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.

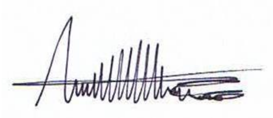
5. Prior to concreting, the underside of existing foundations shall be carefully cleaned of all soil from the sides of the trench, and the formation shall not be left exposed over night. The formation shall be protected from heavy rain and frost.

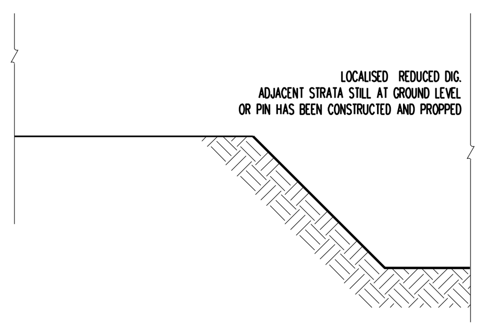
6. Concrete shall be placed with care to avoid loose soil or rubbish falling into the excavation. The concrete shall be carefully compacted by means of a pocket vibrator.

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.

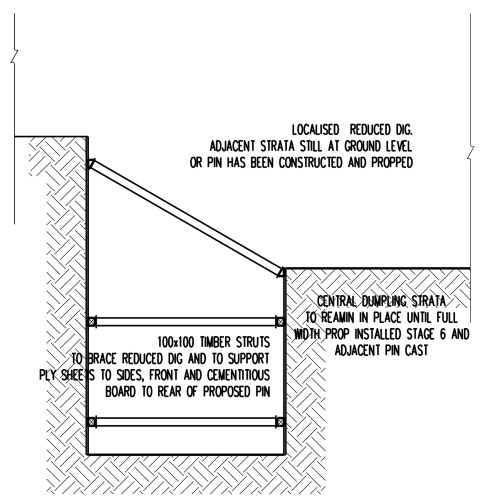
8. Dry pack is to be a mixture of portland cement and sharp sand mixed as dry as possible passing through a No 16 seize with just enough water to hydrate the cement and is to be placed into position using a back shutter against which it should be rammed with a blunt timber rammer and mallet.

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

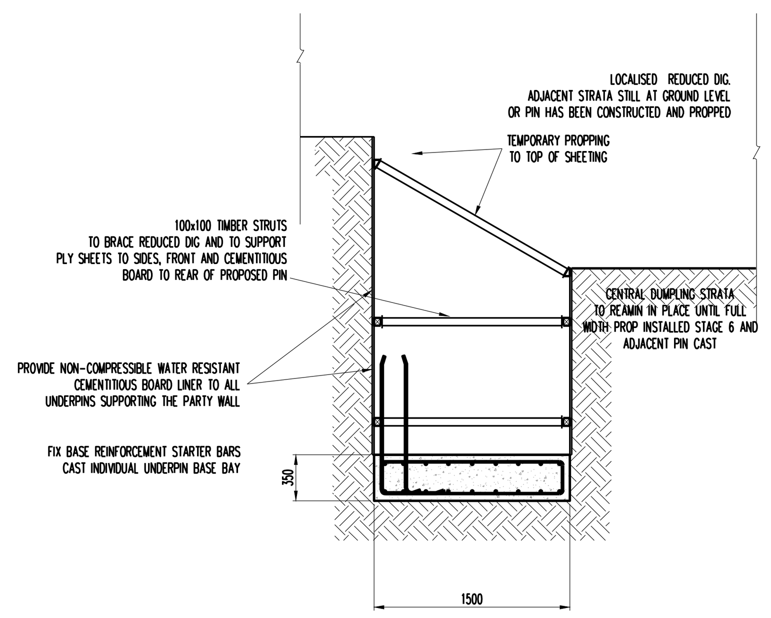
Signed…..

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



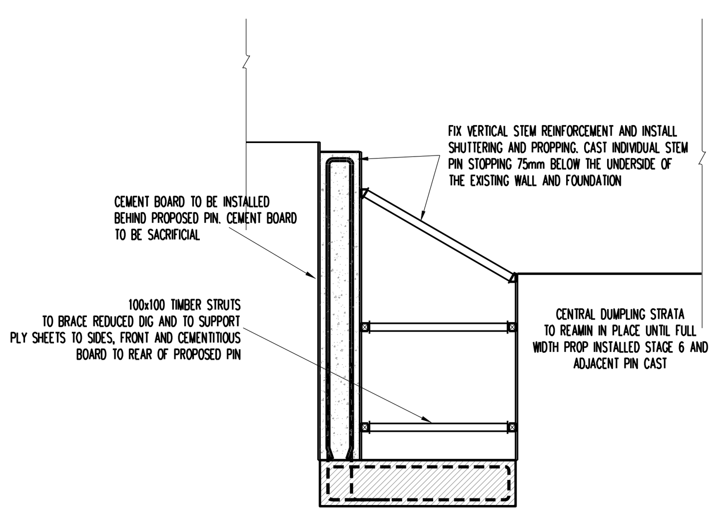
STAGE 1
LOCALISED LEVEL REDUCTION



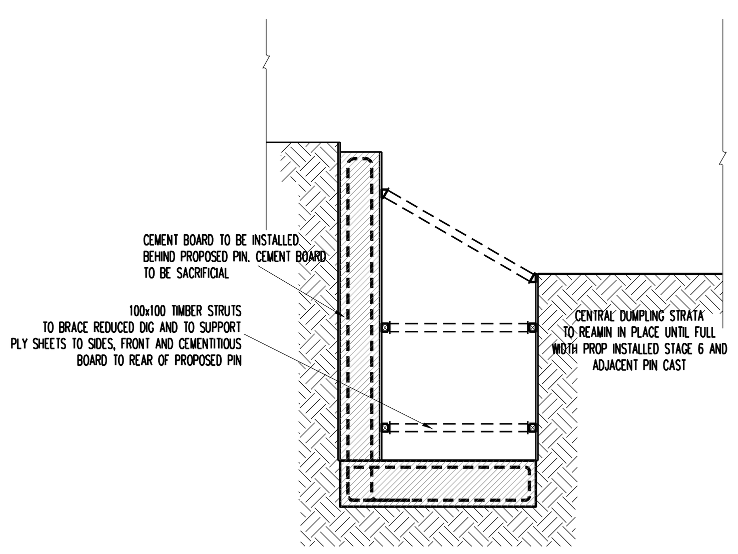
STAGE 2
EXCAVATE TO FORM UNDERPIN



STAGE 3
CONCRETE BASE OF UNDERPIN

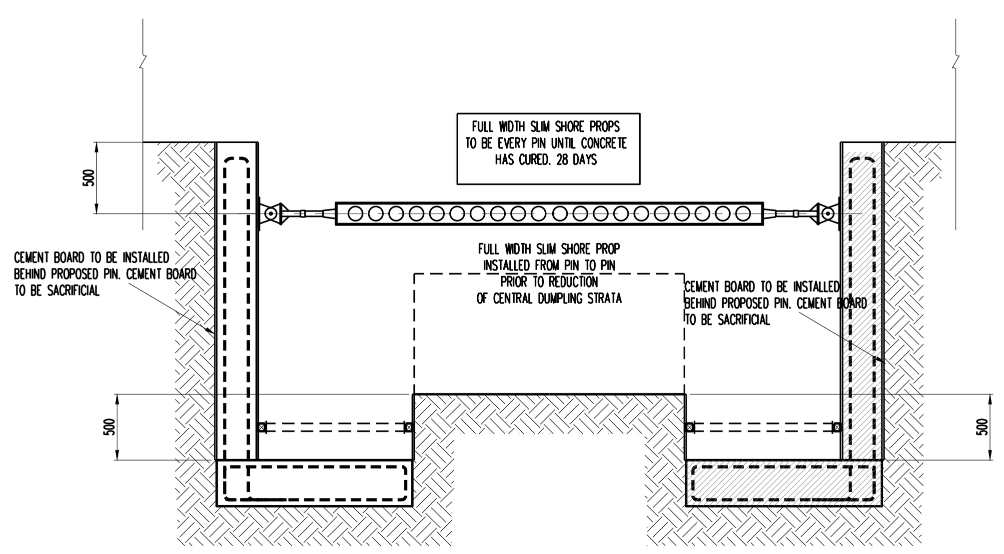


STAGE 4
ERECT SHUTTER CONCRETE STEAM OR UNDERPIN



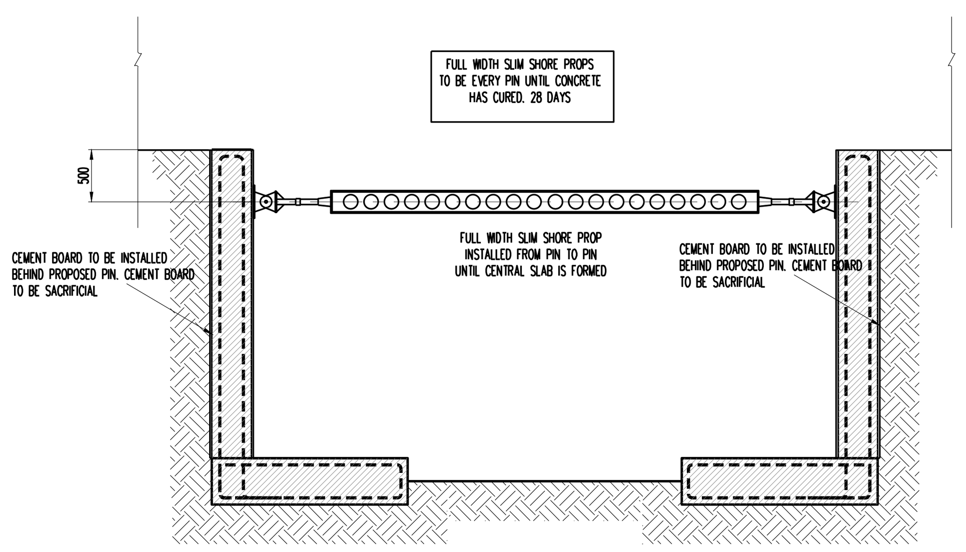
STRIKE SHUTTER WHEN CONCRETE HAS GAINED
SUFFICIENT STRENGTH. DRY PACK, TRIM OFF PROJECTING
FOOTING, RE-PROP UNTIL BASEMENT SLAB IS CAST

STAGE 5
STRIKE SHUTTER



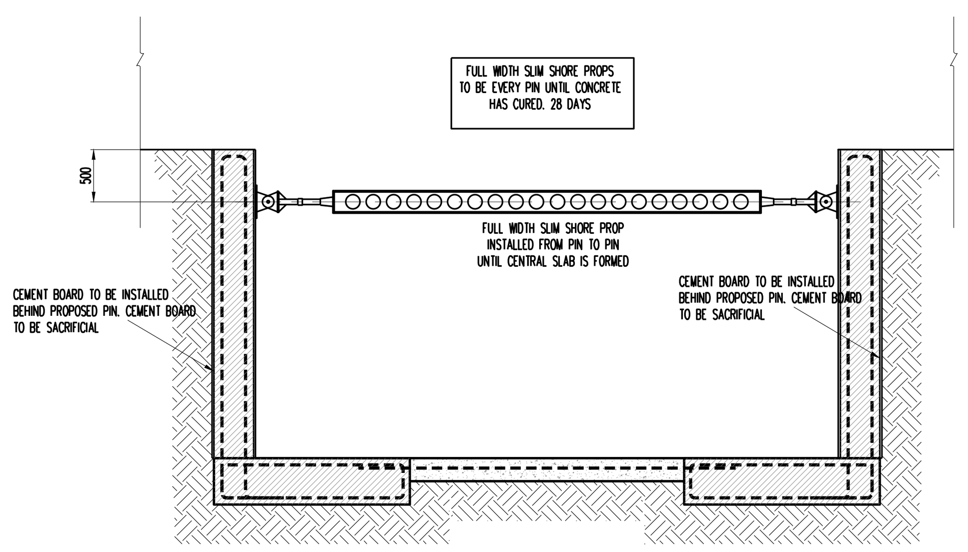
COMMENCE EXCAVATION OF CENTRAL BEAM.
ONCE EXCAVATION IS 500mm ABOVE FORMATION LEVEL
INSTALL SUPER SLIM SOLDIER ACROSS SITE AT LOW LEVEL

STAGE 6
COMMENCE EXCAVATION



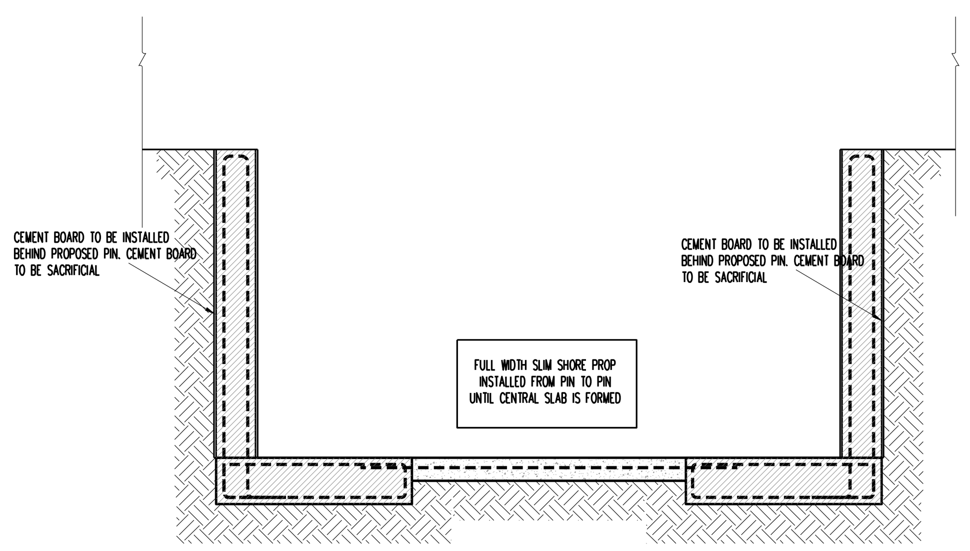
COMPLETE EXCAVATION TO FORMATION LEVEL

STAGE 7
COMMENCE EXCAVATION



CAST BASEMENT SLAB AND LET CURE

STAGE 8
CAST SLAB



ALL PROPS REMOVED

STAGE 9
COMPLETE

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

NOTES

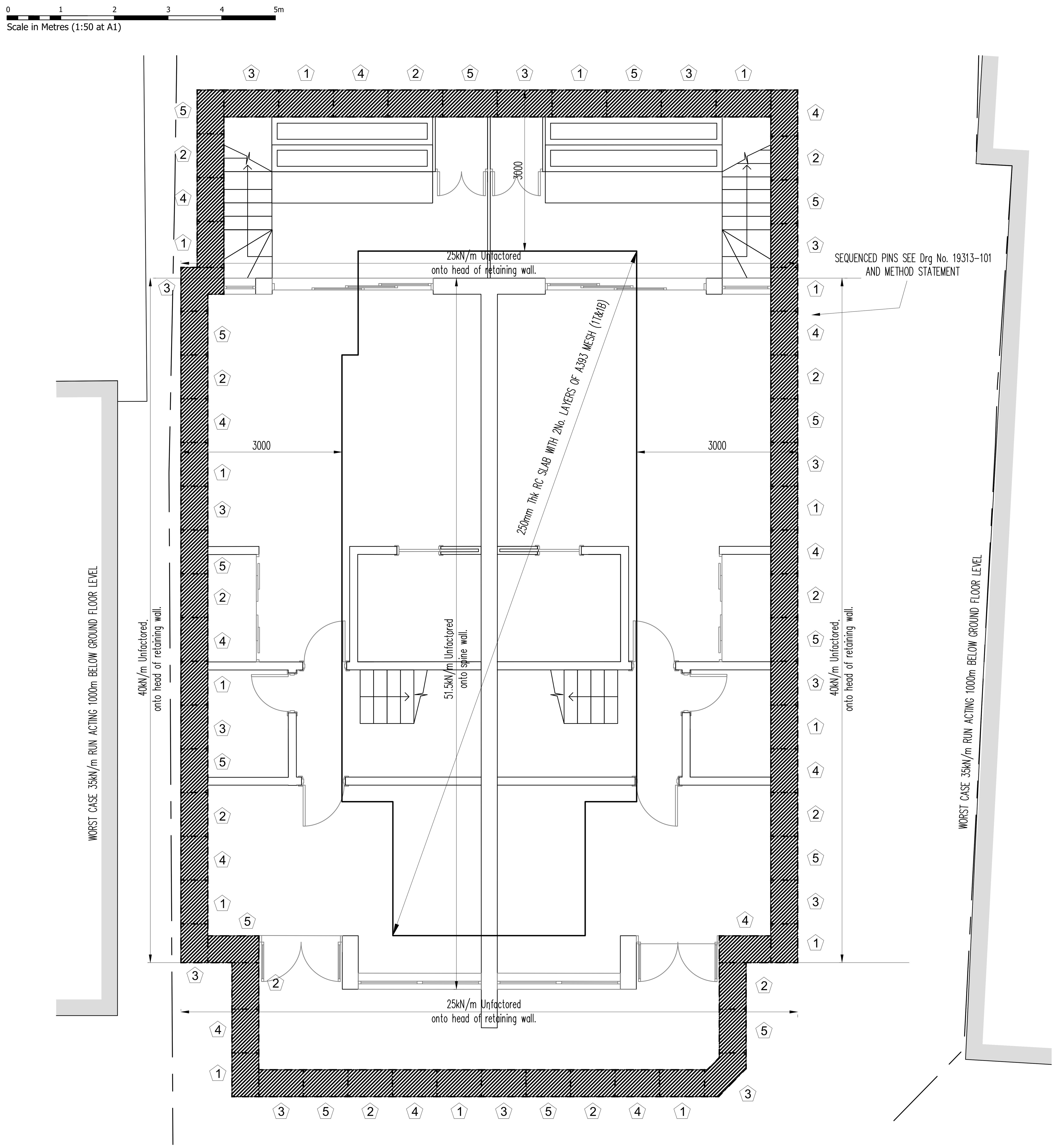
REV	DESCRIPTION	DATE	BY
0	ORIGINAL ISSUE	XXX	MJB

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:



LEGEND ;

	EXISTING STRUCTURE
	NEW CONCRETE FOUNDATIONS

BASEMENT PLAN - SHOWING FOUNDATION LAYOUT

(UNDERPINNING SEQUENCE INDICATED IN BOLD)

NOTES

In addition to these notes, reference shall be made to the specification of works and the relevant Architect's and Specialist's drawings and specifications.

The Contractor is responsible for verifying all site dimensions before commencing work.

All dimensions are in millimetres unless noted otherwise.

This drawing has been produced electronically and may have been photo reduced or enlarged when printed or copied. Dimensions on this drawing shall not be scaled. Work only to figured dimensions. Any dimensional discrepancies errors or omissions are to be reported to the engineer immediately.

Levels are in metres unless noted otherwise to Ordnance Survey datum.

The Contractor is responsible for the stability of the building whilst the works are in progress.

UNDERPINNING SEQUENCE OF WORK

1. Excavate bays 1 down to required level. The underside of existing foundation is to be well cleaned. Sides of excavation are to vertical and smooth faced. Provide 4 no. dowel bars into adjacent soil.
2. Shutter, as necessary to provide required foundation width. Concrete is to be placed up to 75mm below underside of existing foundation .
3. One day after completion of concreting (24 hours), dry pack to bay 1 to be placed between underside of footings and new surface.
4. Repeat operations 1 to 3 for bays 2 allowing at least 48 hours between dry packing and excavation of adjacent bay.
5. When pouring against a section already underpinned, the face of the concrete shall be cleaned and roughened, if necessary, to provide a good key. Exposed dowel bars to be cleaned off.
6. Repeat operations 1 to 3 for additional bay 3 allowing at least 48 hours between dry packing and excavation of adjacent bay.
7. When all underpinning bays have been poured and dry packed placed between underside of footings and new surface. Projected brickwork corbels and concrete footings can be carefully removed by the contractor.

NOTES ON RETAINING WALLS

1. Condition surveys of the subject building and adjoining properties will also be undertaken prior to commencement of the site works.
2. The sequence of retaining wall construction is to be agreed with engineer.
3. Not more than 25% of one wall shall be undercut at any one time. Underpinning shall be in short lengths not exceeding 900mm.
4. 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
5. Dowel bars shall be 20mm plain round bars 600mm long with 300mm embedment in each section.
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9. 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.
10. A continuous trench for working space shall not be permitted.

REV	DESCRIPTION	DATE	BY
A	LOAD TAKE DOWNS	240620	MJB
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

STRUCTURAL ALTERATIONS TO GARAGES
521 FINCHLEY ROAD
LONDON. NW3 7BT

DRAWING

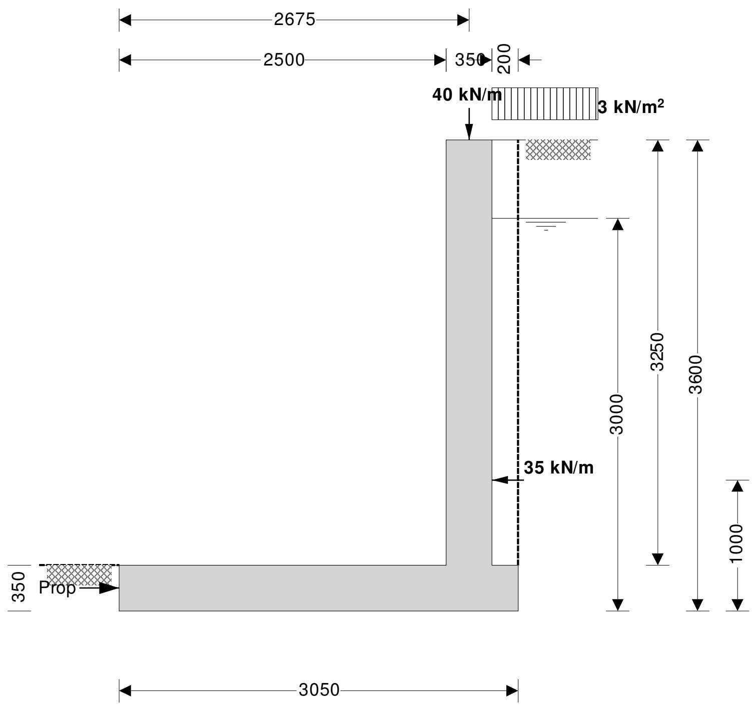
GROUND FLOOR PLAN
SHOWING FOUNDATION LAYOUT

DRAWING No.	REV	CHECKED
19313 / 102	A	

SCALE	DATE	DRAWN	APPROVED
As Shown	June '20	MJB	

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	$h_{sat} = \max(h_{water} - t_{base} - d_{ds}, 0 \text{ mm})$ = **2650** mm
Density of wall construction	γ_{wall} = **23.6** kN/m^3
Density of base construction	γ_{base} = **23.6** kN/m^3
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/m^3

Saturated density of retained material γ_s = **21.0** kN/m³

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/m³

Design shear strength ϕ'_b = **24.2** deg

Design base friction δ_b = **18.6** deg

Allowable bearing pressure $P_{bearing}$ = **175** kN/m²

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/m²

Applied vertical dead load on wall W_{dead} = **20.0** kN/m

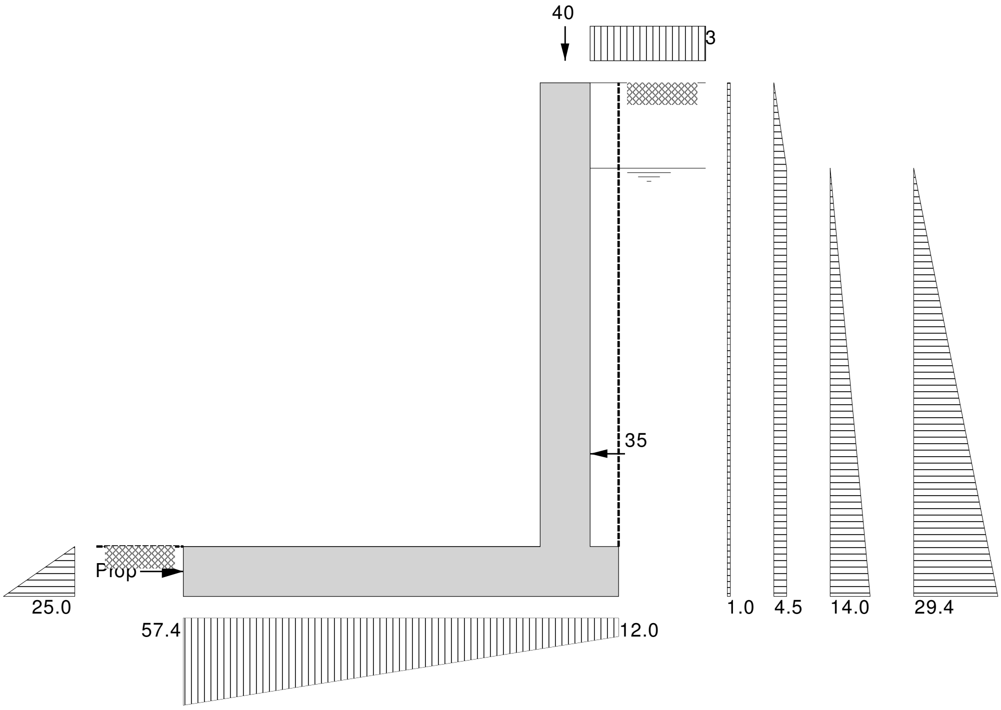
Applied vertical live load on wall W_{live} = **20.0** kN/m

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/m²

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 $F_{prop} = \max(F_{total} - F_p - (W_{total} - w_{sur} - W_{live}) \times \tan(\delta_b), 0 \text{ kN/m})$

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 $e = \text{abs}((l_{base} / 2) - x_{bar})$ = **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 $w_{sur\_f} = \gamma_{f\_l} \times \text{Surcharge} \times l_{heel}$ = **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 $F_{sur\_f} = \gamma_{f\_l} \times K_0 \times \text{Surcharge} \times h_{eff}$ = **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 $F_{prop\_f} = \max(F_{total\_f} - F_{p\_f} - (W_{total\_f} - w_{sur\_f} - \gamma_{f\_l} \times W_{live}) \times \tan(\delta_b), 0 \text{ kN/m})$

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

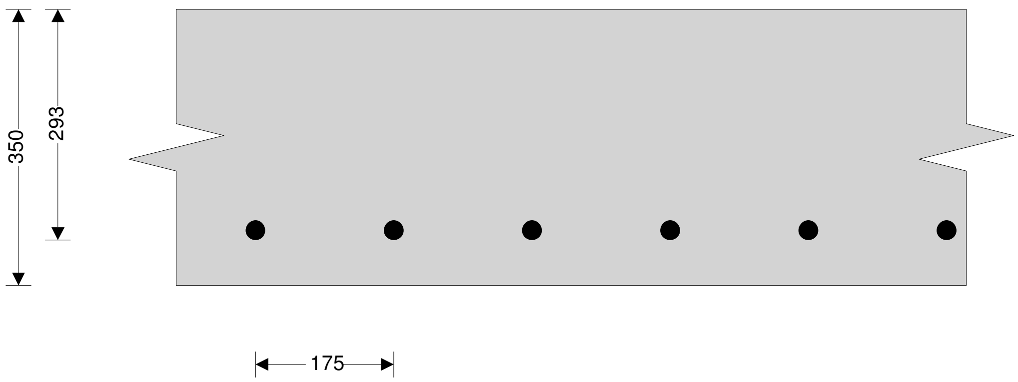
Total shear for toe design — $V_{toe} = V_{toe\_bear} - V_{toe\_wt\_base} =$ **118.1** kN/m

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 $A_{s\_toe\_req} = Max(A_{s\_toe\_des}, A_{s\_toe\_min})$ = **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 $v_{adm} = min(0.8 \times \sqrt{(f_{cu} / 1 N/mm^2)}, 5) \times 1 N/mm^2$ = **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_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

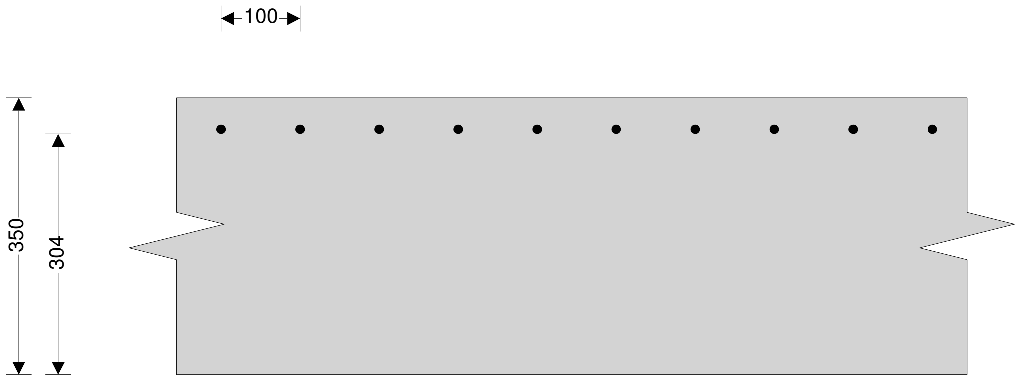
Moment from weight of base $M_{heel\_wt\_base} = (\gamma_{f\_d} \times \gamma_{base} \times t_{base} \times (l_{heel} + t_{wall} / 2)^2 / 2)$ = **0.8** kNm/m

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** mm^2/m

Minimum area of tension reinforcement — $A_{s\_heel\_min} = k \times b \times t_{base}$ = **455** mm^2/m

Area of tension reinforcement required — $A_{s\_heel\_req} = \mathrm{Max}(A_{s\_heel\_des}, A_{s\_heel\_min})$ = **455** mm^2/m

Reinforcement provided — **12 mm dia.bars @ 100 mm centres**

Area of reinforcement provided — $A_{s\_heel\_prov}$ = **1131** mm^2/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/mm^2

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/mm^2

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/mm^2

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

<u>Design of reinforced concrete retaining wall stem (BS 8002:1994)</u>

Material properties

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

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

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 — $F_{s\_sur\_f} = \gamma_{f\_l} \times K_0 \times \mathrm{Surcharge} \times (h_{eff} - t_{base} - d_{ds})$ = **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

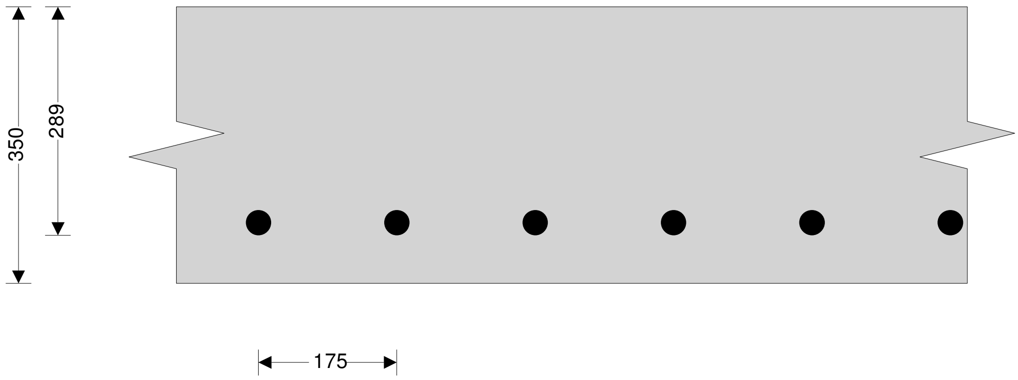
Moist backfill below water table — $M_{s\_m\_b} = F_{s\_m\_b\_f} \times h_{sat} / 2 =$ **31.3** kNm/m

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 — $A_{s\_stem\_req} = \mathrm{Max}(A_{s\_stem\_des}, A_{s\_stem\_min}) =$ **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 — $v_{adm} = \min(0.8 \times \sqrt{(f_{cu} / 1\ \mathrm{N/mm^2})}, 5) \times 1\ \mathrm{N/mm^2} =$ **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/mm²

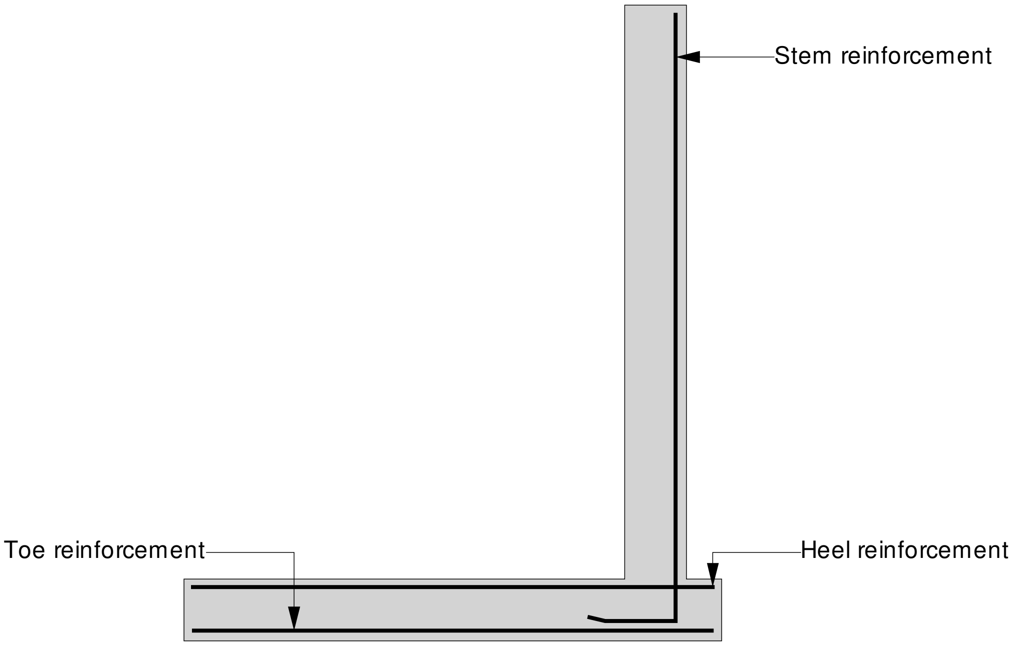
Modification factor $factor_{tens} = \min(0.55 + (477\ N/mm^2 - f_s)/(120 \times (0.9\ N/mm^2 + (M_{stem}/(b \times d_{stem}^2)))),2)$ = **1.64**

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

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)

Granit Chartered Architects

16 Porteus Pl,

Clapham,

London

SW4 0AS

MITCHINSON MACKEN

Unit 4, Trafalgar Mews
15-16 Trafalgar Street, Brighton
East Sussex, BN1 4EQ

www.mitchinsonmacken.co.uk
info@mitchinsonmacken.co.uk
Office 01273 609742

Re:- Parsifal House, 521 Finchley Road, London – Job - 19313

Dear Mr Gaigalas

16/07/19

Regarding the proposed basement construction at the above property; please note this has been designed to comply with Subterranean Development SPD – Clause 6.1.2

We are happy that the strata can support the given loads and sequence of works.
The proposed works will have no effect on existing surrounding utilities and infrastructure.
Slope instability will not apply.
We do not expect ground water to be encountered within the build. A pump shall be present on site to deal with any ground water as a failsafe.

Our design has considered all geological, hydrological and structural concerns. Our sequence, method statement and retaining wall design have considered all these factors.
Please see plans 18515 for these sequenced works.

Please note that if all works are carried out to this Method Statement, Calculations and sequence, we are happy to state that no detrimental effect will occur to the adjoining properties.

Regarding levels of anticipated movement; these are set out and fall under Movement and Expected levels of Damage to BRE Digest 251

Regarding an assessment of the predicted ground movements which may be caused by the works and their effect on the adjoining structures/ground. Ref: Table 1. BRE Digest 251; we would expect:-
CATEGORY 1
1 - Fine cracks that can be treated easily using normal decoration. Damage generally restricted to internal wall finishes; cracks rarely visible in external brickwork. Typical crack widths up to 1 mm

Please note we have not allowed for movement monitoring. As the quality of finishes within the adjacent properties will make any movement obvious.

Please note that heave protection will not be required within our design.

Regards

Andrew Mitchinson BEng(Hons), CEng, MIStructE

MITCHINSON MACKEN

JOB TITLE PARSIFAL HOUSE - 521 FINCHLEY			ITEM LOAD TAKE DOWN		
DESIGNED BY MM	DATE JUNE 20	CHECKED BY	JOB NO. 19313	SHEET 101	REV

LOADING ONTO HEAD OF WALL (FLANK)

$6.4m \times 3.75 kN/m^2 = 24 kN/m$ CAVITY

$5.2m/2 \times 2.0 kN/m^2 = 5.2 kN/m$

$\times 2$ $10.4 kN/m$ FLOORS

$5.2m/2 \times 1.55 kN/m^2 = 4.0 kN/m$ ROOF

$2.8m \times 0.6 kN/m^2 = 1.7 kN/m$ STUD

$\Sigma = 40.1 kN/m$

LOADING SPINE/PARTY

$6.4 \times 3.0 kN/m^2 = 19.2 kN/m$ CAVITY

$5.2m/2 \times 2.0 kN/m^2 = 5.2 kN/m$

$\times 4 = 20.8 kN/m$

$5.2m/2 \times 1.55 kN/m^2 = 4.0 kN/m$

$\times 2 = 8.0 kN/m$

$2.8m \times 0.6 kN/m^2 \times 2 = 3.4 kN/m$

$\Sigma = 51.4 kN/m$