# The Hope Project, 1A Camden High Street, London NW1

## Basement Impact Assessment Audit

For

London Borough of Camden

Project Number: 12466-42

Revision: F1

February 2017

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## Document History and Status

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## Document Details

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| Author | G Kite, BSc MSc DIC FGS |
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| Project Number | 12466-42 |
| Project Name | The Hope Project, 1A Camden High Street |
| Planning Reference | 2016/6959/P |

Structural ◆ Civil ◆ Environmental ◆ Geotechnical ◆ Transportation

## Contents



## Appendix

## 1.0 NON-TECHNICAL SUMMARY

1.1. CampbellReith was instructed by London Borough of Camden, (LBC) to carry out an audit on the Basement Impact Assessment submitted as part of the Planning Submission documentation for The Hope Project, London, NW1 (planning reference 2016/6959/P). The basement is considered to fall within Category C as defined by the Terms of Reference.

1.2. The Audit reviewed the Basement Impact Assessment for potential impact on land stability and local ground and surface water conditions arising from basement development in accordance with LBC's policies and technical procedures.

1.3. CampbellReith was able to access LBC's Planning Portal and gain access to the latest revision of submitted documentation and reviewed it against an agreed audit check list.

1.4. The proposed development site is currently occupied by Koko nightclub, the Hope and Anchor pub and adjacent buildings. The proposal involves the retention of the Grade II listed Koko nightclub, the Hope and Anchor pub and facades to the adjacent buildings, known as the Bayham Street Property. The Bayham Street Property will be demolished with a new 4 to 5 storey hotel constructed with one level of basement. The basement level will be linked to the existing lower ground floors and basement levels present across the site.

1.5. Nearby LUL and Thames Water underground assets have been identified as within the zone of influence of the proposed development.

1.6. The BIA has been prepared by RSK Environment Ltd with supporting documents prepared by Heyne Tillett Steel. The authors' qualifications are in accordance the requirements of CPG4.

1.7. Information within the BIA is broadly in line with the aspects recommended of a desk study within the GSD Appendix G1. The ground investigation report and interpretative geotechnical report are broadly in line with the aspects recommended in the GSD Appendix G2 and G3.

1.8. The BIA states that the site lies upon Made Ground over designated unproductive strata, the London Clay, overlying the Lambeth Group. Groundwater has been detected within the Made Ground and perched at levels within the London Clay.

1.9. The BIA states that the existing basements have suffered from historic water ingress, which are believed to relate to perched water within the Made Ground and drainage issues, including sewer flooding. It is accepted that the proposed development will not impact the wider hydrological environment. However, local perched water conditions will need to be mitigated against both during the construction period and in the permanent case. It is noted that Grade 3 waterproofing is proposed.

1.10. The original BIA stated that the site has not been identified as having the potential for flooding. The revised BIA states that Environment Agency data indicates a low to high surface water flood risk for all the streets surrounding the development site, but that the site itself has a very low risk. The revised BIA indicates that the topography of the site is raised 200mm above street level and that further flood risk mitigation is not required. It is recommended that this assessment is reviewed and that final threshold levels are confirmed within the Basement Construction Plan (BCP).

1.11. Attenuation SUDS is proposed that would reduce peak offsite discharge flow rates by 50% of those discharging currently, including allowance for a 1 in 100 year storm event and a 20% allowance for climate change. The proposals should be agreed with Thames Water and LBC. It is noted that discussions with Thames Water have commenced.

1.12. The new basement will be formed within retaining walls constructed partly by contiguous piles and partly by underpinning existing structures. The revised BIA provides indicative pile diameters, outline construction drawings, outline retaining wall designs and an indicative temporary works scheme. The BIA states that the final scheme will be confirmed by the Contractor, once appointed, and this should be confirmed within the BCP.

1.13. A suitable ground movement assessment (GMA) and damage impact assessment for buildings within the zone of influence appears to have been presented, based on CIRIA C580. Damage Category 0 (Negligible) is predicted for all buildings. Once the Contractors final scheme is proposed the GMA and damage impact assessment should be reviewed and updated as required, and included within the BCP.

1.14. Structural monitoring within the zone of influence is proposed, although no details were originally provided. The revised BIA presents an outline structural monitoring plan. An updated, detailed monitoring strategy should be provided within the BCP, based on any revisions to the GMA as a result of the Contractor's final scheme. The monitoring strategy should control construction ensuring damage impacts are within the predicted Category 0 and agreed under the Party Wall Act, where applicable.

1.15. Damage impact to the adjacent highways and pavements, LUL assets and Thames Water assets are all assessed as Negligible. These should be discussed with the relevant authority responsible for each asset and a suitable monitoring plan implemented to limit movements and consequent damage to within the criteria agreed.

1.16. Queries and matters requiring further information or clarification are discussed in Section 4 and summarised in Appendix 2. Based on securing the required final information within a BCP, the requirements of CPG4 have been met.

## 2.0 INTRODUCTION

2.1. CampbellReith was instructed by London Borough of Camden (LBC) on 11 January 2017 to carry out a Category C Audit on the Basement Impact Assessment (BIA) submitted as part of the Planning Submission documentation for The Hope Project, London NW1, Camden Reference 2016/6959/P.

2.2. The Audit was carried out in accordance with the Terms of Reference set by LBC. It reviewed the Basement Impact Assessment for potential impact on land stability and local ground and surface water conditions arising from basement development.

2.3. A BIA is required for all planning applications with basements in Camden in general accordance with policies and technical procedures contained within:

- Guidance for Subterranean Development (GSD). Issue 01. November 2010. Ove Arup & Partners.
- Camden Planning Guidance (CPG) 4: Basements and Lightwells.
- Camden Development Policy (DP) 27: Basements and Lightwells.
- Camden Development Policy (DP) 23: Water.

2.4. The BIA should demonstrate that schemes:

a) maintain the structural stability of the building and neighbouring properties;

b) avoid adversely affecting drainage and run off or causing other damage to the water environment; and,

c) avoid cumulative impacts upon structural stability or the water environment in the local area;

and evaluate the impacts of the proposed basement considering the issues of hydrology, hydrogeology and land stability via the process described by the GSD and to make recommendations for the detailed design.

2.5. LBC's Audit Instruction described the planning proposal as: "Redevelopment involving change of use from offices (Class B1) and erection of 5 storey building with basement to provide 32 bedroom hotel (Class C1) following demolition of 65 Bayham Place and 1 Bayham Street (retention of façade) including change of use at 1st and 2nd floor of 74 Crowndale Road from pub (Class A4) to hotel (Class C1), mansard roof extension to 74 Crowndale Road, retention of ground floor of Hope & Anchor PH (Class A4), change of use of flytower to hotel (C1) and

KOKO ancillary recording studio, creation of terraces at 3rd and 4th floor level and erection of 4th floor glazed extension above roof of Koko to provide restaurant and bar to hotel (C1)."

2.6. The Audit Instruction confirms that the Koko nightclub is a Grade II listed structure.

2.7. CampbellReith accessed LBC's Planning Portal on 01 February 2017 and gained access to the following relevant documents for audit purposes:

- Basement Impact Assessment (ref 371475-02 (01)) dated 30 November 2016 by RSK Environment Ltd.
- Structural Methodology Statement and Basement Impact Assessment (ref 1444 rev C) dated December 2016 by Heyne Tillett Steel.
- Geo-environmental Site Assessment (ref 371475-01 (02)) dated 9 November 2016 by RSK Environment Ltd.
- Drainage Strategy Report dated October 2016 by Heyne Tillett Steel Ltd.
- Thames Water Utilities Assessment (ref 371475-03 (00)) dated 24 October 2016 by RSK Environment Ltd.
- Comments regarding the proposed development from local residents.

2.8. CampbellReith were provided with the following document for audit purposes in February 2017, which is provided in Appendix 3:

- The Hope Project – HTS response to the BIA Audit (ref 1444, Rev A) dated February 2017 by Heyne Tillett Steel Ltd.

## 3.0 BASEMENT IMPACT ASSESSMENT AUDIT CHECK LIST

| Item | Yes/No/NA | Comment |
|---|---|---|
| Are BIA Author(s) credentials satisfactory? | Yes | |
| Is data required by Cl.233 of the GSD presented? | Yes | Information within the BIA is broadly in line with the information required of a desk study in line with the GSD Appendix G1. Outline construction programme should be provided. |
| Does the description of the proposed development include all aspects of temporary and permanent works which might impact upon geology, hydrogeology and hydrology? | Yes | |
| Are suitable plans/maps included? | Yes | |
| Do the plans/maps show the whole of the relevant area of study and do they show it in sufficient detail? | Yes | |
| Land Stability Screening:<br>Have appropriate data sources been consulted?<br>Is justification provided for 'No' answers? | Yes | Worked ground risks identified and assessed. LUL and Thames Water have been consulted in regards exclusion zones and requirements of construction close to their assets. |
| Hydrogeology Screening:<br>Have appropriate data sources been consulted?<br>Is justification provided for 'No' answers? | Yes | |
| Hydrology Screening:<br>Have appropriate data sources been consulted?<br>Is justification provided for 'No' answers? | Yes | Updated in revised submission. |
| Is a conceptual model presented? | Yes | Ground models presented and structural plans provided separately. However, the information is suitable. |

| Item | Yes/No/NA | Comment |
|---|---|---|
| Land Stability Scoping Provided?<br>Is scoping consistent with screening outcome? | Yes | |
| Hydrogeology Scoping Provided?<br>Is scoping consistent with screening outcome? | N/A | No issues identified at Screening. |
| Hydrology Scoping Provided?<br>Is scoping consistent with screening outcome? | Yes | Updated in revised submission. |
| Is factual ground investigation data provided? | Yes | |
| Is monitoring data presented? | Yes | |
| Is the ground investigation informed by a desk study? | Yes | |
| Has a site walkover been undertaken? | Yes | |
| Is the presence/absence of adjacent or nearby basements confirmed? | Yes | Some levels have been conservatively assumed for the damage impact assessment. |
| Is a geotechnical interpretation presented? | Yes | |
| Does the geotechnical interpretation include information on retaining wall design? | Yes | Indicative parameters provided, 450mm diameter contiguous piles with 300mm liner wall / underpins with 200mm liner wall stated in text. To be confirmed within BCP. |
| Are reports on other investigations required by screening and scoping presented? | Yes | Drainage assessment. |
| Are baseline conditions described, based on the GSD? | Yes | |

| Item | Yes/No/NA | Comment |
|---|---|---|
| Do the base line conditions consider adjacent or nearby basements? | Yes | |
| Is an Impact Assessment provided? | Yes | |
| Are estimates of ground movement and structural impact presented? | Yes | |
| Is the Impact Assessment appropriate to the matters identified by screen and scoping? | Yes | Updated in revised submission. |
| Has the need for mitigation been considered and are appropriate mitigation methods incorporated in the scheme? | Yes | To be confirmed within the BCP (final threshold levels relative to street level). |
| Has the need for monitoring during construction been considered? | Yes | Updated in revised submission. An outline monitoring plan provided. To be confirmed within BCP. |
| Have the residual (after mitigation) impacts been clearly identified? | Yes | Updated in revised submission and to be confirmed in BCP. |
| Has the scheme demonstrated that the structural stability of the building and neighbouring properties and infrastructure will be maintained? | No | Retaining wall calculations, temporary works plan, GMA inputs should be provided. |
| Has the scheme avoided adversely affecting drainage and run-off or causing other damage to the water environment? | Yes | Attenuation SUDS proposals to be agreed with LBC and Thames Water |
| Has the scheme avoided cumulative impacts upon structural stability or the water environment in the local area? | Yes | Updated in revised submission and to be confirmed in BCP. |
| Does report state that damage to surrounding buildings will be no worse than Burland Category 2? | Yes | |
| Are non-technical summaries provided? | Yes | |

## 4.0 DISCUSSION

4.1. The proposed development site is currently occupied by Koko nightclub, the Hope and Anchor pub and adjacent buildings. The proposal involves the retention of the Koko nightclub, the Hope and Anchor pub and facades to the adjacent buildings, known as the Bayham Street Property. The Bayham Street Property will be demolished with a new 4 to 5 storey hotel constructed with one level of basement. The basement level will be linked to the existing lower ground floors and basement levels present across the site. The Koko nightclub building is Grade II listed.

4.2. The Northern Line running tunnels and Mornington Crescent station are present within 10m west of the Koko nightclub, with the tunnel crowns approximately 10m below ground level (bgl). A number of Thames Water assets have been identified within the likely zone of influence of the development. Highways, pavements and shallow local utilities are also adjacent to the development and within the zone of influence.

4.3. The BIA has been prepared by RSK Environment Ltd with supporting documents prepared by Heyne Tillett Steel. The authors' qualifications are in accordance with the requirements of CPG4.

4.4. Information within the BIA is broadly in line with the aspects recommended of a desk study within the GSD Appendix G1. However, flood risk information has been limited to the assessment of flooding from rivers and seas. Surface water flood risk has not been assessed.

4.5. The ground investigation report and interpretative geotechnical report are broadly in line with the aspects recommended in the GSD Appendix G2 and G3.

4.6. The BIA states that the site lies upon Made Ground, of up to approximately 2m thickness, on to designated unproductive strata, the London Clay, which is present to approximately 25m bgl, overlying the Lambeth Group. Groundwater has been detected during the site investigation and subsequent monitoring data indicates water perched within the Made Ground and at levels within the London Clay.

4.7. The original BIA stated that the existing basements have suffered from historic water ingress, which are believed to relate to perched water within the Made Ground and drainage issues, including sewer flooding. Local perched water conditions will need to be mitigated against both during the construction period and in the permanent case. Dewatering via sump pumping is discussed during construction. Consideration of potential stability issues due to dewatering should be considered and mitigated against, if required. It is noted that Grade 3 waterproofing is proposed for the permanent design. Appropriate mitigation against sewer surcharging should be proposed.

The revised BIA provides further details of the anticipated sump pumping. Final details including contingency planning to be adopted will be confirmed by the Contractor's temporary works plan, which will be provided within a Basement Construction Plan (BCP). The revised BIA confirms a drained cavity waterproofing system and the use of non-return valves to mitigate against sewer surcharging.

4.8. It is accepted that the proposed development will not impact the wider hydrological environment and that the water encountered on site is locally perched and not part of a continuous water body.

4.9. The original BIA stated that the site had not been identified as having the potential for flooding. However, Environment Agency data indicates a surface water flood risk for all the streets surrounding the development site. Further flood risk assessment should be considered and suitable flood risk protection measures proposed in mitigation, both for the temporary works and for the permanent structure.

The revised BIA states that Environment Agency data indicates a low to high surface water flood risk for all the streets surrounding the development site, but that the site itself has a very low risk. The revised BIA indicates that the topography of the site is raised 200mm above street level and that further flood risk mitigation is not required. It is recommended that this assessment is reviewed and that final threshold levels are confirmed within the Basement Construction Plan (BCP).

4.10. Attenuation SUDS is proposed that would reduce peak offsite discharge flow rates by 50% of those discharging currently, including allowance for a 1 in 100 year storm event with a 20% allowance for climate change. An attenuation tank is proposed to be placed in the basement with off-site flows limited by a hydrobrake. The proposals should be agreed with Thames Water and LBC. It is noted that discussions with Thames Water have commenced.

4.11. The new basement beneath the Bayham Street Property will be formed within retaining walls constructed partly by contiguous piles and partly by underpinning existing structures, with a formation level approximately 3.2m bgl. The Hope and Anchor basement will be lowered by approximately 1.2m by underpinning the existing basement walls.

4.12. Indicative pile diameters, 450mm, have been provided for the proposed basement retaining walls and outline construction drawings have been presented. The revised BIA provides indicative pile diameters, outline construction drawings, outline retaining wall designs and an indicative temporary works scheme. The BIA states that the final scheme will be confirmed by the Contractor, once appointed, and this should be confirmed within the BCP.

4.13. A suitable ground movement assessment (GMA) and damage impact assessment for buildings within the zone of influence has been presented, based on CIRIA C580 guidance. Differential depths between the proposed development's foundations and nearby structures have been identified, and where unknown these have been conservatively assessed (for ground movement purposes) as being shallow foundations, just below the existing ground level.

4.14. The GMA has considered vertical movements due to the demolition / unloading of the underlying ground and construction / loading of the underlying ground using PDisp, and has considered the movements caused by installation of the retaining walls and basement excavation using XDisp. Damage Category 0 (Negligible) is predicted for all buildings.

The revised BIA confirms the pile diameter and toe depths currently proposed and adopted in the GMA. Once the Contractors final scheme is proposed the GMA and damage impact assessment should be reviewed and updated as required, and included within the BCP.

4.15. Structural monitoring within the zone of influence is proposed, although no details were originally provided. The revised BIA presents an outline structural monitoring plan. An updated, detailed monitoring strategy should be provided within the BCP, based on any revisions to the GMA as a result of the Contractor's final scheme. The monitoring strategy should control construction ensuring damage impacts are within the predicted Category 0 and agreed under the Party Wall Act, where applicable.

4.16. Damage impact to the adjacent highways and pavements is assessed as Negligible. However, this should be discussed with the relevant authority responsible (Transport for London, The Highways Agency or LBC) and a suitable monitoring plan implemented to limit movements and consequent damage to within the criteria agreed.

4.17. Damage impact to the adjacent LUL assets are also assessed as Negligible. This should be discussed with LUL and a suitable monitoring plan implemented to limit movements and consequent damage to within the criteria agreed. It is noted that discussions with LUL have commenced.

4.18. Damage impacts to a number of Thames Water assets are considered, which concludes that damage is unlikely to be caused to the assets by the proposed development activities. The assessment should be presented to Thames Water and additional analysis or mitigation measures, in conjunction with a suitable monitoring plan, should be agreed with them as required.

# 5.0 CONCLUSIONS

5.1. The proposed development site is currently occupied by Koko nightclub, the Hope and Anchor pub and adjacent buildings. The Bayham Street Property will be demolished with a new 4 to 5 storey hotel constructed with one level of basement. Nearby buildings and underground structures have been identified and the development's impact upon them has been assessed.

5.2. The BIA authors' qualifications are in accordance with the requirements of CPG4.

5.3. Information within the BIA is broadly in line with the aspects recommended of a desk study within the GSD Appendix G1.

5.4. The ground investigation report and interpretative geotechnical report are broadly in line with the aspects recommended in the GSD Appendix G2 and G3. The identified ground conditions are Made Ground overlying London Clay and the Lambeth Group.

5.5. It is accepted that the proposed development will not impact the wider hydrological environment. However, the existing basements have suffered water ingress and local perched water conditions will need to be mitigated against both during the construction period and in the permanent case.

5.6. The revised BIA states that Environment Agency data indicates a low to high surface water flood risk for all the streets surrounding the development site, but that the site itself has a very low risk. The revised BIA indicates that the topography of the site is raised 200mm above street level and that further flood risk mitigation is not required. It is recommended that this assessment is reviewed and that final threshold levels are confirmed within the Basement Construction Plan (BCP).

5.7. Attenuation SUDS are proposed. The proposals should be agreed with Thames Water and LBC. It is noted that discussions with Thames Water have commenced. It is accepted that the proposed development will not impact upon the wider hydrological environment.

5.8. The new basement retaining walls will be constructed partly by contiguous piles and partly by underpinning existing structures. The BIA states that the final scheme will be confirmed by the Contractor, once appointed, and this should be confirmed within the BCP.

5.9. A suitable ground movement assessment (GMA) and damage impact assessment for buildings within the zone of has been presented. Once the Contractors final scheme is proposed the GMA and damage impact assessment should be reviewed and updated as required, and included within the BCP.

5.10. The revised BIA presents an outline structural monitoring plan. An updated, detailed monitoring strategy should be provided within the BCP, based on any revisions to the GMA as a result of the Contractor's final scheme. The monitoring strategy should control construction ensuring damage impacts are within the predicted Category 0 and agreed under the Party Wall Act, where applicable.

5.11. Damage impact to the adjacent highways and pavements, LUL assets and Thames Water assets are all assessed as Negligible. These should be discussed with the relevant authority responsible for each asset and a suitable monitoring plan implemented to limit movements and consequent damage to within the criteria agreed.

5.12. Queries and matters requiring further information or clarification are summarised in Appendix 2. Based on securing the required final information within a BCP, the requirements of CPG4 have been met.

# Appendix 1: Residents' Consultation Comments

Residents' Consultation Comments

| Surname | Address | Date | Issue raised | Response |
|---|---|---|---|---|
| Summer Butterfly Investments Ltd | 48 – 56 Bayham Place | 6 January 2017 | Fully supportive of the planned redevelopment. | N/A |
| Thames Water | Development Planning Dept | 20 January 2017 | Surface water drainage proposals should seek approval of Thames Water and should allow for appropriate attenuation. | 4.10 |

# Appendix 2: Audit Query Tracker

Audit Query Tracker

| Query No | Subject | Query | Status/Response | Date closed out |
|---|---|---|---|---|
| 1 | Land Stability | Retaining wall designs, temporary works plan, construction programme | Open – to be provided as 4.12, 4.7. – updated in revised response, but to be confirmed by Contractor's final scheme. | N/A – Ongoing, to be confirmed within BCP. |
| 2 | Land Stability | Ground movement assessment and damage impact assessment | Open – to be provided as 4.13, 4.14. – updated in revised response, but to be confirmed by Contractor's final scheme. | N/A – Ongoing, to be confirmed within BCP. |
| 3 | Land Stability | Structural monitoring | Open – to be provided as 4.15. – updated in revised response, but to be confirmed by Contractor's final scheme. | N/A – Ongoing, to be confirmed within BCP. |
| 4 | Land Stability | Asset monitoring | Open – to be agreed with asset owners, suitable to monitor and control works to within agreed criteria, as 4.16, 4.17, 4.18. | N/A - Ongoing |
| 5 | Flood Risk | Surface water flood risk | Open – suitable assessment and mitigation to be proposed as 4.4, 4.9. – threshold levels to be confirmed as suitable in final scheme. | N/A – Ongoing, to be confirmed within BCP. |
| 6 | Flood Risk | Perched water, sewer surcharging | Open – suitable assessment and mitigation to be proposed as 4.6, 4.7. – updated in revised response, but to be confirmed by Contractor's final scheme. | N/A – Ongoing, to be confirmed within BCP. |
| 7 | Hydrology | Attenuation SUDS | Open – proposals to be agreed with Thames Water and LBC as 4.10. | N/A - Ongoing |

CampbellReith consulting engineers

## Appendix 3: Supplementary Supporting Documents

The Hope Project – HTS response to the BIA Audit (ref 1444, Rev A) dated February 2017 by Heyne Tillett Steel Ltd

# The Hope Project – HTS response to the BIA Audit

Please find appended our response to the Audit of the Basement Impact Assessment for The Hope Project, Camden.

The numbered responses relate to Campbell Reith's Audit Query Tracker dated February 2017 (revision D1).

## Query 1 – Land Stability

- Outline retaining wall calculations – please see attached. The design of the contiguous piled retaining wall will be a contractor design portion.

- Indicative temporary works scheme, sequencing and propping arrangement – please see attached (Sketches SK40-45). The exact construction methodology is to be confirmed by the appointed contractor and temporary works engineer.

- Proposed ground water control measures:

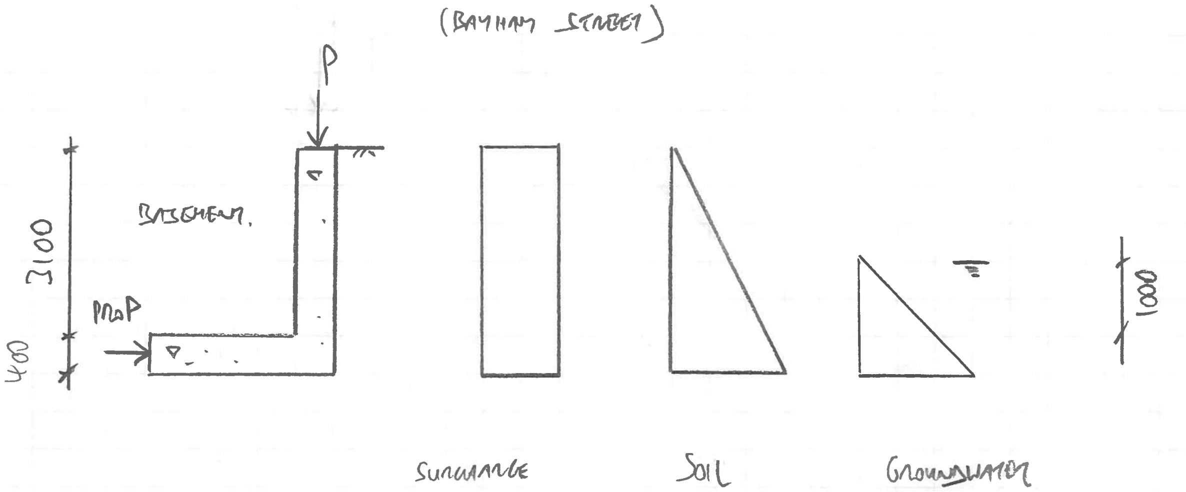
    - The ground water level has been measured below the proposed basement slab level. Localised dewatering will only be required if the ground water level is found to be higher than expected.
    - During construction – localised dewatering is proposed during construction via sump pumping. The sump will be located in the centre of the site to keep the dewatered level local to the site works. The dewatering will be monitored to ensure that no fines are washed in to the sump.
    - Permanent works – A Grade 3 waterproofing system is proposed in the basement areas. A drained cavity system will be installed enabling ground water collection within sump locations. Sump pumps will pump ground water via a rising main to ground floor level where it will be discharged via gravity into the combined Thames Water sewer network. Non return valves will be used to mitigate against sewer surcharging.

- Construction programme – To be confirmed once a contractor has been appointed.

HEYNE TILLETT STEEL

## RETAINING WALL CALCULATIONS

BAYHAM STREET ELEVATION




* RETAINED HEIGHT = 3100mm
* CANTILEVERED RETAINING WALL TO BE PROPPED AT BASE BY NEW BASEMENT SLAB
* ASSUME TOE AND BASE THICKNESS ARE 400mm THICK.
* SURCHARGE → Q = 10 kN/m²
* SOIL - FROM RSK SI REPORT
  ↳ LONDON CLAY $\gamma = 20\ kN/m^3$

  $C_u = 70 + 6.00z$
  $= 70 + 6.00 \times 3.5 = 91\ kN/m^2$

  $\phi' = 25°$
* GROUNDWATER → CONSERVATIVELY ASSUME GWL AT LEVEL 1m ABOVE BASEMENT SSL = 20.5m AOD
* P = VERTICAL LOAD FROM STRUCTURE ABOVE

| | | | | | |
|---|---|---|---|---|---|
| Job | THE HOPE PROJECT | | | Date | FEB. 2017 |
| Title | RETAINING WALL DESIGN - BAYHAM STREET | | | Eng. | MJT |
| Job No. | 1444 | Sheet | 2 | Rev. | - |

HEYNE TILLETT STEEL

$$G = \underbrace{(22\,kN/m^3 \times 5m \times 0.4m)}_{\text{WALL}} + \underbrace{(2\,kN/m^2 \times 1.25m)}_{\text{1ST FLOOR}} + \underbrace{(1.5\,kN/m^2 \times 1.25m)}_{\text{GROUND FLOOR}} = 48.4\,kN/m$$

$$Q = (1.5\,kN/m^2 \times 1.25m) + (5\,kN/m^2 \times 1.25m) = 8.1\,kN/m$$

RETAINING WALL DESIGNED USING TEDDS

↳ DESIGN PASSES, (SEE ATTACHED) //

## 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 2.6.11

### Retaining wall details

| | |
|---|---|
| Stem type | Cantilever |
| Stem height | $h_{stem}$ = **3100** mm |
| Stem thickness | $t_{stem}$ = **400** mm |
| Angle to rear face of stem | $\alpha$ = **90** deg |
| Stem density | $\gamma_{stem}$ = **25** kN/m$^3$ |
| Toe length | $l_{toe}$ = **1200** mm |
| Base thickness | $t_{base}$ = **400** mm |
| Base density | $\gamma_{base}$ = **25** kN/m$^3$ |
| Height of retained soil | $h_{ret}$ = **3100** mm |
| Angle of soil surface | $\beta$ = **0** deg |
| Depth of cover | $d_{cover}$ = **0** mm |
| Height of water | $h_{water}$ = **1000** mm |
| Water density | $\gamma_w$ = **9.8** kN/m$^3$ |

### Retained soil properties

| | |
|---|---|
| Soil type | Hard clay |
| Moist density | $\gamma_{mr}$ = **20** kN/m$^3$ |
| Saturated density | $\gamma_{sr}$ = **20** kN/m$^3$ |
| Characteristic effective shear resistance angle | $\phi'_{r.k}$ = **25** deg |
| Characteristic wall friction angle | $\delta_{r.k}$ = **12.5** deg |

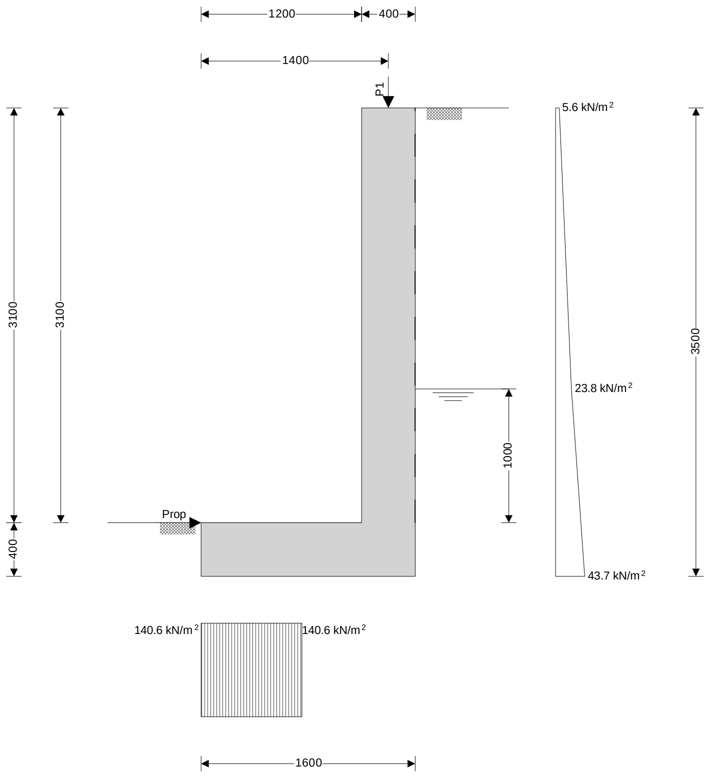
### Base soil properties

| | |
|---|---|
| Soil type | Hard clay |
| Soil density | $\gamma_b$ = **20** kN/m$^3$ |
| Characteristic undrained shear strength | $c_{b.u.k}$ = **91** kN/m$^2$ |
| 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 |

### Loading details

| | |
|---|---|
| Variable surcharge load | $Surcharge_Q$ = **10** kN/m$^2$ |
| Vertical line load at 1400 mm | $P_{G1}$ = **48.4** kN/m |
| | $P_{Q1}$ = **8.1** kN/m |

| Tekla Tedds<br>HTS | Project<br>The Hope Project | | | | Job no.<br>1444 | |
|---|---|---|---|---|---|---|
| | Calcs for<br>Retaining wall design - Bayham Street | | | | Start page no./Revision<br>2 | |
| | Calcs by<br>MJT | Calcs date<br>08/02/2017 | Checked by | Checked date | Approved by | Approved date |




**General arrangement**

**Calculate retaining wall geometry**

| | |
|---|---|
| Base length | $l_{base} = l_{toe} + t_{stem} = \mathbf{1600}$ mm |
| Saturated soil height | $h_{sat} = h_{water} + d_{cover} = \mathbf{1000}$ mm |
| Moist soil height | $h_{moist} = h_{ret} - h_{water} = \mathbf{2100}$ mm |
| Length of surcharge load | $l_{sur} = l_{heel} = \mathbf{0}$ mm |
| - Distance to vertical component | $x_{sur\_v} = l_{base} - l_{heel} / 2 = \mathbf{1600}$ mm |
| Effective height of wall | $h_{eff} = h_{base} + d_{cover} + h_{ret} = \mathbf{3500}$ mm |
| - Distance to horizontal component | $x_{sur\_h} = h_{eff} / 2 = \mathbf{1750}$ mm |
| Area of wall stem | $A_{stem} = h_{stem} \times t_{stem} = \mathbf{1.24}$ m$^2$ |
| - Distance to vertical component | $x_{stem} = l_{toe} + t_{stem} / 2 = \mathbf{1400}$ mm |
| Area of wall base | $A_{base} = l_{base} \times t_{base} = \mathbf{0.64}$ m$^2$ |
| - Distance to vertical component | $x_{base} = l_{base} / 2 = \mathbf{800}$ mm |

**Partial factors on actions - Table A.3 - Combination 1**

| | |
|---|---|
| Permanent unfavourable action | $\gamma_G = \mathbf{1.35}$ |
| Permanent favourable action | $\gamma_{Gf} = \mathbf{1.00}$ |
| Variable unfavourable action | $\gamma_Q = \mathbf{1.50}$ |
| Variable favourable action | $\gamma_{Qf} = \mathbf{0.00}$ |

**Partial factors for soil parameters – Table A.4 - Combination 1**

| | |
|---|---|
| Angle of shearing resistance | $\gamma_{\phi'} = \mathbf{1.00}$ |
| Undrained shear strength | $\gamma_{cu} = \mathbf{1.00}$ |
| Weight density | $\gamma_{\gamma} = \mathbf{1.00}$ |

**Water properties**

Design water density — $\gamma_{w}' = \gamma_{w} / \gamma_{\gamma} =$ **9.8** kN/m$^3$

**Retained soil properties**

Design moist density — $\gamma_{mr}' = \gamma_{mr} / \gamma_{\gamma} =$ **20** kN/m$^3$

Design saturated density — $\gamma_{sr}' = \gamma_{sr} / \gamma_{\gamma} =$ **20** kN/m$^3$

Design effective shear resistance angle — $\phi'_{r.d} = \text{atan}(\tan(\phi'_{r.k}) / \gamma_{\phi'}) =$ **25** deg

Design wall friction angle — $\delta_{r.d} = \text{atan}(\tan(\delta_{r.k}) / \gamma_{\phi'}) =$ **12.5** deg

**Base soil properties**

Design soil density — $\gamma_{b}' = \gamma_{b} / \gamma_{\gamma} =$ **20** kN/m$^3$

Design effective shear resistance angle — $\phi'_{b.d} = \text{atan}(\tan(\phi'_{b.k}) / \gamma_{\phi'}) =$ **18** deg

Design wall friction angle — $\delta_{b.d} = \text{atan}(\tan(\delta_{b.k}) / \gamma_{\phi'}) =$ **9** deg

Design base friction angle — $\delta_{bb.d} = \text{atan}(\tan(\delta_{bb.k}) / \gamma_{\phi'}) =$ **12** deg

Design undrained shear strength — $c_{b.u.d} = c_{b.u.k} / \gamma_{cu} =$ **91** kN/m$^2$

**Using Coulomb theory**

Active pressure coefficient — $K_A = \sin(\alpha + \phi'_{r.d})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.d}) \times [1 + \sqrt{[}\sin(\phi'_{r.d} + \delta_{r.d}) \times \sin(\phi'_{r.d} - \beta) / (\sin(\alpha - \delta_{r.d}) \times \sin(\alpha + \beta))]]^2) =$ **0.367**

Passive pressure coefficient — $K_P = \sin(90 - \phi'_{b.d})^2 / (\sin(90 + \delta_{b.d}) \times [1 - \sqrt{[}\sin(\phi'_{b.d} + \delta_{b.d}) \times \sin(\phi'_{b.d}) / (\sin(90 + \delta_{b.d}))]]^2) =$ **2.359**

**Overturning check**

**Vertical forces on wall**

Wall stem — $F_{stem} = \gamma_{Gf} \times A_{stem} \times \gamma_{stem} =$ **31** kN/m

Wall base — $F_{base} = \gamma_{Gf} \times A_{base} \times \gamma_{base} =$ **16** kN/m

Line loads — $F_{P\_v} = \gamma_{Gf} \times P_{G1} + \gamma_{Qf} \times P_{Q1} =$ **48.4** kN/m

Total — $F_{total\_v} = F_{stem} + F_{base} + F_{water\_v} + F_{P\_v} =$ **95.4** kN/m

**Horizontal forces on wall**

Surcharge load — $F_{sur\_h} = K_A \times \cos(\delta_{r.d}) \times \gamma_{Q} \times \text{Surcharge}_{Q} \times h_{eff} =$ **18.8** kN/m

Saturated retained soil — $F_{sat\_h} = \gamma_{G} \times K_A \times \cos(\delta_{r.d}) \times (\gamma_{sr}' - \gamma_{w}') \times (h_{sat} + h_{base})^2 / 2 =$ **4.8** kN/m

Water — $F_{water\_h} = \gamma_{G} \times \gamma_{w}' \times (h_{water} + d_{cover} + h_{base})^2 / 2 =$ **13** kN/m

Moist retained soil — $F_{moist\_h} = \gamma_{G} \times K_A \times \cos(\delta_{r.d}) \times \gamma_{mr}' \times ((h_{eff} - h_{sat} - h_{base})^2 / 2 + (h_{eff} - h_{sat} - h_{base}) \times (h_{sat} + h_{base})) =$ **49.8** kN/m

Base soil — $F_{exc\_h} = -\gamma_{Gf} \times K_P \times \cos(\delta_{b.d}) \times \gamma_{b}' \times (h_{pass} + h_{base})^2 / 2 =$ **-3.7** kN/m

Total — $F_{total\_h} = F_{sat\_h} + F_{moist\_h} + F_{exc\_h} + F_{water\_h} + F_{sur\_h} =$ **82.7** kN/m

**Overturning moments on wall**

Surcharge load — $M_{sur\_OT} = F_{sur\_h} \times x_{sur\_h} =$ **33** kNm/m

Saturated retained soil — $M_{sat\_OT} = F_{sat\_h} \times x_{sat\_h} =$ **2.3** kNm/m

Water — $M_{water\_OT} = F_{water\_h} \times x_{water\_h} =$ **6.1** kNm/m

Moist retained soil — $M_{moist\_OT} = F_{moist\_h} \times x_{moist\_h} =$ **64.8** kNm/m

Total — $M_{total\_OT} = M_{sat\_OT} + M_{moist\_OT} + M_{water\_OT} + M_{sur\_OT} =$ **106** kNm/m

**Restoring moments on wall**

Wall stem — $M_{stem\_R} = F_{stem} \times x_{stem} =$ **43.4** kNm/m

Wall base — $M_{base\_R} = F_{base} \times x_{base} =$ **12.8** kNm/m

Line loads — $M_{P\_R} = (\text{abs}(\gamma_{Gf} \times P_{G1} + \gamma_{Qf} \times P_{Q1})) \times p_1 =$ **67.8** kNm/m

Total — $M_{total\_R} = M_{stem\_R} + M_{base\_R} + M_{P\_R} =$ **124** kNm/m

**Check stability against overturning**

Factor of safety — $FoS_{ot} = M_{total\_R} / M_{total\_OT} = \mathbf{1.169}$

***PASS - Maximum restoring moment is greater than overturning moment***

**Bearing pressure check**

**Vertical forces on wall**

Wall stem — $F_{stem} = \gamma_G \times A_{stem} \times \gamma_{stem} = \mathbf{41.9}$ kN/m

Wall base — $F_{base} = \gamma_G \times A_{base} \times \gamma_{base} = \mathbf{21.6}$ kN/m

Line loads — $F_{P\_v} = \gamma_G \times P_{G1} + \gamma_Q \times P_{Q1} = \mathbf{77.5}$ kN/m

Total — $F_{total\_v} = F_{stem} + F_{base} + F_{water\_v} + F_{P\_v} = \mathbf{140.9}$ kN/m

**Horizontal forces on wall**

Surcharge load — $F_{sur\_h} = K_A \times \cos(\delta_{r.d}) \times \gamma_Q \times Surcharge_Q \times h_{eff} = \mathbf{18.8}$ kN/m

Saturated retained soil — $F_{sat\_h} = \gamma_G \times K_A \times \cos(\delta_{r.d}) \times (\gamma_{sr}' - \gamma_w') \times (h_{sat} + h_{base})^2 / 2 = \mathbf{4.8}$ kN/m

Water — $F_{water\_h} = \gamma_G \times \gamma_w' \times (h_{water} + d_{cover} + h_{base})^2 / 2 = \mathbf{13}$ kN/m

Moist retained soil — $F_{moist\_h} = \gamma_G \times K_A \times \cos(\delta_{r.d}) \times \gamma_{mr}' \times ((h_{eff} - h_{sat} - h_{base})^2 / 2 + (h_{eff} - h_{sat} - h_{base}) \times (h_{sat} + h_{base})) = \mathbf{49.8}$ kN/m

Base soil — $F_{pass\_h} = -\gamma_{Gf} \times K_P \times \cos(\delta_{b.d}) \times \gamma_b' \times (d_{cover} + h_{base})^2 / 2 = \mathbf{-3.7}$ kN/m

Total — $F_{total\_h} = F_{sat\_h} + F_{moist\_h} + F_{pass\_h} + F_{water\_h} + F_{sur\_h} = \mathbf{82.7}$ kN/m

**Moments on wall**

Wall stem — $M_{stem} = F_{stem} \times x_{stem} = \mathbf{58.6}$ kNm/m

Wall base — $M_{base} = F_{base} \times x_{base} = \mathbf{17.3}$ kNm/m

Surcharge load — $M_{sur} = -F_{sur\_h} \times x_{sur\_h} = \mathbf{-33}$ kNm/m

Line loads — $M_P = (\gamma_G \times P_{G1} + \gamma_Q \times P_{Q1}) \times p_1 = \mathbf{108.5}$ kNm/m

Saturated retained soil — $M_{sat} = -F_{sat\_h} \times x_{sat\_h} = \mathbf{-2.3}$ kNm/m

Water — $M_{water} = -F_{water\_h} \times x_{water\_h} = \mathbf{-6.1}$ kNm/m

Moist retained soil — $M_{moist} = -F_{moist\_h} \times x_{moist\_h} = \mathbf{-64.8}$ kNm/m

Total — $M_{total} = M_{stem} + M_{base} + M_{sat} + M_{moist} + M_{water} + M_{sur} + M_P = \mathbf{78.3}$ kNm/m

**Check bearing pressure**

Propping force — $F_{prop\_base} = F_{total\_h} = \mathbf{82.7}$ kN/m

Distance to reaction — $\bar{x} = M_{total} / F_{total\_v} = \mathbf{556}$ mm

Eccentricity of reaction — $e = \bar{x} - l_{base} / 2 = \mathbf{-244}$ mm

Loaded length of base — $l_{load} = 2 \times \bar{x} = \mathbf{1111}$ mm

Bearing pressure at toe — $q_{toe} = F_{total\_v} / l_{load} = \mathbf{126.8}$ kN/m$^2$

Bearing pressure at heel — $q_{heel} = \mathbf{0}$ kN/m$^2$

Effective overburden pressure — $q = (t_{base} + d_{cover}) \times \gamma_b' = \mathbf{8}$ kN/m$^2$

Design effective overburden pressure — $q' = q / \gamma_\gamma = \mathbf{8}$ kN/m$^2$

Foundation shape factors — $s_c = 1$

Load inclination factors — $H = F_{sur\_h} + F_{sat\_h} + F_{water\_h} + F_{moist\_h} = \mathbf{86.5}$ kN/m

$i_c = 0.5 \times (1 + \sqrt{(1 - H / (l_{load} \times c_{b.u.d}))}) = \mathbf{0.69}$

Net ultimate bearing capacity — $n_f = (\pi + 2) \times c_{b.u.d} \times s_c \times i_c + q = \mathbf{331.1}$ kN/m$^2$

Factor of safety — $FoS_{bp} = n_f / \max(q_{toe}, q_{heel}) = \mathbf{2.611}$

***PASS - Allowable bearing pressure exceeds maximum applied bearing pressure***

**Partial factors on actions - Table A.3 - Combination 2**

Permanent unfavourable action — $\gamma_G = \mathbf{1.00}$

Permanent favourable action — $\gamma_{Gf} = \mathbf{1.00}$

| | |
|---|---|
| Variable unfavourable action | $\gamma_Q$ = **1.30** |
| Variable favourable action | $\gamma_{Qf}$ = **0.00** |

**Partial factors for soil parameters – Table A.4 - Combination 2**

| | |
|---|---|
| Angle of shearing resistance | $\gamma_{\phi'}$ = **1.25** |
| Undrained shear strength | $\gamma_{cu}$ = **1.40** |
| Weight density | $\gamma_\gamma$ = **1.00** |

**Water properties**

| | |
|---|---|
| Design water density | $\gamma_w' = \gamma_w / \gamma_\gamma$ = **9.8** kN/m$^3$ |

**Retained soil properties**

| | |
|---|---|
| Design moist density | $\gamma_{mr}' = \gamma_{mr} / \gamma_\gamma$ = **20** kN/m$^3$ |
| Design saturated density | $\gamma_{sr}' = \gamma_{sr} / \gamma_\gamma$ = **20** kN/m$^3$ |
| Design effective shear resistance angle | $\phi'_{r.d} = \text{atan}(\tan(\phi'_{r.k}) / \gamma_{\phi'})$ = **20.5** deg |
| Design wall friction angle | $\delta_{r.d} = \text{atan}(\tan(\delta_{r.k}) / \gamma_{\phi'})$ = **10.1** deg |

**Base soil properties**

| | |
|---|---|
| Design soil density | $\gamma_b' = \gamma_b / \gamma_\gamma$ = **20** kN/m$^3$ |
| Design effective shear resistance angle | $\phi'_{b.d} = \text{atan}(\tan(\phi'_{b.k}) / \gamma_{\phi'})$ = **14.6** deg |
| Design wall friction angle | $\delta_{b.d} = \text{atan}(\tan(\delta_{b.k}) / \gamma_{\phi'})$ = **7.2** deg |
| Design base friction angle | $\delta_{bb.d} = \text{atan}(\tan(\delta_{bb.k}) / \gamma_{\phi'})$ = **9.7** deg |
| Design undrained shear strength | $c_{b.u.d} = c_{b.u.k} / \gamma_{cu}$ = **65** kN/m$^2$ |

**Using Coulomb theory**

| | |
|---|---|
| Active pressure coefficient | $K_A = \sin(\alpha + \phi'_{r.d})^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta_{r.d}) \times [1 + \sqrt{[}\sin(\phi'_{r.d} + \delta_{r.d}) \times \sin(\phi'_{r.d} - \beta) / (\sin(\alpha - \delta_{r.d}) \times \sin(\alpha + \beta))]]^2)$ = **0.439** |
| Passive pressure coefficient | $K_P = \sin(90 - \phi'_{b.d})^2 / (\sin(90 + \delta_{b.d}) \times [1 - \sqrt{[}\sin(\phi'_{b.d} + \delta_{b.d}) \times \sin(\phi'_{b.d}) / (\sin(90 + \delta_{b.d}))]]^2)$ = **1.965** |

**Overturning check**

**Vertical forces on wall**

| | |
|---|---|
| Wall stem | $F_{stem} = \gamma_{Gf} \times A_{stem} \times \gamma_{stem}$ = **31** kN/m |
| Wall base | $F_{base} = \gamma_{Gf} \times A_{base} \times \gamma_{base}$ = **16** kN/m |
| Line loads | $F_{P\_v} = \gamma_{Gf} \times P_{G1} + \gamma_{Qf} \times P_{Q1}$ = **48.4** kN/m |
| Total | $F_{total\_v} = F_{stem} + F_{base} + F_{water\_v} + F_{P\_v}$ = **95.4** kN/m |

**Horizontal forces on wall**

| | |
|---|---|
| Surcharge load | $F_{sur\_h} = K_A \times \cos(\delta_{r.d}) \times \gamma_Q \times \text{Surcharge}_Q \times h_{eff}$ = **19.7** kN/m |
| Saturated retained soil | $F_{sat\_h} = \gamma_G \times K_A \times \cos(\delta_{r.d}) \times (\gamma_{sr}' - \gamma_w') \times (h_{sat} + h_{base})^2 / 2$ = **4.3** kN/m |
| Water | $F_{water\_h} = \gamma_G \times \gamma_w' \times (h_{water} + d_{cover} + h_{base})^2 / 2$ = **9.6** kN/m |
| Moist retained soil | $F_{moist\_h} = \gamma_G \times K_A \times \cos(\delta_{r.d}) \times \gamma_{mr}' \times ((h_{eff} - h_{sat} - h_{base})^2 / 2 + (h_{eff} - h_{sat} - h_{base}) \times (h_{sat} + h_{base}))$ = **44.5** kN/m |
| Base soil | $F_{exc\_h} = -\gamma_{Gf} \times K_P \times \cos(\delta_{b.d}) \times \gamma_b' \times (h_{pass} + h_{base})^2 / 2$ = **-3.1** kN/m |
| Total | $F_{total\_h} = F_{sat\_h} + F_{moist\_h} + F_{exc\_h} + F_{water\_h} + F_{sur\_h}$ = **75** kN/m |

**Overturning moments on wall**

| | |
|---|---|
| Surcharge load | $M_{sur\_OT} = F_{sur\_h} \times x_{sur\_h}$ = **34.4** kNm/m |
| Saturated retained soil | $M_{sat\_OT} = F_{sat\_h} \times x_{sat\_h}$ = **2** kNm/m |
| Water | $M_{water\_OT} = F_{water\_h} \times x_{water\_h}$ = **4.5** kNm/m |
| Moist retained soil | $M_{moist\_OT} = F_{moist\_h} \times x_{moist\_h}$ = **57.9** kNm/m |

| | |
|---|---|
| Total | $M_{total\_OT} = M_{sat\_OT} + M_{moist\_OT} + M_{water\_OT} + M_{sur\_OT} =$ **98.8** kNm/m |

**Restoring moments on wall**

| | |
|---|---|
| Wall stem | $M_{stem\_R} = F_{stem} \times x_{stem} =$ **43.4** kNm/m |
| Wall base | $M_{base\_R} = F_{base} \times x_{base} =$ **12.8** kNm/m |
| Line loads | $M_{P\_R} = (\text{abs}(\gamma_{Gf} \times P_{G1} + \gamma_{Qf} \times P_{Q1})) \times p_1 =$ **67.8** kNm/m |
| Total | $M_{total\_R} = M_{stem\_R} + M_{base\_R} + M_{P\_R} =$ **124** kNm/m |

**Check stability against overturning**

| | |
|---|---|
| Factor of safety | $FoS_{ot} = M_{total\_R} / M_{total\_OT} =$ **1.255** |

***PASS - Maximum restoring moment is greater than overturning moment***

**Bearing pressure check**

**Vertical forces on wall**

| | |
|---|---|
| Wall stem | $F_{stem} = \gamma_G \times A_{stem} \times \gamma_{stem} =$ **31** kN/m |
| Wall base | $F_{base} = \gamma_G \times A_{base} \times \gamma_{base} =$ **16** kN/m |
| Line loads | $F_{P\_v} = \gamma_G \times P_{G1} + \gamma_Q \times P_{Q1} =$ **58.9** kN/m |
| Total | $F_{total\_v} = F_{stem} + F_{base} + F_{water\_v} + F_{P\_v} =$ **105.9** kN/m |

**Horizontal forces on wall**

| | |
|---|---|
| Surcharge load | $F_{sur\_h} = K_A \times \cos(\delta_{r.d}) \times \gamma_Q \times Surcharge_Q \times h_{eff} =$ **19.7** kN/m |
| Saturated retained soil | $F_{sat\_h} = \gamma_G \times K_A \times \cos(\delta_{r.d}) \times (\gamma_{sr}' - \gamma_w') \times (h_{sat} + h_{base})^2 / 2 =$ **4.3** kN/m |
| Water | $F_{water\_h} = \gamma_G \times \gamma_w' \times (h_{water} + d_{cover} + h_{base})^2 / 2 =$ **9.6** kN/m |
| Moist retained soil | $F_{moist\_h} = \gamma_G \times K_A \times \cos(\delta_{r.d}) \times \gamma_{mr}' \times ((h_{eff} - h_{sat} - h_{base})^2 / 2 + (h_{eff} - h_{sat} - h_{base}) \times (h_{sat} + h_{base})) =$ **44.5** kN/m |
| Base soil | $F_{pass\_h} = -\gamma_{Gf} \times K_P \times \cos(\delta_{b.d}) \times \gamma_b' \times (d_{cover} + h_{base})^2 / 2 =$ **-3.1** kN/m |
| Total | $F_{total\_h} = F_{sat\_h} + F_{moist\_h} + F_{pass\_h} + F_{water\_h} + F_{sur\_h} =$ **75** kN/m |

**Moments on wall**

| | |
|---|---|
| Wall stem | $M_{stem} = F_{stem} \times x_{stem} =$ **43.4** kNm/m |
| Wall base | $M_{base} = F_{base} \times x_{base} =$ **12.8** kNm/m |
| Surcharge load | $M_{sur} = -F_{sur\_h} \times x_{sur\_h} =$ **-34.4** kNm/m |
| Line loads | $M_P = (\gamma_G \times P_{G1} + \gamma_Q \times P_{Q1}) \times p_1 =$ **82.5** kNm/m |
| Saturated retained soil | $M_{sat} = -F_{sat\_h} \times x_{sat\_h} =$ **-2** kNm/m |
| Water | $M_{water} = -F_{water\_h} \times x_{water\_h} =$ **-4.5** kNm/m |
| Moist retained soil | $M_{moist} = -F_{moist\_h} \times x_{moist\_h} =$ **-57.9** kNm/m |
| Total | $M_{total} = M_{stem} + M_{base} + M_{sat} + M_{moist} + M_{water} + M_{sur} + M_P =$ **39.9** kNm/m |

**Check bearing pressure**

| | |
|---|---|
| Propping force | $F_{prop\_base} = F_{total\_h} =$ **75** kN/m |
| Distance to reaction | $\bar{x} = M_{total} / F_{total\_v} =$ **377** mm |
| Eccentricity of reaction | $e = \bar{x} - l_{base} / 2 =$ **-423** mm |
| Loaded length of base | $l_{load} = 2 \times \bar{x} =$ **753** mm |
| Bearing pressure at toe | $q_{toe} = F_{total\_v} / l_{load} =$ **140.6** kN/m$^2$ |
| Bearing pressure at heel | $q_{heel} =$ **0** kN/m$^2$ |
| Effective overburden pressure | $q = (t_{base} + d_{cover}) \times \gamma_b' =$ **8** kN/m$^2$ |
| Design effective overburden pressure | $q' = q / \gamma_\gamma =$ **8** kN/m$^2$ |
| Foundation shape factors | $s_c = 1$ |
| Load inclination factors | $H = F_{sur\_h} + F_{sat\_h} + F_{water\_h} + F_{moist\_h} =$ **78.1** kN/m |
| | $i_c = 0.5 \times (1 + \sqrt{(H / (l_{load} \times c_{b.u.d}) - 1)}) =$ **0.886** |

Net ultimate bearing capacity $n_f = (\pi + 2) \times c_{b.u.d} \times s_c \times i_c + q$ = **304.1** kN/m$^2$

Factor of safety $FoS_{bp} = n_f / \max(q_{toe}, q_{heel})$ = **2.162**

***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 2.6.11

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

Concrete strength class C32/40

Characteristic compressive cylinder strength $f_{ck}$ = **32** N/mm$^2$

Characteristic compressive cube strength $f_{ck,cube}$ = **40** N/mm$^2$

Mean value of compressive cylinder strength $f_{cm} = f_{ck} + 8$ N/mm$^2$ = **40** N/mm$^2$

Mean value of axial tensile strength $f_{ctm} = 0.3$ N/mm$^2 \times (f_{ck} / 1$ N/mm$^2)^{2/3}$ = **3.0** N/mm$^2$

5% fractile of axial tensile strength $f_{ctk,0.05} = 0.7 \times f_{ctm}$ = **2.1** N/mm$^2$

Secant modulus of elasticity of concrete $E_{cm} = 22$ kN/mm$^2 \times (f_{cm} / 10$ N/mm$^2)^{0.3}$ = **33346** N/mm$^2$

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/mm$^2$

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

### Reinforcement details

Characteristic yield strength of reinforcement $f_{yk}$ = **500** N/mm$^2$

Modulus of elasticity of reinforcement $E_s$ = **200000** N/mm$^2$

Partial factor for reinforcing steel - Table 2.1N $\gamma_S$ = **1.15**

Design yield strength of reinforcement $f_{yd} = f_{yk} / \gamma_S$ = **435** N/mm$^2$

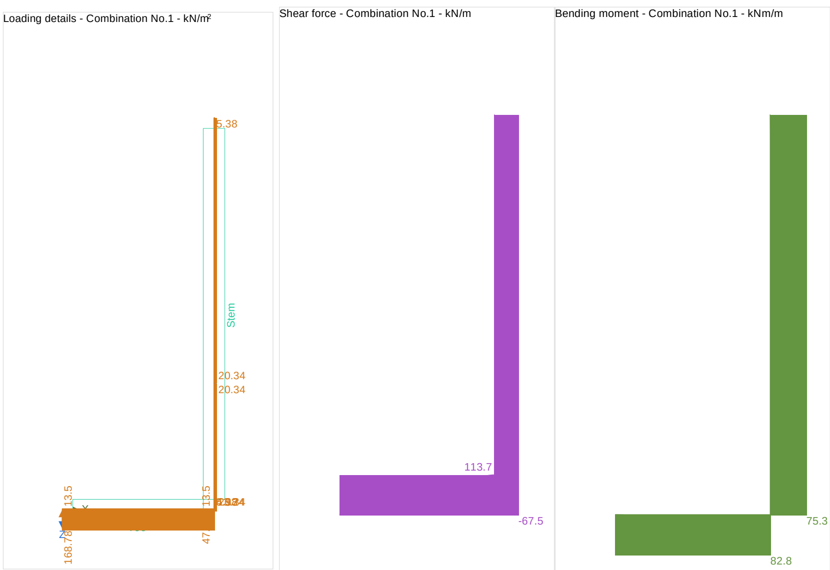
### Cover to reinforcement

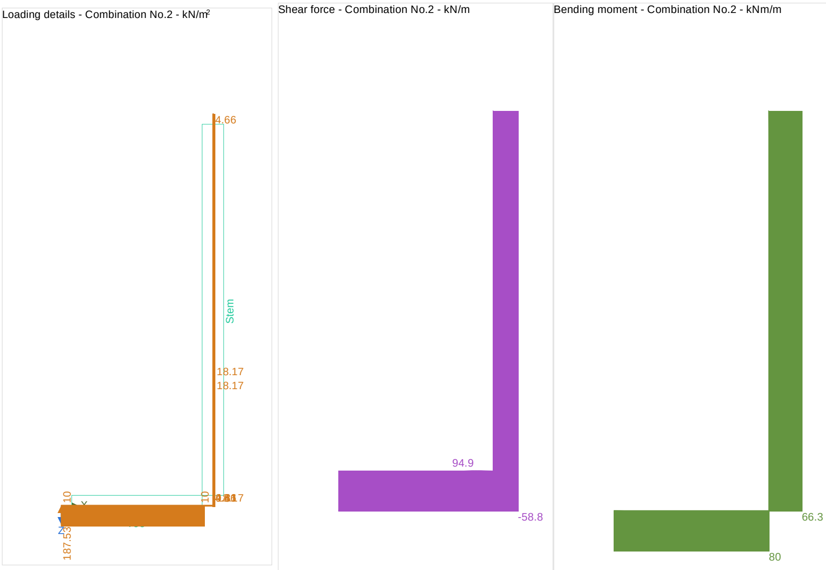
Front face of stem $c_{sf}$ = **40** mm

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 — $h = \mathbf{400}$ mm

**Rectangular section in flexure - Section 6.1**

Design bending moment combination 1 — $M = \mathbf{75.3}$ kNm/m

Depth to tension reinforcement — $d = h - c_{sr} - \phi_{sr} / 2 = \mathbf{344}$ mm

$K = M / (d^2 \times f_{ck}) = \mathbf{0.020}$

$K' = \mathbf{0.207}$

***K' > K - No compression reinforcement is required***

Lever arm — $z = \min(0.5 + 0.5 \times (1 - 3.53 \times K)^{0.5}, 0.95) \times d = \mathbf{327}$ mm

Depth of neutral axis — $x = 2.5 \times (d – z) = \mathbf{43}$ mm

Area of tension reinforcement required — $A_{sr.req} = M / (f_{yd} \times z) = \mathbf{530}$ mm²/m

Tension reinforcement provided — 12 dia.bars @ 150 c/c

Area of tension reinforcement provided — $A_{sr.prov} = \pi \times \phi_{sr}^2 / (4 \times s_{sr}) = \mathbf{754}$ mm²/m

Minimum area of reinforcement - exp.9.1N — $A_{sr.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d = \mathbf{541}$ mm²/m

Maximum area of reinforcement - cl.9.2.1.1(3) — $A_{sr.max} = 0.04 \times h = \mathbf{16000}$ mm²/m

$\max(A_{sr.req}, A_{sr.min}) / A_{sr.prov} = \mathbf{0.717}$

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

**Deflection control - Section 7.4**

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

Required tension reinforcement ratio — $\rho = A_{sr.req} / d = \mathbf{0.002}$

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

Structural system factor - Table 7.4N — $K_b = \mathbf{0.4}$

Reinforcement factor - exp.7.17 — $K_s = \min(500\ N/mm^2 / (f_{yk} \times A_{sr.req} / A_{sr.prov}), 1.5) = \mathbf{1.422}$

Limiting span to depth ratio - exp.7.16.a — $K_s \times K_b \times [11 + 1.5 \times \sqrt{(f_{ck} / 1\ N/mm^2)} \times \rho_0 / \rho + 3.2 \times \sqrt{(f_{ck} / 1\ N/mm^2)} \times (\rho_0 / \rho - 1)^{3/2}] = \mathbf{68.9}$

Actual span to depth ratio — $h_{stem} / d = \mathbf{9}$

***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 | $M_{sls}$ = **47** kNm/m |
| Tensile stress in reinforcement | $\sigma_s = M_{sls} / (A_{sr.prov} \times z)$ = **190.8** N/mm$^2$ |
| Load duration | Long term |
| Load duration factor | $k_t$ = **0.4** |
| Effective area of concrete in tension | $A_{c.eff} = \min(2.5 \times (h - d), (h – x) / 3, h / 2)$ = **119000** mm$^2$/m |
| Mean value of concrete tensile strength | $f_{ct.eff} = f_{ctm}$ = **3.0** N/mm$^2$ |
| Reinforcement ratio | $\rho_{p.eff} = A_{sr.prov} / A_{c.eff}$ = **0.006** |
| 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 | $s_{r.max} = k_3 \times c_{sr} + k_1 \times k_2 \times k_4 \times \phi_{sr} / \rho_{p.eff}$ = **492** mm |
| Maximum crack width - exp.7.8 | $w_k = s_{r.max} \times \max(\sigma_s – k_t \times (f_{ct.eff} / \rho_{p.eff}) \times (1 + \alpha_e \times \rho_{p.eff}), 0.6 \times \sigma_s) / E_s$ |
| | $w_k$ = **0.282** mm |
| | $w_k / w_{max}$ = **0.938** |

***PASS - Maximum crack width is less than limiting crack width***

**Rectangular section in shear - Section 6.2**

| | |
|---|---|
| Design shear force | $V$ = **67.5** kN/m |
| | $C_{Rd,c} = 0.18 / \gamma_C$ = **0.120** |
| | $k = \min(1 + \sqrt{(200 \text{ mm} / d)}, 2)$ = **1.762** |
| Longitudinal reinforcement ratio | $\rho_l = \min(A_{sr.prov} / d, 0.02)$ = **0.002** |
| | $v_{min} = 0.035 \text{ N}^{1/2}/\text{mm} \times k^{3/2} \times f_{ck}^{0.5}$ = **0.463** N/mm$^2$ |
| Design shear resistance - exp.6.2a & 6.2b | $V_{Rd.c} = \max(C_{Rd.c} \times k \times (100 \text{ N}^2/\text{mm}^4 \times \rho_l \times f_{ck})^{1/3}, v_{min}) \times d$ |
| | $V_{Rd.c}$ = **159.4** kN/m |
| | $V / V_{Rd.c}$ = **0.423** |

***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) | $A_{sx.req} = \max(0.25 \times A_{sr.prov}, 0.001 \times t_{stem})$ = **400** mm$^2$/m |
| Maximum spacing of reinforcement – cl.9.6.3(2) | $s_{sx\_max}$ = **400** mm |
| Transverse reinforcement provided | 10 dia.bars @ 150 c/c |
| Area of transverse reinforcement provided | $A_{sx.prov} = \pi \times \phi_{sx}^2 / (4 \times s_{sx})$ = **524** mm$^2$/m |

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

**Check base design at toe**

| | |
|---|---|
| Depth of section | $h$ = **400** mm |

**Rectangular section in flexure - Section 6.1**

| | |
|---|---|
| Design bending moment combination 1 | $M$ = **82.8** kNm/m |
| Depth to tension reinforcement | $d = h - c_{bb} - \phi_{bb} / 2$ = **317** mm |
| | $K = M / (d^2 \times f_{ck})$ = **0.026** |
| | $K'$ = **0.207** |

***K' > K - No compression reinforcement is required***

| | |
|---|---|
| Lever arm | $z = \min(0.5 + 0.5 \times (1 - 3.53 \times K)^{0.5}, 0.95) \times d$ = **301** mm |
| Depth of neutral axis | $x = 2.5 \times (d – z)$ = **40** mm |

Area of tension reinforcement required $A_{bb.req} = M / (f_{yd} \times z) = \mathbf{632}$ mm²/m

Tension reinforcement provided 16 dia.bars @ 150 c/c

Area of tension reinforcement provided $A_{bb.prov} = \pi \times \phi_{bb}^2 / (4 \times s_{bb}) = \mathbf{1340}$ mm²/m

Minimum area of reinforcement - exp.9.1N $A_{bb.min} = \max(0.26 \times f_{ctm} / f_{yk}, 0.0013) \times d = \mathbf{498}$ mm²/m

Maximum area of reinforcement - cl.9.2.1.1(3) $A_{bb.max} = 0.04 \times h = \mathbf{16000}$ mm²/m

$\max(A_{bb.req}, A_{bb.min}) / A_{bb.prov} = \mathbf{0.472}$

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

**Crack control - Section 7.3**

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

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

Serviceability bending moment $M_{sls} = \mathbf{59.3}$ kNm/m

Tensile stress in reinforcement $\sigma_s = M_{sls} / (A_{bb.prov} \times z) = \mathbf{146.9}$ N/mm²

Load duration Long term

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

Effective area of concrete in tension $A_{c.eff} = \min(2.5 \times (h - d), (h – x) / 3, h / 2) = \mathbf{120125}$ mm²/m

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

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

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

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

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

$k_3 = \mathbf{3.4}$

$k_4 = \mathbf{0.425}$

Maximum crack spacing - exp.7.11 $s_{r.max} = k_3 \times c_{bb} + k_1 \times k_2 \times k_4 \times \phi_{bb} / \rho_{p.eff} = \mathbf{499}$ mm

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

$w_k = \mathbf{0.22}$ mm

$w_k / w_{max} = \mathbf{0.733}$

***PASS - Maximum crack width is less than limiting crack width***

**Rectangular section in shear - Section 6.2**

Design shear force $V = \mathbf{113.7}$ kN/m

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

$k = \min(1 + \sqrt{(200 \text{ mm} / d)}, 2) = \mathbf{1.794}$

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

$v_{min} = 0.035 \text{ N}^{1/2}/\text{mm} \times k^{3/2} \times f_{ck}^{0.5} = \mathbf{0.476}$ N/mm²

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

$V_{Rd.c} = \mathbf{162.6}$ kN/m

$V / V_{Rd.c} = \mathbf{0.699}$

***PASS - Design shear resistance exceeds design shear force***

**Secondary transverse reinforcement to base - Section 9.3**

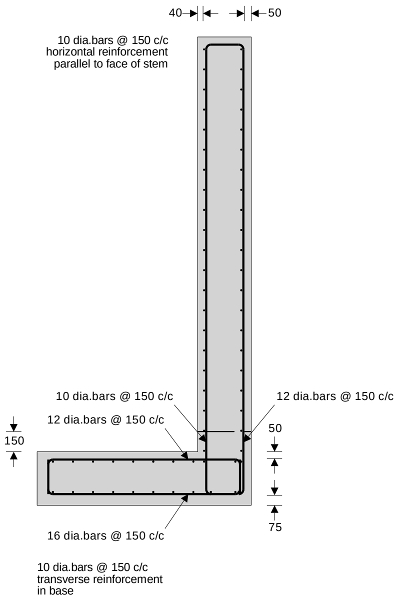
Minimum area of reinforcement – cl.9.3.1.1(2) $A_{bx.req} = 0.2 \times A_{bb.prov} = \mathbf{268}$ mm²/m

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

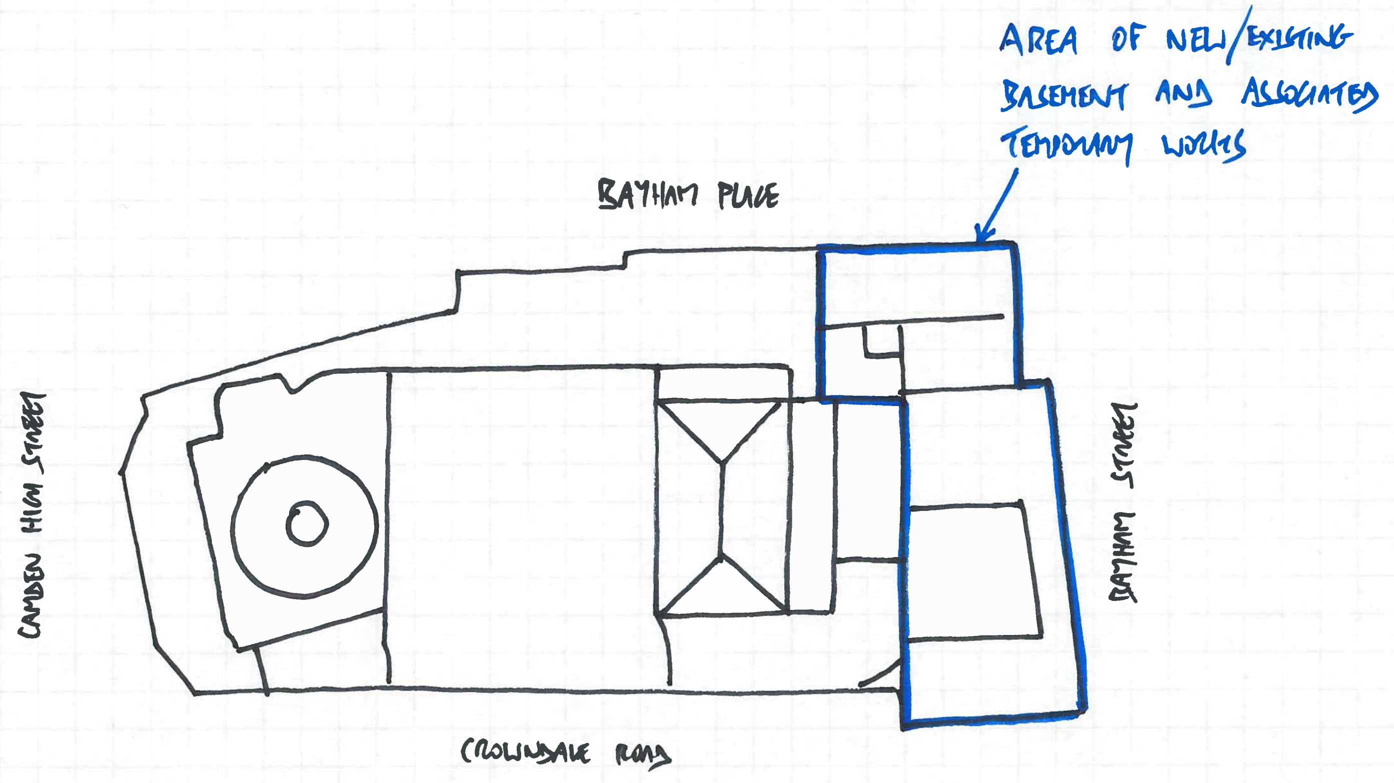
Transverse reinforcement provided 10 dia.bars @ 150 c/c

Area of transverse reinforcement provided $A_{bx.prov} = \pi \times \phi_{bx}^2 / (4 \times s_{bx}) = \mathbf{524}$ mm²/m

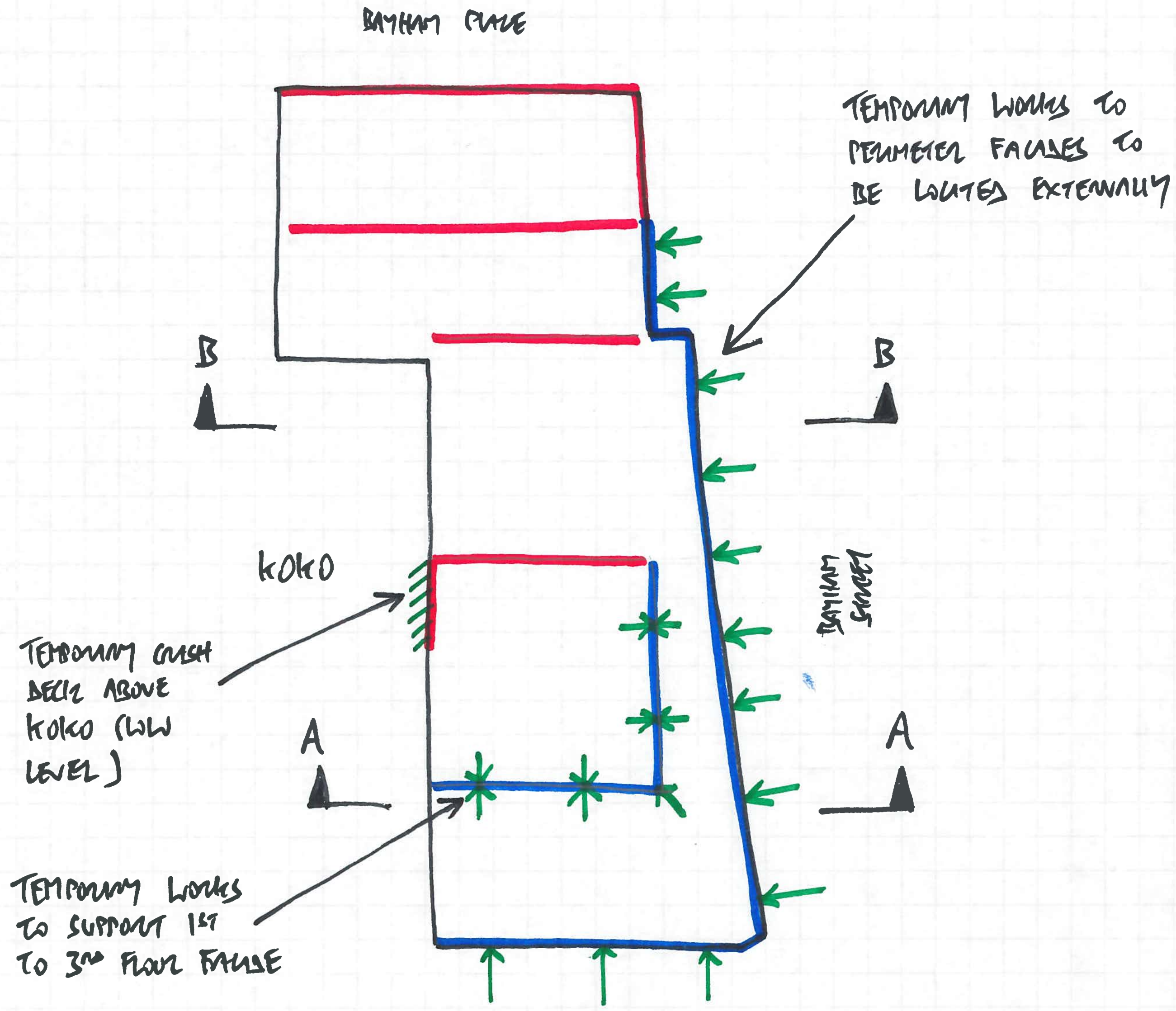
***PASS - Area of reinforcement provided is greater than area of reinforcement required***




**Reinforcement details**




SITE PLAN
NTS




PART PLAN
NTS

## TEMPORARY WORKS, SEQUENCING & PROPPING

6.1 SITE SET UP

- ERECT SCAFFOLDING.
- ERECT HOARDING.
- SET UP SITE FACILITIES.
- INSTALL MONITORING SURVEY TARGETS.
- TERMINATE/PROTECT EXISTING SERVICES.
- CHECK CURRENT GROUNDWATER LEVELS.
- COMPLETE STRIP OUT.

EXISTING WALLS TO BE DEMOLISHED

EXISTING WALLS TO BE RETAINED

INDICATIVE LOCATION OF TEMPORARY WORKS

TO BE READ WITH HTS STRUCTURAL METHODOLOGY STATEMENT & BASEMENT IMPACT ASSESSMENT (REV C - DEC 2016), RSK BASEMENT IMPACT ASSESSMENT AND HTS SKETCHES SK40-45.

| | | | |
|---|---|---|---|
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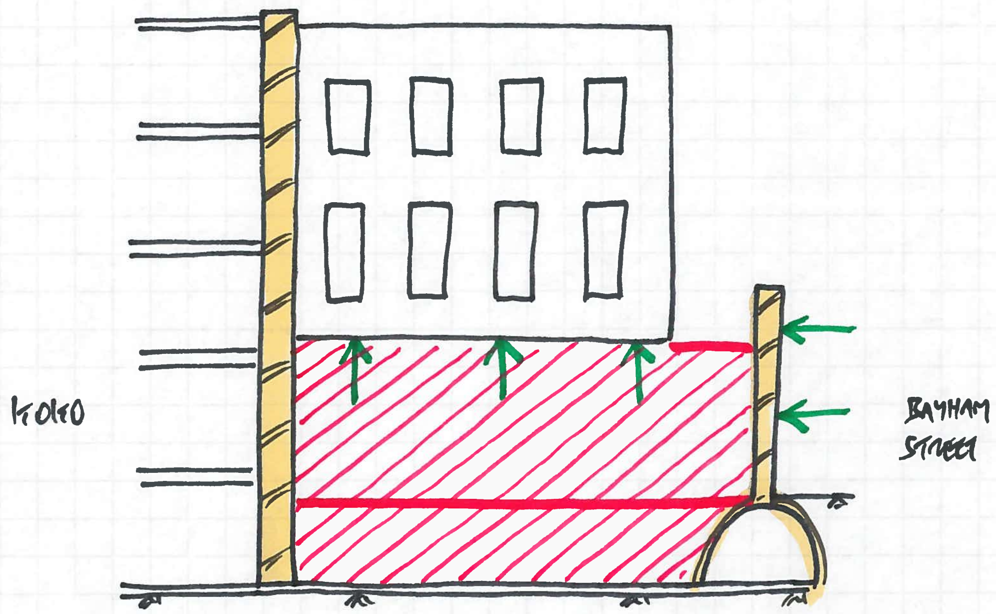
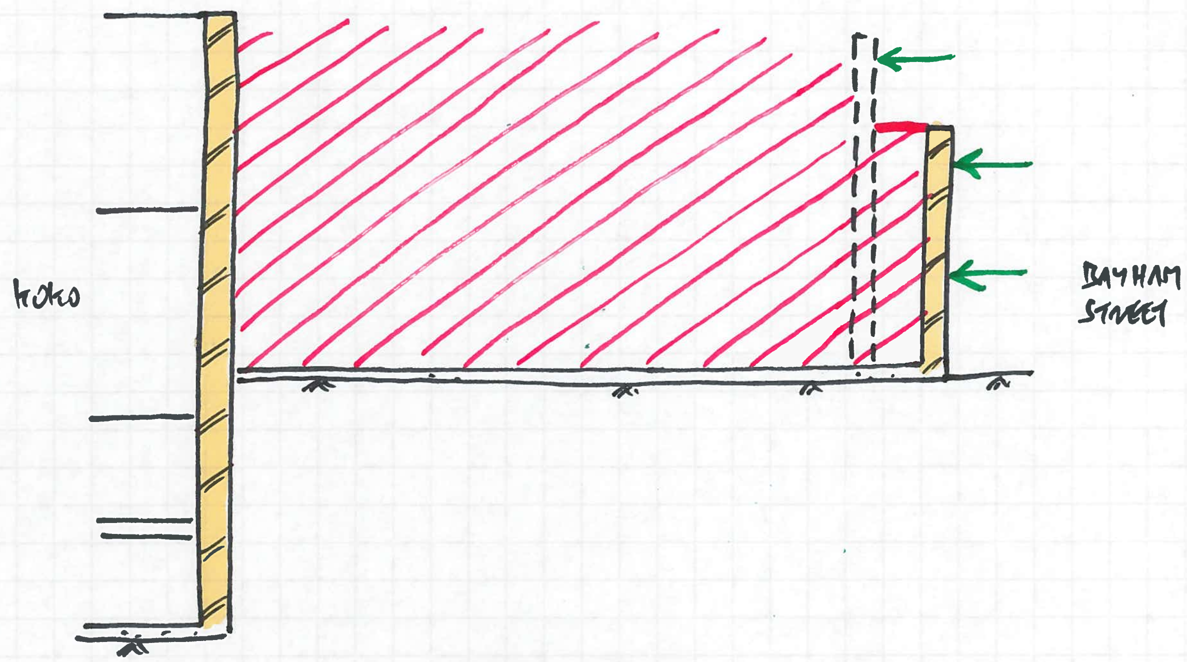
| Title INDICATIVE TEMPORARY WORKS, PROPPING & SEQUENCING | | Eng. MJT | |
| Job No. 1444 | Sheet SK40 | Rev. - | |

HEYNE TILLETT STEEL




SECTION A-A
NTS




SECTION B-B
NTS

6.2 DEMOLITION OF EXISTING STRUCTURE.

- INSTALL TEMPORARY WORKS TO RETAINED FACADES.
- COMMENCE DEMOLITION OF THE EXISTING SUPERSTRUCTURE FROM TOP LEVEL DOWN.
- GRUB OUT EXISTING FOUNDATIONS AT PILE LOCATIONS.

/// = DEMOLITION OF EXISTING STRUCTURE

TO BE READ WITH HTS SMS & BIA (REV C - DEC 2016), RSK BIA AND HTS SK40-45.

| | | | |
|---|---|---|---|
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| Title | INDICATIVE TEMPORARY WORKS, PROPPING & SEQUENCING | Eng. | MJT |
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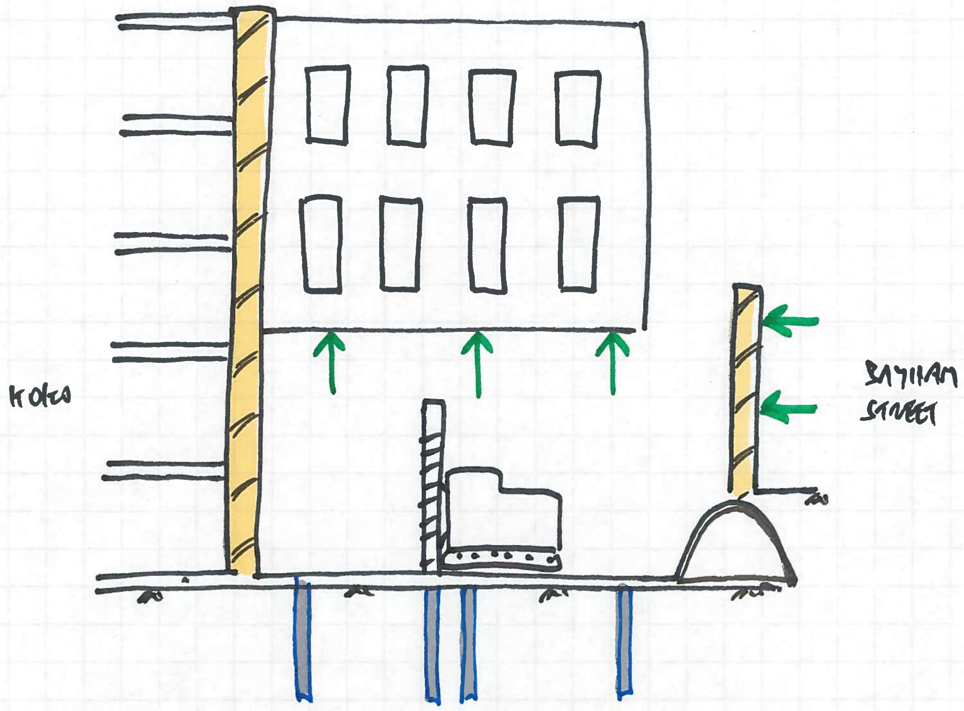
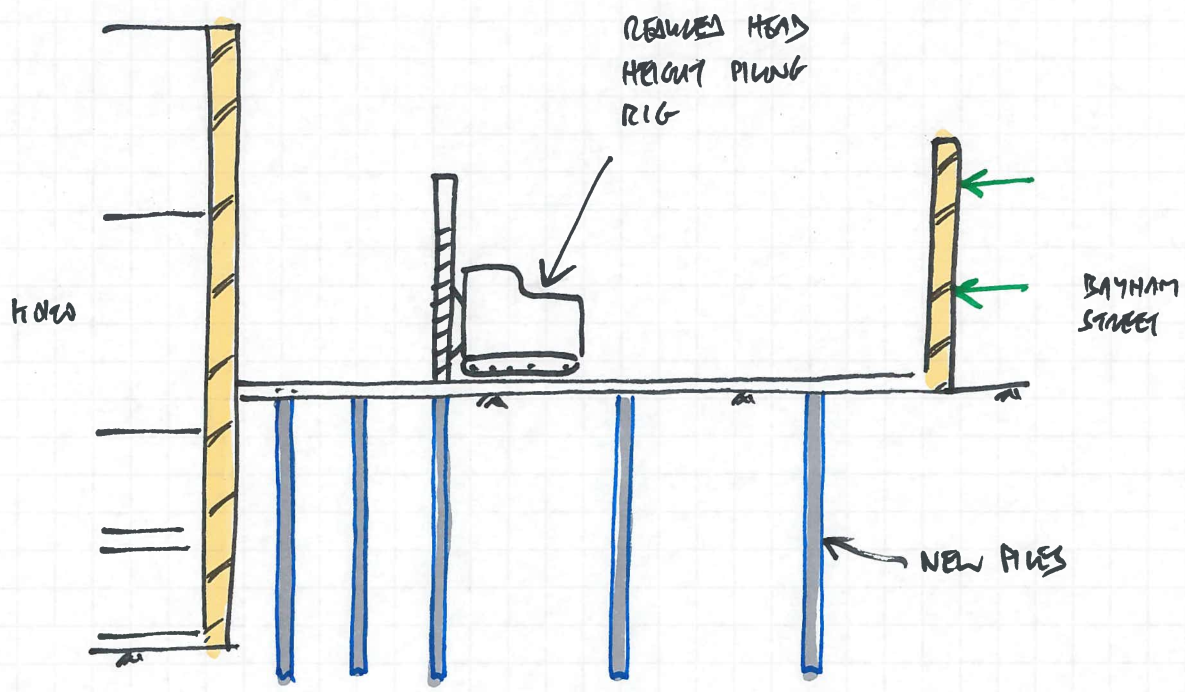
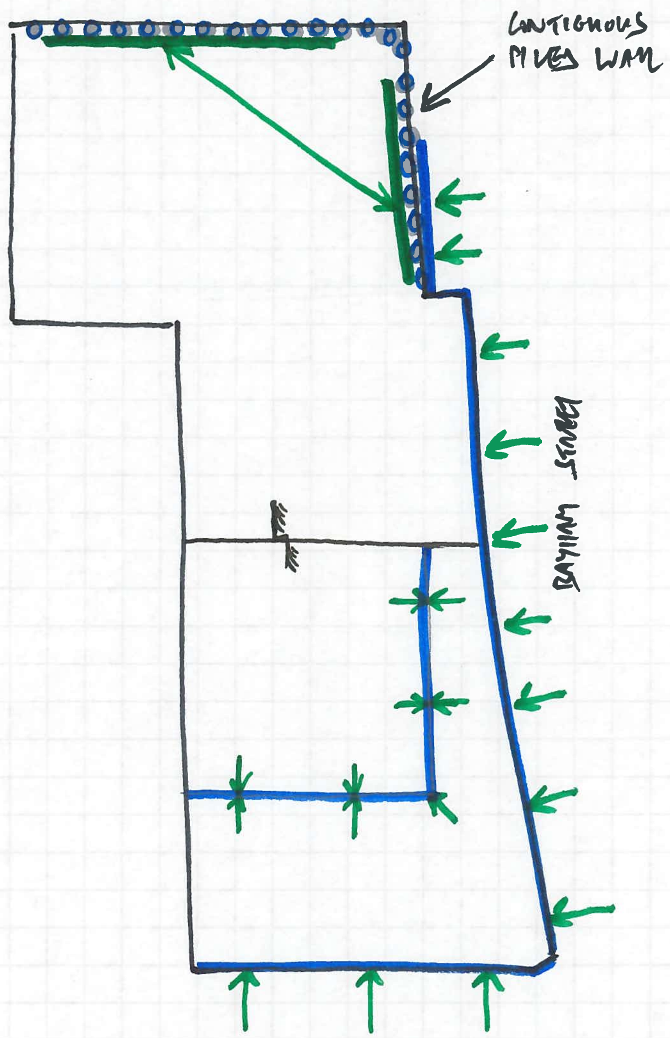



SECTION A-A
NTS




SECTION B-B
NTS




PLAN NTS

## 6.3 PILING

- PROVIDE PILING MAT.
- INSTALL CONTIGUOUS PILES WALL.
- INSTALL PILES TO NEW FOUNDATIONS WITH REDUCED HEIGHT PILING RIG.
- INSTALL WALERS AND DIAGONAL PROPPING TO TOP OF CONTIGUOUS PILES WALL.

TO BE READ WITH HTS SMS & BIA (REV C - DEC 2016), RSK BIA AND HTS SK40-45.

| | | | |
|---|---|---|---|
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| Title | INDICATIVE TEMPORARY WORKS, PROPPING & SEQUENCING | Eng. | MJT |
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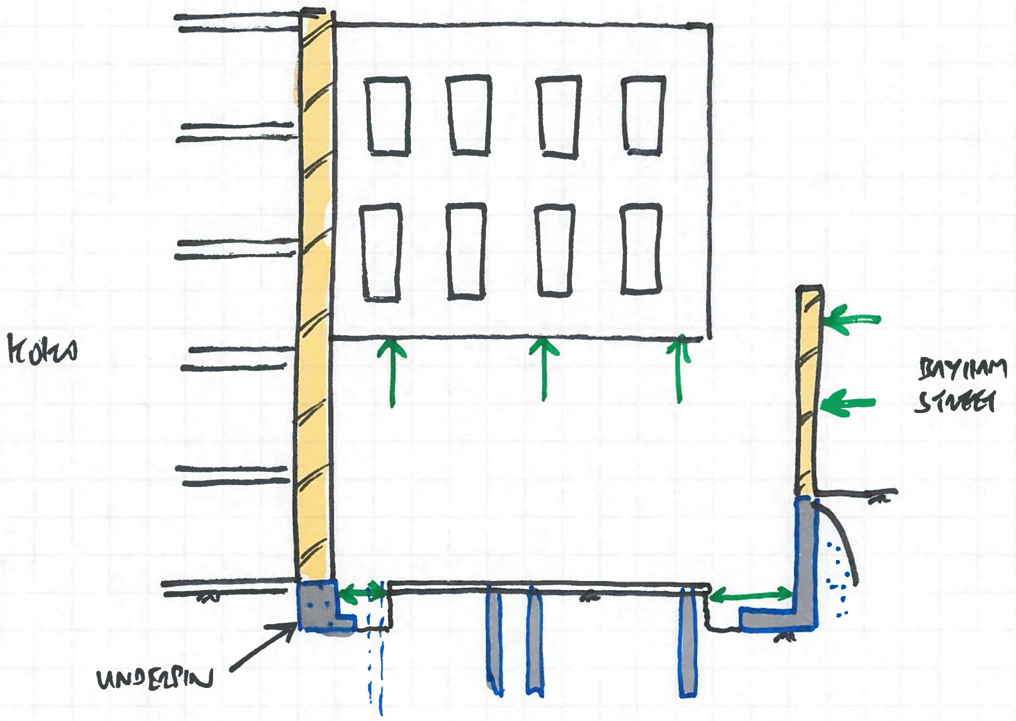
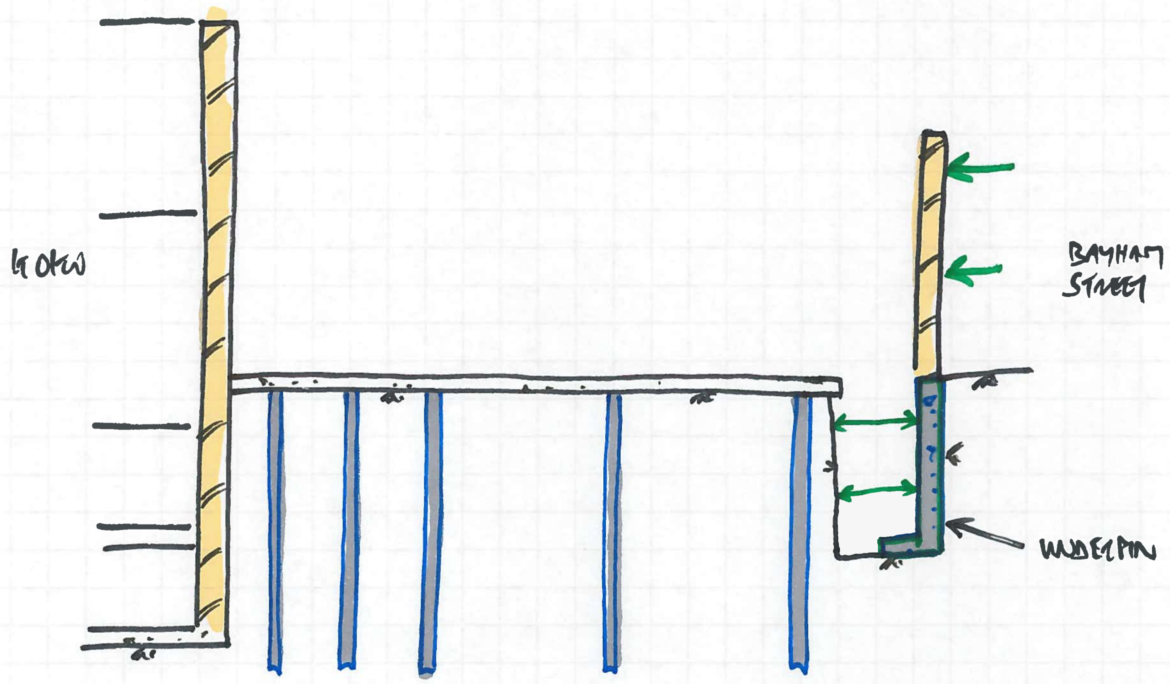



SECTION A-A
NTS




SECTION B-B
NTS

6.4 UNDERPINNING OF EXISTING WALLS

- COMMENCE INSTALLATION OF MASS & R.C. UNDERPINNING.
- INSTALL DEWATERING SUMP LOCATED CENTRALLY IN SITE TO ENABLE CONSTRUCTION OF PINS WHERE THE GROUND WATER LEVEL IS FOUND TO BE HIGH.
- PINS TO BE INSTALLED IN AGREED SEQUENCE WITH ADEQUATE TEMPORARY PROPPING/SHORING.
- EXCAVATIONS TO BE BACKFILLED TO LOWEST SUB LEVEL FOLLOWING COMPLETION OF PIN.

TO BE READ WITH HTS SMS & BIA (REV C - DEC 2016), RSK BIA AND HTS SK40-43.

| | | | |
|---|---|---|---|
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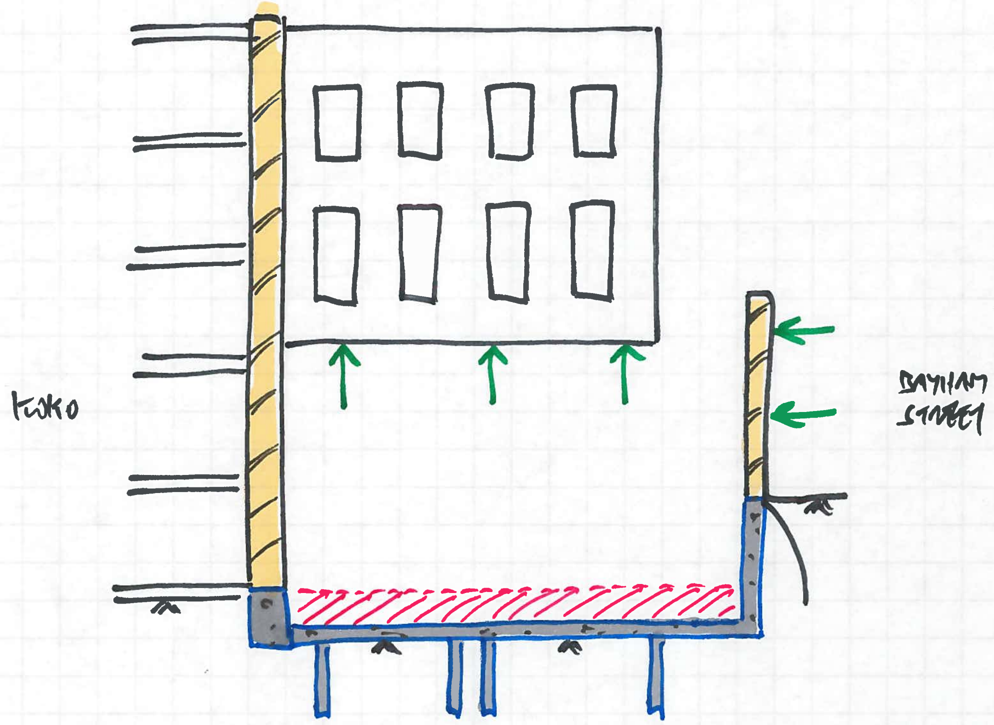
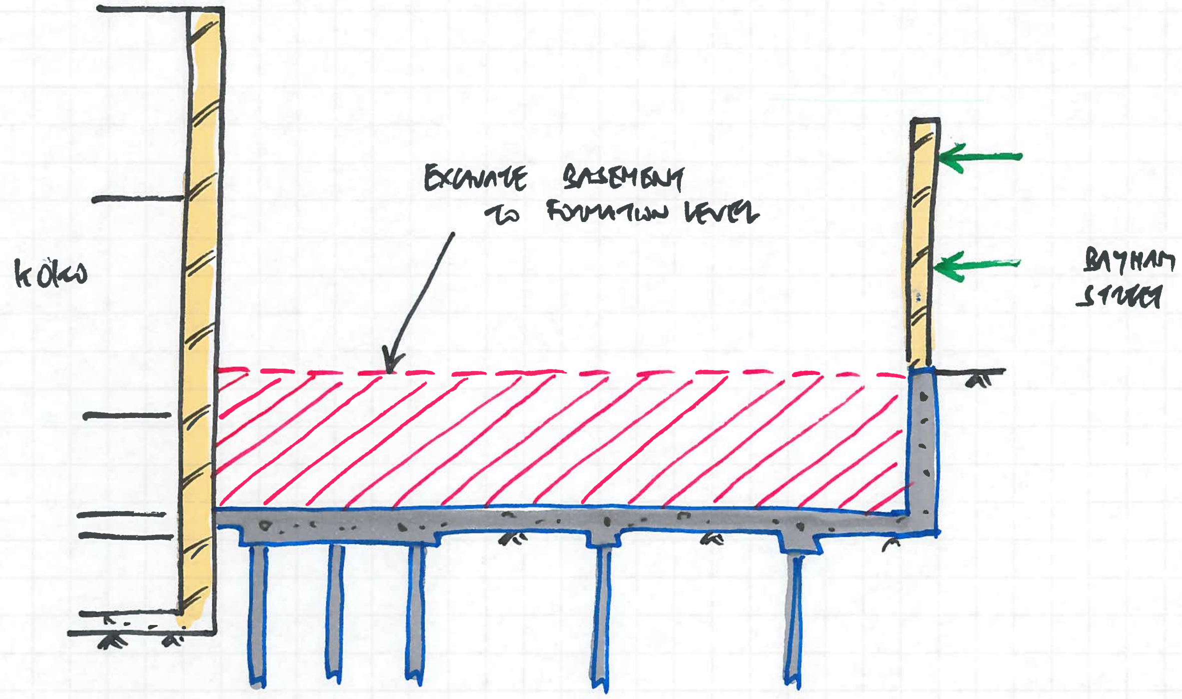



SECTION A-A
NTS




SECTION B-B
NTS

6.5/6.6 EXCAVATION OF BASEMENT, CASTING OF FOUNDATIONS, RC WALL AND BASEMENT

- COMPLETE EXCAVATION/DEMOLITION TO BASEMENT FORMATION LEVEL.
- ADDITIONAL TEMPORARY WORKS TO BE INSTALLED AS REQUIRED DURING REDUCED LEVEL DIG.
- COMPLETE OUTSTANDING UNDERPINNING IN THE AGREED SEQUENCE.
- INSTALL ADDITIONAL DEWATERING SUMP LOCATED CENTRALLY IN NEW BASEMENT.
- CUT DOWN PILES AS REQUIRED.
- CAST NEW FOUNDATIONS AND BASEMENT SLAB.

TO BE READ WITH HTS SMS & BIA (REV C-DEC 2016), RSK BIA AND HTS SK 40-45.

| | | | |
|---|---|---|---|
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| Job No. | 1444 Sheet SK 44 | Rev. | - |

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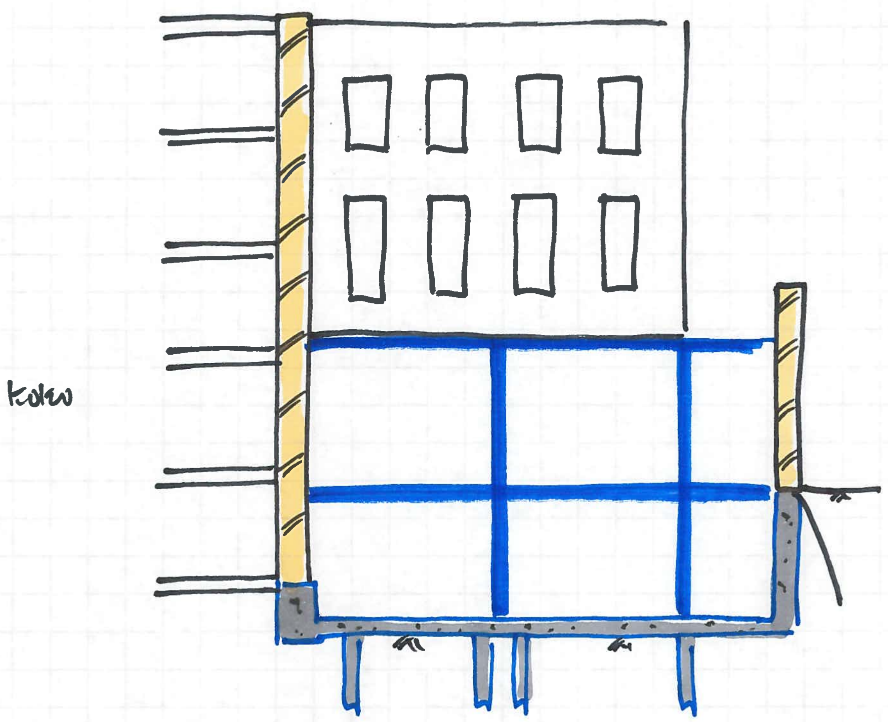
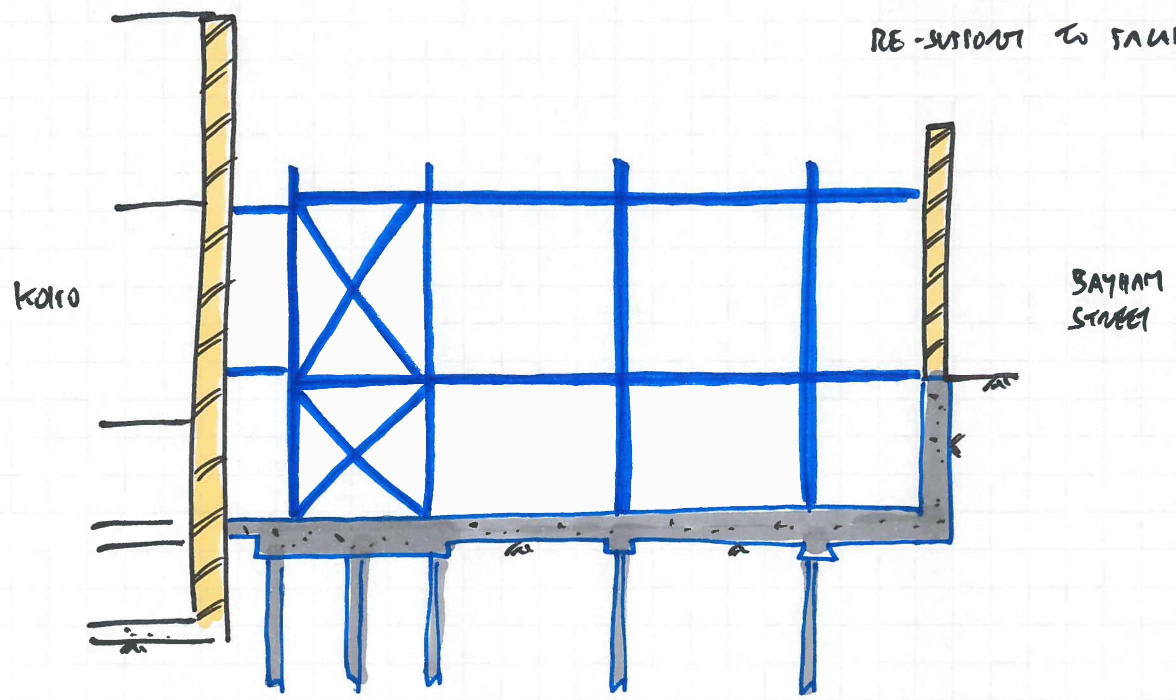



SECTION A-A
NTS

TEMPORARY WORKS REMOVED
FOLLOWING INSTALLATION OF
NEW SUPERSTRUCTURE AND
RE-SUPPORT TO FACADES




SECTION B-B
NTS

6.7 COMPLETE SUPERSTRUCTURE WORKS & REMOVE TEMPORARY WORKS

- ERECT NEW SUPERSTRUCTURE AND PERMANENT SUPPORT TO RETAINED STRUCTURE.
- SEQUENTIALLY REMOVE TEMPORARY WORKS FOLLOWING CONFIRMATION FROM S.E.
- REMAINING INSTALLATION/ERECTION OF SUPERSTRUCTURE TO COMMENCE.

TO BE READ WITH HTS SMS & BIA (REV C - DEC 2016), RSK BIA AND HTS SK 40-45.

| | | | |
|---|---|---|---|
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| Job No. 1444 | Sheet SK 45 | Rev. | - |

HEYNE TILLETT STEEL

## Query 2 – Land Stability

- Dimensions of the piles used in the ground movement assessment of the contiguous piled retaining wall (as confirmed by RSK):
  - Diameter = 450mm
  - Length = 12.3m deep
  - Toe depth = 10.2m AOD

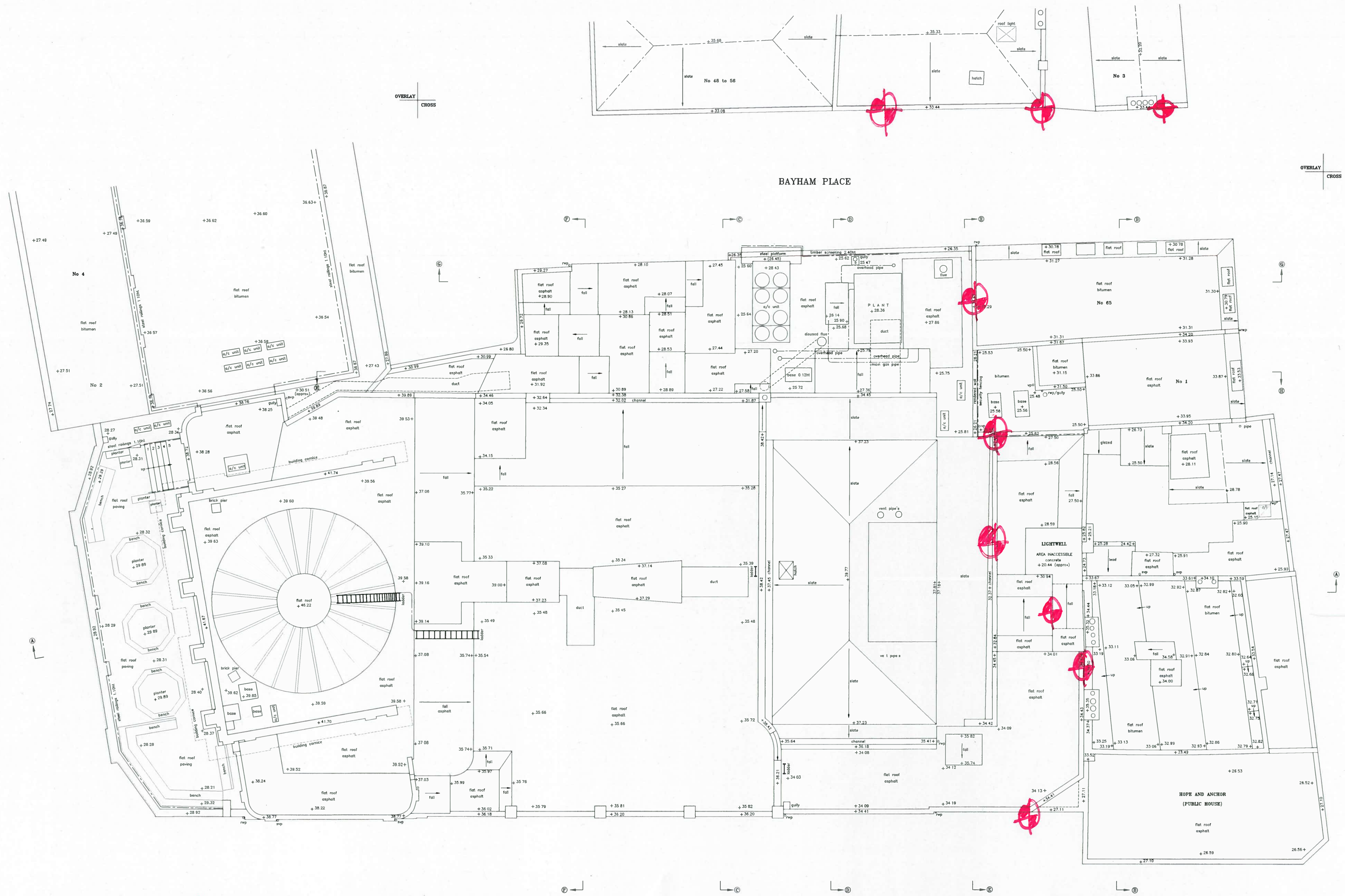
## Query 3 – Land Stability

- Structural monitoring – see below for an outline structural monitoring plan. The final detailed monitoring plans with adjacent buildings will be agreed with the appointed contractor. There are no party wall awards as the buildings on the site are under the same ownership. A site plan with indicative locations of monitoring points is appended:

- The integrity of excavations is to be maintained by the contractor at all times.
- The contractor shall be responsible for establishing and setting out of all levels and datum.
- The contractor is to provide a schedule of conditions of all adjacent buildings with photographs agreed with the CA prior to works commencing.
- Any cracks to the fabric of the adjacent structures or perimeter retained walls are to have graduated tell tales applied prior to the commencement of the demotion works, or as they are uncovered.
- The perimeter walls shall be monitored regularly for signs of movement by all of the follow methods:
    - Visual inspection
    - Accurate survey techniques
    - Graduated tell tales
- Movement shall be measured with the use of prism reflector targets. Results are to be tabulated and represented graphically and submitted on a weekly basis.
- Monitoring to be undertaken until the retained walls are tied into the new structure.
- Monitoring is to be undertaken for a suitable period prior to main demolition and excavation works commencing to enable base movement due to daily thermal effects to be established.
- Readings should be taken at the same time each day to minimise the effects of temperature fluctuations.
- Frequency of monitoring to be in accordance with CIRIA guide C579.
- Lateral or vertical movements and deflections of the perimeter retained walls and adjacent structures above those due to daily thermal effects should be monitored against an agreed traffic light system to be proposed by the contractor, based on the following:
    - Green - The wall movement is within an acceptable range. Site works and frequency of monitoring can proceed as planned. Max lateral/vertical deflection trigger level 5mm.
    - Amber - Wall movement exceeds the green limit but is below the red limit. Monitoring frequency is increased. A meeting is convened to review working procedures and assumptions. Max lateral/vertical deflection trigger level is greater than 5mm but less than 10mm.
    - Red - Wall movement exceeds amber control limit. Work is stopped immediately and team meeting convened to identify the reason for reaching the limit and any remedial action or propping that may be required.
- Structural Engineer to be present on site to confirm remedial action.
- Differential movement trigger levels:
    - Amber - Differential movement between adjacent horizontal targets which exceed 3mm difference in figures but less than 5mm. A meeting is convened to review working procedures, condition of AO finishes & assumptions.
    - Red - Differential movement between adjacent horizontal targets which exceeds 5mm difference in figures. Work is stopped immediately and team meeting is convened to identify the reason for reaching the limit and any remedial action required.
- The contractor is to undertake a movement survey of the piled wall during basement construction twice weekly. Contractor to confirm method of survey. A brief report detailing monitoring locations & movement is to be issued 24 hours following survey.

- Suggested frequency of monitoring:

| Activity | Suggested frequency |
|---|---|
| From installation of monitoring to start of demolition | Weekly until reading have stabilised (allow 4 weeks) |
| During demolition and excavation | Weekly |
| Construction of all remaining structure | Fortnightly |
| Remainder of contract period | Every 3 months |
| During defects liability period | Twice, at least 6 months apart |




= INDICATIVE LOCATION OF STRUCTURAL MONITORING LOCATIONS

Scale = 1 : 100

HEYNE
TILLETT
STEEL

BIA - AUDIT
QUERY 3
HTS - 1444
FEB 2017 MJT.

## Notes

THIS SURVEY HAS BEEN PREPARED WITH A SCALING ACCURACY FOR A PLOT AT A SCALE OF 1/100

ALL LEVELS ARE IN METRES DERIVED FROM GPS TRANSFORMATION OSGM02

THE CO-ORDINATES ARE DERIVED FROM THE ORDNANCE SURVEY ACTIVE STATION NETWORK OSTM02 (BASE STATION ST02)

| | |
|---|---|
| sh | sill to head height |
| fs | floor to sill height |
| u/s | underside height |
| t/s | topside height |
| fb | floorboard direction |
| conc | concrete |
| rl | roof light |
| cup'd | cupboard |
| fp | fireplace |
| sd | sliding door |
| svp | soil and vent pipe |
| rwp | rain water pipe |
| © | carpet |
| 3.17 | room height |
| | roof slope |
| | radiator |

NOTE:

R2= FLOOR PLANS EXTENDED 08/08/16

AEM/MJM



ACAD

job

KOKO
CAMDEN HIGH STREET
LONDON
NW1 7JE

client

BURKE HUNTER ADAMS LLP
On Behalf Of
VEVIL INTERNATIONAL LIMITED

| title | dwg no |
|---|---|
| ROOF PLAN | 23745A-8-R2 |
| scale | date |
| 1/100 | JANUARY 2016 |

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## Query 4 – Land Stability

N/A - Ongoing

## Query 5 – Flood Risk

- Surface Water Floor Risk – please see the following response from RSK.

  *"By way of background, if intense rain is unable to soak into the ground or be carried through manmade drainage systems, for a variety of reasons, it can run off over the surface causing localised floods before reaching a river or other watercourse. Generally, where there is impermeable surfacing or where the ground infiltration capacity is exceeded, surface water runoff will occur. Excess surface water flows from the site are believed to drain into the surrounding Thames Water sewer network. For the avoidance of all doubt, the surrounding private drainage and highway drainage and/or surface/combined sewer network would either have to be blocked or overflowing for there to be any risk of surface water flooding in the area.*

  - *There is a surface water flow path along Crowndale Road to the south, which extends (to a lesser extent) up Camden High Street to the west, Bayham Street to the east and into Bayham Place to the north of the site. The flood risk associated with this flow path ranges from* ***low*** *to* ***high****, however, the flow pathways do not encroach onto the site and* <u>*the site itself is assessed as being at* ***very low*** *risk from surface water flooding.*</u> *Meaning that any surface water flows are likely to be confined to the surrounding road network, and probably contained within the existing road gullies adjacent to the pavements surrounding the site.*

  - *As the area of high risk is confined to the surrounding road network, it is likely that surface water would be prevented from flowing through the site due to raised kerbs and the walls along the boundaries of the site. From Google Street View, it seems like there is a degree of freeboard between the road gullies and the site doorways, probably between 100mm and 200mm, meaning that flood depths would have to exceed these depths in order to flood the site.*

  - *Further reference to the expected flood depths mapping in the surrounding road network indicate that expected flood depths are likely to be less than 300mm and have a velocity in excess of 0.25m/s. The main flow route is expected to be north to south down Camden High Street then west to east along Crowndale Road.*

  - *The overall risk of flooding to the site from surface water is considered low, and therefore further site specific mitigation is not considered necessary. "*

## Query 6 – Flood Risk

- Proposed ground water control measures:
    - The ground water level has been measured below the proposed basement slab level. Localised dewatering will only be required if the ground water level is found to be higher than expected.
    - During construction – localised dewatering is proposed during construction via sump pumping. The sump will be located in the centre of the site to keep the dewatered level local to the site works. The dewatering will be monitored to ensure that no fines are washed in to the sump.
    - Permanent works – A Grade 3 waterproofing system is proposed in the basement areas. A drained cavity system will be installed enabling ground water collection within sump locations. Sump pumps will pump ground water via a rising main to ground floor level where it will be discharged via gravity into the combined Thames Water sewer network. Non return valves will be used to mitigate against sewer surcharging.

## Query 7 – Hydrology

N/A - Ongoing

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