VINCENT & RYMILL

APPENDIX 2

STRUCTURAL CALCULATIONS

PITCHED ROOF	**KN/m^2**	**CEILING**	**KN/m^2**
Tiles	0.70	Ceiling Joists	0.10
Felt & battens	0.05	Plasterboard	0.15
Rafters	0.10	D. L.	0.25 KN/m^2
	0.85	I. L. where applicable	0.25 KN/m^2
45^0 on plan load D. L.	1.20 KN/m^2		0.50 KN/m^2
45^0 Imposed Load	0.38 KN/m^2		
	1.58 KN/m^2		

FLAT ROOF	**KN/m^2**	**TIMBER FLOORS**	**KN/m^2**
Felt	0.25	Boards	0.20
Boards	0.25	Joists	0.10
Joists & firrings	0.15	Ceiling	0.20
Ceiling	0.15	D. L.	0.50 KN/m^2
D. L.	0.80 KN/m^2	I. L.	1.50 KN/m^2
I .L.	0.75 KN/m^2		2.00 KN/m^2
	1.55 KN/m^2		

MASONRY	**KN/m^2**
102 Brick	2.20 KN/m^2
100 lt. wt blk + (1 x plaster)	1.10 KN/m^2
100 lt. wt blk + (2 x plaster)	1.35 KN/m^2
100 dense blk + (1 x plaster)	1.85 KN/m^2
215 BRICK + PLASTER	4.60KN/m^2
330 BRICK + PLASTER	6.80KN/m^2

DESIGN PHILOSOPHY

Walls to be Underpinned

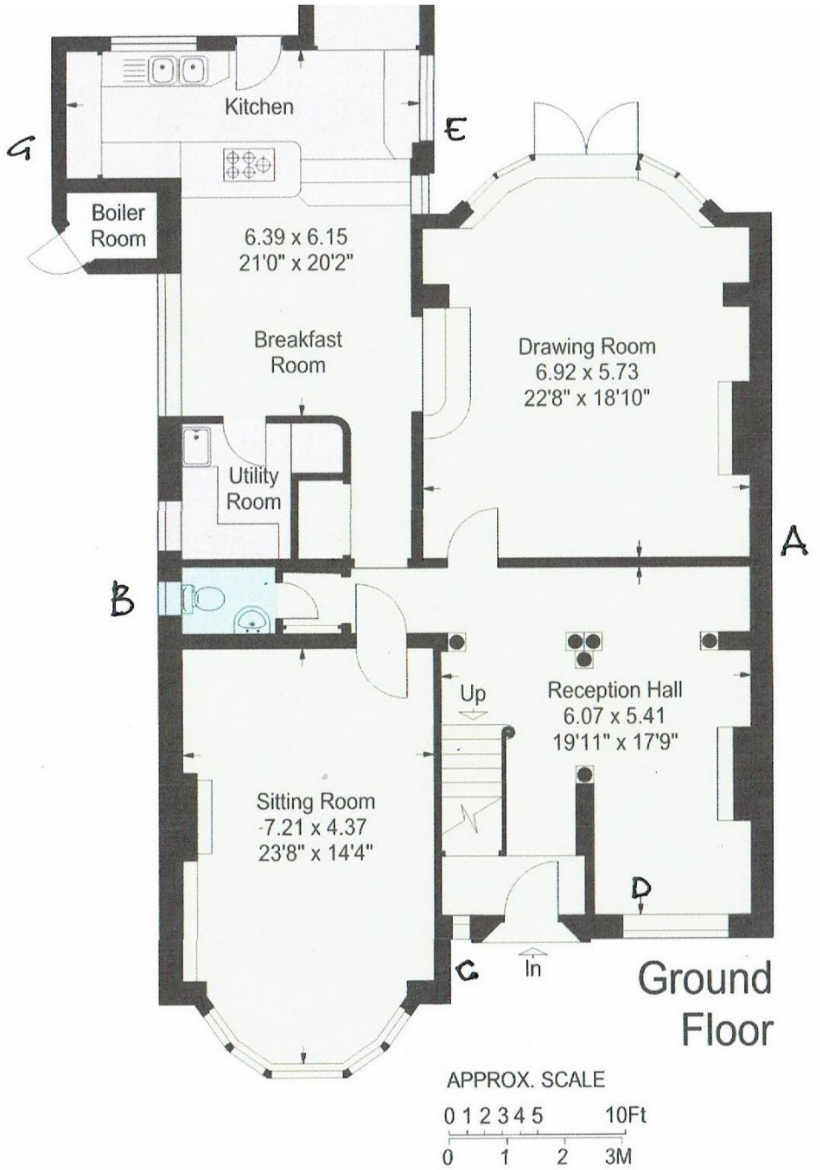
New concrete walls below the property are designed as propped cantilevers in reinforced concrete, the lower ground floor slab acting as a lateral at the base prop at base level. The walls will be designed using the soil parameters relative to the site. The walls will be designed for a water table at 1.0m below ground level.

The surcharge load allowed on the external walls of the property will be 10KN/m^2 . The party wall bounding will have a surcharge load of 10.00KN/m^2 for adjoining floor and partition wall construction and will also take into account any loads from adjoining foundations.

The basement slab will be formed in reinforced concrete. It will be designed for uplift due to water pressure below, and as a clear span under finish and imposed load, it will be protected by any uplift due to heave from Cordek. The basement slab will act as a lateral prop to the base of the basement walls.

Final super structure design is subject to soft strip of the existing building to expose existing floor spans etc. Calculations for the proposed revised super structure elements as well as the new ground floor concrete slab and steel beams will not form part of this preliminary set of calculations.

KEY PLAN



V&R VINCENT & RYMILL	Project			Job Ref.	
VINCENT & RYMILL LAKESIDE COUNTRY CLUB FRIMLEY GREEN SURREY GU16 6PT	16 ROSECROFT AVE., LONDON. NW3 7QB			18E03	
	Section			Sheet no./rev.	
	PRELIMINARY STRUCTURAL CALCULATIONS			3	
	Calc. by	Date	Chk'd by	Date	App'd by	Date
	TV	29/06/2018				

WALL A

WALL	11.5 X 6.8	=	78.20	
ROOF DL	1.2 X 2	=	2.40	
ROOF IL	0.4 X 2	=	______	0.80
			80.60KN/m	0.80KN/m

WALL B

ROOF DL	1.2 X 3	=	3.60	
ROOF IL	0.4 X 3	=		1.20
FLR DL	2 X 0.6 X 2	=	2.40	
FLR IL	2 X 1.5 X 2	=		6.00
WALL	7 X 6.8 X 85%	=	40.50	_____
			47.5KN/m	7.2KN/m

WALL C

WALL	8.5 X 6.8	=	57.80KN/m

WALL D

WALL	7 X 6.8 X 60%	=	29.00KN/m

WALLS E & G

ROOF DL	2.5 X 1.2	=	3.00	
ROOF IL	2.50 X 0.5	=		1.25
WALL	7.5 X 4.6	=	34.50	
FLRS DL	2 X 2 X 0.6	=	2.40	
FLRS IL	2 X 2X 1.5	=	______	6.00
			39.40KN/m	7.25KN/m

WALL F

WALL	7.5 X 4.6 X 0.5	=	17.25KN/m

WALLS AND BASES TO LOWER GROUND FLOOR

WALL A – PARTY WALL

DL = 80.6KN/m, IL = 0.8KN/m

ALREADY UNDERPINNED BY PREVIOUIS WORKS TO NO 16 ROSECROFT

WALL B

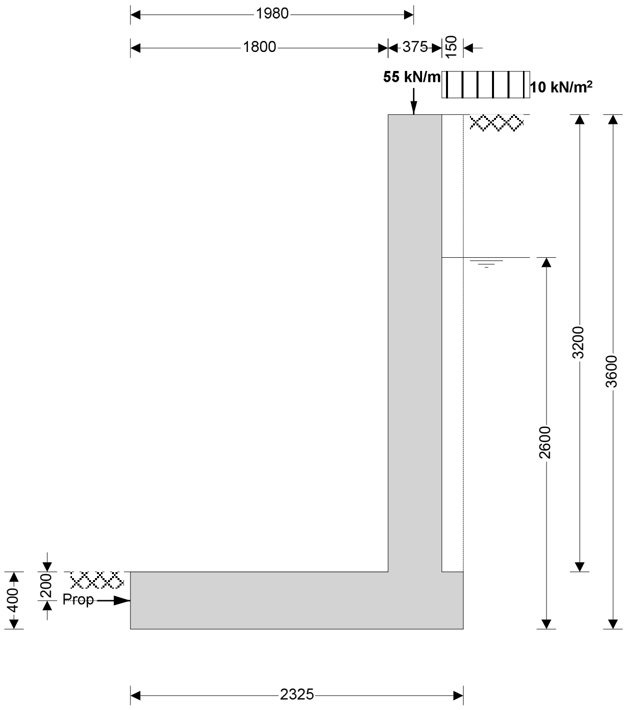
SIDE WALL

DL = 47.5KN/m, IL = 7.2KN/m

RETAINING WALL ANALYSIS & DESIGN (BS8002)

RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.06



Wall details

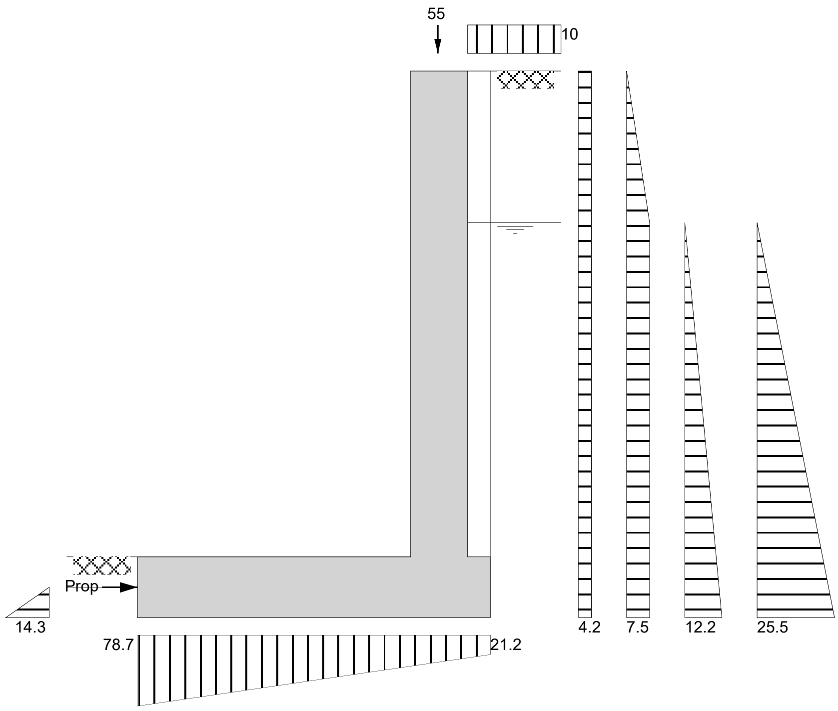
Retaining wall type	**Cantilever**		
Height of wall stem	h_{stem} = **3200** mm	Wall stem thickness	t_{wall} = **375** mm
Length of toe	l_{toe} = **1800** mm	Length of heel	l_{heel} = **150** mm
Overall length of base	l_{base} = **2325** mm	Base thickness	t_{base} = **400** mm
Height of retaining wall	h_{wall} = **3600** mm		
Depth of downstand	d_{ds} = **0** mm	Thickness of downstand	t_{ds} = **400** mm
Position of downstand	l_{ds} = **1900** mm		
Depth of cover in front of wall	d_{cover} = **0** mm	Unplanned excavation depth	d_{exc} = **200** mm
Height of ground water	h_{water} = **2600** mm	Density of water	γ_{water} = 9.81 kN/m^3
Density of wall construction	γ_{wall} = **23.6** kN/m^3	Density of base construction	γ_{base} = **23.6** kN/m^3
Angle of soil surface	β = **0.0** deg	Effective height at back of wall	h_{eff} = **3600** mm
Mobilisation factor	M = **1.5**		
Moist density	γ_m = **18.0** kN/m^3	Saturated density	γ_s = **21.0** kN/m^3
Design shear strength	ϕ' = **24.2** deg	Angle of wall friction	δ = **0.0** deg
Design shear strength	ϕ'_b = **24.2** deg	Design base friction	δ_b = **18.6** deg
Moist density	γ_{mb} = **18.0** kN/m^3	Allowable bearing	$P_{bearing}$ = **125** kN/m^2

Using Coulomb theory

Active pressure	K_a =**0.419**	Passive pressure	K_p = **4.187**
At-rest pressure	K_0 = **0.590**		

Loading details

Surcharge load	Surcharge = **10.0** kN/m^2		
Vertical dead load	W_{dead} = **47.5** kN/m	Vertical live load	W_{live} = **7.2** kN/m
Horizontal dead load	F_{dead} = **0.0** kN/m	Horizontal live load	F_{live} = **0.0** kN/m
Position of vertical load	l_{load} = **1980** mm	Height of horizontal load	h_{load} = **0** mm



Loads shown in kN/m, pressures shown in kN/m^2

Calculate propping force

Propping force F_{prop} = **49.8** kN/m

Check bearing pressure

Total vertical reaction	R = **116.1** kN/m	Distance to reaction	x_{bar} = **939** mm
Eccentricity of reaction	e = **223** mm		

Reaction acts within middle third of base

Bearing pressure at toe	p_{toe} = **78.7** kN/m^2	Bearing pressure at heel	p_{heel} = **21.2** kN/m^2

PASS - Maximum bearing pressure is less than allowable bearing pressure

RETAINING WALL DESIGN (BS 8002:1994)

TEDDS calculation version 1.2.01.06

Ultimate limit state load factors

Dead load factor γ_{f_d} = **1.4** Live load factor γ_{f_l} = **1.6**

Earth pressure factor γ_{f_e} = **1.4**

Calculate propping force

Propping force F_{prop} = **49.8** kN/m

Design of reinforced concrete retaining wall toe (BS 8002:1994)

Material properties

Strength of concrete f_{cu} = **40** N/mm^2 Strength of reinforcement f_y = **500** N/mm^2

Base details

Minimum reinforcement k = **0.13** % Cover in toe c_{toe} = **50** mm

Design of retaining wall toe

Shear at heel V_{toe} = **140.0** kN/m Moment at heel M_{toe} = **201.3** kNm/m

Compression reinforcement is not required

Check toe in bending

Reinforcement provided **16 mm dia.bars @ 125 mm centres**

Area required $A_{s\_toe\_req}$ = **1424.8** mm^2/m Area provided $A_{s\_toe\_prov}$ = **1608** mm^2/m

PASS - Reinforcement provided at the retaining wall toe is adequate

Check shear resistance at toe

Design shear stress v_{toe} = **0.409** N/mm^2 Allowable shear stress v_{adm} = **5.000** N/mm^2

PASS - Design shear stress is less than maximum shear stress

Concrete shear stress v_{c_toe} = **0.563** N/mm^2

$v_{toe} < v_{c\_toe}$ - No shear reinforcement required

Design of reinforced concrete retaining wall heel (BS 8002:1994)

Material properties

Strength of concrete f_{cu} = **40** N/mm^2 Strength of reinforcement f_y = **500** N/mm^2

Base details

Minimum reinforcement k = **0.13** % Cover in heel c_{heel} = **50** mm

Design of retaining wall heel

Shear at heel V_{heel} = **17.9** kN/m Moment at heel M_{heel} = **4.9** kNm/m

Compression reinforcement is not required

Check heel in bending

Reinforcement provided **B785 mesh**

Area required $A_{s\_heel\_req}$ = **520.0** mm^2/m Area provided $A_{s\_heel\_prov}$ = **785** mm^2/m

PASS - Reinforcement provided at the retaining wall heel is adequate

Check shear resistance at heel

Design shear stress v_{heel} = **0.052** N/mm^2 Allowable shear stress v_{adm} = **5.000** N/mm^2

PASS - Design shear stress is less than maximum shear stress

Concrete shear stress v_{c_heel} = **0.468** N/mm^2

$v_{heel} < v_{c\_heel}$ - No shear reinforcement required

Design of reinforced concrete retaining wall stem (BS 8002:1994)

Material properties

Strength of concrete f_{cu} = **40** N/mm^2 Strength of reinforcement f_y = **500** N/mm^2

Wall details

Minimum reinforcement k = **0.13** %

Cover in stem c_{stem} = **75** mm Cover in wall c_{wall} = **50** mm

Design of retaining wall stem

Shear at base of stem V_{stem} = **20.8** kN/m Moment at base of stem M_{stem} = **151.5** kNm/m

Compression reinforcement is not required

Check wall stem in bending

Reinforcement provided **16 mm dia.bars @ 100 mm centres**

Area required $A_{s\_stem\_req}$ = **1258.0** mm^2/m Area provided $A_{s\_stem\_prov}$ = **2011** mm^2/m

PASS - Reinforcement provided at the retaining wall stem is adequate

Check shear resistance at wall stem

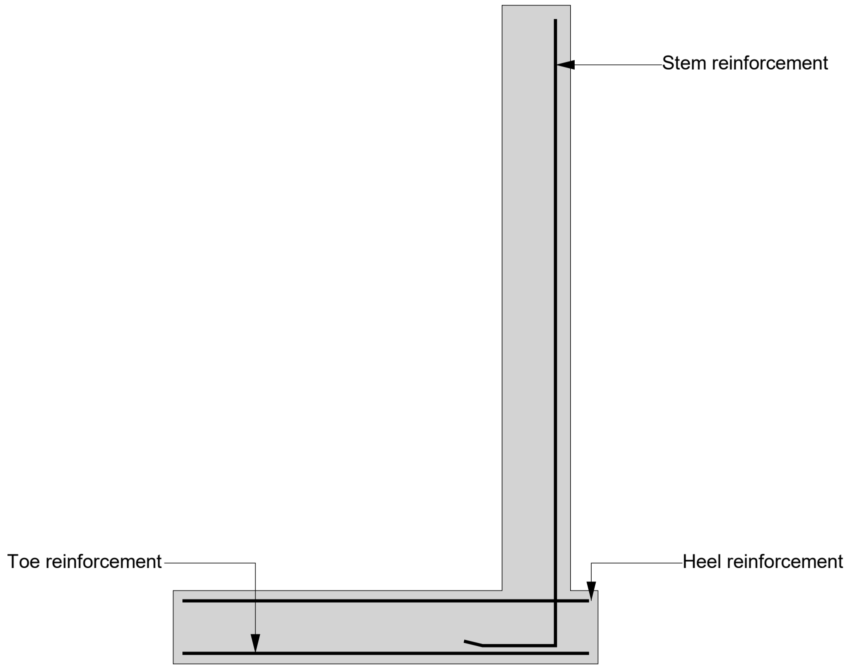
Design shear stress v_{stem} = **0.071** N/mm^2 Allowable shear stress v_{adm} = **5.000** N/mm^2

PASS - Design shear stress is less than maximum shear stress

Concrete shear stress v_{c_stem} = **0.706** N/mm^2

$v_{stem} < v_{c\_stem}$ - No shear reinforcement required

Indicative retaining wall reinforcement diagram



Toe bars - 16 mm dia.@ 125 mm centres - (1608 mm^2/m)

Heel mesh - B785 - (785 mm^2/m)

Stem bars - 16 mm dia.@ 100 mm centres - (2011 mm^2/m)

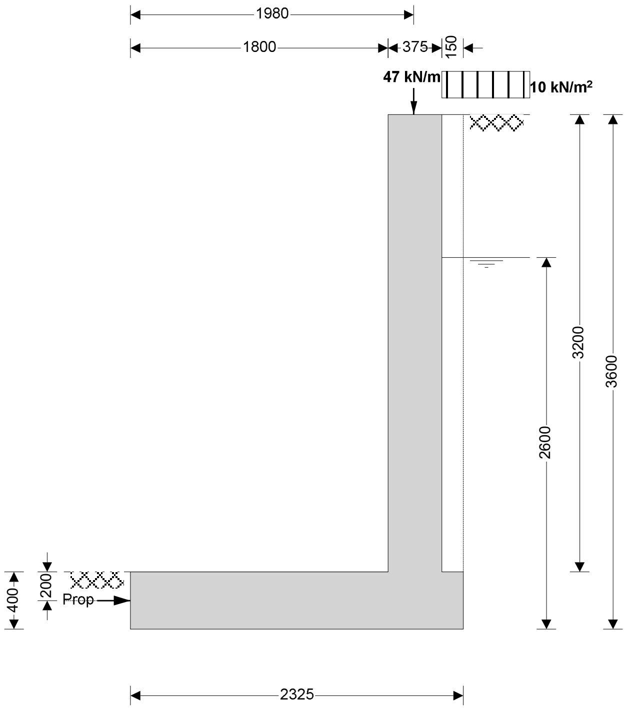
WALLS E AND G

DL = 39.4KN/m, IL = 7.25KN/m

RETAINING WALL ANALYSIS & DESIGN (BS8002)

RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.06



Wall details

Retaining wall type	**Cantilever**		
Height of wall stem	h_{stem} = **3200** mm	Wall stem thickness	t_{wall} = **375** mm
Length of toe	l_{toe} = **1800** mm	Length of heel	l_{heel} = **150** mm
Overall length of base	l_{base} = **2325** mm	Base thickness	t_{base} = **400** mm
Height of retaining wall	h_{wall} = **3600** mm		
Depth of downstand	d_{ds} = **0** mm	Thickness of downstand	t_{ds} = **400** mm
Position of downstand	l_{ds} = **1850** mm		
Depth of cover in front of wall	d_{cover} = **0** mm	Unplanned excavation depth	d_{exc} = **200** mm
Height of ground water	h_{water} = **2600** mm	Density of water	γ_{water} = 9.81 kN/m^3
Density of wall construction	γ_{wall} = **23.6** kN/m^3	Density of base construction	γ_{base} = **23.6** kN/m^3
Angle of soil surface	β = **0.0** deg	Effective height at back of wall	h_{eff} = **3600** mm
Mobilisation factor	M = **1.5**		
Moist density	γ_m = **18.0** kN/m^3	Saturated density	γ_s = **21.0** kN/m^3
Design shear strength	ϕ' = **24.2** deg	Angle of wall friction	δ = **0.0** deg
Design shear strength	ϕ'_b = **24.2** deg	Design base friction	δ_b = **18.6** deg
Moist density	γ_{mb} = **18.0** kN/m^3	Allowable bearing	$P_{bearing}$ = **125** kN/m^2

Using Coulomb theory

Active pressure	K_a =**0.419**	Passive pressure	K_p = **4.187**
At-rest pressure	K_0 = **0.590**		

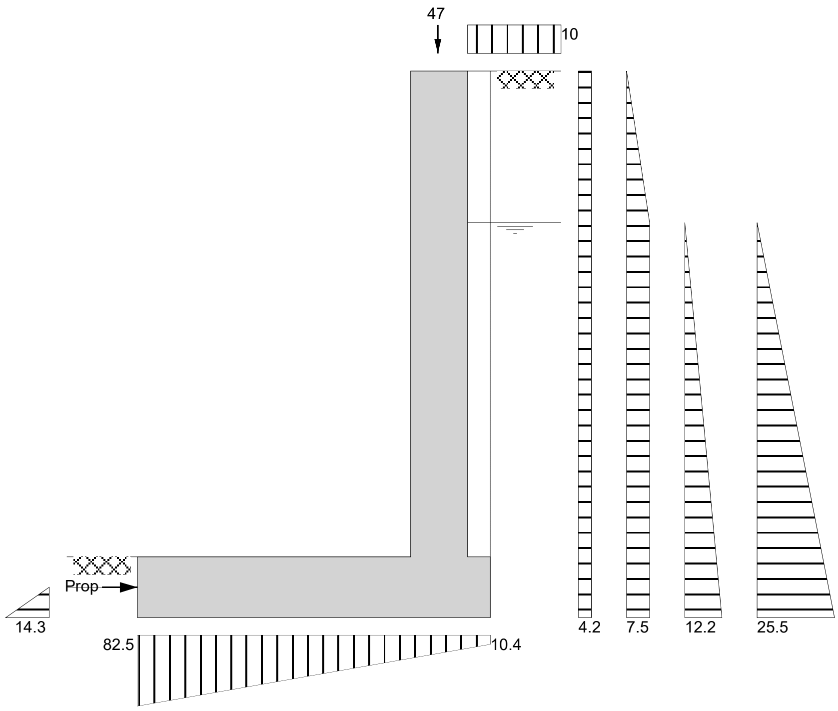
Loading details

Surcharge load — Surcharge = **10.0** kN/m^2

Vertical dead load — W_{dead} = **39.4** kN/m — Vertical live load — W_{live} = **7.3** kN/m

Horizontal dead load — F_{dead} = **0.0** kN/m — Horizontal live load — F_{live} = **0.0** kN/m

Position of vertical load — l_{load} = **1980** mm — Height of horizontal load — h_{load} = **0** mm



Loads shown in kN/m, pressures shown in kN/m^2

Calculate propping force

Propping force — F_{prop} = **52.6** kN/m

Check bearing pressure

Total vertical reaction — R = **108.0** kN/m — Distance to reaction — x_{bar} = **862** mm

Eccentricity of reaction — e = **301** mm

Reaction acts within middle third of base

Bearing pressure at toe — p_{toe} = **82.5** kN/m^2 — Bearing pressure at heel — p_{heel} = **10.4** kN/m^2

PASS - Maximum bearing pressure is less than allowable bearing pressure

RETAINING WALL DESIGN (BS 8002:1994)

TEDDS calculation version 1.2.01.06

Ultimate limit state load factors

Dead load factor γ_{f_d} = **1.4** Live load factor γ_{f_l} = **1.6**

Earth pressure factor γ_{f_e} = **1.4**

Calculate propping force

Propping force F_{prop} = **52.6** kN/m

Design of reinforced concrete retaining wall toe (BS 8002:1994)

Material properties

Strength of concrete f_{cu} = **40** N/mm^2 Strength of reinforcement f_y = **500** N/mm^2

Base details

Minimum reinforcement k = **0.13** % Cover in toe c_{toe} = **50** mm

Design of retaining wall toe

Shear at heel V_{toe} = **129.2** kN/m Moment at heel M_{toe} = **196.1** kNm/m

Compression reinforcement is not required

Check toe in bending

Reinforcement provided **16 mm dia.bars @ 125 mm centres**

Area required $A_{s\_toe\_req}$ = **1387.8** mm^2/m Area provided $A_{s\_toe\_prov}$ = **1608** mm^2/m

PASS - Reinforcement provided at the retaining wall toe is adequate

Check shear resistance at toe

Design shear stress v_{toe} = **0.378** N/mm^2 Allowable shear stress v_{adm} = **5.000** N/mm^2

PASS - Design shear stress is less than maximum shear stress

Concrete shear stress v_{c_toe} = **0.598** N/mm^2

$v_{toe} < v_{c\_toe}$ - No shear reinforcement required

Design of reinforced concrete retaining wall heel (BS 8002:1994)

Material properties

Strength of concrete f_{cu} = **40** N/mm^2 Strength of reinforcement f_y = **500** N/mm^2

Base details

Minimum reinforcement k = **0.13** % Cover in heel c_{heel} = **50** mm

Design of retaining wall heel

Shear at heel V_{heel} = **17.9** kN/m Moment at heel M_{heel} = **4.9** kNm/m

Compression reinforcement is not required

Check heel in bending

Reinforcement provided **B785 mesh**

Area required $A_{s\_heel\_req}$ = **520.0** mm^2/m Area provided $A_{s\_heel\_prov}$ = **785** mm^2/m

PASS - Reinforcement provided at the retaining wall heel is adequate

Check shear resistance at heel

Design shear stress v_{heel} = **0.052** N/mm^2 Allowable shear stress v_{adm} = **5.000** N/mm^2

PASS - Design shear stress is less than maximum shear stress

Concrete shear stress v_{c_heel} = **0.463** N/mm^2

$v_{heel} < v_{c\_heel}$ - No shear reinforcement required

Design of reinforced concrete retaining wall stem (BS 8002:1994)

Material properties

Strength of concrete f_{cu} = **40** N/mm^2 Strength of reinforcement f_y = **500** N/mm^2

Wall details

Minimum reinforcement k = **0.13** %

Cover in stem c_{stem} = **75** mm Cover in wall c_{wall} = **50** mm

Design of retaining wall stem

Shear at base of stem V_{stem} = **17.0** kN/m Moment at base of stem M_{stem} = **151.5** kNm/m

Compression reinforcement is not required

Check wall stem in bending

Reinforcement provided **16 mm dia.bars @ 100 mm centres**

Area required $A_{s\_stem\_req}$ = **1258.0** mm^2/m Area provided $A_{s\_stem\_prov}$ = **2011** mm^2/m

PASS - Reinforcement provided at the retaining wall stem is adequate

Check shear resistance at wall stem

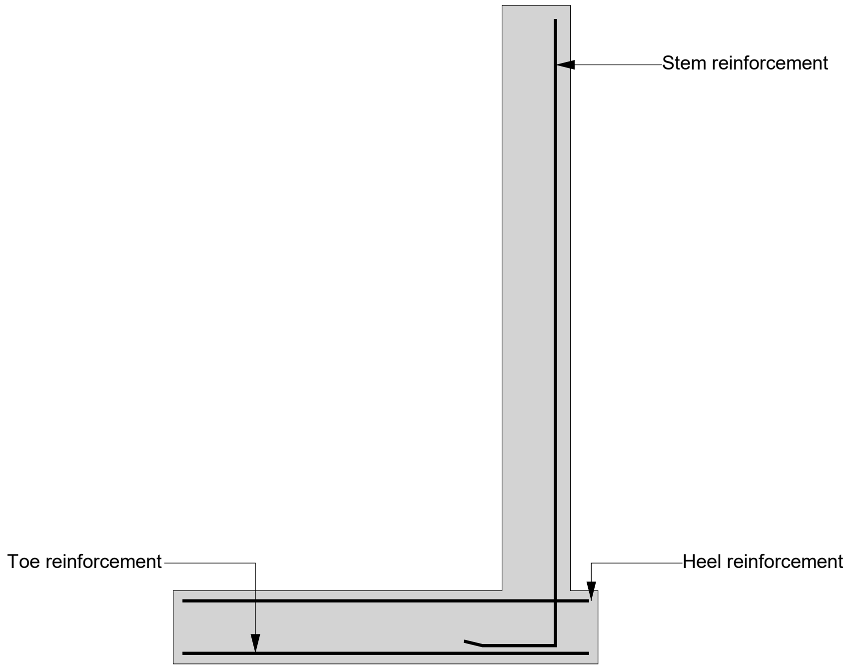
Design shear stress v_{stem} = **0.058** N/mm^2 Allowable shear stress v_{adm} = **5.000** N/mm^2

PASS - Design shear stress is less than maximum shear stress

Concrete shear stress v_{c_stem} = **0.706** N/mm^2

$v_{stem} < v_{c\_stem}$ - No shear reinforcement required

Indicative retaining wall reinforcement diagram



Toe bars - 16 mm dia.@ 125 mm centres - (1608 mm^2/m)

Heel mesh - B785 - (785 mm^2/m)

Stem bars - 16 mm dia.@ 100 mm centres - (2011 mm^2/m)

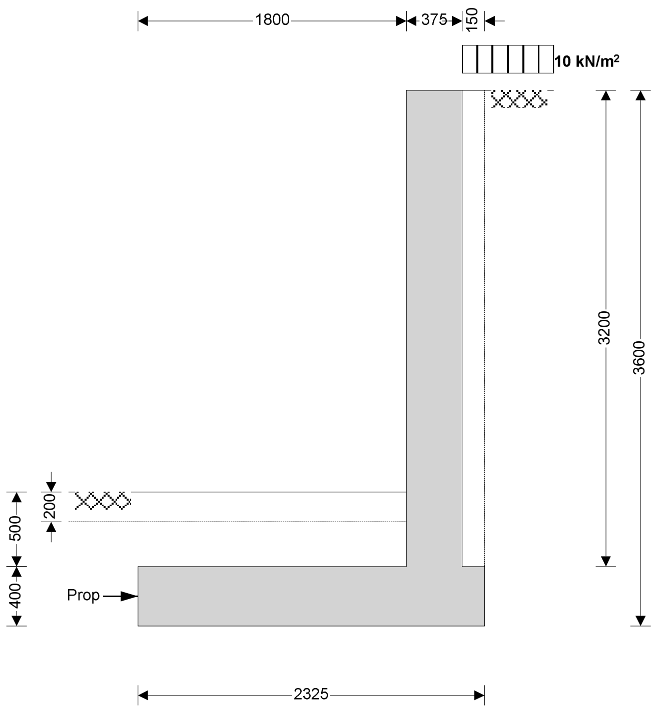
WALL F

DL = 17.25KN/m

RETAINING WALL ANALYSIS & DESIGN (BS8002)

RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.06



Wall details

Retaining wall type	**Cantilever**		
Height of wall stem	h_{stem} = **3200** mm	Wall stem thickness	t_{wall} = **375** mm
Length of toe	l_{toe} = **1800** mm	Length of heel	l_{heel} = **150** mm
Overall length of base	l_{base} = **2325** mm	Base thickness	t_{base} = **400** mm
Height of retaining wall	h_{wall} = **3600** mm		
Depth of downstand	d_{ds} = **0** mm	Thickness of downstand	t_{ds} = **400** mm
Position of downstand	l_{ds} = **1050** mm		
Depth of cover in front of wall	d_{cover} = **500** mm	Unplanned excavation depth	d_{exc} = **200** mm
Height of ground water	h_{water} = **0** mm	Density of water	γ_{water} = 9.81 kN/m^3
Density of wall construction	γ_{wall} = **23.6** kN/m^3	Density of base construction	γ_{base} = **23.6** kN/m^3
Angle of soil surface	β = **0.0** deg	Effective height at back of wall	h_{eff} = **3600** mm
Mobilisation factor	M = **1.5**		
Moist density	γ_m = **18.0** kN/m^3	Saturated density	γ_s = **21.0** kN/m^3
Design shear strength	ϕ' = **24.2** deg	Angle of wall friction	δ = **0.0** deg
Design shear strength	ϕ'_b = **24.2** deg	Design base friction	δ_b = **18.6** deg
Moist density	γ_{mb} = **18.0** kN/m^3	Allowable bearing	$P_{bearing}$ = **125** kN/m^2

Using Coulomb theory

Active pressure	K_a =**0.419**	Passive pressure	K_p = **4.187**
At-rest pressure	K_0 = **0.590**		

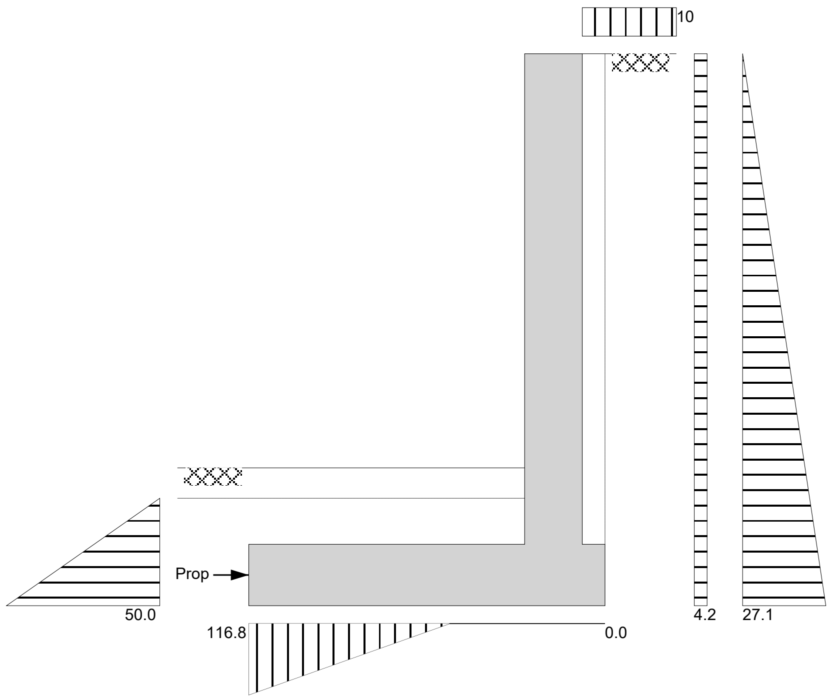
Loading details

Surcharge load — Surcharge = **10.0** kN/m^2

Vertical dead load — W_{dead} = **0.0** kN/m — Vertical live load — W_{live} = **0.0** kN/m

Horizontal dead load — F_{dead} = **0.0** kN/m — Horizontal live load — F_{live} = **0.0** kN/m

Position of vertical load — l_{load} = **0** mm — Height of horizontal load — h_{load} = **0** mm



Loads shown in kN/m, pressures shown in kN/m^2

Calculate propping force

Propping force — F_{prop} = **26.6** kN/m

Check bearing pressure

Total vertical reaction — R = **76.6** kN/m — Distance to reaction — x_{bar} = **437** mm

Eccentricity of reaction — e = **725** mm

Reaction acts outside middle third of base

Bearing pressure at toe — p_{toe} = **116.8** kN/m^2 — Bearing pressure at heel — p_{heel} = **0.0** kN/m^2

PASS - Maximum bearing pressure is less than allowable bearing pressure

RETAINING WALL DESIGN (BS 8002:1994)

TEDDS calculation version 1.2.01.06

Ultimate limit state load factors

Dead load factor γ_{f_d} = **1.4** Live load factor γ_{f_l} = **1.6**

Earth pressure factor γ_{f_e} = **1.4**

Calculate propping force

Propping force F_{prop} = **26.6** kN/m

Design of reinforced concrete retaining wall toe (BS 8002:1994)

Material properties

Strength of concrete f_{cu} = **40** N/mm^2 Strength of reinforcement f_y = **500** N/mm^2

Base details

Minimum reinforcement k = **0.13** % Cover in toe c_{toe} = **50** mm

Design of retaining wall toe

Shear at heel V_{toe} = **10.2** kN/m Moment at heel M_{toe} = **11.3** kNm/m

Compression reinforcement is not required

Check toe in bending

Reinforcement provided **16 mm dia.bars @ 150 mm centres**

Area required $A_{s\_toe\_req}$ = **520.0** mm^2/m Area provided $A_{s\_toe\_prov}$ = **1340** mm^2/m

PASS - Reinforcement provided at the retaining wall toe is adequate

Check shear resistance at toe

Design shear stress v_{toe} = **0.030** N/mm^2 Allowable shear stress v_{adm} = **5.000** N/mm^2

PASS - Design shear stress is less than maximum shear stress

Concrete shear stress v_{c_toe} = **0.563** N/mm^2

$v_{toe} < v_{c\_toe}$ - No shear reinforcement required

Design of reinforced concrete retaining wall heel (BS 8002:1994)

Material properties

Strength of concrete f_{cu} = **40** N/mm^2 Strength of reinforcement f_y = **500** N/mm^2

Base details

Minimum reinforcement k = **0.13** % Cover in heel c_{heel} = **50** mm

Design of retaining wall heel

Shear at heel V_{heel} = **16.5** kN/m Moment at heel M_{heel} = **4.6** kNm/m

Compression reinforcement is not required

Check heel in bending

Reinforcement provided **B785 mesh**

Area required $A_{s\_heel\_req}$ = **520.0** mm^2/m Area provided $A_{s\_heel\_prov}$ = **785** mm^2/m

PASS - Reinforcement provided at the retaining wall heel is adequate

Check shear resistance at heel

Design shear stress v_{heel} = **0.048** N/mm^2 Allowable shear stress v_{adm} = **5.000** N/mm^2

PASS - Design shear stress is less than maximum shear stress

Concrete shear stress v_{c_heel} = **0.468** N/mm^2

$v_{heel} < v_{c\_heel}$ - No shear reinforcement required

Design of reinforced concrete retaining wall stem (BS 8002:1994)

Material properties

Strength of concrete f_{cu} = **40** N/mm^2 Strength of reinforcement f_y = **500** N/mm^2

Wall details

Minimum reinforcement k = **0.13** %

Cover in stem c_{stem} = **75** mm Cover in wall c_{wall} = **50** mm

Design of retaining wall stem

Shear at base of stem V_{stem} = **28.3** kN/m Moment at base of stem M_{stem} = **150.8** kNm/m

Compression reinforcement is not required

Check wall stem in bending

Reinforcement provided **16 mm dia.bars @ 100 mm centres**

Area required $A_{s\_stem\_req}$ = **1252.2** mm^2/m Area provided $A_{s\_stem\_prov}$ = **2011** mm^2/m

PASS - Reinforcement provided at the retaining wall stem is adequate

Check shear resistance at wall stem

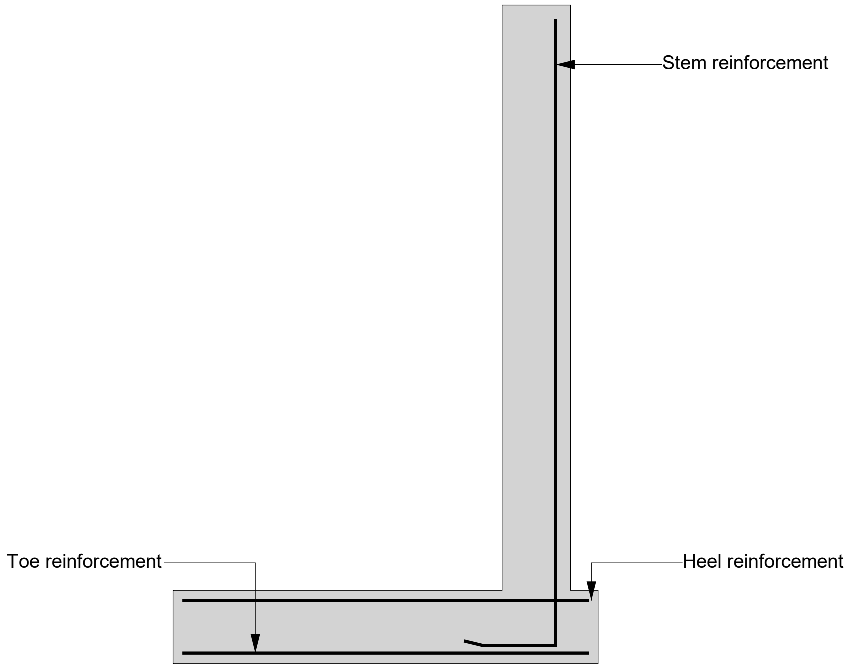
Design shear stress v_{stem} = **0.097** N/mm^2 Allowable shear stress v_{adm} = **5.000** N/mm^2

PASS - Design shear stress is less than maximum shear stress

Concrete shear stress v_{c_stem} = **0.706** N/mm^2

v_{stem} < v_{c_stem} - No shear reinforcement required

Indicative retaining wall reinforcement diagram



Toe bars - 16 mm dia.@ 150 mm centres - (1340 mm^2/m)

Heel mesh - B785 - (785 mm^2/m)

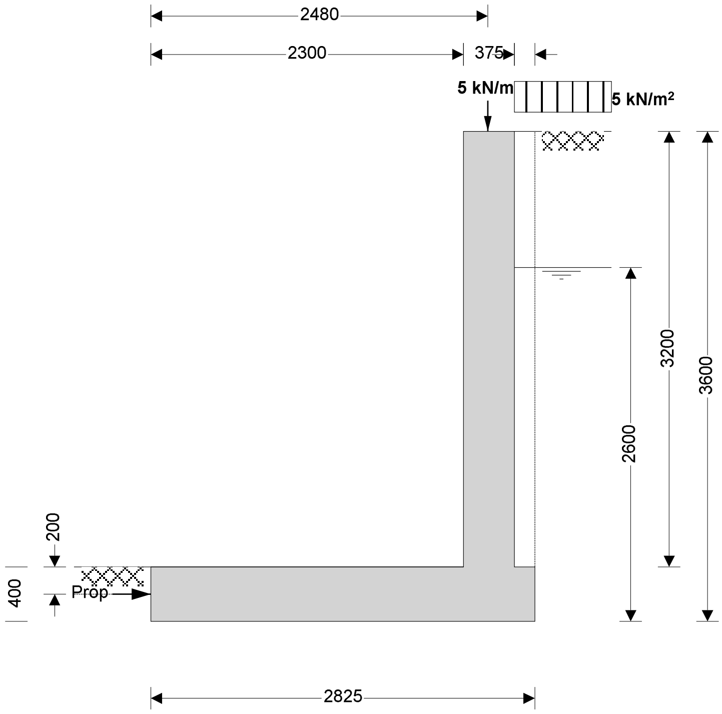
Stem bars - 16 mm dia.@ 100 mm centres - (2011 mm^2/m)

LIGHT WELLS

RETAINING WALL ANALYSIS & DESIGN (BS8002)

RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.06



Wall details

Retaining wall type	**Cantilever**		
Height of wall stem	h_{stem} = **3200** mm	Wall stem thickness	t_{wall} = **375** mm
Length of toe	l_{toe} = **2300** mm	Length of heel	l_{heel} = **150** mm
Overall length of base	l_{base} = **2825** mm	Base thickness	t_{base} = **400** mm
Height of retaining wall	h_{wall} = **3600** mm		
Depth of downstand	d_{ds} = **0** mm	Thickness of downstand	t_{ds} = **400** mm
Position of downstand	l_{ds} = **1900** mm		
Depth of cover in front of wall	d_{cover} = **0** mm	Unplanned excavation depth	d_{exc} = **200** mm
Height of ground water	h_{water} = **2600** mm	Density of water	γ_{water} = 9.81 kN/m^3
Density of wall construction	γ_{wall} = **23.6** kN/m^3	Density of base construction	γ_{base} = **23.6** kN/m^3
Angle of soil surface	β = **0.0** deg	Effective height at back of wall	h_{eff} = **3600** mm
Mobilisation factor	M = **1.5**		
Moist density	γ_m = **18.0** kN/m^3	Saturated density	γ_s = **21.0** kN/m^3
Design shear strength	ϕ' = **24.2** deg	Angle of wall friction	δ = **0.0** deg
Design shear strength	ϕ'_b = **24.2** deg	Design base friction	δ_b = **18.6** deg
Moist density	γ_{mb} = **18.0** kN/m^3	Allowable bearing	$P_{bearing}$ = **100** kN/m^2

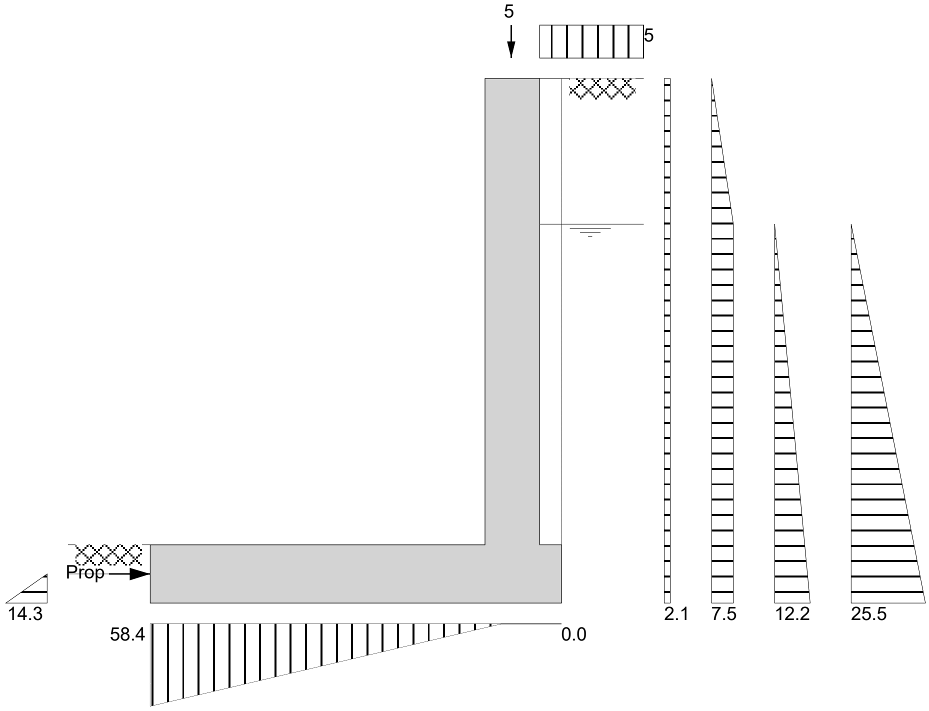
Using Coulomb theory

Active pressure	K_a =**0.419**	Passive pressure	K_p = **4.187**

At-rest pressure K_0 = **0.590**

Loading details

Surcharge load	Surcharge = **5.0** kN/m^2		
Vertical dead load	W_{dead} = **5.0** kN/m	Vertical live load	W_{live} = **0.0** kN/m
Horizontal dead load	F_{dead} = **0.0** kN/m	Horizontal live load	F_{live} = **0.0** kN/m
Position of vertical load	l_{load} = **2480** mm	Height of horizontal load	h_{load} = **0** mm



Loads shown in kN/m, pressures shown in kN/m^2

Calculate propping force

Propping force F_{prop} = **55.0** kN/m

Check bearing pressure

Total vertical reaction	R = **70.4** kN/m	Distance to reaction	x_{bar} = **803** mm
Eccentricity of reaction	e = **609** mm		

Reaction acts outside middle third of base

Bearing pressure at toe	p_{toe} = **58.4** kN/m^2	Bearing pressure at heel	p_{heel} = **0.0** kN/m^2

PASS - Maximum bearing pressure is less than allowable bearing pressure

RETAINING WALL DESIGN (BS 8002:1994)

TEDDS calculation version 1.2.01.06

Ultimate limit state load factors

Dead load factor γ_{f_d} = **1.4** Live load factor γ_{f_l} = **1.6**

Earth pressure factor γ_{f_e} = **1.4**

Calculate propping force

Propping force F_{prop} = **55.0** kN/m

Design of reinforced concrete retaining wall toe (BS 8002:1994)

Material properties

Strength of concrete f_{cu} = **40** N/mm^2 Strength of reinforcement f_y = **500** N/mm^2

Base details

Minimum reinforcement k = **0.13** % Cover in toe c_{toe} = **50** mm

Design of retaining wall toe

Shear at heel V_{toe} = **68.3** kN/m Moment at heel M_{toe} = **165.4** kNm/m

Compression reinforcement is not required

Check toe in bending

Reinforcement provided **16 mm dia.bars @ 150 mm centres**

Area required $A_{s\_toe\_req}$ = **1170.4** mm^2/m Area provided $A_{s\_toe\_prov}$ = **1340** mm^2/m

PASS - Reinforcement provided at the retaining wall toe is adequate

Check shear resistance at toe

Design shear stress v_{toe} = **0.200** N/mm^2 Allowable shear stress v_{adm} = **5.000** N/mm^2

PASS - Design shear stress is less than maximum shear stress

Concrete shear stress v_{c_toe} = **0.563** N/mm^2

$v_{toe} < v_{c\_toe}$ - No shear reinforcement required

Design of reinforced concrete retaining wall heel (BS 8002:1994)

Material properties

Strength of concrete f_{cu} = **40** N/mm^2 Strength of reinforcement f_y = **500** N/mm^2

Base details

Minimum reinforcement k = **0.13** % Cover in heel c_{heel} = **50** mm

Design of retaining wall heel

Shear at heel V_{heel} = **16.7** kN/m Moment at heel M_{heel} = **4.6** kNm/m

Compression reinforcement is not required

Check heel in bending

Reinforcement provided **B785 mesh**

Area required $A_{s\_heel\_req}$ = **520.0** mm^2/m Area provided $A_{s\_heel\_prov}$ = **785** mm^2/m

PASS - Reinforcement provided at the retaining wall heel is adequate

Check shear resistance at heel

Design shear stress v_{heel} = **0.048** N/mm^2 Allowable shear stress v_{adm} = **5.000** N/mm^2

PASS - Design shear stress is less than maximum shear stress

Concrete shear stress v_{c_heel} = **0.468** N/mm^2

$v_{heel} < v_{c\_heel}$ - No shear reinforcement required

Design of reinforced concrete retaining wall stem (BS 8002:1994)

Material properties

Strength of concrete f_{cu} = **40** N/mm^2 Strength of reinforcement f_y = **500** N/mm^2

Wall details

Minimum reinforcement k = **0.13** %

Cover in stem c_{stem} = **75** mm Cover in wall c_{wall} = **50** mm

Design of retaining wall stem

Shear at base of stem V_{stem} = **4.9** kN/m Moment at base of stem M_{stem} = **124.3** kNm/m

Compression reinforcement is not required

Check wall stem in bending

Reinforcement provided **16 mm dia.bars @ 125 mm centres**

Area required $A_{s\_stem\_req}$ = **1029.9** mm^2/m Area provided $A_{s\_stem\_prov}$ = **1608** mm^2/m

PASS - Reinforcement provided at the retaining wall stem is adequate

Check shear resistance at wall stem

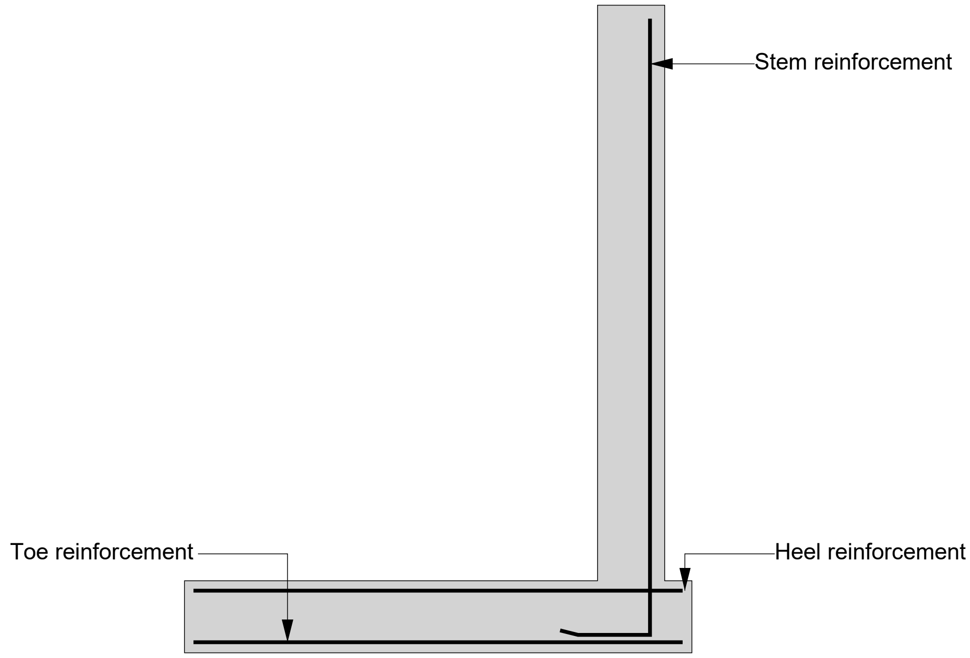
Design shear stress v_{stem} = **0.017** N/mm^2 Allowable shear stress v_{adm} = **5.000** N/mm^2

PASS - Design shear stress is less than maximum shear stress

Concrete shear stress v_{c_stem} = **0.656** N/mm^2

v_{stem} < v_{c_stem} - No shear reinforcement required

Indicative retaining wall reinforcement diagram



Toe bars - 16 mm dia.@ 150 mm centres - (1340 mm^2/m)
Heel mesh - B785 - (785 mm^2/m)
Stem bars - 16 mm dia.@ 125 mm centres - (1608 mm^2/m)

BASEMENT SLAB

1. DUE TO WATER UPLIFT
UPLIFT LOADING = 2.4 X 10 = $24KN/m^2$
NETT UPLIFT = 24 – (2 + 4.8) = 17.2KN.m

BM MAX = 17.2 X 1.4 X 3^{2} / 8 = 27.1KN.m

RC SLAB DESIGN (BS8110)

RC SLAB DESIGN (BS8110:PART1:1997)

TEDDS calculation version 1.0.04

CONCRETE SLAB DESIGN (CL 3.5.3 & 4)

SIMPLE ONE WAY SPANNING SLAB DEFINITION

Overall depth of slab h = **200** mm

Cover to tension reinforcement resisting sagging c_b = **50** mm

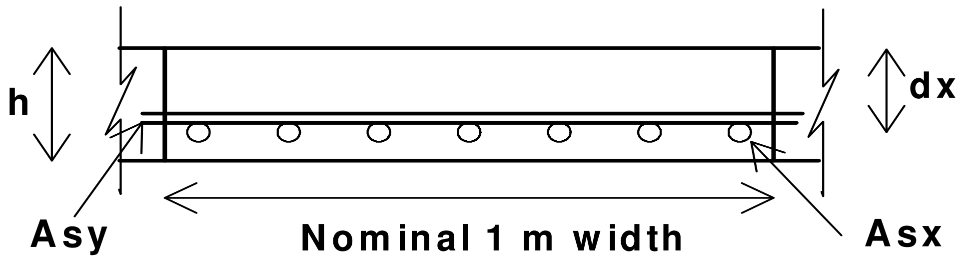
Trial bar diameter D_{tryx} = **10** mm

Depth to tension steel (resisting sagging)

$d_x = h - c_b - D_{tryx}/2$ = **145** mm

Characteristic strength of reinforcement f_y = **500** N/mm^2

Characteristic strength of concrete f_{cu} = **35** N/mm^2



One-way spanning slab
(simple)

ONE WAY SPANNING SLAB (CL 3.5.4)

MAXIMUM DESIGN MOMENTS IN SPAN

Design sagging moment (per m width of slab) m_{sx} = **27.1** kNm/m

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

Design sagging moment (per m width of slab) m_{sx} = **27.1** kNm/m

Moment Redistribution Factor β_{bx} = **1.0**

Area of reinforcement required

$K_x = abs(m_{sx}) / (d_x^2 \times f_{cu})$ = **0.037**

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

Outer compression steel not required to resist sagging

One-way Spanning Slab requiring tension steel only (sagging) - mesh

$z_x = \min ((0.95 \times d_x),(d_x \times (0.5+\sqrt{(0.25-K_x/0.9)})))$ = **138** mm

Neutral axis depth $x_x = (d_x - z_x) / 0.45$ = **16** mm

Area of tension steel required

$A_{sx\_req} = abs(m_{sx}) / (1/\gamma_{ms} \times f_y \times z_x)$ = **452** mm^2/m

Tension steel

Use C785 Mesh

$A_{sx\_prov} = A_{sl}$ = **785** mm^2/m $A_{sy\_prov} = A_{st}$ = **71** mm^2/m

$D_x = d_{sl}$ = **10** mm $D_y = d_{st}$ = **6** mm

Area of tension steel provided sufficient to resist sagging

Check min and max areas of steel resisting sagging

Total area of concrete $A_c = h$ = **200000** mm^2/m

Minimum % reinforcement k = **0.13** %

$A_{st\_min} = k \times A_c$ = **260** mm^2/m

$A_{st\_max} = 4 \% \times A_c$ = **8000** mm^2/m

Steel defined:

Outer steel resisting sagging A_{sx_prov} = **785** mm^2/m

Area of outer steel provided (sagging) OK

Inner steel resisting sagging A_{sy_prov} = **71** mm^2/m

Less than min area of inner steel (sagging) FAIL

CONCRETE SLAB DEFLECTION CHECK (CL 3.5.7)

Slab span length l_x = **3.000** m

Design ultimate moment in shorter span per m width m_{sx} = **27** kNm/m

Depth to outer tension steel d_x = **145** mm

Tension steel

Area of outer tension reinforcement provided A_{sx_prov} = **785** mm^2/m

Area of tension reinforcement required A_{sx_req} = **452** mm^2/m

Moment Redistribution Factor β_{bx} = **1.00**

Modification Factors

Basic span / effective depth ratio (Table 3.9) $ratio_{span\_depth}$ = **20**

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

$f_s = 2 \times f_y \times A_{sx\_req} / (3 \times A_{sx\_prov} \times \beta_{bx})$ = **192.1** N/mm^2

$factor_{tens} = \min(2, 0.55 + (477\ N/mm^2 - f_s) / (120 \times (0.9\ N/mm^2 + m_{sx} / d_x^2)))$ = **1.634**

Calculate Maximum Span

This is a simplified approach and further attention should be given where special circumstances exist. Refer to clauses 3.4.6.4 and 3.4.6.7.

Maximum span $l_{max} = ratio_{span\_depth} \times factor_{tens} \times d_x$ = **4.74** m

Check the actual beam span

Actual span/depth ratio l_x / d_x = **20.69**

Span depth limit $ratio_{span\_depth} \times factor_{tens}$ = **32.69**

Span/Depth ratio check satisfied

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

Slab thickness h = **200** mm

Effective depth to bottom outer tension reinforcement d_x = **145.0** mm

Diameter of tension reinforcement D_x = **10** mm

Diameter of links L_{diax} = **0** mm

Cover to outer tension reinforcement

$c_{tenx} = h - d_x - D_x / 2$ = **50.0** mm

Nominal cover to links steel

$c_{nomx} = c_{tenx} - L_{diax}$ = **50.0** mm

Permissable minimum nominal cover to all reinforcement (Table 3.4)

c_{min} = **50** mm

Cover over steel resisting sagging OK

2 LAYERS A393 FABRIC TOP 50 COVER

2. FOR VERTICAL LOAD

DESIGN LOAD = (6.8 X 1.4) + (1.5 X 1.6) = 11.90KN/m^2

BM = 11.9 X 3^2 / 8 = 13.4KN.m

RC SLAB DESIGN (BS8110)

RC SLAB DESIGN (BS8110:PART1:1997)

TEDDS calculation version 1.0.04

CONCRETE SLAB DESIGN (CL 3.5.3 & 4)

SIMPLE ONE WAY SPANNING SLAB DEFINITION

Overall depth of slab h = **200** mm

Cover to tension reinforcement resisting sagging c_b = **50** mm

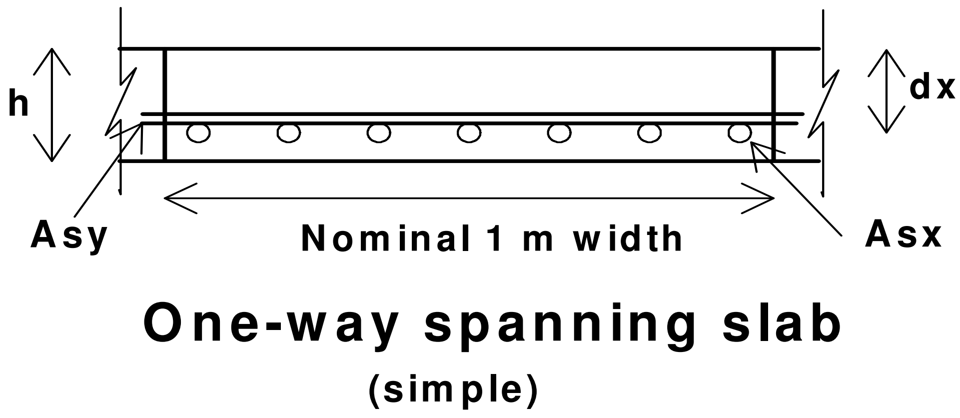
Trial bar diameter D_{tryx} = **10** mm

Depth to tension steel (resisting sagging)

$d_x = h - c_b - D_{tryx}/2$ = **145** mm

Characteristic strength of reinforcement f_y = **500** N/mm^2

Characteristic strength of concrete f_{cu} = **35** N/mm^2



ONE WAY SPANNING SLAB (CL 3.5.4)

MAXIMUM DESIGN MOMENTS IN SPAN

Design sagging moment (per m width of slab) m_{sx} = **13.4** kNm/m

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

Design sagging moment (per m width of slab) m_{sx} = **13.4** kNm/m

Moment Redistribution Factor β_{bx} = **1.0**

Area of reinforcement required

$K_x = abs(m_{sx}) / (d_x^2 \times f_{cu})$ = **0.018**

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

Outer compression steel not required to resist sagging

One-way Spanning Slab requiring tension steel only (sagging) - mesh

$z_x = \min((0.95 \times d_x),(d_x \times (0.5+\sqrt{(0.25-K_x/0.9)}))) =$ **138** mm

Neutral axis depth $x_x = (d_x - z_x) / 0.45 =$ **16** mm

Area of tension steel required

$A_{sx\_req} = abs(m_{sx}) / (1/\gamma_{ms} \times f_y \times z_x) =$ **224** mm^2/m

Tension steel

Use A393 Mesh

$A_{sx\_prov} = A_{sl} =$ **393** mm^2/m $A_{sy\_prov} = A_{st} =$ **393** mm^2/m

$D_x = d_{sl} =$ **10** mm $D_y = d_{st} =$ **10** mm

Area of tension steel provided sufficient to resist sagging

Check min and max areas of steel resisting sagging

Total area of concrete $A_c = h =$ **200000** mm^2/m

Minimum % reinforcement k = **0.13** %

$A_{st\_min} = k \times A_c =$ **260** mm^2/m

$A_{st\_max} = 4\ \% \times A_c =$ **8000** mm^2/m

Steel defined:

Outer steel resisting sagging $A_{sx\_prov} =$ **393** mm^2/m

Area of outer steel provided (sagging) OK

Inner steel resisting sagging $A_{sy\_prov} =$ **393** mm^2/m

Area of inner steel provided (sagging) OK

CONCRETE SLAB DEFLECTION CHECK (CL 3.5.7)

Slab span length $l_x =$ **3.000** m

Design ultimate moment in shorter span per m width $m_{sx} =$ **13** kNm/m

Depth to outer tension steel $d_x =$ **145** mm

Tension steel

Area of outer tension reinforcement provided $A_{sx\_prov} =$ **393** mm^2/m

Area of tension reinforcement required $A_{sx\_req} =$ **224** mm^2/m

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

Modification Factors

Basic span / effective depth ratio (Table 3.9) $ratio_{span\_depth} =$ **20**

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

$f_s = 2 \times f_y \times A_{sx\_req} / (3 \times A_{sx\_prov} \times \beta_{bx}) =$ **189.8** N/mm^2

$factor_{tens} = \min(2, 0.55 + (477\ N/mm^2 - f_s) / (120 \times (0.9\ N/mm^2 + m_{sx} / d_x^2))) =$ **2.000**

Calculate Maximum Span

This is a simplified approach and further attention should be given where special circumstances exist. Refer to clauses 3.4.6.4 and 3.4.6.7.

Maximum span $l_{max} = ratio_{span\_depth} \times factor_{tens} \times d_x =$ **5.80** m

Check the actual beam span

Actual span/depth ratio l_x / d_x = **20.69**

Span depth limit $ratio_{span\_depth} \times factor_{tens}$ = **40.00**

Span/Depth ratio check satisfied

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

Slab thickness h = **200** mm

Effective depth to bottom outer tension reinforcement d_x = **145.0** mm

Diameter of tension reinforcement D_x = **10** mm

Diameter of links L_{diax} = **0** mm

Cover to outer tension reinforcement

$c_{tenx} = h - d_x - D_x / 2$ = **50.0** mm

Nominal cover to links steel

$c_{nomx} = c_{tenx} - L_{diax}$ = **50.0** mm

Permissable minimum nominal cover to all reinforcement (Table 3.4)

c_{min} = **50** mm

Cover over steel resisting sagging OK

A 393 FABRIC BOTTOM 50 COVER.

HEAVE OF OVER CONSOLIDATED CLAYS.

DUE TO THE EXCAVTION WHICH RESULTS IN OVER BURDEN RELIEF TO THE OVER CONSOLIDATED LODON CLAYS BELOW PEAK HEAVE PRESSURES OF APPROXIMATELY 3.6 X 20 = 72KN/m^2 ARE LIKELY TO OCCUR. THESE PEAK PRESSURE WILL DISSIPATE LOCALLY AT UNDER PIN POSITIONS THEN WHOLLY AS BULK EXCAVTION PROCEEDS, A LIKELY RESULTING HEAVE PRESSURE AT SLAB CONSTRUCTION WILL BE APPROXIMATELY 50% OF THE ABOVE, i.e. 36KN/m^2. THIS DISSIPATING FURTHER AS THE CLAY CAN HEAVE AGAINST AND INTO THE CORDEK BELOW THE 200 SLABS. BEARING PRESSURES BELOW THE BASES ARE GENERALLY HIGHER THAN THE 36KN/m^2 THUS RESISTING THE HEAVE FORCES.