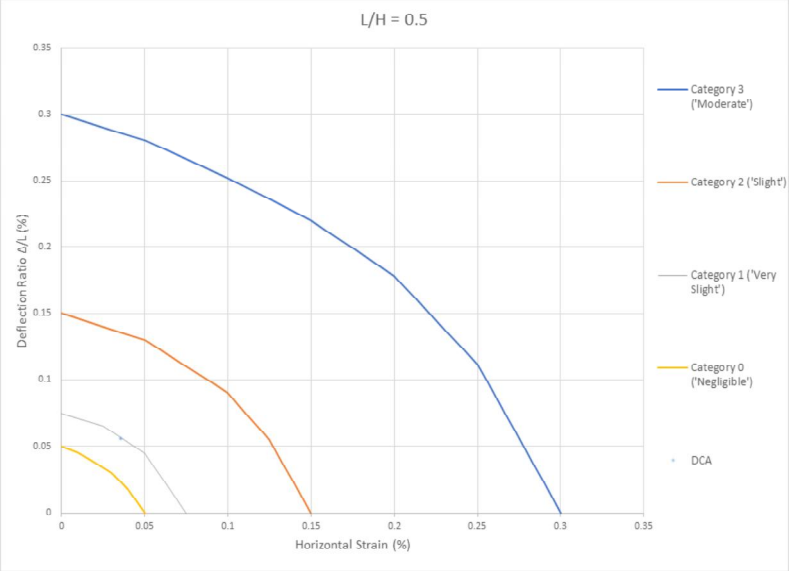
Appendix 3: Supplementary Supporting Documents

Re: 34a King Henry's Road - BIA/7806
Will Dewar
to:
AntonioPontes, martin dowle, neil gaskin, RobertMorley, grahamkite
02/11/2017 17:09
Hide Details
From: "Will Dewar" <will@sketch-london.co.uk> Sort List...
To: AntonioPontes@campbellreith.com, "martin dowle" <martin@sketch-london.co.uk>, "neil gaskin" <neil@sketch-london.co.uk>, RobertMorley@campbellreith.com, grahamkite@campbellreith.com

Sent again in case the image wasn't attached.



On 2 November 2017 at 17:09, Will Dewar <will@sketch-london.co.uk> wrote:

> Antonio,
>
> Please see attached below from Chelmers.
>
> I have also had a response from the Structural engineer. which I will forward in a separate email.
>
> Best regards
>
> Will
>
> ---------- Forwarded message ----------
> From: **Patrick O'Toole** <potoole@chelmerglobal.co.uk>
> Date: 2 November 2017 at 15:28
> Subject: RE: 34a King Henry's Road - BIA/7806
> To: "will@sketch-london.co.uk" <will@sketch-london.co.uk>
>
> Will
>
> In regards to point one of your query, please find attached our geotechnical interpretive report, GEO/7806.
>
> Regarding wall movement, on closer inspection, whilst we have previously stated that the wall in question is between Category 1 and Category 2, it does in fact fall within Category 1. Please see below the same graph as in the report, however we have made finer the category line and made smaller the point for additional clarity
>
> We do however insist you are alerted in regard to the proximity of Category 2, and move forward with the required caution.

Kindest regards

Patrick O'Toole

From: Matthew Proctor [mailto:mproctor@siteinvestigations.co.uk]
Sent: 26 October 2017 16:22
To: Patrick O'Toole <potoole@chelmerglobal.co.uk>
Subject: FW: 34a King Henry's Road - BIA/7806

FYI

Matthew Proctor BEng. (Hons), FGS, IAEG, AMIEnvSc

Consultancy Director

cid:image001.png@01D1336A.BE1E45E0

Essex | *01245 400930* *Spain* | *0034 9511 96375*
Website | *www.chelmer.website*

Registered Company: Chelmer Site Investigation Laboratories Ltd

Unit 15 East Hanningfield Industrial Estate | Old Church Road | East Hanningfield | Chelmsford | Essex CM3 8AB

From: Will Dewar [mailto:will@sketch-london.co.uk]
Sent: 26 October 2017 15:34
To: Matthew Proctor <mproctor@siteinvestigations.co.uk>
Cc: Julian Harrison <jharrison@siteinvestigations.co.uk>; neil gaskin <neil@sketch-london.co.uk>; Patrick O'Toole <potoole@chelmerglobal.co.uk>
Subject: Re: 34a King Henry's Road - BIA/7806

Matt,

I have just spoken to Campbell Reith and they wanted to reiterate that they are more concerned about the ground movement affecting the road rather than the ground movement against the neighbouring buildings.

They have said that as the new excavation will only be a maximum of 1m under the the level of the existing lightwell but 3m lower than the road level, this is their main concern. Not sure this helps at all but thought it would be useful to know?

I have also received the following from Packman Lucas regarding point 1:

The calculation has been provided, page 14 of the calcs, but presumably not in enough detail. Please find attached here expanded.

The toe would be constructed as an under-ream, therefore no backfilling would be required. The retaining wall would be installed as a sequential wall construction.

I hope that helps.

Best regards

Will

On 25 October 2017 at 15:52, Matthew Proctor <mproctor@siteinvestigations.co.uk> wrote:

> Will,

This is already being reviewed.

Most of this is to do with the CNS which is commonly prepared by the Structural Engineer involved with the project.

We are taking a look at items 1 and 5 now…

Regards,

Matt

Matthew Proctor BEng. (Hons), FGS, IAEG, AMIEnvSc

Consultancy Director

From: Will Dewar [mailto:will@sketch-london.co.uk]
Sent: 25 October 2017 15:45
To: Julian Harrison <jharrison@siteinvestigations.co.uk>; Matthew Proctor <mproctor@siteinvestigations.co.uk>; neil gaskin <neil@sketch-london.co.uk>
Subject: Fwd: 34a King Henry's Road - BIA/7806

Julian,

Further to our conversation just now, please see the email chain below. If someone could review this and call me back on my mobile - 07793123160 to discuss, that would be fantastic.

Best regards

Will

---------- Forwarded message ----------
From: **Will Dewar** <will@sketch-london.co.uk>
Date: 24 October 2017 at 12:48
Subject: Re: 34a King Henry's Road - BIA/7806
To: Matthew Proctor <mproctor@siteinvestigations.co.uk>

Matthew,

I tried to call earlier but you were in a meeting.

Campbell Reith have come back with some additional items they require to sign off the BIA Audit, I believe we will require your input on a couple of these items.

Could you call me to discuss when you have a moment, I have listed the items below:

1) RC Retaining Wall: bearing pressure at base and a stem design calculations should be provided. Any assumptions regarding stem propping, temporary and permanent, should be indicated. The construction method statement should clarify how the 300mm toe is going to be constructed and how the wall will be back filled to achieve a good level of soil compaction.

2) The BIA indicates that the basement slab should be designed to accommodate swelling displacements and pressures developed underneath. Retaining wall base and slab heave design must be provided.

3) A works programme, identifying all key phases of the project should be provided.

4) Surface Water Disposal: a requirements for SUDS was identified but no solution was specified. The outline design must be presented for the proposed SUDS solution.

5) The category of damage assessment for property No. 32 is "between" 1 and 2. In accordance with the latest Camden Local plan, Policy A5 (June 2017), the category of damage must be maximum of 1.

6) No construction method is being presented.

Best regards

Will

On 17 October 2017 at 12:58, Matthew Proctor <mproctor@siteinvestigations.co.uk> wrote:

> Will,
>
> Apologies for the delay in coming back to you on this….
>
> Having reviewed the documents it would appear that the stamen is correct and this review would fall into the Cat B requirement.
>
> Sorry this isn't better news!
>
> Regards,
>
> Matt
>
> Matthew Proctor BEng. (Hons), FGS, IAEG, AMIEnvSc
>
> Consultancy Director

cid:image001.png@01D1336A.BE1E45E0

From: Will Dewar [mailto:will@sketch-london.co.uk]
Sent: 09 October 2017 16:52
To: Matthew Proctor <mproctor@siteinvestigations.co.uk>
Subject: Re: 34a King Henry's Road - BIA/7806

Matthew,

Further to our conversation last week, have you had a chance to have a look at this?

My apologies for chasing but we need to appoint the auditing engineer in the next couple of days otherwise we will run out of time on the planning application. I

Best regards

Will

On 6 September 2017 at 10:16, Matthew Proctor <mproctor@siteinvestigations.co.uk> wrote:

> Will,
>
> I will be the best point of contact regarding Alex's past projects now…
>
> Can I ask you to please outline your queries in an email back to me, then I can review and revert asap.
>
> Kind Regards,
>
> Matt
>
> Matthew Proctor BEng. (Hons), FGS, IAEG, AMIEnvSc
>
> Consultancy Director

cid:image001.png@01D1336A.BE1E45E0

From: Will Dewar [mailto:will@sketch-london.co.uk]
Sent: Tuesday, September 5, 2017 3:31 PM
To: info@chelmerglobal <info@chelmerglobal.co.uk>
Subject: 34a King Henry's Road - BIA/7806

Hello,

We had the above BIA produced earlier this year but I understand the person dealing with it - Alexandra Ash, has now left. We have some questions about the documents so could the person who is taking on Alexandra Ash's workload please contact me at their earliest convenience.

Kind regards

Will

--

WILL DEWAR

Director

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DD: 0203 7734882
M: 07793 123160
E: will@sketch-london.co.uk

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www.sketch-architects.co.uk

--

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Fwd: 5682 - 34A King Henrys Road - BIA
Will Dewar
to:
AntonioPontes, grahamkite, neil gaskin, RobertMorley
02/11/2017 17:14
Hide Details
From: "Will Dewar" <will@sketch-london.co.uk>
To: AntonioPontes@campbellreith.com, grahamkite@campbellreith.com, "neil gaskin" <neil@sketch-london.co.uk>, RobertMorley@campbellreith.com
History: This message has been replied to.

4 Attachments

4923-01-010.dwg 5682 - Drawing Issue Register.pdf 5682-SK-01 - P3.pdf

Retaining wall analysis & design (EN1992.pdf

Antonio,

Please see below and attached from the engineer Packman Lucas

Hi Will.

Compiled points below:

- **RC Retaining Wall: bearing pressure at base and a stem design calculations should be provided. Any assumptions regarding stem propping, temporary and permanent, should be indicated. The construction method statement should clarify how the 300mm toe is going to be constructed and how the wall will be back filled to achieve a good level of soil compaction.**

The calculation has been provided, page 14 of the calcs, but presumably not in enough detail. Please find attached here expanded.

The toe would be constructed as an under-ream, therefore no backfilling would be required. The retaining wall would be installed as a sequential wall construction.

- **The BIA indicates that the basement slab should be designed to accommodate swelling displacements and pressures developed underneath. Retaining wall base and slab heave design must be provided.**
A works programme, identifying all key phases of the project should be

provided.

A suspended slab has been proposed (beam and block). An indicative section has been added to the drawings, attached.

- **Surface Water Disposal: a requirements for SUDS was identified but no solution was specified. The outline design must be presented for the proposed SUDS solution.**

We can't help with this directly, but I think we're talking about attenuation and a drainage design.

- **The category of damage assessment for property No. 32 is "between" 1 and 2. In accordance with the latest Camden Local plan, Policy A5 (June 2017), the category of damage must be maximum of 1.**

The Chelmer Report does include a ground movement assessment, and a damage assessment. However, it seems that there results land outside of what is acceptable. I'd have them review this.

Regards,

Ben Bradshaw BEng CEng MIStructE

Associate

packmanlucas

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SKETCH ARCHITECTS

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Re: 34A King Henrys Road - monitoring
Will Dewar
to:
RobertMorley, neil gaskin
23/11/2017 17:33
Cc:
camdenaudit
Hide Details
From: "Will Dewar" <will@sketch-london.co.uk>
To: RobertMorley@campbellreith.com, "neil gaskin" <neil@sketch-london.co.uk>
Cc: camdenaudit@campbellreith.com
History: This message has been replied to.

Rob,

I can confirm that this is the case and it will of course be included in the CMP. Camden have also stated that a section 106 agreement will be needed to monitor the CMP and our client has confirmed that they are happy to cover the cost of this monitoring.

I hope this helps?

Best regards

Will

On 23 November 2017 at 17:29, <RobertMorley@campbellreith.com> wrote:

> Hi Will
>
> I notice in Chelmer's conclusions they make a recommendation that monitoring of the neighbouring properties is carried out during construction, however no mention of monitoring is made in the construction method statement or elsewhere to confirm that this recommendation will be carried out.
>
> Can it be confirmed if movement monitoring is proposed to be carried out, and if so that best practise will be followed.
>
> Kind regards,
>
> **Robert Morley**
> Senior Engineer
>
> CampbellReith
> Consulting engineers
> Friars Bridge Court,
> 41-45 Blackfriars Road,
> London
> SE1 8NZ
>
> Tel +44 (0)20 7340 1700
> www.campbellreith.com
>
>

--

WILL DEWAR

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Structural Engineers Report

34A King Henrys Road, London
Retaining wall construction suggested method statement

Reference: 5681 12 171114
Date: 14Th November 2017

1. Basement Formation Suggested Method Statement

1.1. This method statement provides an approach which will allow the basement design to be correctly considered during construction, and the temporary support to be provided during the works. The Contractor is responsible for the works on site and the final temporary works methodology and design on this site and any adjacent sites.

1.2. This method statement has been written by a Chartered Engineer. The sequencing has been developed considering guidance from ASUC.

1.3. This method has been produced to allow for improved costings and for inclusion in the party wall Award. Should the contractor provide alternative methodology the changes shall be at their own costs, and an Addendum to the Party Wall Award will be required.

1.4. Contact party wall surveyors to inform them of any changes to this method statement.

1.5. The approach followed in this design is; to cast sequential wall retaining walls to expand the existing lightwell to the front of the property.

1.6. The cantilever pins are designed to be inherently stable during the construction stage without temporary propping to the head. The base benefits from propping, this is provided in the final condition by the ground slab. In the temporary condition the edge of the slab is buttressed against the soil in the middle of the property, also the skin friction between the concrete base and the soil provides further resistance. The central slab is to be poured in a maximum of a 1/3 of the floor area.

1.7. A soil investigation has been undertaken. The soil conditions are London Clays.

1.8. The bearing pressures have been limited to 100kN/m2. This is standard loadings for local ground conditions and acceptable to building control and their approvals.

1.9. The bore hole finished at 6m deep and no water has been encountered.

4 Underpinning and Cantilevered Walls

4.1. Prior to installation of new structural beams in the superstructure, the contractor may undertake the local exploration of specific areas in the superstructure. This will confirm the exact form and location of the temporary works that are required. The permanent structural work can then be undertaken whilst ensuring that the full integrity of the structure above is maintained.

4.2. Provide propping to floor where necessary.

4.3. Excavate first section of retaining wall (no more than 1200mm wide). Where excavation is greater than 1.2m deep provide temporary propping to sides of excavation to prevent earth collapse (Health and Safety). A 1200mm width wall has a lower risk of collapse to the heel face.

4.4. Backpropping of rear face. Rear face to be propped in the temporary conditions with a minimum of 2 Trench sheets. Trench sheets are to

extend over entire height of excavation. Trench sheets can be placed in short sections are the excavation progresses.

4.4.1. If the ground is stable, trench sheets can be removed as the wall reinforcement is placed and the shuttering is constructed.

4.4.2. Where soft spots are encountered leave in trench sheets or alternatively back prop with Precast lintels or trench sheeting. (If the soil support to the ends of the lintels is insufficient then brace the ends of the PC lintels with 150x150 C24 Timbers and prop with Acrows diagonally back to the floor.)

4.4.3. Where voids are present behind the lintels or trench sheeting. Grout voids behind sacrificial propping; Grout to be 3:1 sand cement packed into voids.

4.4.4. Prior to casting place layer of DPM between trench sheeting (or PC lintels) and new concrete. The lintels are to be cut into the soil by 150mm either side of the pin. A site stock of a minimum of 10 lintels to be present for to prevent delays due to ordering.

4.5. If cut face is not straight, or sacrificial boards noted have been used, place a 15mm cement particle board between sacrificial sheets and or soil prior to casting. Cement particle board is to line up with the adjacent owners face of wall. The method adopted to prevent localised collapse of the soil is to install these progressively one at a time. Cement particle board must be used to in any condition where overspill onto the adjacent owners land is possible.

4.6. Excavate base. Mass concrete heels to be excavated. If soil over unstable prop top with PC lintel and sacrificial prop.

4.7. Visually inspect the footings and provide propping to local brickwork, if necessary sacrificial Acrow, or pit props, to be sacrificial and cast into the retaining wall.

4.8. Clear underside of existing footing.

4.9. Local authority inspection to be carried for approval of excavation base.

4.10. Place reinforcement for retaining wall base & toe. Site supervisor to Inspect and sign off works for proceeding to next stage.

4.11. Cast base. (on short stems it is possible to cast base and wall at same time)

4.12. Take 2 cubes of concrete and store for testing. Test one at 28 days if result is low test second cube. Provide results to client and design team on request or if values are below those required.

4.13. Horizontal temporary prop to base of wall to be inserted. Alternatively cast base against soil.

4.14. Place reinforcement for retaining wall stem. Site supervisor to inspect and sign off works for proceeding to next stage.

4.15. Drive H16 Bars U-Bars into soil along centre line of stem to act as shear ties to adjacent wall.

4.16. Place shuttering & pour concrete for retaining wall. Stop a minimum of 75mm from the underside of existing footing.

4.17. Ram in drypack between retaining wall and existing masonry. (24 hours after pouring the concrete pin the gap shall be filled using a dry pack mortar.)
4.18. After 24 hours the temporary wall shutters are removed.
4.19. Trim back existing masonry corbel and concrete on internal face.
4.20. Site supervisor to inspect and sign off for proceeding to the next stage.

END

3.0 Observations and Discussions

3.1

1.0 Conclusions

1.1

SKETCH
LONDON ARCHITECTS

34a King Henry's Road

Proposed Outline Programme of Works

- **Estimated Start Date: May 2018**
- **Estimated Completion Date: Dec 2018**

Main Phases of Work:

- Site set up – 2 Weeks
- Underpinning and cantilevered walls - 1 Month
- Remaining excavation of front extension – 1 month
- Strip out of interior – 2 Weeks
- Propping and removal of load bearing walls – 2 Weeks
- Installation of Structural Steelwork – 2 Weeks
- Drainage installation – 1 Week
- Groundworks, Slab and basement walls – 3 Weeks
- Extension walls and roofs – 1 Month
- Internal partition walls – 1 Week
- Installation of glazing – 1 Week
- Internal fit out – 2 Months
- Internal and External decoration – 1 Month
- Landscaping - 2 Weeks

Sketch London Ltd, Studio A112, Riverside Business Centre, Haldane Place, London, SW18 4UQ
T: 0203 773 4880 | ***E:*** info@sketch-london.co.uk | ***sketch-london.co.uk***

34a King Henry's Road - Sustainable Drainage Design:

Response for further information from Campbell Reith:

Sketch London Architects drawing reference 1081-050 describes the proposed general arrangement of drainage features and attenuation strategy.
The existing surface water drain to the front of the property is understood to be surface gully running into a 100mm diameter combined drain which in turn flows to the Thames Water sewer. The proposed condition increases the impermeable surface water catchment area to the rear of the property by an additional 21.6 square metres, representing a 10% increase in plan area. The proposed roofs to the rear are proposed to be covered in Sedum, giving a degree of attenuation before the water is discharged into the rainwater pipes.
In lieu of Thames Water approval for an increased surface water discharge into the public sewer and in order to exceed the requirements of reasonable Sustainable Urban Drainage, we will employ the use of an attenuating holding tank of 1.0 cub.m which will be pumped using a commercially available submersible float activated pump to discharge at a rate not exceeding 0.1 l/s. An integrated baffled oil interceptor will be used to remove the risk of contaminants reaching the public drain.

Design Principles:
The below ground drainage network will be checked using a simulation analysis to ensure it achieves the following criteria to comply with British and European Standards BS EN752:
• No significant surcharging (gravity flow only) for storm flows with a 2 year return period.
• No flooding for storm flows with a 30 year return period.
• No flooding off-site or as such to present risk to person or property for storm flows with a 100 year return period.
• The volume of water to be stored in the attenuation tanks will be determined using the Microdrainage analysis software based on the following input variables;
• Storm Water Return Period - 1 in 100 years + 30%
• Site location – to determine the rainfall hyetograph characteristics
• Pipe network volume – calculated by the automated process
• Out flow control device – pump

NOTES

These drawings are for planning purposes only and not for construction.

Drawing Title:

SUSTAINABLE DRAINAGE PLAN

Scale	1:100 @ A3	Date	FEB '17
Project Co-ordinator			WD
Issue Status	PLANNING		

Client:

RUPERT WEST

Client Ref:

Project:

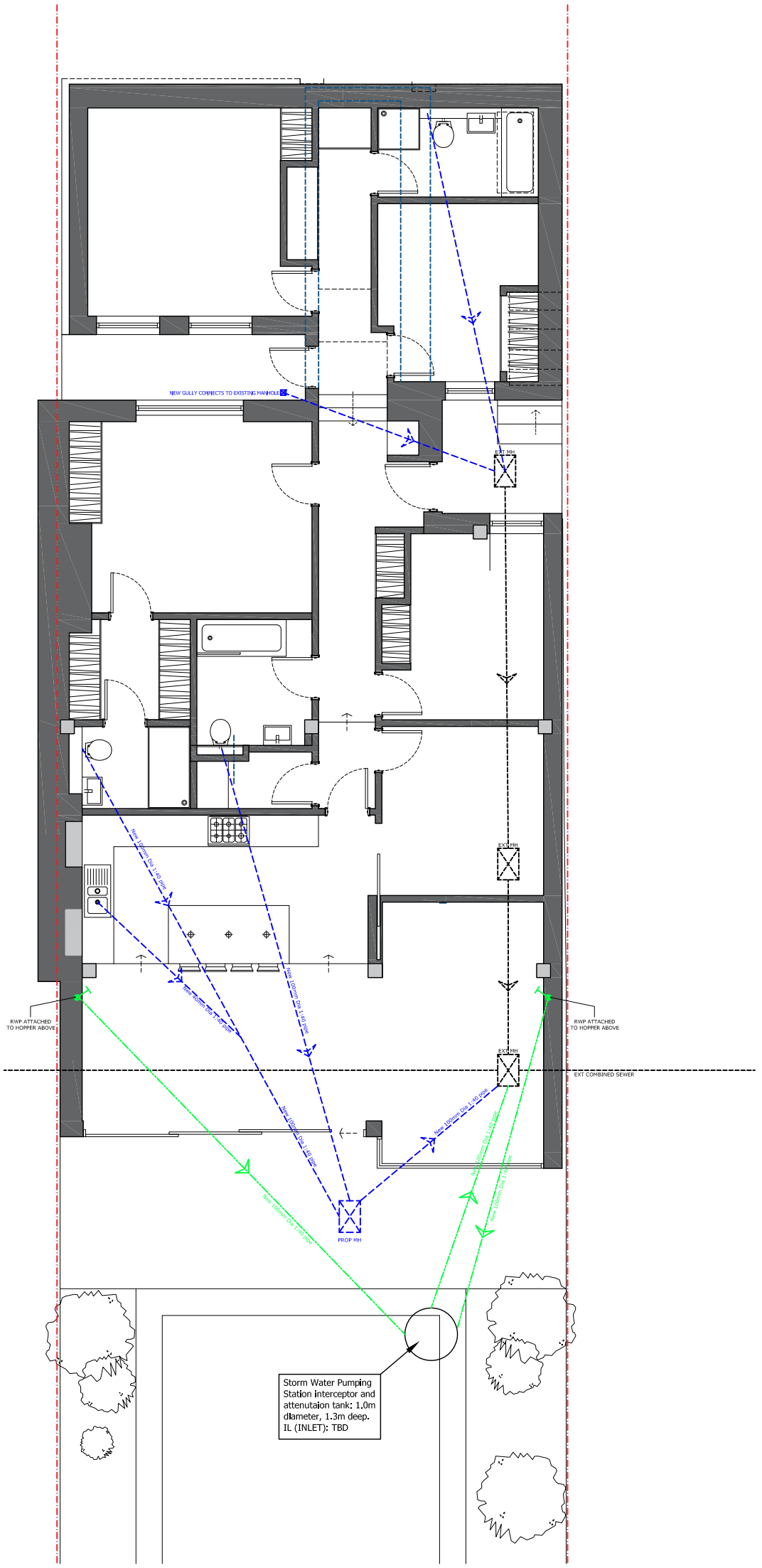
34A KING HENRYS ROAD

Job No:	Type:	Dwg No:	Revision:
1079	D	050	A

SKETCH
LONDON ARCHITECTS
STUDIO 415, THE LIGHTBULB
1 FILAMENT WALK
WANDSWORTH
SW18 4GQ

Issue:

Revision:	Notes:	Date:
A	ISSUED TO CAMPBELL REITH	07.11.2017



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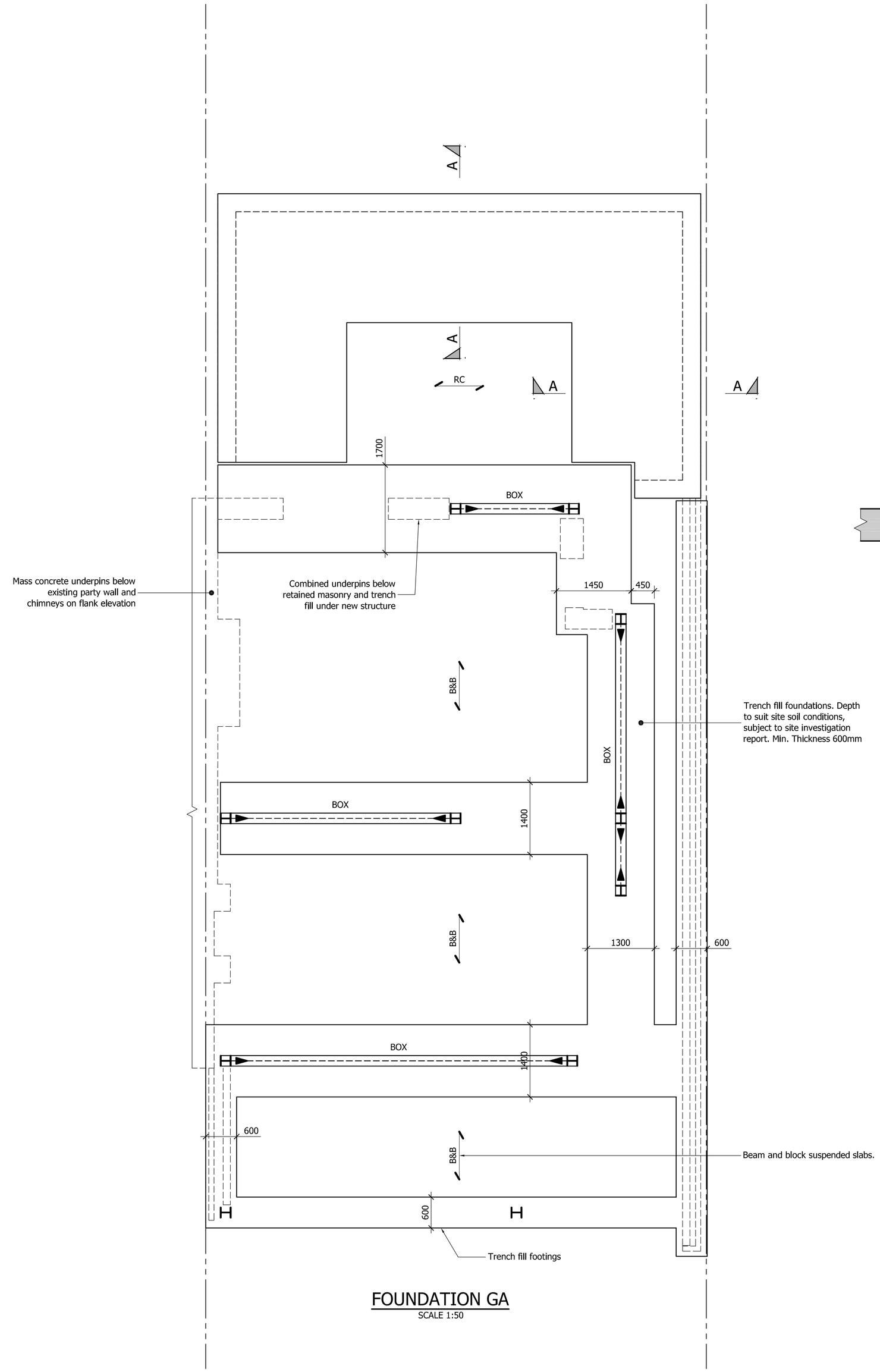
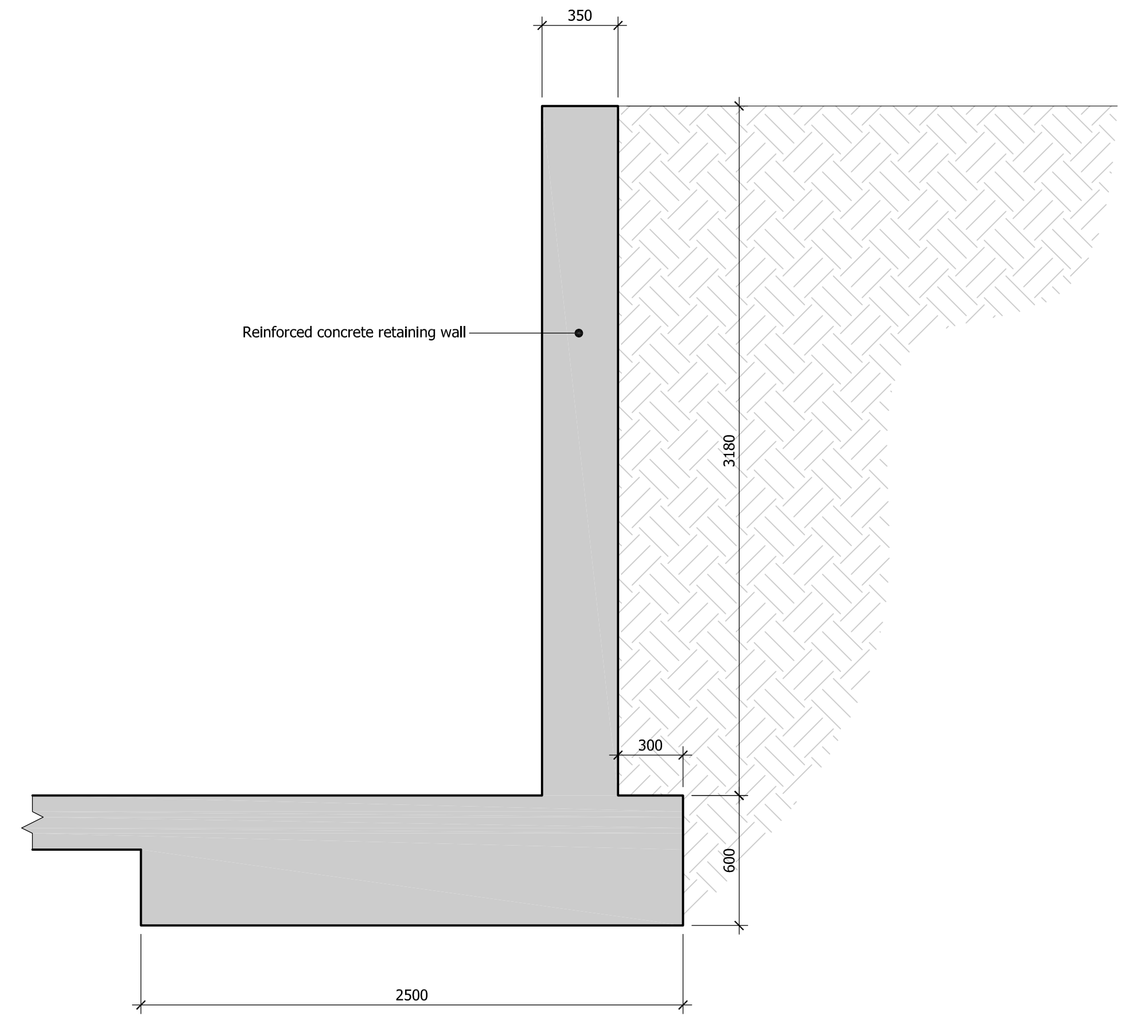
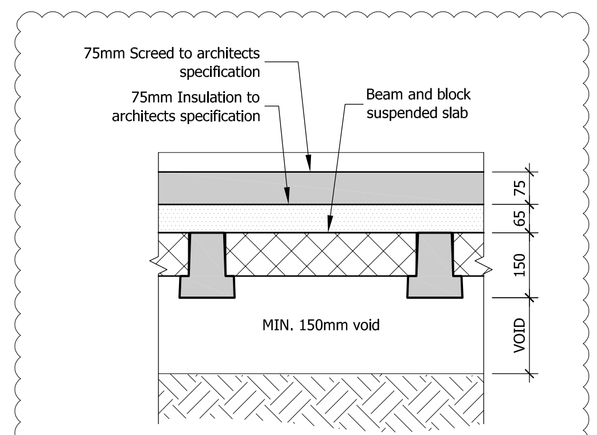
DO NOT SCALE



FOUNDATION GA
SCALE 1:50



SECTION A-A
SCALE 1:20



B&B BEAM AND BLOCK SLAB BUILD UP DETAIL
SCALE 1:10

REV	DATE	DESCRIPTION	DRAWN	CHKD
P3	24.10.17	REVISED AS CLOUDED	BB	BB
P2	09.05.17	ISSUED FOR APPROVAL	BB	BB
P1	05.05.17	WIP ISSUE	BB	BB

REVISIONS

The contractor is to verify all dimensions on site before commencing work. All errors and omissions are to be reported to the Engineer. This drawing is to be read in conjunction with all relevant Architects, Services Engineers and Engineers drawings and specifications.

Project
34A King Henrys Road
London

Title
Foundation GA

Client
Ms. E. Wynd
Mr. R. West

Scale	Drawn	Date	Checked
1:50 @ A1	BB	May-17	BB

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Butlers Wharf West
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E: info@packmanlucas.co.uk

Drawing No. 5682 - SK - 01

Revision P3

Drawing Status
☒ INFORMATION ☐ APPROVAL ☐ COSTING
☐ TENDER ☐ CONSTRUCTION ☐ FINAL CONSTRUCTION

A1

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Project				Job no.	
34A King Henrys Road				5682	
Calcs for				Start page no./Revision	
Retaining Wall				1	
Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
YM	24/10/2017				

RETAINING WALL ANALYSIS

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

Tedds calculation version 2.9.00

Retaining wall details

Stem type	Cantilever
Stem height	h_{stem} = **3180** mm
Stem thickness	t_{stem} = **350** mm
Angle to rear face of stem	α = **90** deg
Stem density	γ_{stem} = **25** kN/m^3
Toe length	l_{toe} = **1850** mm
Heel length	l_{heel} = **300** mm
Base thickness	t_{base} = **600** mm
Base density	γ_{base} = **25** kN/m^3
Height of retained soil	h_{ret} = **3178** mm
Angle of soil surface	β = **0** deg
Depth of cover	d_{cover} = **0** mm

Retained soil properties

Soil type	Organic clay
Moist density	γ_{mr} = **15** kN/m^3
Saturated density	γ_{sr} = **15** kN/m^3
Characteristic effective shear resistance angle	$\phi'_{r.k}$ = **18** deg
Characteristic wall friction angle	$\delta_{r.k}$ = **9** deg

Base soil properties

Soil type	Organic clay
Soil density	γ_b = **15** kN/m^3
Characteristic effective shear resistance angle	$\phi'_{b.k}$ = **18** deg
Characteristic wall friction angle	$\delta_{b.k}$ = **9** deg
Characteristic base friction angle	$\delta_{bb.k}$ = **12** deg
Presumed bearing capacity	$P_{bearing}$ = **95** kN/m^2

Loading details

Variable surcharge load	$Surcharge_Q$ = **5** kN/m^2
Vertical line load at 2000 mm	P_{G1} = **6** kN/m
	P_{Q1} = **1.6** kN/m

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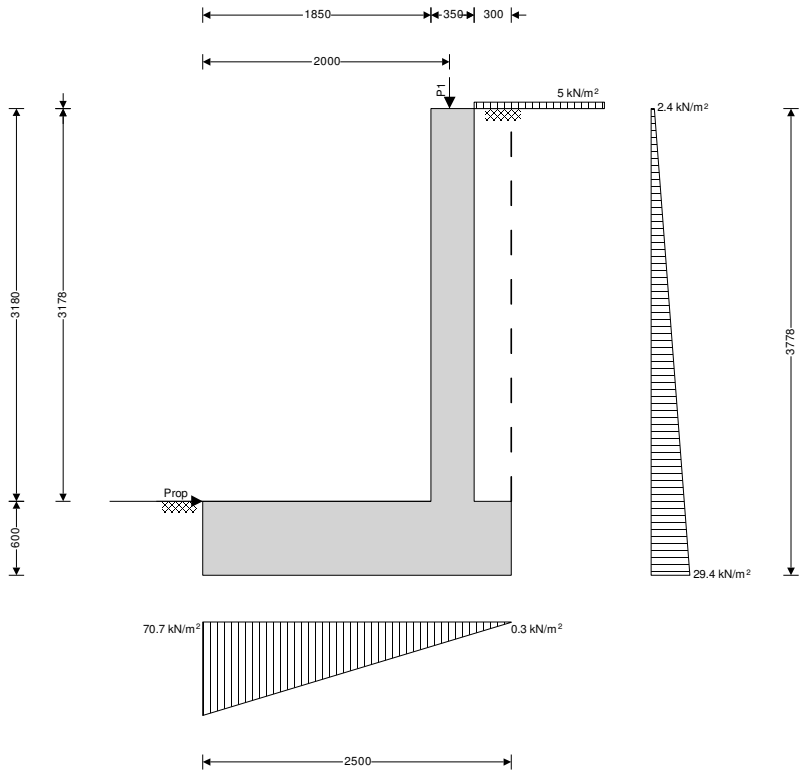

General arrangement

Calculate retaining wall geometry

Base length	$l_{base} = l_{toe} + t_{stem} + l_{heel} =$ **2500** mm
Moist soil height	$h_{moist} = h_{soil} =$ **3178** mm
Length of surcharge load	$l_{sur} = l_{heel} =$ **300** mm
- Distance to vertical component	$x_{sur\_v} = l_{base} - l_{heel} / 2 =$ **2350** mm
Effective height of wall	$h_{eff} = h_{base} + d_{cover} + h_{ret} =$ **3778** mm
- Distance to horizontal component	$x_{sur\_h} = h_{eff} / 2 =$ **1889** mm
Area of wall stem	$A_{stem} = h_{stem} \times t_{stem} =$ **1.113** m²
- Distance to vertical component	$x_{stem} = l_{toe} + t_{stem} / 2 =$ **2025** mm
Area of wall base	$A_{base} = l_{base} \times t_{base} =$ **1.5** m²
- Distance to vertical component	$x_{base} = l_{base} / 2 =$ **1250** mm
Area of moist soil	$A_{moist} = h_{moist} \times l_{heel} =$ **0.953** m²
- Distance to vertical component	$x_{moist\_v} = l_{base} - (h_{moist} \times l_{heel}^2 / 2) / A_{moist} =$ **2350** mm
- Distance to horizontal component	$x_{moist\_h} = h_{eff} / 3 =$ **1259** mm

Using Coulomb theory

Active pressure coefficient	$K_A = \sin(\alpha + \phi'_{r.k})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.k}) \times [1 + \sqrt{[\sin(\phi'_{r.k} + \delta_{r.k}) \times \sin(\phi'_{r.k} - \beta) / (\sin(\alpha - \delta_{r.k}) \times \sin(\alpha + \beta))]}]^2) =$ **0.483**
Passive pressure coefficient	$K_P = \sin(90 - \phi'_{b.k})^2 / (\sin(90 + \delta_{b.k}) \times [1 - \sqrt{[\sin(\phi'_{b.k} + \delta_{b.k}) \times \sin(\phi'_{b.k}) / (\sin(90 + \delta_{b.k}))]}]^2) =$ **2.359**

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Bearing pressure check

Vertical forces on wall

Wall stem	$F_{stem} = A_{stem} \times \gamma_{stem} =$ **27.8** kN/m
Wall base	$F_{base} = A_{base} \times \gamma_{base} =$ **37.5** kN/m
Surcharge load	$F_{sur\_v} = Surcharge_Q \times l_{heel} =$ **1.5** kN/m
Line loads	$F_{P\_v} = P_{G1} + P_{Q1} =$ **7.6** kN/m
Moist retained soil	$F_{moist\_v} = A_{moist} \times \gamma_{mr}' =$ **14.3** kN/m
Total	$F_{total\_v} = F_{stem} + F_{base} + F_{moist\_v} + F_{sur\_v} + F_{P\_v} =$ **88.7** kN/m

Horizontal forces on wall

Surcharge load	$F_{sur\_h} = K_A \times \cos(\delta_{r.d}) \times Surcharge_Q \times h_{eff} =$ **9** kN/m
Moist retained soil	$F_{moist\_h} = K_A \times \cos(\delta_{r.d}) \times \gamma_{mr}' \times h_{eff}^2 / 2 =$ **51.1** kN/m
Base soil	$F_{pass\_h} = -K_P \times \cos(\delta_{b.d}) \times \gamma_b' \times (d_{cover} + h_{base})^2 / 2 =$ **-6.3** kN/m
Total	$F_{total\_h} = F_{moist\_h} + F_{pass\_h} + F_{sur\_h} =$ **53.8** kN/m

Moments on wall

Wall stem	$M_{stem} = F_{stem} \times x_{stem} =$ **56.3** kNm/m
Wall base	$M_{base} = F_{base} \times x_{base} =$ **46.9** kNm/m
Surcharge load	$M_{sur} = F_{sur\_v} \times x_{sur\_v} - F_{sur\_h} \times x_{sur\_h} =$ **-13.5** kNm/m
Line loads	$M_P = (P_{G1} + P_{Q1}) \times p_1 =$ **15.2** kNm/m
Moist retained soil	$M_{moist} = F_{moist\_v} \times x_{moist\_v} - F_{moist\_h} \times x_{moist\_h} =$ **-30.7** kNm/m
Total	$M_{total} = M_{stem} + M_{base} + M_{moist} + M_{sur} + M_P =$ **74.2** kNm/m

Check bearing pressure

Propping force	$F_{prop\_base} = F_{total\_h} =$ **53.8** kN/m
Distance to reaction	$\bar{x} = M_{total} / F_{total\_v} =$ **836** mm
Eccentricity of reaction	$e = \bar{x} - l_{base} / 2 =$ **-414** mm
Loaded length of base	$l_{load} = l_{base} =$ **2500** mm
Bearing pressure at toe	$q_{toe} = F_{total\_v} / l_{base} \times (1 - 6 \times e / l_{base}) =$ **70.7** kN/m²
Bearing pressure at heel	$q_{heel} = F_{total\_v} / l_{base} \times (1 + 6 \times e / l_{base}) =$ **0.3** kN/m²
Factor of safety	$FoS_{bp} = P_{bearing} / \max(q_{toe}, q_{heel}) =$ **1.343**

PASS - Allowable bearing pressure exceeds maximum applied bearing pressure

RETAINING WALL DESIGN

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

Tedds calculation version 2.9.00

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

Concrete strength class	C32/40
Characteristic compressive cylinder strength	$f_{ck} =$ **32** N/mm²
Characteristic compressive cube strength	$f_{ck,cube} =$ **40** N/mm²
Mean value of compressive cylinder strength	$f_{cm} = f_{ck} + 8$ N/mm² = **40** N/mm²
Mean value of axial tensile strength	$f_{ctm} = 0.3$ N/mm² $\times (f_{ck} / 1$ N/mm²$)^{2/3} =$ **3.0** N/mm²
5% fractile of axial tensile strength	$f_{ctk,0.05} = 0.7 \times f_{ctm} =$ **2.1** N/mm²
Secant modulus of elasticity of concrete	$E_{cm} = 22$ kN/mm² $\times (f_{cm} / 10$ N/mm²$)^{0.3} =$ **33346** N/mm²
Partial factor for concrete - Table 2.1N	$\gamma_C =$ **1.50**
Compressive strength coefficient - cl.3.1.6(1)	$\alpha_{cc} =$ **0.85**
Design compressive concrete strength - exp.3.15	$f_{cd} = \alpha_{cc} \times f_{ck} / \gamma_C =$ **18.1** N/mm²

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Maximum aggregate size — h_{agg} = **20** mm

Reinforcement details

Characteristic yield strength of reinforcement — f_{yk} = **500** N/mm²

Modulus of elasticity of reinforcement — E_s = **200000** N/mm²

Partial factor for reinforcing steel - Table 2.1N — γ_S = **1.15**

Design yield strength of reinforcement — $f_{yd} = f_{yk} / \gamma_S$ = **435** N/mm²

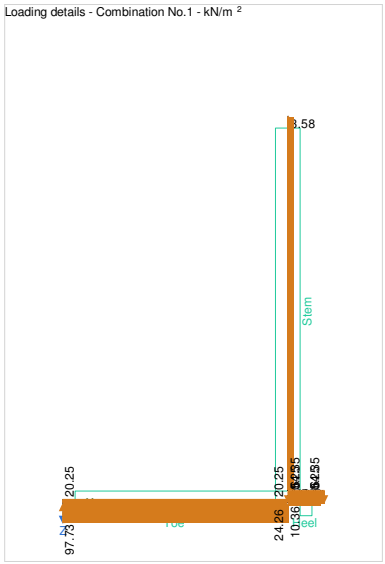
Cover to reinforcement

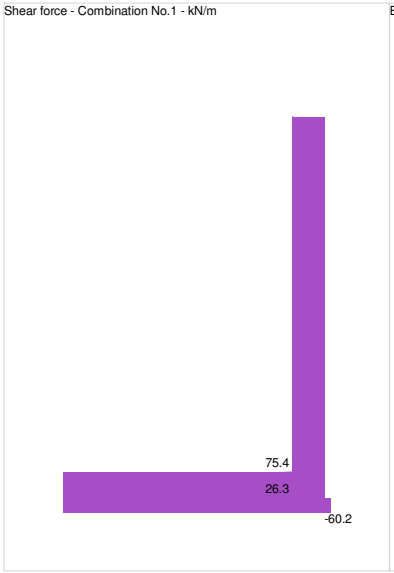
Front face of stem — c_{sf} = **40** mm

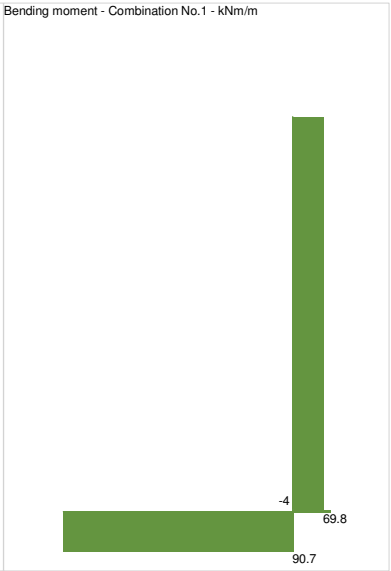
Rear face of stem — c_{sr} = **50** mm

Top face of base — c_{bt} = **50** mm

Bottom face of base — c_{bb} = **75** mm







Check stem design at base of stem

Depth of section — h = **350** mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1 — M = **69.8** kNm/m

Depth to tension reinforcement — $d = h - c_{sr} - \phi_{sr} / 2$ = **292** mm

$K = M / (d^2 \times f_{ck})$ = **0.026**

K' = **0.207**

K' > K - No compression reinforcement is required

Lever arm — $z = \min(0.5 + 0.5 \times (1 - 3.53 \times K)^{0.5}, 0.95) \times d$ = **277** mm

Depth of neutral axis — $x = 2.5 \times (d - z)$ = **37** mm

Area of tension reinforcement required — $A_{sr.req} = M / (f_{yd} \times z)$ = **578** mm²/m

Tension reinforcement provided — 16 dia.bars @ 200 c/c

Area of tension reinforcement provided — $A_{sr.prov} = \pi \times \phi_{sr}^2 / (4 \times s_{sr})$ = **1005** mm²/m

Minimum area of reinforcement - exp.9.1N — $A_{sr.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d$ = **459** mm²/m

Maximum area of reinforcement - cl.9.2.1.1(3) — $A_{sr.max} = 0.04 \times h$ = **14000** mm²/m

$\max(A_{sr.req}, A_{sr.min}) / A_{sr.prov}$ = **0.575**

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

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Deflection control - Section 7.4

Reference reinforcement ratio	$\rho_0 = \sqrt{(f_{ck} / 1\ N/mm^2)} / 1000 =$ **0.006**
Required tension reinforcement ratio	$\rho = A_{sr.req} / d =$ **0.002**
Required compression reinforcement ratio	$\rho' = A_{sr.2.req} / d_2 =$ **0.000**
Structural system factor - Table 7.4N	$K_b =$ **0.4**
Reinforcement factor - exp.7.17	$K_s = \min(500\ N/mm^2 / (f_{yk} \times A_{sr.req} / A_{sr.prov}), 1.5) =$ **1.5**
Limiting span to depth ratio - exp.7.16.a	$K_s \times K_b \times [11 + 1.5 \times \sqrt{(f_{ck} / 1\ N/mm^2)} \times \rho_0 / \rho + 3.2 \times \sqrt{(f_{ck} / 1\ N/mm^2)} \times (\rho_0 / \rho - 1)^{3/2}] =$ **48.6**
Actual span to depth ratio	$h_{stem} / d =$ **10.9**

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

Crack control - Section 7.3

Limiting crack width	$w_{max} =$ **0.3** mm
Variable load factor - EN1990 – Table A1.1	$\psi_2 =$ **0.6**
Serviceability bending moment	$M_{sls} =$ **45.5** kNm/m
Tensile stress in reinforcement	$\sigma_s = M_{sls} / (A_{sr.prov} \times z) =$ **163.2** N/mm^2
Load duration	Long term
Load duration factor	$k_t =$ **0.4**
Effective area of concrete in tension	$A_{c.eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2) =$ **104500** mm^2/m
Mean value of concrete tensile strength	$f_{ct.eff} = f_{ctm} =$ **3.0** N/mm^2
Reinforcement ratio	$\rho_{p.eff} = A_{sr.prov} / A_{c.eff} =$ **0.010**
Modular ratio	$\alpha_e = E_s / E_{cm} =$ **5.998**
Bond property coefficient	$k_1 =$ **0.8**
Strain distribution coefficient	$k_2 =$ **0.5**
	$k_3 =$ **3.4**
	$k_4 =$ **0.425**
Maximum crack spacing - exp.7.11	$s_{r.max} = k_3 \times c_{sr} + k_1 \times k_2 \times k_4 \times \phi_{sr} / \rho_{p.eff} =$ **453** mm
Maximum crack width - exp.7.8	$w_k = s_{r.max} \times \max(\sigma_s - k_t \times (f_{ct.eff} / \rho_{p.eff}) \times (1 + \alpha_e \times \rho_{p.eff}), 0.6 \times \sigma_s) / E_s$
	$w_k =$ **0.222** mm
	$w_k / w_{max} =$ **0.739**

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force	$V =$ **60.2** kN/m
	$C_{Rd,c} = 0.18 / \gamma_C =$ **0.120**
	$k = \min(1 + \sqrt{(200\ mm / d)}, 2) =$ **1.828**
Longitudinal reinforcement ratio	$\rho_l = \min(A_{sr.prov} / d, 0.02) =$ **0.003**
	$v_{min} = 0.035\ N^{1/2}/mm \times k^{3/2} \times f_{ck}^{0.5} =$ **0.489** N/mm^2
Design shear resistance - exp.6.2a & 6.2b	$V_{Rd.c} = \max(C_{Rd.c} \times k \times (100\ N^2/mm^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$
	$V_{Rd.c} =$ **142.8** kN/m
	$V / V_{Rd.c} =$ **0.421**

PASS - Design shear resistance exceeds design shear force

Horizontal reinforcement parallel to face of stem - Section 9.6

Minimum area of reinforcement – cl.9.6.3(1)	$A_{sx.req} = \max(0.25 \times A_{sr.prov}, 0.001 \times t_{stem}) =$ **350** mm^2/m
Maximum spacing of reinforcement – cl.9.6.3(2)	$s_{sx\_max} =$ **400** mm
Transverse reinforcement provided	10 dia.bars @ 200 c/c
Area of transverse reinforcement provided	$A_{sx.prov} = \pi \times \phi_{sx}^2 / (4 \times s_{sx}) =$ **393** mm^2/m

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

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Check base design at toe

Depth of section — h = **600** mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1 — M = **90.7** kNm/m

Depth to tension reinforcement — $d = h - c_{bb} - \phi_{bb} / 2 =$ **517** mm

$K = M / (d^2 \times f_{ck}) =$ **0.011**

$K' =$ **0.207**

K' > K - No compression reinforcement is required

Lever arm — $z = \min(0.5 + 0.5 \times (1 - 3.53 \times K)^{0.5}, 0.95) \times d =$ **491** mm

Depth of neutral axis — $x = 2.5 \times (d - z) =$ **65** mm

Area of tension reinforcement required — $A_{bb.req} = M / (f_{yd} \times z) =$ **425** mm²/m

Tension reinforcement provided — 16 dia.bars @ 200 c/c

Area of tension reinforcement provided — $A_{bb.prov} = \pi \times \phi_{bb}^2 / (4 \times s_{bb}) =$ **1005** mm²/m

Minimum area of reinforcement - exp.9.1N — $A_{bb.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d =$ **813** mm²/m

Maximum area of reinforcement - cl.9.2.1.1(3) — $A_{bb.max} = 0.04 \times h =$ **24000** mm²/m

$\max(A_{bb.req}, A_{bb.min}) / A_{bb.prov} =$ **0.809**

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

Crack control - Section 7.3

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

Variable load factor - EN1990 – Table A1.1 — $\psi_2 =$ **0.6**

Serviceability bending moment — $M_{sls} =$ **65.6** kNm/m

Tensile stress in reinforcement — $\sigma_s = M_{sls} / (A_{bb.prov} \times z) =$ **132.9** N/mm²

Load duration — Long term

Load duration factor — $k_t =$ **0.4**

Effective area of concrete in tension — $A_{c.eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2) =$ **178458** mm²/m

Mean value of concrete tensile strength — $f_{ct.eff} = f_{ctm} =$ **3.0** N/mm²

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

Modular ratio — $\alpha_e = E_s / E_{cm} =$ **5.998**

Bond property coefficient — $k_1 =$ **0.8**

Strain distribution coefficient — $k_2 =$ **0.5**

$k_3 =$ **3.4**

$k_4 =$ **0.425**

Maximum crack spacing - exp.7.11 — $s_{r.max} = k_3 \times c_{bb} + k_1 \times k_2 \times k_4 \times \phi_{bb} / \rho_{p.eff} =$ **738** mm

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

$w_k =$ **0.294** mm

$w_k / w_{max} =$ **0.98**

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force — V = **75.4** kN/m

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

$k = \min(1 + \sqrt{}(200 \text{ mm} / d), 2) =$ **1.622**

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

$v_{min} = 0.035 \text{ N}^{1/2}/\text{mm} \times k^{3/2} \times f_{ck}^{0.5} =$ **0.409** N/mm²

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

$V_{Rd.c} =$ **211.4** kN/m

$V / V_{Rd.c}$ = **0.356**

PASS - Design shear resistance exceeds design shear force

Check base design at heel

Depth of section — h = **600** mm

Rectangular section in flexure - Section 6.1

Design bending moment combination 1 — M = **4** kNm/m

Depth to tension reinforcement — $d = h - c_{bt} - \phi_{bt} / 2$ = **542** mm

$K = M / (d^2 \times f_{ck})$ = **0.000**

K' = **0.207**

K' > K - No compression reinforcement is required

Lever arm — $z = \min(0.5 + 0.5 \times (1 - 3.53 \times K)^{0.5}, 0.95) \times d$ = **515** mm

Depth of neutral axis — $x = 2.5 \times (d - z)$ = **68** mm

Area of tension reinforcement required — $A_{bt.req} = M / (f_{yd} \times z)$ = **18** mm^2/m

Tension reinforcement provided — 16 dia.bars @ 200 c/c

Area of tension reinforcement provided — $A_{bt.prov} = \pi \times \phi_{bt}^2 / (4 \times s_{bt})$ = **1005** mm^2/m

Minimum area of reinforcement - exp.9.1N — $A_{bt.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d$ = **852** mm^2/m

Maximum area of reinforcement - cl.9.2.1.1(3) — $A_{bt.max} = 0.04 \times h$ = **24000** mm^2/m

$\max(A_{bt.req}, A_{bt.min}) / A_{bt.prov}$ = **0.848**

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

Crack control - Section 7.3

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

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

Serviceability bending moment — M_{sls} = **2.8** kNm/m

Tensile stress in reinforcement — $\sigma_s = M_{sls} / (A_{bt.prov} \times z)$ = **5.4** N/mm^2

Load duration — Long term

Load duration factor — k_t = **0.4**

Effective area of concrete in tension — $A_{c.eff} = \min(2.5 \times (h - d), (h - x) / 3, h / 2)$ = **145000** mm^2/m

Mean value of concrete tensile strength — $f_{ct.eff} = f_{ctm}$ = **3.0** N/mm^2

Reinforcement ratio — $\rho_{p.eff} = A_{bt.prov} / A_{c.eff}$ = **0.007**

Modular ratio — $\alpha_e = E_s / E_{cm}$ = **5.998**

Bond property coefficient — k_1 = **0.8**

Strain distribution coefficient — k_2 = **0.5**

k_3 = **3.4**

k_4 = **0.425**

Maximum crack spacing - exp.7.11 — $s_{r.max} = k_3 \times c_{bt} + k_1 \times k_2 \times k_4 \times \phi_{bt} / \rho_{p.eff}$ = **562** mm

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

w_k = **0.009** mm

w_k / w_{max} = **0.031**

PASS - Maximum crack width is less than limiting crack width

Rectangular section in shear - Section 6.2

Design shear force — V = **26.3** kN/m

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

$k = \min(1 + \sqrt{(200 \text{ mm} / d)}, 2)$ = **1.607**

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

$v_{min} = 0.035 \, N^{1/2}/mm \times k^{3/2} \times f_{ck}^{0.5}$ = **0.404** N/mm^2

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Project				Job no.	
34A King Henrys Road				5682	
Calcs for				Start page no./Revision	
Retaining Wall				8	
Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
YM	24/10/2017				

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

$V_{Rd.c}$ = **218.7** kN/m

$V / V_{Rd.c}$ = **0.120**

PASS - Design shear resistance exceeds design shear force

Secondary transverse reinforcement to base - Section 9.3

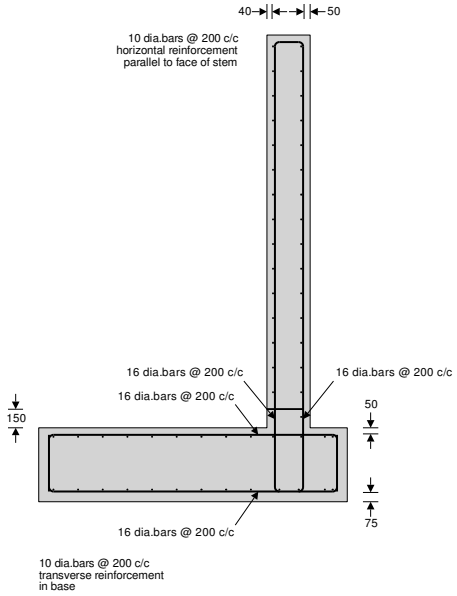
Minimum area of reinforcement – cl.9.3.1.1(2) $A_{bx.req} = 0.2 \times A_{bb.prov}$ = **201** mm²/m

Maximum spacing of reinforcement – cl.9.3.1.1(3) s_{bx_max} = **450** mm

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

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

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



Reinforcement details