) \times \sin(\phi'_{b.k}) / (\sin(90 + \delta_{b.k}))]}]^2) = \mathbf{3.337}$

Bearing pressure check

Vertical forces on wall

Wall stem $F_{stem} = A_{stem} \times \gamma_{stem} = \mathbf{21}$ kN/m

Wall base $F_{base} = A_{base} \times \gamma_{base} = \mathbf{11.4}$ kN/m

Line loads $F_{P\_v} = P_{G1} + P_{Q1} = \mathbf{106}$ kN/m

Total $F_{total\_v} = F_{stem} + F_{base} + F_{P\_v} + F_{water\_v} = \mathbf{138.4}$ kN/m

Horizontal forces on wall

Surcharge load $F_{sur\_h} = K_0 \times \cos(\delta_{r.k}) \times Surcharge_Q \times h_{eff} = \mathbf{18.3}$ kN/m

Saturated retained soil $F_{sat\_h} = K_0 \times \cos(\delta_{r.k}) \times (\gamma_{sr} - \gamma_w) \times (h_{sat} + h_{base})^2 / 2 = \mathbf{10.1}$ kN/m

Water $F_{water\_h} = \gamma_w \times (h_{water} + d_{cover} + h_{base})^2 / 2 = \mathbf{17.7}$ kN/m

Moist retained soil $F_{moist\_h} = K_0 \times \cos(\delta_{r.k}) \times \gamma_{mr} \times ((h_{eff} - h_{sat} - h_{base})^2 / 2 + (h_{eff} - h_{sat} - h_{base}) \times (h_{sat} + h_{base})) = \mathbf{35.7}$ kN/m

Base soil $F_{pass\_h} = -K_P \times \cos(\delta_{b.k}) \times \gamma_b \times (d_{cover} + h_{base})^2 / 2 = \mathbf{-3.9}$ kN/m

Total $F_{total\_h} = F_{sur\_h} + F_{sat\_h} + F_{water\_h} + F_{moist\_h} + F_{pass\_h} = \mathbf{78}$ kN/m

Moments on wall

Wall stem $M_{stem} = F_{stem} \times x_{stem} = \mathbf{24.2}$ kNm/m

Wall base $M_{base} = F_{base} \times x_{base} = \mathbf{7.4}$ kNm/m

Surcharge load $M_{sur} = -F_{sur\_h} \times x_{sur\_h} = \mathbf{-28.8}$ kNm/m

Line loads $M_P = (P_{G1} + P_{Q1}) \times p_1 = \mathbf{121.9}$ kNm/m

Saturated retained soil $M_{sat} = -F_{sat\_h} \times x_{sat\_h} = \mathbf{-6.4}$ kNm/m

Water $M_{water} = -F_{water\_h} \times x_{water\_h} = \mathbf{-11.2}$ kNm/m

Moist retained soil $M_{moist} = -F_{moist\_h} \times x_{moist\_h} = \mathbf{-46}$ kNm/m

Total $M_{total} = M_{stem} + M_{base} + M_{sur} + M_P + M_{sat} + M_{water} + M_{moist} = \mathbf{61}$ kNm/m

Check bearing pressure

Propping force to stem $F_{prop\_stem} = (F_{total\_v} \times l_{base} / 2 - M_{total}) / (h_{prop} + t_{base}) = \mathbf{9.2}$ kN/m

Propping force to base $F_{prop\_base} = F_{total\_h} - F_{prop\_stem} = \mathbf{68.8}$ kN/m

Moment from propping force $M_{prop} = F_{prop\_stem} \times (h_{prop} + t_{base}) = \mathbf{28.9}$ kNm/m

Distance to reaction $\bar{x} = (M_{total} + M_{prop}) / F_{total\_v} = \mathbf{650}$ mm

Eccentricity of reaction $e = \bar{x} - l_{base} / 2 = \mathbf{0}$ mm

Loaded length of base $l_{load} = l_{base} = \mathbf{1300}$ mm

Bearing pressure at toe $q_{toe} = F_{total\_v} / l_{base} \times (1 - 6 \times e / l_{base}) = \mathbf{106.4}$ kN/m^2

Bearing pressure at heel $q_{heel} = F_{total\_v} / l_{base} \times (1 + 6 \times e / l_{base}) = \mathbf{106.4}$ kN/m^2

Factor of safety $FoS_{bp} = P_{bearing} / \max(q_{toe}, q_{heel}) = \mathbf{1.409}$

PASS - Allowable bearing pressure exceeds maximum applied bearing pressure

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 2.9.12

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

Concrete strength class C35/45

Characteristic compressive cylinder strength $f_{ck} = \mathbf{35}$ N/mm^2

Characteristic compressive cube strength $f_{ck,cube} = \mathbf{45}$ N/mm^2

Mean value of compressive cylinder strength $f_{cm} = f_{ck} + 8$ N/mm^2 $= \mathbf{43}$ N/mm^2

Mean value of axial tensile strength $f_{ctm} = 0.3$ N/mm$^2 \times (f_{ck} / 1$ N/mm$^2)^{2/3} = \mathbf{3.2}$ N/mm^2

5% fractile of axial tensile strength $f_{ctk,0.05} = 0.7 \times f_{ctm} = \mathbf{2.2}$ N/mm^2

Secant modulus of elasticity of concrete $E_{cm} = 22$ kN/mm$^2 \times (f_{cm} / 10$ N/mm$^2)^{0.3} = \mathbf{34077}$ N/mm^2

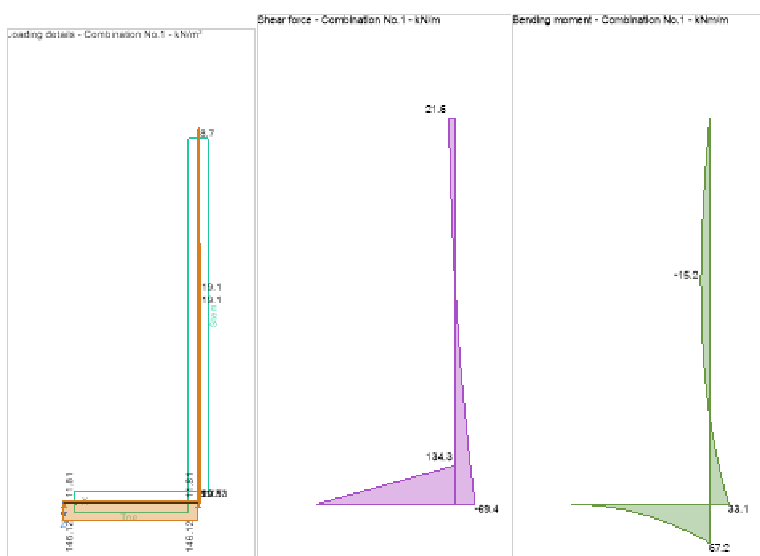
Partial factor for concrete - Table 2.1N	γ_C = **1.50**
Compressive strength coefficient - cl.3.1.6(1)	α_{cc} = **0.85**
Design compressive concrete strength - exp.3.15	$f_{cd} = \alpha_{cc} \times f_{ck} / \gamma_C$ = **19.8** N/mm^2
Maximum aggregate size	h_{agg} = **20** mm
Ultimate strain - Table 3.1	ε_{cu2} = **0.0035**
Shortening strain - Table 3.1	ε_{cu3} = **0.0035**
Effective compression zone height factor	λ = **0.80**
Effective strength factor	η = **1.00**
Bending coefficient k_1	K_1 = **0.40**
Bending coefficient k_2	$K_2 = 1.00 \times (0.6 + 0.0014/\varepsilon_{cu2})$ = **1.00**
Bending coefficient k_3	K_3 =**0.40**
Bending coefficient k_4	$K_4 = 1.00 \times (0.6 + 0.0014/\varepsilon_{cu2})$ =**1.00**

Reinforcement details

Characteristic yield strength of reinforcement	f_{yk} = **500** N/mm^2
Modulus of elasticity of reinforcement	E_s = **200000** N/mm^2
Partial factor for reinforcing steel - Table 2.1N	γ_S = **1.15**
Design yield strength of reinforcement	$f_{yd} = f_{yk} / \gamma_S$ = **435** N/mm^2

Cover to reinforcement

Front face of stem	c_{sf} = **25** mm
Rear face of stem	c_{sr} = **60** mm
Top face of base	c_{bt} = **25** mm
Bottom face of base	c_{bb} = **40** mm



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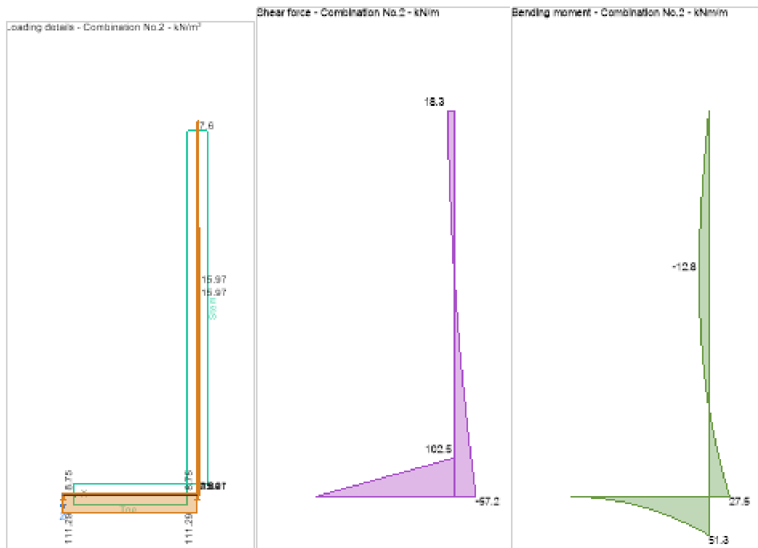


Check stem design at 1595 mm

Depth of section h = **300** mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1 M = **15.2** kNm/m

Depth to tension reinforcement $d = h - c_{sf} - \phi_{sx} - \phi_{sfM} / 2$ = **259** mm

$K = M / (d^2 \times f_{ck})$ = **0.006**

$K' = (2 \times \eta \times \alpha_{cc}/\gamma_C)\times(1 - \lambda \times (\delta - K_1)/(2 \times K_2))\times(\lambda \times (\delta - K_1)/(2 \times K_2))$

K' = **0.207**

K' > K - No compression reinforcement is required

Lever arm $z = \min(0.5 + 0.5 \times (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_C))^{0.5}, 0.95) \times d$ = **246** mm

Depth of neutral axis $x = 2.5 \times (d - z)$ = **32** mm

Area of tension reinforcement required $A_{sfM.req} = M / (f_{yd} \times z)$ = **142** mm²/m

Tension reinforcement provided 12 dia.bars @ 200 c/c

Area of tension reinforcement provided $A_{sfM.prov} = \pi \times \phi_{sfM}^2 / (4 \times s_{sfM})$ = **565** mm²/m

Minimum area of reinforcement - exp.9.1N $A_{sfM.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d$ = **432** mm²/m

Maximum area of reinforcement - cl.9.2.1.1(3) $A_{sfM.max} = 0.04 \times h$ = **12000** mm²/m

$\max(A_{sfM.req}, A_{sfM.min}) / A_{sfM.prov}$ = **0.765**

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

Library item: Rectangular single output

Deflection control - Section 7.4

Reference reinforcement ratio $\rho_0 = \sqrt{(f_{ck} / 1\ \text{N/mm}^2)} / 1000$ = **0.006**

Required tension reinforcement ratio $\rho = A_{sfM.req} / d$ = **0.001**

Required compression reinforcement ratio $\rho' = A_{sfM.2.req} / d_2$ = **0.000**

Structural system factor - Table 7.4N K_b = **1**

Reinforcement factor - exp.7.17 $K_s = \min(500\ \text{N/mm}^2 / (f_{yk} \times A_{sfM.req} / A_{sfM.prov}), 1.5)$ = **1.5**

Limiting span to depth ratio - exp.7.16.a $\min(K_s \times K_b \times [11 + 1.5 \times \sqrt{(f_{ck} / 1\ \text{N/mm}^2)} \times \rho_0 / \rho + 3.2 \times \sqrt{(f_{ck} / 1\ \text{N/mm}^2)} \times (\rho_0 / \rho - 1)^{3/2}], 40 \times K_b)$ = **40**

Actual span to depth ratio h_{prop} / d = **10.8**

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

Crack control - Section 7.3

Limiting crack width w_{max} = **0.3** mm

Variable load factor - EN1990 – Table A1.1 ψ_2 = **0.6**

Serviceability bending moment M_{sls} = **9.7** kNm/m

Tensile stress in reinforcement $\sigma_s = M_{sls} / (A_{sfM.prov} \times z)$ = **69.6** N/mm^2

Load duration Long term

Load duration factor k_t = **0.4**

Effective area of concrete in tension $A_{c.eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$

$A_{c.eff}$ = **89208** mm^2/m

Mean value of concrete tensile strength $f_{ct.eff} = f_{ctm}$ = **3.2** N/mm^2

Reinforcement ratio $\rho_{p.eff} = A_{sfM.prov} / A_{c.eff}$ = **0.006**

Modular ratio $\alpha_e = E_s / E_{cm}$ = **5.869**

Bond property coefficient k_1 = **0.8**

Strain distribution coefficient k_2 = **0.5**

k_3 = **3.4**

k_4 = **0.425**

Maximum crack spacing - exp.7.11 $s_{r.max} = k_3 \times c_{sf} + k_1 \times k_2 \times k_4 \times \phi_{sfM} / \rho_{p.eff}$ = **407** mm

Maximum crack width - exp.7.8 $w_k = s_{r.max} \times \max(\sigma_s - k_t \times (f_{ct.eff} / \rho_{p.eff}) \times (1 + \alpha_e \times \rho_{p.eff}), 0.6 \times \sigma_s) / E_s$

w_k = **0.085** mm

w_k / w_{max} = **0.283**

PASS - Maximum crack width is less than limiting crack width

Check stem design at base of stem

Depth of section h = **300** mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1 M = **33.1** kNm/m

Depth to tension reinforcement $d = h - c_{sr} - \phi_{sr} / 2$ = **234** mm

$K = M / (d^2 \times f_{ck})$ = **0.017**

$K' = (2 \times \eta \times \alpha_{cc}/\gamma_C)\times(1 - \lambda \times (\delta - K_1)/(2 \times K_2))\times(\lambda \times (\delta - K_1)/(2 \times K_2))$

K' = **0.207**

K' > K - No compression reinforcement is required

Lever arm $z = \min(0.5 + 0.5 \times (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_C))^{0.5}, 0.95) \times d$ = **222** mm

Depth of neutral axis $x = 2.5 \times (d – z)$ = **29** mm

Area of tension reinforcement required $A_{sr.req} = M / (f_{yd} \times z)$ = **342** mm^2/m

Tension reinforcement provided 12 dia.bars @ 200 c/c

Area of tension reinforcement provided $A_{sr.prov} = \pi \times \phi_{sr}^2 / (4 \times s_{sr})$ = **565** mm^2/m

Minimum area of reinforcement - exp.9.1N $A_{sr.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d$ = **391** mm^2/m

Maximum area of reinforcement - cl.9.2.1.1(3) $A_{sr.max} = 0.04 \times h$ = **12000** mm^2/m

$\max(A_{sr.req}, A_{sr.min}) / A_{sr.prov}$ = **0.691**

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

Library item: Rectangular single output

Deflection control - Section 7.4

Reference reinforcement ratio $\rho_0 = \sqrt{(f_{ck} / 1 \text{ N/mm}^2)} / 1000$ = **0.006**

Required tension reinforcement ratio $\rho = A_{sr.req} / d = \mathbf{0.001}$

Required compression reinforcement ratio $\rho' = A_{sr.2.req} / d_2 = \mathbf{0.000}$

Structural system factor - Table 7.4N $K_b = \mathbf{1}$

Reinforcement factor - exp.7.17 $K_s = \min(500\ N/mm^2 / (f_{yk} \times A_{sr.req} / A_{sr.prov}), 1.5) = \mathbf{1.5}$

Limiting span to depth ratio - exp.7.16.a $\min(K_s \times K_b \times [11 + 1.5 \times \sqrt{(f_{ck} / 1\ N/mm^2)} \times \rho_0 / \rho + 3.2 \times \sqrt{(f_{ck} / 1\ N/mm^2)} \times (\rho_0 / \rho - 1)^{3/2}], 40 \times K_b) = \mathbf{40}$

Actual span to depth ratio $h_{prop} / d = \mathbf{12}$

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

Crack control - Section 7.3

Limiting crack width $w_{max} = \mathbf{0.3}$ mm

Variable load factor - EN1990 – Table A1.1 $\psi_2 = \mathbf{0.6}$

Serviceability bending moment $M_{sls} = \mathbf{21.6}$ kNm/m

Tensile stress in reinforcement $\sigma_s = M_{sls} / (A_{sr.prov} \times z) = \mathbf{171.7}$ N/mm²

Load duration Long term

Load duration factor $k_t = \mathbf{0.4}$

Effective area of concrete in tension $A_{c.eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$

$A_{c.eff} = \mathbf{90250}$ mm²/m

Mean value of concrete tensile strength $f_{ct.eff} = f_{ctm} = \mathbf{3.2}$ N/mm²

Reinforcement ratio $\rho_{p.eff} = A_{sr.prov} / A_{c.eff} = \mathbf{0.006}$

Modular ratio $\alpha_e = E_s / E_{cm} = \mathbf{5.869}$

Bond property coefficient $k_1 = \mathbf{0.8}$

Strain distribution coefficient $k_2 = \mathbf{0.5}$

$k_3 = \mathbf{3.4}$

$k_4 = \mathbf{0.425}$

Maximum crack spacing - exp.7.11 $s_{r.max} = k_3 \times c_{sr} + k_1 \times k_2 \times k_4 \times \phi_{sr} / \rho_{p.eff} = \mathbf{530}$ mm

Maximum crack width - exp.7.8 $w_k = s_{r.max} \times \max(\sigma_s - k_t \times (f_{ct.eff} / \rho_{p.eff}) \times (1 + \alpha_e \times \rho_{p.eff}), 0.6 \times \sigma_s) / E_s$

$w_k = \mathbf{0.273}$ mm

$w_k / w_{max} = \mathbf{0.909}$

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force $V = \mathbf{69.4}$ kN/m

$C_{Rd,c} = 0.18 / \gamma_C = \mathbf{0.120}$

$k = \min(1 + \sqrt{(200\ mm / d)}, 2) = \mathbf{1.925}$

Longitudinal reinforcement ratio $\rho_l = \min(A_{sr.prov} / d, 0.02) = \mathbf{0.002}$

$v_{min} = 0.035\ N^{1/2}/mm \times k^{3/2} \times f_{ck}^{0.5} = \mathbf{0.553}$ N/mm²

Design shear resistance - exp.6.2a & 6.2b $V_{Rd.c} = \max(C_{Rd.c} \times k \times (100\ N^2/mm^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$

$V_{Rd.c} = \mathbf{129.4}$ kN/m

$V / V_{Rd.c} = \mathbf{0.536}$

PASS - Design shear resistance exceeds design shear force

Check stem design at prop

Depth of section $h = \mathbf{300}$ mm

Rectangular section in shear - Section 6.2

Design shear force $V = \mathbf{21.6}$ kN/m

$C_{Rd,c} = 0.18 / \gamma_C = \mathbf{0.120}$

$k = \min(1 + \sqrt{(200\ mm / d)}, 2) = \mathbf{1.925}$

Longitudinal reinforcement ratio $\rho_l = \min(A_{sr1.prov} / d, 0.02) = \mathbf{0.002}$

$v_{min} = 0.035\ N^{1/2}/mm \times k^{3/2} \times f_{ck}^{0.5} = \mathbf{0.553}\ N/mm^2$

Design shear resistance - exp.6.2a & 6.2b $V_{Rd.c} = \max(C_{Rd.c} \times k \times (100\ N^2/mm^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$

$V_{Rd.c} = \mathbf{129.4}\ kN/m$

$V / V_{Rd.c} = \mathbf{0.167}$

PASS - Design shear resistance exceeds design shear force

Horizontal reinforcement parallel to face of stem - Section 9.6

Minimum area of reinforcement – cl.9.6.3(1) $A_{sx.req} = \max(0.25 \times A_{sr.prov}, 0.001 \times t_{stem}) = \mathbf{300}\ mm^2/m$

Maximum spacing of reinforcement – cl.9.6.3(2) $s_{sx\_max} = \mathbf{400}\ mm$

Transverse reinforcement provided 10 dia.bars @ 200 c/c

Area of transverse reinforcement provided $A_{sx.prov} = \pi \times \phi_{sx}^2 / (4 \times s_{sx}) = \mathbf{393}\ mm^2/m$

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

Check base design at toe

Depth of section $h = \mathbf{350}\ mm$

Rectangular section in flexure - Section 6.1

Design bending moment combination 1 $M = \mathbf{67.2}\ kNm/m$

Depth to tension reinforcement $d = h - c_{bb} - \phi_{bb} / 2 = \mathbf{304}\ mm$

$K = M / (d^2 \times f_{ck}) = \mathbf{0.021}$

$K' = (2 \times \eta \times \alpha_{cc}/\gamma_C)\times(1 - \lambda \times (\delta - K_1)/(2 \times K_2))\times(\lambda \times (\delta - K_1)/(2 \times K_2))$

$K' = \mathbf{0.207}$

K' > K - No compression reinforcement is required

Lever arm $z = \min(0.5 + 0.5 \times (1 - 2 \times K / (\eta \times \alpha_{cc} / \gamma_C))^{0.5}, 0.95) \times d = \mathbf{289}\ mm$

Depth of neutral axis $x = 2.5 \times (d – z) = \mathbf{38}\ mm$

Area of tension reinforcement required $A_{bb.req} = M / (f_{yd} \times z) = \mathbf{535}\ mm^2/m$

Tension reinforcement provided 12 dia.bars @ 100 c/c

Area of tension reinforcement provided $A_{bb.prov} = \pi \times \phi_{bb}^2 / (4 \times s_{bb}) = \mathbf{1131}\ mm^2/m$

Minimum area of reinforcement - exp.9.1N $A_{bb.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d = \mathbf{507}\ mm^2/m$

Maximum area of reinforcement - cl.9.2.1.1(3) $A_{bb.max} = 0.04 \times h = \mathbf{14000}\ mm^2/m$

$\max(A_{bb.req}, A_{bb.min}) / A_{bb.prov} = \mathbf{0.473}$

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

Library item: Rectangular single output

Crack control - Section 7.3

Limiting crack width $w_{max} = \mathbf{0.3}\ mm$

Variable load factor - EN1990 – Table A1.1 $\psi_2 = \mathbf{0.6}$

Serviceability bending moment $M_{sls} = \mathbf{48.8}\ kNm/m$

Tensile stress in reinforcement $\sigma_s = M_{sls} / (A_{bb.prov} \times z) = \mathbf{149.5}\ N/mm^2$

Load duration Long term

Load duration factor $k_t = \mathbf{0.4}$

Effective area of concrete in tension $A_{c.eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$

$A_{c.eff} = \mathbf{104000}\ mm^2/m$

Mean value of concrete tensile strength $f_{ct.eff} = f_{ctm} = \mathbf{3.2}\ N/mm^2$

Reinforcement ratio — $\rho_{p.eff} = A_{bb.prov} / A_{c.eff} = \mathbf{0.011}$

Modular ratio — $\alpha_e = E_s / E_{cm} = \mathbf{5.869}$

Bond property coefficient — $k_1 = \mathbf{0.8}$

Strain distribution coefficient — $k_2 = \mathbf{0.5}$

$k_3 = \mathbf{3.4}$

$k_4 = \mathbf{0.425}$

Maximum crack spacing - exp.7.11 — $s_{r.max} = k_3 \times c_{bb} + k_1 \times k_2 \times k_4 \times \phi_{bb} / \rho_{p.eff} = \mathbf{324}$ mm

Maximum crack width - exp.7.8 — $w_k = s_{r.max} \times \max(\sigma_s - k_t \times (f_{ct.eff} / \rho_{p.eff}) \times (1 + \alpha_e \times \rho_{p.eff}), 0.6 \times \sigma_s) / E_s$

$w_k = \mathbf{0.145}$ mm

$w_k / w_{max} = \mathbf{0.484}$

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force — V = **134.3** kN/m

$C_{Rd,c} = 0.18 / \gamma_C = \mathbf{0.120}$

$k = \min(1 + \sqrt{(200 \text{ mm} / d)}, 2) = \mathbf{1.811}$

Longitudinal reinforcement ratio — $\rho_l = \min(A_{bb.prov} / d, 0.02) = \mathbf{0.004}$

$v_{min} = 0.035 \text{ N}^{1/2}/\text{mm} \times k^{3/2} \times f_{ck}^{0.5} = \mathbf{0.505}$ N/mm²

Design shear resistance - exp.6.2a & 6.2b — $V_{Rd.c} = \max(C_{Rd.c} \times k \times (100 \text{ N}^2/\text{mm}^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$

$V_{Rd.c} = \mathbf{155.4}$ kN/m

$V / V_{Rd.c} = \mathbf{0.864}$

PASS - Design shear resistance exceeds design shear force

Secondary transverse reinforcement to base - Section 9.3

Minimum area of reinforcement – cl.9.3.1.1(2) — $A_{bx.req} = 0.2 \times A_{bb.prov} = \mathbf{226}$ mm²/m

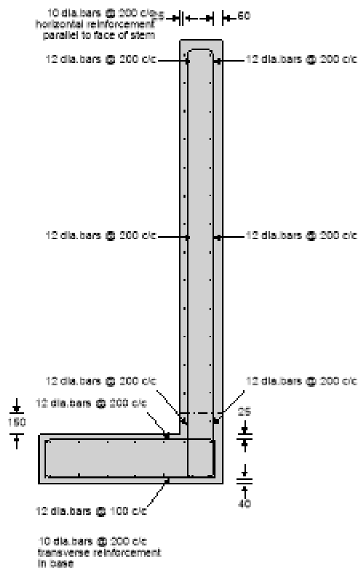
Maximum spacing of reinforcement – cl.9.3.1.1(3) — $s_{bx\_max} = \mathbf{450}$ mm

Transverse reinforcement provided — 10 dia.bars @ 200 c/c

Area of transverse reinforcement provided — $A_{bx.prov} = \pi \times \phi_{bx}^2 / (4 \times s_{bx}) = \mathbf{393}$ mm²/m

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

Tekla Tedds	Project 11-15 King's Terrace				Job Ref. 8292	
	Section Propped underpin analysis and design for party wall				Sheet no./rev. 10	
	Calc. by JE	Date	Chk'd by MB	Date	App'd by	Date



Reinforcement details