METHOD STATEMENT
FOR
CONSTRUCTION OF
RETAINING WALL

PARSIFAL HOUSE
521 FINCHLEY ROAD
LONDON

Ref:-19313

Suite 1, 100 North Road, Brighton. 01273 609742. www.mitchinsonmacken.co.uk

1.0 NOTES ON RETAINING WALLS

New retaining walls to basement to be designed using BS8110
Please refer to TW plans 19313 101 and 102

1. The sequence of retaining wall construction is to be agreed with engineer.

2. Not more than 25% of one wall shall be undercut at any one time. Underpinning shall be in short lengths not exceeding 1000mm.

3. Reinforced concrete for underpinning shall be Design Sulphate class DS-1 and ACEc class AC-1 grade C35, maximum aggregate size of 20mm, and a w/c of 0.45

4. Dowel bars shall be 20mm plain round bars 600mm long with 300mm embedment in each section.

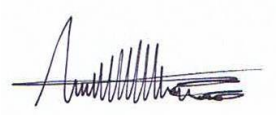
5. Prior to concreting, the underside of existing foundations shall be carefully cleaned of all soil from the sides of the trench, and the formation shall not be left exposed over night. The formation shall be protected from heavy rain and frost.

6. Concrete shall be placed with care to avoid loose soil or rubbish falling into the excavation. The concrete shall be carefully compacted by means of a pocket vibrator.

7. No two adjoining sections shall be worked concurrently. A minimum period of 48 hours should be given between placing dry pack mortar and commencing excavation of any adjacent section.

8. Dry pack is to be a mixture of portland cement and sharp sand mixed as dry as possible passing through a No 16 seize with just enough water to hydrate the cement and is to be placed into position using a back shutter against which it should be rammed with a blunt timber rammer and mallet.

9. A continuous trench for working space shall not be permitted.



Signed…..
Date 16/07/19
Mr A J Mitchinson BEng, CEng, MIStructE

Suite 1, 100 North Road, Brighton. 01273 609742

Mitchinson Macken Ltd
Unit 1
100 North Road
BN1 1YE

Project	Job no.
PARSIFAL HOUSE - 521 FINCHLEY ROAD LONDON	19313
Calcs for	**Start page no./Revision**
Retaining Wall A-A	1

Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
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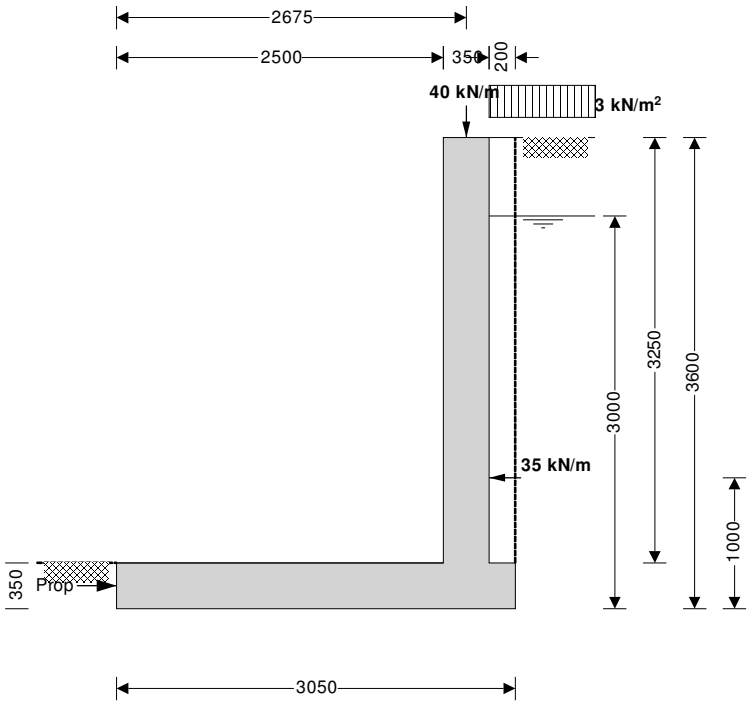
RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.06



Wall details

Retaining wall type	**Cantilever propped at base**
Height of retaining wall stem	h_{stem} = **3250** mm
Thickness of wall stem	t_{wall} = **350** mm
Length of toe	l_{toe} = **2500** mm
Length of heel	l_{heel} = **200** mm
Overall length of base	$l_{base} = l_{toe} + l_{heel} + t_{wall}$ = **3050** mm
Thickness of base	t_{base} = **350** mm
Depth of downstand	d_{ds} = **0** mm
Position of downstand	l_{ds} = **1500** mm
Thickness of downstand	t_{ds} = **350** mm
Height of retaining wall	$h_{wall} = h_{stem} + t_{base} + d_{ds}$ = **3600** mm
Depth of cover in front of wall	d_{cover} = **0** mm
Depth of unplanned excavation	d_{exc} = **0** mm
Height of ground water behind wall	h_{water} = **3000** mm
Height of saturated fill above base	$h_{sat} = \max(h_{water} - t_{base} - d_{ds}, 0\ mm)$ = **2650** mm
Density of wall construction	γ_{wall} = **23.6** kN/m³
Density of base construction	γ_{base} = **23.6** kN/m³
Angle of rear face of wall	α = **90.0** deg
Angle of soil surface behind wall	β = **0.0** deg
Effective height at virtual back of wall	$h_{eff} = h_{wall} + l_{heel} \times \tan(\beta)$ = **3600** mm

Retained material details

Mobilisation factor	M = **1.2**
Moist density of retained material	γ_m = **18.0** kN/m³

Saturated density of retained material	γ_s = **21.0** kN/m^3
Design shear strength	ϕ' = **24.2** deg
Angle of wall friction	δ = **0.0** deg

Base material details

Stiff clay

Moist density	γ_{mb} = **18.0** kN/m^3
Design shear strength	ϕ'_b = **24.2** deg
Design base friction	δ_b = **18.6** deg
Allowable bearing pressure	$P_{bearing}$ = **175** kN/m^2

Using Coulomb theory

Active pressure coefficient for retained material

$$K_a = \sin(\alpha + \phi')^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta) \times [1 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta) / (\sin(\alpha - \delta) \times \sin(\alpha + \beta)))}]^2) = \mathbf{0.419}$$

Passive pressure coefficient for base material

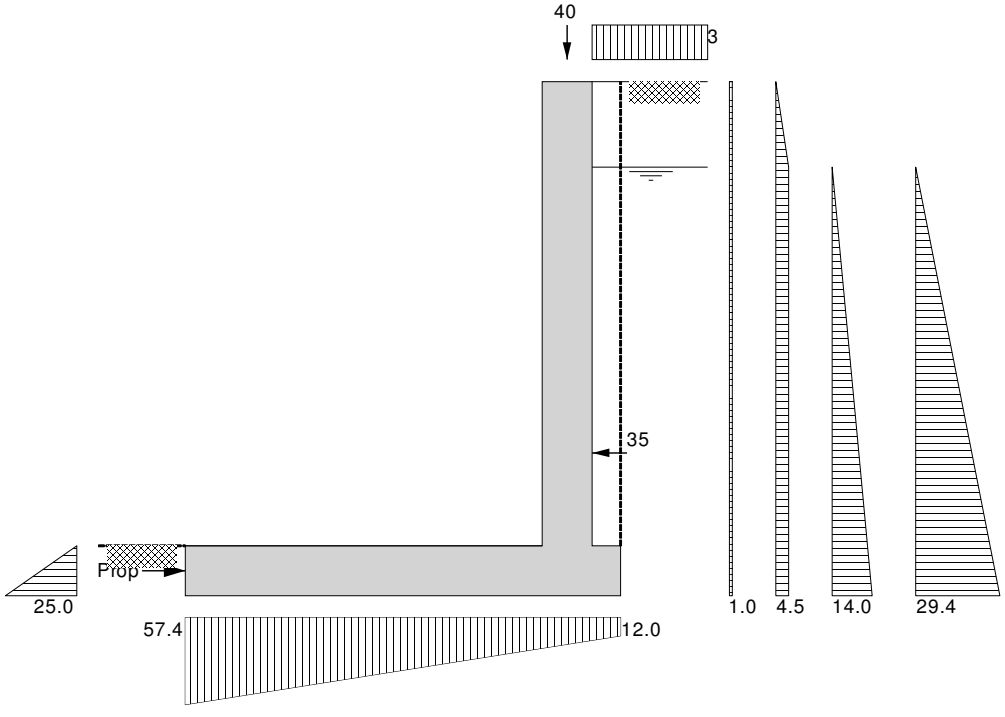
$$K_p = \sin(90 - \phi'_b)^2 / (\sin(90 - \delta_b) \times [1 - \sqrt{(\sin(\phi'_b + \delta_b) \times \sin(\phi'_b) / (\sin(90 + \delta_b)))}]^2) = \mathbf{4.187}$$

At-rest pressure

At-rest pressure for retained material	$K_0 = 1 - \sin(\phi') = \mathbf{0.590}$

Loading details

Surcharge load on plan	Surcharge = **2.5** kN/m^2
Applied vertical dead load on wall	W_{dead} = **20.0** kN/m
Applied vertical live load on wall	W_{live} = **20.0** kN/m
Position of applied vertical load on wall	l_{load} = **2675** mm
Applied horizontal dead load on wall	F_{dead} = **35.0** kN/m
Applied horizontal live load on wall	F_{live} = **0.0** kN/m
Height of applied horizontal load on wall	h_{load} = **1000** mm



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

Mitchinson Macken Ltd
Unit 1
100 North Road
BN1 1YE

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Vertical forces on wall

Wall stem	$w_{wall} = h_{stem} \times t_{wall} \times \gamma_{wall}$ = **26.8** kN/m
Wall base	$w_{base} = l_{base} \times t_{base} \times \gamma_{base}$ = **25.2** kN/m
Surcharge	$w_{sur} = Surcharge \times l_{heel}$ = **0.5** kN/m
Moist backfill to top of wall	$w_{m\_w} = l_{heel} \times (h_{stem} - h_{sat}) \times \gamma_m$ = **2.2** kN/m
Saturated backfill	$w_s = l_{heel} \times h_{sat} \times \gamma_s$ = **11.1** kN/m
Applied vertical load	$W_v = W_{dead} + W_{live}$ = **40** kN/m
Total vertical load	$W_{total} = w_{wall} + w_{base} + w_{sur} + w_{m\_w} + w_s + W_v$ = **105.8** kN/m

Horizontal forces on wall

Surcharge	$F_{sur} = K_a \times Surcharge \times h_{eff}$ = **3.8** kN/m
Moist backfill above water table	$F_{m\_a} = 0.5 \times K_a \times \gamma_m \times (h_{eff} - h_{water})^2$ = **1.4** kN/m
Moist backfill below water table	$F_{m\_b} = K_a \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water}$ = **13.6** kN/m
Saturated backfill	$F_s = 0.5 \times K_a \times (\gamma_s - \gamma_{water}) \times h_{water}^2$ = **21.1** kN/m
Water	$F_{water} = 0.5 \times h_{water}^2 \times \gamma_{water}$ = **44.1** kN/m
Applied horizontal load	$F_h = F_{dead} + F_{live}$ = **35** kN/m
Total horizontal load	$F_{total} = F_{sur} + F_{m\_a} + F_{m\_b} + F_s + F_{water} + F_h$ = **118.9** kN/m

Calculate propping force

Passive resistance of soil in front of wall	$F_p = 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb}$ = **4.4** kN/m
Propping force	$F_{prop} = \max(F_{total} - F_p - (W_{total} - w_{sur} - W_{live}) \times \tan(\delta_b), 0\ kN/m)$
	F_{prop} = **85.8** kN/m

Overturning moments

Surcharge	$M_{sur} = F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2$ = **6.8** kNm/m
Moist backfill above water table	$M_{m\_a} = F_{m\_a} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3$ = **4.3** kNm/m
Moist backfill below water table	$M_{m\_b} = F_{m\_b} \times (h_{water} - 2 \times d_{ds}) / 2$ = **20.3** kNm/m
Saturated backfill	$M_s = F_s \times (h_{water} - 3 \times d_{ds}) / 3$ = **21.1** kNm/m
Water	$M_{water} = F_{water} \times (h_{water} - 3 \times d_{ds}) / 3$ = **44.1** kNm/m
Applied horizontal load	$M_{hor} = F_h \times h_{load}$ = **35** kNm/m
Total overturning moment	$M_{ot} = M_{sur} + M_{m\_a} + M_{m\_b} + M_s + M_{water} + M_{hor}$ = **131.7** kNm/m

Restoring moments

Wall stem	$M_{wall} = w_{wall} \times (l_{toe} + t_{wall} / 2)$ = **71.8** kNm/m
Wall base	$M_{base} = w_{base} \times l_{base} / 2$ = **38.4** kNm/m
Moist backfill	$M_{m\_r} = (w_{m\_w} \times (l_{base} - l_{heel} / 2) + w_{m\_s} \times (l_{base} - l_{heel} / 3))$ = **6.4** kNm/m
Saturated backfill	$M_{s\_r} = w_s \times (l_{base} - l_{heel} / 2)$ = **32.8** kNm/m
Design vertical dead load	$M_{dead} = W_{dead} \times l_{load}$ = **53.5** kNm/m
Total restoring moment	$M_{rest} = M_{wall} + M_{base} + M_{m\_r} + M_{s\_r} + M_{dead}$ = **202.9** kNm/m

Check bearing pressure

Surcharge	$M_{sur\_r} = w_{sur} \times (l_{base} - l_{heel} / 2)$ = **1.5** kNm/m
Design vertical live load	$M_{live} = W_{live} \times l_{load}$ = **53.5** kNm/m
Total moment for bearing	$M_{total} = M_{rest} - M_{ot} + M_{sur\_r} + M_{live}$ = **126.2** kNm/m
Total vertical reaction	$R = W_{total}$ = **105.8** kN/m
Distance to reaction	$x_{bar} = M_{total} / R$ = **1193** mm
Eccentricity of reaction	$e = abs((l_{base} / 2) - x_{bar})$ = **332** mm
	Reaction acts within middle third of base
Bearing pressure at toe	$p_{toe} = (R / l_{base}) + (6 \times R \times e / l_{base}^2)$ = **57.4** kN/m^2

Bearing pressure at heel

$p_{heel} = (R / l_{base}) - (6 \times R \times e / l_{base}^2) =$ **12** 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 and water pressure factor γ_{f_e} = **1.4**

Factored vertical forces on wall

Wall stem $w_{wall\_f} = \gamma_{f\_d} \times h_{stem} \times t_{wall} \times \gamma_{wall}$ = **37.6** kN/m

Wall base $w_{base\_f} = \gamma_{f\_d} \times l_{base} \times t_{base} \times \gamma_{base}$ = **35.3** kN/m

Surcharge $w_{sur\_f} = \gamma_{f\_l} \times Surcharge \times l_{heel}$ = **0.8** kN/m

Moist backfill to top of wall $w_{m\_w\_f} = \gamma_{f\_d} \times l_{heel} \times (h_{stem} - h_{sat}) \times \gamma_m$ = **3** kN/m

Saturated backfill $w_{s\_f} = \gamma_{f\_d} \times l_{heel} \times h_{sat} \times \gamma_s$ = **15.6** kN/m

Applied vertical load $W_{v\_f} = \gamma_{f\_d} \times W_{dead} + \gamma_{f\_l} \times W_{live}$ = **60** kN/m

Total vertical load $W_{total\_f} = w_{wall\_f} + w_{base\_f} + w_{sur\_f} + w_{m\_w\_f} + w_{s\_f} + W_{v\_f}$ = **152.3** kN/m

Factored horizontal at-rest forces on wall

Surcharge $F_{sur\_f} = \gamma_{f\_l} \times K_0 \times Surcharge \times h_{eff}$ = **8.5** kN/m

Moist backfill above water table $F_{m\_a\_f} = \gamma_{f\_e} \times 0.5 \times K_0 \times \gamma_m \times (h_{eff} - h_{water})^2$ = **2.7** kN/m

Moist backfill below water table $F_{m\_b\_f} = \gamma_{f\_e} \times K_0 \times \gamma_m \times (h_{eff} - h_{water}) \times h_{water}$ = **26.8** kN/m

Saturated backfill $F_{s\_f} = \gamma_{f\_e} \times 0.5 \times K_0 \times (\gamma_s - \gamma_{water}) \times h_{water}^2$ = **41.6** kN/m

Water $F_{water\_f} = \gamma_{f\_e} \times 0.5 \times h_{water}^2 \times \gamma_{water}$ = **61.8** kN/m

Applied horizontal load $F_{h\_f} = \gamma_{f\_e} \times F_{dead} + \gamma_{f\_l} \times F_{live}$ = **49** kN/m

Total horizontal load $F_{total\_f} = F_{sur\_f} + F_{m\_a\_f} + F_{m\_b\_f} + F_{s\_f} + F_{water\_f} + F_{h\_f}$ = **190.3** kN/m

Calculate propping force

Passive resistance of soil in front of wall $F_{p\_f} = \gamma_{f\_e} \times 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb}$ = **6.1** kN/m

Propping force $F_{prop\_f} = \max(F_{total\_f} - F_{p\_f} - (W_{total\_f} - w_{sur\_f} - \gamma_{f\_l} \times W_{live}) \times \tan(\delta_b), 0\ kN/m)$

F_{prop_f} = **144.0** kN/m

Factored overturning moments

Surcharge $M_{sur\_f} = F_{sur\_f} \times (h_{eff} - 2 \times d_{ds}) / 2$ = **15.3** kNm/m

Moist backfill above water table $M_{m\_a\_f} = F_{m\_a\_f} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3$ = **8.6** kNm/m

Moist backfill below water table $M_{m\_b\_f} = F_{m\_b\_f} \times (h_{water} - 2 \times d_{ds}) / 2$ = **40.1** kNm/m

Saturated backfill $M_{s\_f} = F_{s\_f} \times (h_{water} - 3 \times d_{ds}) / 3$ = **41.6** kNm/m

Water $M_{water\_f} = F_{water\_f} \times (h_{water} - 3 \times d_{ds}) / 3$ = **61.8** kNm/m

Applied horizontal load $M_{hor\_f} = F_{h\_f} \times h_{load}$ = **49** kNm/m

Total overturning moment $M_{ot\_f} = M_{sur\_f} + M_{m\_a\_f} + M_{m\_b\_f} + M_{s\_f} + M_{water\_f} + M_{hor\_f}$ = **216.4** kNm/m

Restoring moments

Wall stem $M_{wall\_f} = w_{wall\_f} \times (l_{toe} + t_{wall} / 2)$ = **100.5** kNm/m

Wall base $M_{base\_f} = w_{base\_f} \times l_{base} / 2$ = **53.8** kNm/m

Surcharge $M_{sur\_r\_f} = w_{sur\_f} \times (l_{base} - l_{heel} / 2)$ = **2.4** kNm/m

Moist backfill $M_{m\_r\_f} = (w_{m\_w\_f} \times (l_{base} - l_{heel} / 2) + w_{m\_s\_f} \times (l_{base} - l_{heel} / 3))$ = **8.9** kNm/m

Saturated backfill $M_{s\_r\_f} = w_{s\_f} \times (l_{base} - l_{heel} / 2)$ = **46** kNm/m

Design vertical load $M_{v\_f} = W_{v\_f} \times l_{load}$ = **160.5** kNm/m

Total restoring moment $M_{rest\_f} = M_{wall\_f} + M_{base\_f} + M_{sur\_r\_f} + M_{m\_r\_f} + M_{s\_r\_f} + M_{v\_f}$ = **372.1** kNm/m

Factored bearing pressure

Total moment for bearing	$M_{total\_f} = M_{rest\_f} - M_{ot\_f} =$ **155.7** kNm/m
Total vertical reaction	$R_f = W_{total\_f} =$ **152.3** kN/m
Distance to reaction	$x_{bar\_f} = M_{total\_f} / R_f =$ **1022** mm
Eccentricity of reaction	$e_f = abs((l_{base} / 2) - x_{bar\_f}) =$ **503** mm
	Reaction acts within middle third of base
Bearing pressure at toe	$p_{toe\_f} = (R_f / l_{base}) + (6 \times R_f \times e_f / l_{base}^2) =$ **99.3** kN/m²
Bearing pressure at heel	$p_{heel\_f} = (R_f / l_{base}) - (6 \times R_f \times e_f / l_{base}^2) =$ **0.6** kN/m²
Rate of change of base reaction	$rate = (p_{toe\_f} - p_{heel\_f}) / l_{base} =$ **32.37** kN/m²/m
Bearing pressure at stem / toe	$p_{stem\_toe\_f} = max(p_{toe\_f} - (rate \times l_{toe}), 0\ kN/m^2) =$ **18.4** kN/m²
Bearing pressure at mid stem	$p_{stem\_mid\_f} = max(p_{toe\_f} - (rate \times (l_{toe} + t_{wall} / 2)), 0\ kN/m^2) =$ **12.7** kN/m²
Bearing pressure at stem / heel	$p_{stem\_heel\_f} = max(p_{toe\_f} - (rate \times (l_{toe} + t_{wall})), 0\ kN/m^2) =$ **7** kN/m²

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

Material properties

Characteristic strength of concrete	$f_{cu} =$ **35** N/mm²
Characteristic strength of reinforcement	$f_y =$ **500** N/mm²

Base details

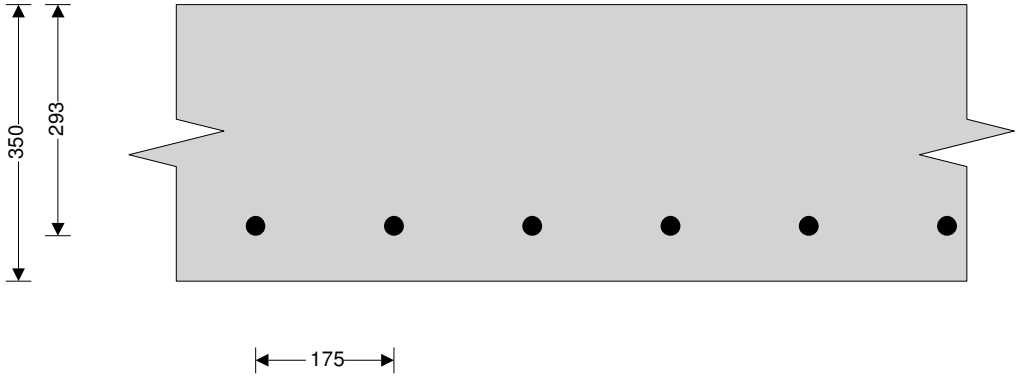
Minimum area of reinforcement	k = **0.13** %
Cover to reinforcement in toe	$c_{toe} =$ **45** mm

Calculate shear for toe design

Shear from bearing pressure	$V_{toe\_bear} = (p_{toe\_f} + p_{stem\_toe\_f}) \times l_{toe} / 2 =$ **147.1** kN/m
Shear from weight of base	$V_{toe\_wt\_base} = \gamma_{f\_d} \times \gamma_{base} \times l_{toe} \times t_{base} =$ **28.9** kN/m
Total shear for toe design	$V_{toe} = V_{toe\_bear} - V_{toe\_wt\_base} =$ **118.1** kN/m

Calculate moment for toe design

Moment from bearing pressure	$M_{toe\_bear} = (2 \times p_{toe\_f} + p_{stem\_mid\_f}) \times (l_{toe} + t_{wall} / 2)^2 / 6 =$ **252** kNm/m
Moment from weight of base	$M_{toe\_wt\_base} = (\gamma_{f\_d} \times \gamma_{base} \times t_{base} \times (l_{toe} + t_{wall} / 2)^2 / 2) =$ **41.4** kNm/m
Total moment for toe design	$M_{toe} = M_{toe\_bear} - M_{toe\_wt\_base} =$ **210.6** kNm/m



Check toe in bending

Width of toe	b = **1000** mm/m
Depth of reinforcement	$d_{toe} = t_{base} - c_{toe} - (\phi_{toe} / 2) =$ **292.5** mm
Constant	$K_{toe} = M_{toe} / (b \times d_{toe}^2 \times f_{cu}) =$ **0.070**
	Compression reinforcement is not required
Lever arm	$z_{toe} = min(0.5 + \sqrt{}(0.25 - (min(K_{toe}, 0.225) / 0.9)), 0.95) \times d_{toe}$
	$z_{toe} =$ **268** mm

Area of tension reinforcement required	$A_{s\_toe\_des} = M_{toe} / (0.87 \times f_y \times z_{toe})$ = **1810** mm²/m
Minimum area of tension reinforcement	$A_{s\_toe\_min} = k \times b \times t_{base}$ = **455** mm²/m
Area of tension reinforcement required	$A_{s\_toe\_req} = \text{Max}(A_{s\_toe\_des}, A_{s\_toe\_min})$ = **1810** mm²/m
Reinforcement provided	**25 mm dia.bars @ 175 mm centres**
Area of reinforcement provided	$A_{s\_toe\_prov}$ = **2805** mm²/m

PASS - Reinforcement provided at the retaining wall toe is adequate

Check shear resistance at toe

Design shear stress	$v_{toe} = V_{toe} / (b \times d_{toe})$ = **0.404** N/mm²
Allowable shear stress	$v_{adm} = \min(0.8 \times \sqrt{(f_{cu} / 1\ \text{N/mm}^2)}, 5) \times 1\ \text{N/mm}^2$ = **4.733** N/mm²

PASS - Design shear stress is less than maximum shear stress

From BS8110:Part 1:1997 – Table 3.8

Design concrete shear stress	v_{c_toe} = **0.754** N/mm²

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

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

Material properties

Characteristic strength of concrete	f_{cu} = **35** N/mm²
Characteristic strength of reinforcement	f_y = **500** N/mm²

Base details

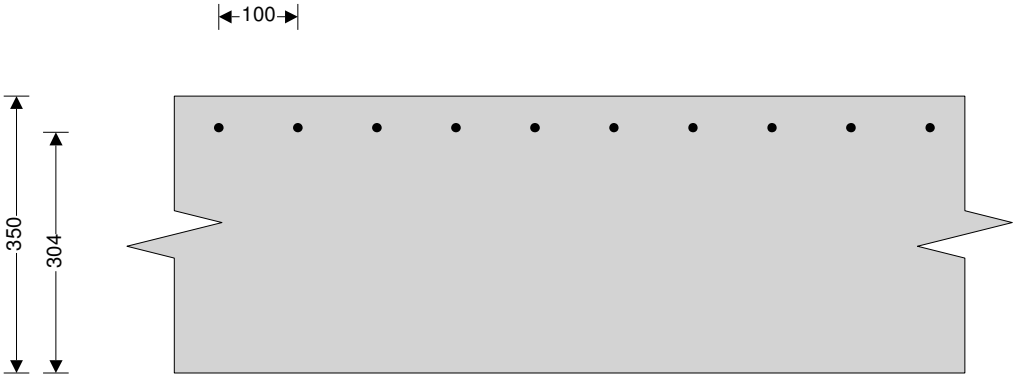
Minimum area of reinforcement	k = **0.13** %
Cover to reinforcement in heel	c_{heel} = **40** mm

Calculate shear for heel design

Shear from bearing pressure	$V_{heel\_bear} = (p_{heel\_f} + p_{stem\_heel\_f}) \times l_{heel} / 2$ = **0.8** kN/m
Shear from weight of base	$V_{heel\_wt\_base} = \gamma_{f\_d} \times \gamma_{base} \times l_{heel} \times t_{base}$ = **2.3** kN/m
Shear from weight of moist backfill	$V_{heel\_wt\_m} = w_{m\_w\_f}$ = **3** kN/m
Shear from weight of saturated backfill	$V_{heel\_wt\_s} = w_{s\_f}$ = **15.6** kN/m
Shear from surcharge	$V_{heel\_sur} = w_{sur\_f}$ = **0.8** kN/m
Total shear for heel design	V_{heel} = - V_{heel_bear} + $V_{heel\_wt\_base}$ + $V_{heel\_wt\_m}$ + $V_{heel\_wt\_s}$ + V_{heel_sur} = **21** kN/m

Calculate moment for heel design

Moment from bearing pressure	$M_{heel\_bear} = (2 \times p_{heel\_f} + p_{stem\_mid\_f}) \times (l_{heel} + t_{wall} / 2)^2 / 6$ = **0.3** kNm/m
Moment from weight of base	$M_{heel\_wt\_base} = (\gamma_{f\_d} \times \gamma_{base} \times t_{base} \times (l_{heel} + t_{wall} / 2)^2 / 2)$ = **0.8** kNm/m
Moment from weight of moist backfill	$M_{heel\_wt\_m} = w_{m\_w\_f} \times (l_{heel} + t_{wall}) / 2$ = **0.8** kNm/m
Moment from weight of saturated backfill	$M_{heel\_wt\_s} = w_{s\_f} \times (l_{heel} + t_{wall}) / 2$ = **4.3** kNm/m
Moment from surcharge	$M_{heel\_sur} = w_{sur\_f} \times (l_{heel} + t_{wall}) / 2$ = **0.2** kNm/m
Total moment for heel design	M_{heel} = - M_{heel_bear} + $M_{heel\_wt\_base}$ + $M_{heel\_wt\_m}$ + $M_{heel\_wt\_s}$ + M_{heel_sur} = **5.8** kNm/m



Check heel in bending

Width of heel	b = **1000** mm/m
Depth of reinforcement	$d_{heel} = t_{base} - c_{heel} - (\phi_{heel} / 2)$ = **304.0** mm
Constant	$K_{heel} = M_{heel} / (b \times d_{heel}^2 \times f_{cu})$ = **0.002**
	Compression reinforcement is not required
Lever arm	$z_{heel} = \min(0.5 + \sqrt{}(0.25 - (\min(K_{heel}, 0.225) / 0.9)), 0.95) \times d_{heel}$
	z_{heel} = **289** mm
Area of tension reinforcement required	$A_{s\_heel\_des} = M_{heel} / (0.87 \times f_y \times z_{heel})$ = **46** mm²/m
Minimum area of tension reinforcement	$A_{s\_heel\_min} = k \times b \times t_{base}$ = **455** mm²/m
Area of tension reinforcement required	$A_{s\_heel\_req} = \max(A_{s\_heel\_des}, A_{s\_heel\_min})$ = **455** mm²/m
Reinforcement provided	**12 mm dia.bars @ 100 mm centres**
Area of reinforcement provided	$A_{s\_heel\_prov}$ = **1131** mm²/m
	PASS - Reinforcement provided at the retaining wall heel is adequate

Check shear resistance at heel

Design shear stress	$v_{heel} = V_{heel} / (b \times d_{heel})$ = **0.069** N/mm²
Allowable shear stress	$v_{adm} = \min(0.8 \times \sqrt{}(f_{cu} / 1\ N/mm^2), 5) \times 1\ N/mm^2$ = **4.733** N/mm²
	PASS - Design shear stress is less than maximum shear stress

From BS8110:Part 1:1997 – Table 3.8

Design concrete shear stress	v_{c_heel} = **0.545** N/mm²
	$v_{heel} < v_{c\_heel}$ - No shear reinforcement required

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

Material properties

Characteristic strength of concrete	f_{cu} = **35** N/mm²
Characteristic strength of reinforcement	f_y = **500** N/mm²

Wall details

Minimum area of reinforcement	k = **0.13** %
Cover to reinforcement in stem	c_{stem} = **45** mm
Cover to reinforcement in wall	c_{wall} = **45** mm

Factored horizontal at-rest forces on stem

Surcharge	$F_{s\_sur\_f} = \gamma_{f\_l} \times K_0 \times \text{Surcharge} \times (h_{eff} - t_{base} - d_{ds})$ = **7.7** kN/m
Moist backfill above water table	$F_{s\_m\_a\_f} = 0.5 \times \gamma_{f\_e} \times K_0 \times \gamma_m \times (h_{eff} - t_{base} - d_{ds} - h_{sat})^2$ = **2.7** kN/m
Moist backfill below water table	$F_{s\_m\_b\_f} = \gamma_{f\_e} \times K_0 \times \gamma_m \times (h_{eff} - t_{base} - d_{ds} - h_{sat}) \times h_{sat}$ = **23.6** kN/m
Saturated backfill	$F_{s\_s\_f} = 0.5 \times \gamma_{f\_e} \times K_0 \times (\gamma_s - \gamma_{water}) \times h_{sat}^2$ = **32.5** kN/m
Water	$F_{s\_water\_f} = 0.5 \times \gamma_{f\_e} \times \gamma_{water} \times h_{sat}^2$ = **48.2** kN/m

Applied horizontal load $F_{s\_h\_f} = \gamma_{f\_d} \times F_{dead} + \gamma_{f\_l} \times F_{live} =$ **49** kN/m

Calculate shear for stem design

Shear at base of stem $V_{stem} = F_{s\_sur\_f} + F_{s\_m\_a\_f} + F_{s\_m\_b\_f} + F_{s\_s\_f} + F_{s\_water\_f} + F_{s\_h\_f} - F_{prop\_f} =$ **19.7** kN/m

Calculate moment for stem design

Surcharge $M_{s\_sur} = F_{s\_sur\_f} \times (h_{stem} + t_{base}) / 2 =$ **13.8** kNm/m

Moist backfill above water table $M_{s\_m\_a} = F_{s\_m\_a\_f} \times (2 \times h_{sat} + h_{eff} - d_{ds} + t_{base} / 2) / 3 =$ **8.1** kNm/m

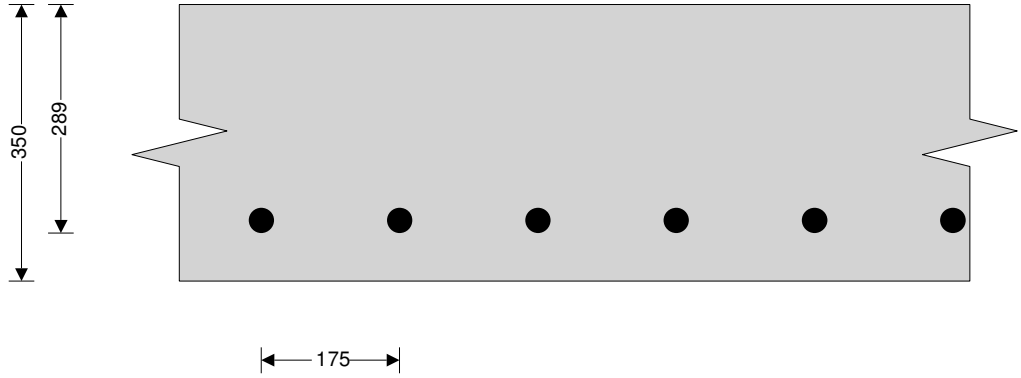
Moist backfill below water table $M_{s\_m\_b} = F_{s\_m\_b\_f} \times h_{sat} / 2 =$ **31.3** kNm/m

Saturated backfill $M_{s\_s} = F_{s\_s\_f} \times h_{sat} / 3 =$ **28.7** kNm/m

Water $M_{s\_water} = F_{s\_water\_f} \times h_{sat} / 3 =$ **42.6** kNm/m

Applied horizontal load $M_{s\_hor} = F_{s\_h\_f} \times (h_{load} - t_{base} / 2) =$ **40.4** kNm/m

Total moment for stem design $M_{stem} = M_{s\_sur} + M_{s\_m\_a} + M_{s\_m\_b} + M_{s\_s} + M_{s\_water} + M_{s\_hor} =$ **164.9** kNm/m



Check wall stem in bending

Width of wall stem $b =$ **1000** mm/m

Depth of reinforcement $d_{stem} = t_{wall} - c_{stem} - (\phi_{stem} / 2) =$ **289.0** mm

Constant $K_{stem} = M_{stem} / (b \times d_{stem}^2 \times f_{cu}) =$ **0.056**

Compression reinforcement is not required

Lever arm $z_{stem} = \min(0.5 + \sqrt{}(0.25 - (\min(K_{stem}, 0.225) / 0.9)), 0.95) \times d_{stem}$

$z_{stem} =$ **270** mm

Area of tension reinforcement required $A_{s\_stem\_des} = M_{stem} / (0.87 \times f_y \times z_{stem}) =$ **1406** mm²/m

Minimum area of tension reinforcement $A_{s\_stem\_min} = k \times b \times t_{wall} =$ **455** mm²/m

Area of tension reinforcement required $A_{s\_stem\_req} = \text{Max}(A_{s\_stem\_des}, A_{s\_stem\_min}) =$ **1406** mm²/m

Reinforcement provided **32 mm dia.bars @ 175 mm centres**

Area of reinforcement provided $A_{s\_stem\_prov} =$ **4596** mm²/m

PASS - Reinforcement provided at the retaining wall stem is adequate

Check shear resistance at wall stem

Design shear stress $v_{stem} = V_{stem} / (b \times d_{stem}) =$ **0.068** N/mm²

Allowable shear stress $v_{adm} = \min(0.8 \times \sqrt{}(f_{cu} / 1\ \text{N/mm}^2), 5) \times 1\ \text{N/mm}^2 =$ **4.733** N/mm²

PASS - Design shear stress is less than maximum shear stress

From BS8110:Part 1:1997 – Table 3.8

Design concrete shear stress $v_{c\_stem} =$ **0.895** N/mm²

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

Check retaining wall deflection

Basic span/effective depth ratio $ratio_{bas} =$ **7**

Design service stress $f_s = 2 \times f_y \times A_{s\_stem\_req} / (3 \times A_{s\_stem\_prov}) =$ **102.0** N/mm^2

Modification factor $factor_{tens} = \min(0.55 + (477\ N/mm^2 - f_s)/(120 \times (0.9\ N/mm^2 + (M_{stem}/(b \times d_{stem}^2)))),2) =$ **1.64**

Maximum span/effective depth ratio $ratio_{max} = ratio_{bas} \times factor_{tens} =$ **11.46**

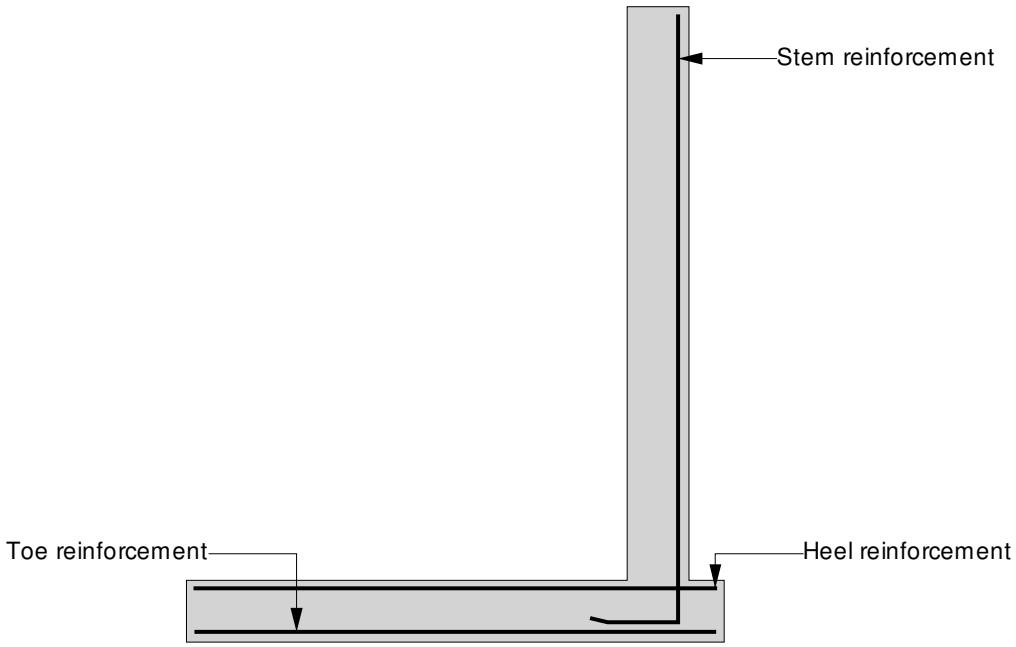
Actual span/effective depth ratio $ratio_{act} = h_{stem} / d_{stem} =$ **11.25**

PASS - Span to depth ratio is acceptable

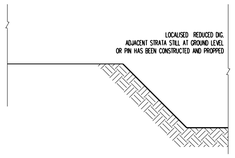
Mitchinson Macken Ltd
Unit 1
100 North Road
BN1 1YE

Project				Job no.	
PARSIFAL HOUSE - 521 FINCHLEY ROAD LONDON				19313	
Calcs for				Start page no./Revision	
Retaining Wall A-A				11	
Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
SM	16/07/2019	MM			

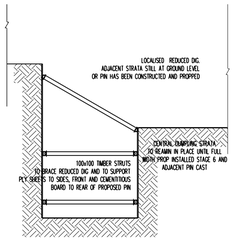
Indicative retaining wall reinforcement diagram



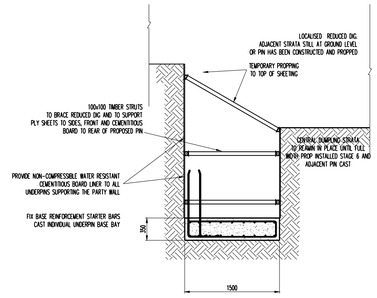
Toe bars - 25 mm dia.@ 175 mm centres - (2805 mm^2/m)
Heel bars - 12 mm dia.@ 100 mm centres - (1131 mm^2/m)
Stem bars - 32 mm dia.@ 175 mm centres - (4596 mm^2/m)



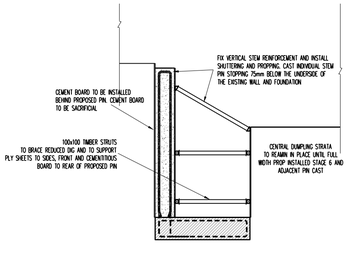
STAGE 1
LOCALISED LEVEL REDUCTION



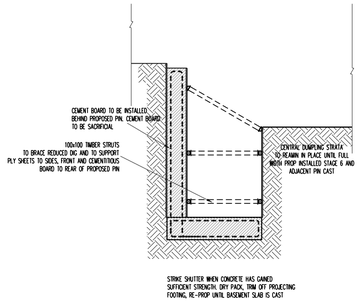
STAGE 2
EXCAVATE TO FORM UNDERPIN



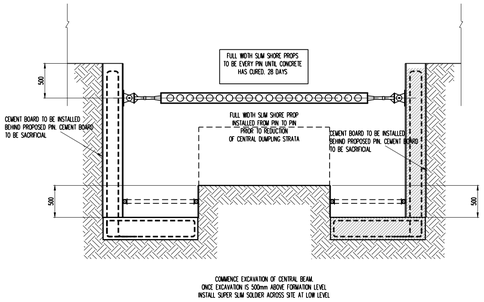
STAGE 3
CONCRETE BASE OF UNDERPIN



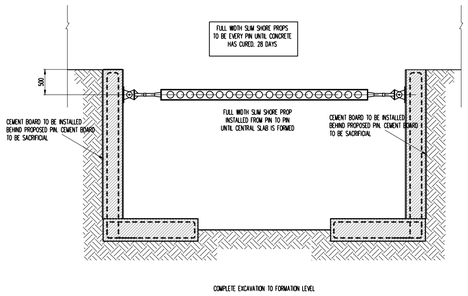
STAGE 4
ERECT SHUTTER CONCRETE STEAM OR UNDERPIN



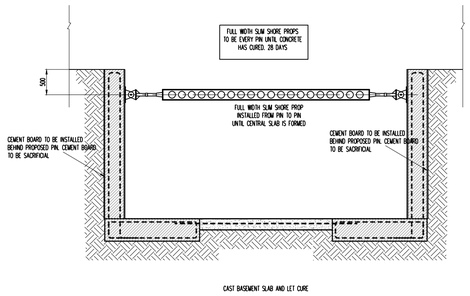
STAGE 5
STRIKE SHUTTER



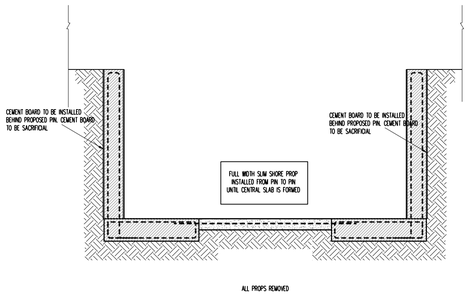
STAGE 6
COMMENCE EXCAVATION



STAGE 7
COMMENCE EXCAVATION



STAGE 8
CAST SLAB



STAGE 9
COMPLETE

0 1 2 3 4 5m
Scale in Metres (1:50 at A1)

NOTES

REV	DESCRIPTION	DATE	BY
0	ORIGINAL ISSUE	XXX	MJB

MITCHINSON MACKEN
Unit 1, 100 North Road, Brighton, East Sussex, BN1 1YE
T: 01273 609742 M: 07968 188928
W: www.mitchinsonmacken.co.uk E: info@mitchinsonmacken.co.uk

PROJECT
PARSIFAL HOUSE
521 FINCHLEY ROAD
LONDON

DRAWING
TEMPORARY WORKS

DRAWING No.	REV	CHECKED
19313 / 101		
SCALE: As Shown	DATE: July 19	DRAWN: MJB
		APPROVED

N

SEQUENCED PINS
SEE 19313-102
& METHOD STATEMENT

SUNKEN GARDEN
CA: 30.49 m²

SUNKEN GARDEN
CA: 30.47 m²

3000 mm

KITCHEN/DINING
GIA: 38.39 m²

KITCHEN/DINING
GIA: 38.47 m²

3000 mm

3000 mm

BASEMENT
GIA: 107.81 m²

BASEMENT
GIA: 107.99 m²

WC
GIA: 2 m²

HALL
GIA: 3.39 m²

STORE
GIA: 1.94 m²

STORE
GIA: 1.94 m²

HALL
GIA: 3.39 m²

WC
GIA: 2.01 m²

BEDROOM 3
GIA: 19.36 m²

BEDROOM 3
GIA: 19.36 m²

ENSUITE
GIA: 5.75 m²

LIGHTWELL
CA: 6.12 m²

3000 mm

LIGHTWELL
CA: 6.1 m²

2,350

ENSUITE
GIA: 5.75 m²

UNIT A

UNIT B

WORST CASE 35 kV/m RUN ACTING 1000 mm FROM G.L

WORST CASE 35 kV/m RUN ACTING - 1000 mm FROM GL

19313-102

0 1 2 3 4 5

REV	DATE	DRAWN	AMENDMENT

Granit
Architecture + Interiors

Studios 18-19, 16 Porteus Place,
Clapham, London SW4 0AS

t +44 (0) 20 7924 4555
e info@granit.co.uk
w www.granit.co.uk

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Project	**Garages at Parsifal**	Drawing No.	**1850/P/100/2**
For	**Gary Sugarman**	Drawing	**Basement Floor Plan**
Project Address	**Parsifal House, 521 Finchley Road, London NW3 7BT**	Revision	*
Scale	1:100 @ A3	Date	04/07/2019
Drawn	JW & MG	Purpose	**FOR INFORMATION**
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