2 Elsworthy Terrace,

NW3 3DR

# Structural Construction Method Statement

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| Job number: | 223176 |
| Revision: | P2 |
| Status: | Planning |
| Date: | November 2023 |

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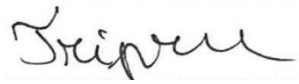
| 01.12.23 | P1 | ISSUED FOR PLANNING | |
| Structures by: | Bianca Tripsa | Approved by: | Tim Botfield |
| Qualification | MSc BEng (Hons) | | MEng CEng MIStructE |
| signature: |  | |  |

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| 26.02.24 | P2 | ISSUED FOR PLANNING | |
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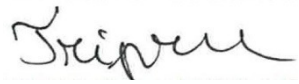
| signature: |  | |  |

## Contents

## 1.0 Non-technical Summary

Structural Design Studio Limited were appointed by the client, Mr. Sasha and Mrs. Charlotte Knobloch, to advise on the structural implications of a full renovation of their property including extending the rear of the property into the garden with aspects of excavating & retaining involved. The following report has been prepared to help ensure that the structures on both the site and neighbouring sites are safeguarded during the works.

The report provides information in accordance with the advice provided in Camden Planning Guidance: Basements. Dated January 2021.

A desktop study of the site has been completed to establish the site's history and a risk-based interpretation used to inform the onsite testing. As part of Basement Impact Assessment, a site-specific ground investigation at No. 2 comprising of trial pits and boreholes has been completed by Ground and Water Ltd to confirm soil and groundwater conditions, as well as the size and profile of the existing foundations to the building. The results of this investigation have been used to provide information on the local ground conditions and to inform the structural scheme design.

This report supports the conclusion that should the works be completed by a competent contractor, the basement extension can be constructed without any significant adverse effect on the property, neighbouring properties, groundwater, surface water or on the stability of the adjoining ground.

## 2.0 Description of Existing Buildings and Site

The existing building at No. 2 Elsworthy Terrace is a four-storey terraced house located in the London Borough of Camden. The house has an existing lower ground floor beneath the footprint of the building which currently serves as dining room, kitchen, and utility.

Figure 1. *2 Elsworthy Terrace, Front Elevation (Google Maps, July 2022)*

The main house is rectangular on plan with a frontage onto Elsworthy Terrace. It is bounded by No.1 and No.3 Elsworthy Terrace to the northwest and southeast respectively.

The site is part of a terrace of houses forming part of a street dated back to c1893-1895, with the earliest maps dated 1850 showing the terraced buildings developed in the area.


Figure 2. Ordnance Survey Map 1850s

## Main house:

The building is traditionally constructed with timber roof and floors supported on load bearing internal and perimeter walls. The ground floor is of suspended timber floor construction and spans side to side. The upper timber floors also span from side to side and the load bearing walls are situated along the corridor line throughout.

The overall stability of the building appears to be provided by the cellular layout of the masonry walls and diaphragm action of the timber floors at each level.

The existing property has an existing rear balcony/terrace at ground floor level with an adjacent staircase which currently serves as access to the rear garden from ground floor level.

Access is gained to the site from the front of the property via Elsworthy Terrace.

## Front Lower Ground Floor courtyard and vaults:

To the front of the property there is a small existing courtyard set at the existing lower ground floor level, and a vault located under the entrance stair which extends across a third of the width of the property.

## Neighbouring Properties

There is currently no rear extension on either adjoining properties No.1 or No.3 Elsworthy Terrace, however there is an existing rear balcony/terrace at No.3 similar to the one at No.2.

Existing garden and lower ground levels of adjoining properties have been marked approximately on the drawings in APPENDIX A – Proposed Structural Scheme Drawings.

## 3.0 Ground Conditions

Geological maps show that the site is situated in an area of London Clay Formation. The maps available from the British Geological Survey indicate that the site is clay, silt and sand.

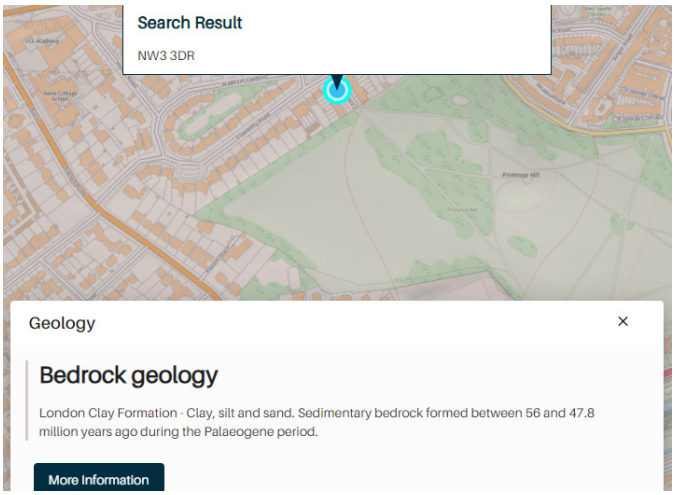



Figure 3 *Excerpt of Geology of Britain Viewer (British Geological Survey, 12/06/2022)*

A review of the nearby historic borehole records available online from the British Geological Survey provide more detail. Borehole reference TQ28SE2056 encounters approximately 3m of firm to locally soft brown mottled orange, brown and grey CLAY, 10m of firm brown fissured silty CLAY over firm to stiff brown-grey laminated fissured CLAY.

A site-specific soil investigation has been carried out by Ground and Water Ltd which included 2 boreholes - one window sampler borehole down to 3m in the rear garden(BH1) and one windowless sampler borehole down to 6.45m in the front of the property(BH2) and 5 trial pits on the Boundary Walls.

The boreholes and trial pits revealed ground conditions that were generally consistent with the geological records and comprised Top Soil and/or fill down to 0.9m in thickness resting on London Clay formation at depth. Groundwater was encountered at 5.5m BGL in BH2 with a second visit showing the water level at 1.6m BGL in BH2, which suggests the high water table (perched on the clay) is due to seasonal changes as the investigation was undertaken when groundwater levels are likely to be approaching their annual maximum (investigation was undertaken in October-November 2023).

The site investigation has concluded that foundations should be designed with an allowable bearing pressure of 70KN/m² in accordance with NHBC standards, for high volume potential soils.

## 4.0 Desk Study Summary and Observations

The results of our desk study are as summarised below;

- The site is located within a Flood zone 1. It therefore has a low probability of flooding from rivers and the sea. The site appears to be at 'very low risk' of flooding due to surface water, as shown on the latest Environment Agency Flood Maps (reference; www.environmentagency.gov.uk).
- No railway cuttings were noted within a 250m radius of the site. A National Railway tunnel was noted 75m north north-west of the site orientated in a west to east direction. A number of additional National Railway tunnels, labelled as Primrose Hill Tunnels, were note 175m north north-west of the site orientated in a west to east direction. No other tunnels were noted within the site environs. No London Underground tunnels were noted within a 250m radius of the site. The site was considered to be not sufficiently close to underground transport services, in order for these to affect the property and there are no approved proposals for any TfL services in the vicinity that would affect the development.
- There are no records of historical bombs dropping on Elsworthy Terrace (Reference, The LCC London Bomb Damage Maps 1939-1945).

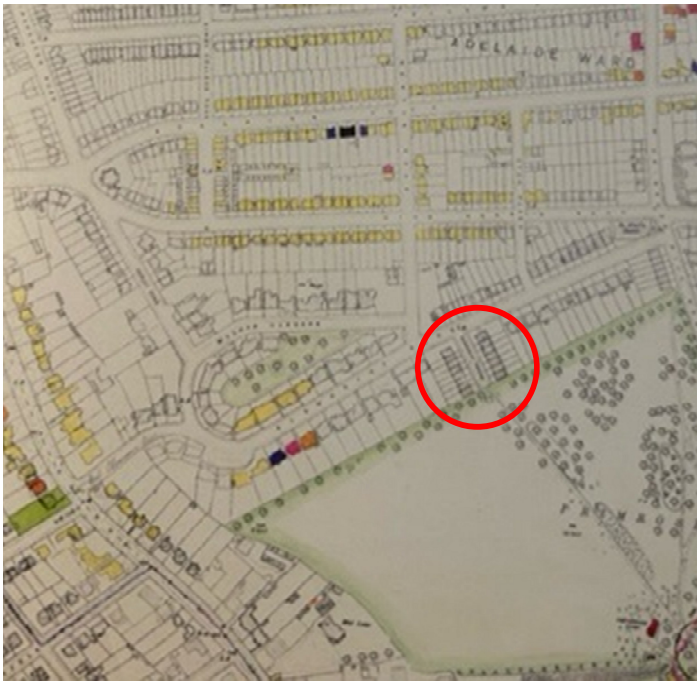


Figure 4 *Excerpt of The LCC London Bomb Damage Maps*

Please refer to the BIA completed by Ground and Water for a full desktop study & screening assessment in line with Camden's policy.

## 5.0 Existing Condition

A visual structural survey of the property has been completed by SDS Ltd. Some isolated areas of opening up have also been completed to compliment our understanding of the building's structure and its condition.

Broadly speaking the building is in fair condition. There are some isolated areas of cracking to the brickwork elevations – but we expect these can be repaired using crack stitching methods and do not appear to be severe enough to require rebuilding.

Based on some rudimentary measurements taken on site, and from the cracking patterns noted on the internal walls there does appear to have been some downwards movement at the front of the property. This is also reflected in the floor levels, which dip towards the front elevation.

It is not clear at this stage if this movement is progressive, nor is it clear what the cause is. However – the trial pits in the front garden show roots of up to 30mm, and the front elevation is within the zone of influence of the plane tree located on the pavement directly in front of the house. The soil report shows that the clay is dehydrated – and therefore we suspect that this movement may have been caused by the tree. In conjunction with the arboriculturist recommendations we are proposing a root barrier at the front of the property.

## 6.0 Proposed Alterations

The proposed works consist of extending the lower ground floor at the rear, replacing the lower ground floor throughout, extending the lightwell at the front, and lowering the vaults under the entrance stairs. Additionally the rear of the property is to be demolished at lower ground floor level to create an open plan space.

These works will require aspects of excavating and retaining.

A set of proposed structural scheme drawings detailing these aspects can be seen in Appendix A.

The main house is to have a full renovation throughout, with the superstructure largely retained and strengthened as required. The existing lower ground floor has a suspended timber floor construction which is proposed to be replaced with a new ground bearing concrete slab. Based on the trial pit information this new slab will not undermine the existing footings to the Party Walls and front elevation – and therefore no underpinning is proposed in association with these works.

L-shaped reinforced concrete retaining walls will form the Party Walls of the proposed extension at the lower ground floor level. These are proposed to be cast in a 5-stage underpinning sequence with a maximum width of 1m. We are proposing to rebuild the garden Party Walls – which are in a poor state of repair.

Vertical loads from the new extension's superstructure will be transferred to the ground via the proposed walls by the base of retaining walls.

The reinforced concrete retaining walls at the rear will be designed to cantilever, resisting the surcharge from the soil and water pressure.

Under the extension and garden area a suspended reinforced concrete slab will be constructed at lower ground floor level to provide permanent propping to the bases of the underpins. Cordek heav protection is proposed here to alleviate any heave from the London Clay associated with the removal of the over-burden.

A root barrier will be installed in the form of a concrete shear key to the new lightwell at the front.

The existing front vault is to be lowered by circa 1.2m with underpins proposed to the vault's walls.

The groundwater level will be monitored as part of the works however given the ground conditions are clay we do not anticipate excessive inflows of ground water in the excavations.

If groundwater is experienced during excavation, suitable control of any inflows would be achieved using sump pumping. If required, a detailed method statement for this process will need to be prepared by the Contractor for comment by all relevant parties including party wall surveyors and their engineers.

Trial pits have been undertaken as part of the investigations and no groundwater inflows have been observed. Trial underpins will be dug when the contractor first starts on site to confirm the stability of the soil and to further investigate the presence of any groundwater inflows.

## 7.0 Lower Ground Floor Waterproofing

The basement waterproofing will be the responsibility of the Contractor.

We assume that any reinforced concrete retaining walls and basement slabs will be cast using water resistant concrete to form an initial barrier with an internal drained cavity system as a primary barrier against possible water ingress. As part of the system, any water that seeps through will be collected and drained out into the main drainage system.

## 8.0 Party Wall Matters

The proposed works development falls within the scope of the Party Walls Act 1996. Procedures under the act will be dealt with in full by the Building Owner's Party Wall Surveyor. The Party Wall Surveyor will prepare and serve necessary notices under the provisions of the Act and agree Party Wall awards. The Contractor will be required to provide the Party Wall Surveyor with appropriate drawings, method statements and other relevant information covering the works that are notifiable under the Act. The resolution of matters under the Act and provisions of the Party Wall Awards will protect the interests of the owners.

The proposed works on the site of No.2 Elsworthy Terrace will be developed so as not to inhibit any works on the adjoining properties. This will be verified by the Surveyors as part of the process under the Act.

## 9.0 Hydrological Statement Summary

The site investigation indicates that ground water is not likely to be encountered during the excavation. Arup's Subterranean Development Scoping Study (para 5.1), June 2008, notes that the impact of subterranean development on groundwater flows is negligible as groundwater flows will find an alternative route if blocked by a subterranean structure.

A Basement Impact Assessment has been completed by Ground and Water Ltd dated November 2023 and this has found that the proposed development will not cause significant change to the hard surfaced area and due to impermeable underlying Clay the effect on the existing drainage system will be minimal – please refer to their report for the detailed assessment.

## 10.0 Impacts on Proposed Below Ground Drainage

A drainage CCTV survey has been completed to confirm the size and condition of the existing drainage prior to works commencing on site. It is proposed to maintain gravity connections at lower ground Floor level and above, where possible. It is assumed the new drainage for the lowered floor extension will be routed to a submersible pumping station which will pump waste directly to the outfalls. A non-return valve will be installed to protect against sewer surcharging. It is proposed that the rear of the property will house the pumping chambers for the foul surface/cavity water drainage.

A cavity drain system will be incorporated into the design to provide the second means of defence against water ingress. The waterproofing will be to a specialist design.

Thames Water Public Sewer Records will also be procured to ensure there are no Thames Water assets within the boundary of the property.

## 11.0 Ground Movement

The trial pits demonstrate that the neither the proposed foundations for the rear extension, nor the proposed slab formation level, nor the front lightwell are below the level of the existing building's footings. Further, the extent of soil proposed to be excavated is minimal. We therefore do not anticipate any significant ground movement to be triggered by these aspects of the works. This is reflected in the BIA reporting.

The foundations proposed to the Vaults at the front of the property extend below the existing footing level. Ground and Water report concludes due to the limited volume of soil proposed to be excavated below the vaults, the risk of ground movement being triggered is minimal, and the impact on surrounding walls utilities and structures is considered negligible.

Based on the above, and provided the works are carried out by a competent contractor and in accordance with our proposed design, then we consider it unlikely that any significant damage will occur to the property and adjacent properties.

If deemed necessary and in agreement through the Party Wall process ground movement monitoring system may also be installed to the neighbouring properties, No.1 Elsworthy Terrace in the area of the vaults with trigger values set to allow the works to be controlled appropriately in the event of ground movement occurring (as outlined in section 14.0).

With the implementation of these mitigation measures, any damage caused to the property and surrounding properties should be limited to within acceptable limits.

## 12.0 Conclusions

It is intended that the above measures and sequence of works are adopted for the eventual design and construction of the proposed works.

Detailed method statements and calculations for the enabling and temporary works will need to be prepared by the Contractor for comment by all relevant parties including Party Wall surveyors and their engineers. The Contractor will need to ensure that adequate supervision and monitoring is provided throughout the works particularly during the excavation and demolition stages. A specification and indication of monitoring requirements is given in Section 15.0.

To this end, SDS Ltd. will have an on-going role during the works on site to monitor that the works are being carried out generally in accordance with our design and specification. This role will typically involve fortnightly site visits during the main structural works. A written site report will be provided to the design team, Contractor and Party Wall Surveyor.

It is assumed that the above measures and sequence of works are taken into account in the eventual design and construction of the proposed works. If the works noted above are properly undertaken by suitably qualified contractors, these works should pose no significant threat to the structural stability of the house or the adjoining properties.

## 13.0 Construction Method Statement (to be read in conjunction with drawings in Appendix A)

Some of the issues that affect the sequence of works on this project are:

- The stability of the existing lower ground floor and main house structures;
- The stability of adjoining and adjacent buildings;
- Forming sensible access onto the site to minimise disruption to the neighbouring residents; and
- Providing a safe working environment.
- Providing protection to the nearby trees in accordance with specialist requirements

The undertaking of such projects to existing buildings is specialist work and SDS Ltd. will be involved in the selection of an appropriate Contractor with the relevant expertise and experience for this type of project.

The Contractor is entirely responsible for maintaining the stability of all existing buildings and structures, within and adjacent to the works, and of all the works from the date of possession of the site until practical completion of the works.

A full set of temporary works drawings and calculations will be provided by the Contractor and will be reviewed by SDS Ltd. prior to works starting on site.

Please refer to section 14.0 for noise, vibration and dust assessment with proposed associated mitigation methodologies.

**Stage 0 – Site Setup and Enabling Works**

- All incoming services to the property are to be located and marked. Their location and depths should be communicated to the design team.
- Schedules of conditions for the adjoining properties to be completed.
- If movement monitoring has been agreed as part of the Party Wall awards this should be installed and base readings taken.
- Soft Strip of the existing building.
- Install temporary hoarding and protection to the neighbouring properties.
- Install tree protection measures in accordance with specialist recommendations

**Stage 1 – Demolish Existing Terrace/Balcony including the slab and retaining walls around sunken area**

- The existing rear terrace/balcony should be carefully demolished prior to any underpinning works.
- The existing rear terrace slab and surrounding retaining walls should be carefully cut back to allow access for the new retaining walls works. Remove the existing drainage where necessary.

**Stage 2 – Demolish Existing Roof Coverings**

- The existing roof coverings are to be replaced with associated strengthening works to the timber carcass.

**Stage 3 – Demolish Existing Spine Wall Down to Ground Floor Level**

- The existing non-loadbearing spine wall should be carefully demolished down to ground floor level with associated frame installed to reinstate lost buttressing to Party Wall.

**Stage 4 – Install Underpins to Front Vault**

- The underpins will be completed to the vault at the front in three stages as full width strips. Refer to drawings in Appendix A and Stage 1 Underpins.
- Dig the underpins in maximum 1 metre sections in the agreed sequence, installing localised trench sheeting and props around the perimeter of the shaft as required.
- The reinforcement in the toe of the underpin can be tied and the toe cast.
- The reinforcement in the stem of the underpin can be tied, lapping with the reinforcement from the toe and the stem cast.
- Leave the underpin to cure for 3 days and then dry-pack to the underside of the wall above (where applicable) with 3:1 sharp sand to cement dry-pack well rammed in.
- The Contractor should wait a minimum of 48 hours after dry-packing before digging an adjacent underpin. Adjacent underpins should be dowelled together. An assumed sequence of underpinning is shown on the attached drawing however, the exact sequence of underpinning will be advised by the Contractor as it will relate to their sequence of construction.

**Stage 5 – Upper floors strengthening and levelling**

- The upper floors to be carefully strengthened and levelled.

- Install new floor joists at second floor level.
- Lateral restraint straps to be installed to all upper floors.

**Stage 6 – Prop and ply openings on rear elevation**

- All openings on the rear elevation to be propped and covered with ply.

**Stage 7 – Install temporary foundations**

- Cast all temporary footings which will serve as supports for the rear elevation props

**Stage 8– Needle Propping to Rear Elevation and Internal Walls**

- Needle prop the rear elevation with Mabey props supported on temporary footings cast below the formation level of the new slab.
- Needle prop the internal walls with Acro props supported on temporary footings cast below the formation level of the new slab.

**Stage 9 – Demolish Rear Elevation**

- The existing rear elevation should be carefully demolished from lower ground floor level to ground floor level.

**Stage 10 – Install Steelwork under Rear Elevation and Under Main House**

- Pour mass concrete strip footings under box frames internally and picture frame at the rear
- Install the steel box frame to support the rear elevation in the permanent case
- Base beams to be wrapped in D49 wrapping mesh and concrete encased with minimum 75mm cover all around.
- Install the steel beams and box frames at ground floor level to support the internal walls in the permanent case
- Dry pack and allow 48 hours to cure
- Remove temporary needles, and vertical props

**Stage 11 – Demolish Garden Walls**

- The existing garden walls should be carefully demolished.

**Stage 12 – Install New RC Retaining walls at the rear and under the garden walls**

- The retaining walls are to be formed in reinforced concrete in a 5 stage underpinning sequence.
- First stage pins will be excavated and shuttered as required retaining the central bund.
- The reinforcement in the toe of the underpin can be tied and the toe cast.
- The reinforcement in the stem of the retaining wall can be tied, lapping with the reinforcement from the toe and the stem cast.
- The second stage of pins are completed as above, and so on until the RC walls are complete.

**Stage 13 – Remove existing timber floor at lower ground floor**

- Remove the existing timber floor joists at lower ground floor level.

**Stage 14 – Cast the New Slab under Main House, Rear Extension and Garden Area**

- Install the new drainage including the surface water runs and pump sumps. The drainage should be tested prior to casting the slab.
- The Lower Ground Floor slab can be cast under the main house
- At the rear of the property the slab is to be poured in phased bays to ensure that adequate propping to the base of the pins is maintained.

**Stage 15 – Superstructure Works**

- Construct new extension from lower ground to ground floor level and complete internal works
- Install the new cavity drain system
- Complete the fit out

**Stage 16 – Install RC Walls to Front Lightwell**

- The existing lightwell should be carefully demolished. Remove existing drainage where necessary.
- The lightwell to be formed in reinforced concrete, in 1m sections in a staged sequence to ensure the soil in the front garden is retained (no battering back).
- The reinforcement in the toe, stem and root barrier to be tied up with the necessary laps.
- Concrete to be cast in an underpinning sequence.

**Stage 17 – Cast the New Slab in the lightwell area**

- Install the new drainage including the surface water runs and pump sumps. The drainage should be tested prior to casting the slab.
- The front lightwell's slab cast.

## 14.0 Noise, Vibration and Dust Mitigation

The Camden Planning Guidance: Basement dated January 2021 states that during the undertaking of any basement works it is necessary to provide a plan for management of noise, vibration, dust and waste to manage and mitigate the amenity of neighbouring residents during construction, as well as guide the use of the highway and minimise noise and air pollution."

The proposed works at No.2 Elsworthy Terrace consist of extending the rear of the property into the garden, this will require aspects of excavating and retaining with the extent to be determined on site. The rest of the property will undergo a full renovation. A new lightwell on an extended footprint to the existing one is proposed at the front of the property.

The construction works involve partial demolition of existing floor, underpinning beneath existing walls, as well as excavation and construction of the rear extension. A more detailed sequence of the works has been given in section 14.0. Those most likely to be affected by noise, dust and vibration will be the immediate neighbours at No.1 and No.3 Elsworthy Terrace. The properties opposite and behind No.2 Elsworthy Terrace are remote from the proposed development and are therefore less likely to be affected, however need to be considered. There may be some impact on other residents on Elsworthy Terrace due to the related construction traffic, but this should be minimal.

Below we have described the mitigation measures that are proposed to keep noise, dust and vibration to acceptable levels.

**Mitigation Measures for Demolition**

The breaking out of existing structures shall be carried out by diamond saw cutting and hydraulic bursting where possible to minimise noise and vibration to the adjacent properties. All demolition and excavation work will be undertaken in a carefully controlled sequence, taking into account the requirement to minimise vibration and noise. The contractor will need to utilise non-percussive breaking techniques where practicable.

As the property is a terraced property, careful consideration needs to be given to minimise noise and vibration transfer to the adjoining properties. The contractor should ensure that where any slab is adjacent to the boundary the concrete slab should be diamond saw cut first along the boundary to isolate the slab from any adjoining structures.

Dust suppression equipment should be used during the demolition process to ensure that any airborne dust is kept to a minimum. Where practical, concrete should also be wetted down prior to and during breakout to further inhibit airborne dust.

**Mitigation Measures for Underpinning works to Vault**

The underpin shafts will be excavated using hand tools where possible. At the base of the underpin shaft it may be found that compressed air tools are required due to the compaction of the ground. Care should be taken in selecting a suitable air compressor that keeps noise to a minimum. The air compressor should be located within the site and behind a hoarding to minimise noise transfer to the adjoining properties.

The spoil will be removed from the excavation using an electrically powered conveyor. The contractor will need to ensure that this is regularly serviced and inspected to ensure any noise from this is kept to a minimum. In order to minimise dust, skips and conveyors should be covered or completely enclosed to ensure that dust cannot escape.

**Mitigation Measures for Excavation**

It is likely that the bulk excavation will be completed by hand. The contractor should ensure that any mechanical plant is switched off when not in use and is subject to regular maintenance checks and servicing. An electrically powered conveyor will be used as detailed above for large volumes of spoil removed.

**Mitigation Measures for the Reinforced Retaining Walls**

The contractor should ensure that any concrete pours are completed within the permitted hours for noise generating works. The contractor should allow for a contingency period to ensure that concrete pours can be completed within these hours regardless of unforeseen circumstances such as batching plant delays and traffic congestion.

The fabrication and cutting of steelwork for the reinforced concrete retaining wall and slabs shall take place off site. If any rebar needs to be trimmed on site this should be completed using hydraulic or pneumatic tools instead of angle grinders.

**Dust Control**

In order to reduce the amount of dust generated from the site, the contractor should ensure that any cutting, grinding and sawing should be completed off site where practicable. If cutting, grinding and sawing is being carried out on site, surfaces are to be wetted down prior to and during these types of work whenever possible. Any equipment used on site should be fitted with dust suppression or a dust collection facility.

The contractor will be responsible for ensuring good practice with regards to dust and should adopt regular sweeping, cleaning and washing down of the hoardings and scaffolding to ensure that the site is kept within good order. The Contractor selected will be a member of the Considerate Constructors Scheme. Contact details of the contractor who will be responsible for containing dust and emissions within the site will be displayed on the site boundary so that the local residents can contact the contractor to raise any concerns regarding noise and dust.

The building will be enclosed within suitable scaffold sheeting and any stockpiles of sand or dust-generating materials will be covered. Cement, fine aggregates, sand and other fine powders should be sealed after use.

## 15.0 Structural Monitoring Proposals

Monitoring and limits on ground movements during excavation and construction

The Contractor shall provide monitoring in line with the agreements made in the Party Wall agreements.

Monitoring shall be completed as follows:

1) One month prior to any works being started to provide a base reading.

2) Weekly readings during the excavation and until the basement slab and lining wall has been cast.

3) On a monthly basis thereafter for a three-month period following completion of the notifiable works.

Cumulative movement of survey points must not exceed:

a). Settlement

Code amber trigger values: +/-5mm

Code red trigger values: +/-10mm

b). Lateral displacement

Code amber trigger values: +/-5mm

Code red trigger values: +/-10mm

Movement approaching critical values:

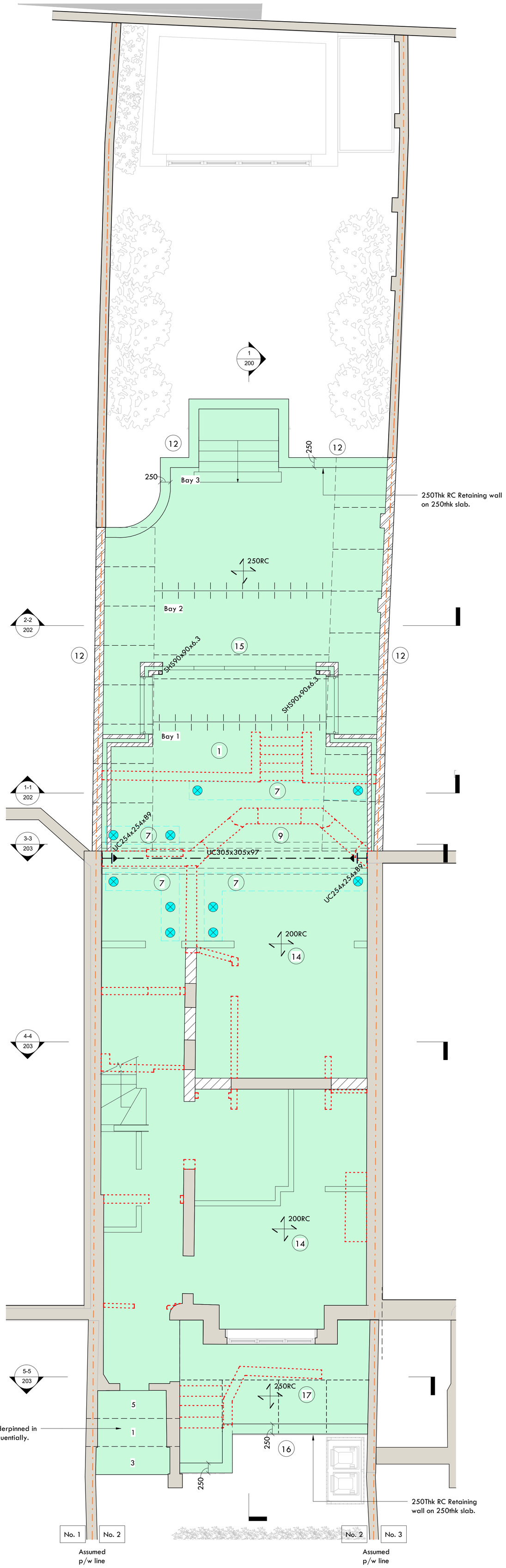
Code amber trigger value:

All interested parties, including the Adjoining Owner's Surveyor and their Engineer should be informed and further actions immediately agreed between two of the three Surveyors and implemented by the Building Owner. The Contractor is to ensure that he has 24 hour/7 days a week access to emergency support provision including but not limited to additional temporary props, needles, waling beams and concrete supply at the start of the excavation and prior to any likelihood of this trigger value being reached. If this value is reached the Contractor must without delay provide all interested parties with their plan to implement any emergency remedial and supporting works deemed necessary. The Contractor must be ready to carry out these works without delay if the movement continues and approaches the trigger value above.

Code red trigger value:

All interested parties including Adjoining Owner's Surveyor and Engineer will be informed immediately. Works will stop and be made safe using methods and equipment agreed at the above stage. The Contractor is to ensure that the movement has stopped as a result of the implemented remedial works designed and installed at this stage. The requirements of the Party Wall Act will also ensure that two of the three Surveyors and their advising Engineers shall then enter into an addendum Award, setting out whether or not the Building Owner's works can re-commence and when, and if so agree additional precautions or modifications to the proposals prior to re-commencement.

**APPENDIX A – Proposed Structural Scheme Drawings**




## Drawing Notes:

1. These drawings are not to be used for setting out purposes. Refer to the latest Architects information and site measure as required.
2. Contact Structural Design Studio Ltd in the event of any discrepancies between findings on site and these drawings.
3. Drawing is to be read in conjunction with the Structural Design Studio Ltd Specification and General Notes.
4. 3D views are indicative only and any conflicting 2D information should take precedence. If in doubt contact Structural Design Studio Ltd prior to starting work

**INFORMATION RECEIVED:**
This drawing has been developed using information received up to and including
Where information provided to us is incomplete or subject to change, our drawings will need to be updated accordingly.

## TEMP WORKS LEGEND

- Denotes existing structure
- Denotes structure to be demolished
- Denotes Temporary works beams by others.
- Denotes indicative Temporary works props by others.
- Denotes Temporary works foundations by others.

## SEQUENCE

1. Demolish External Terrace
2. Demolish Roof and Mansard
3. Demolish spine wall to Ground Floor
4. Install RC underpins to front vault
5. Strengthen Floors and straps
6. Prop and ply openings on rear elevation
7. Install temporary works foundations
8. Install needle propping to rear elevation. Layout shown for example and to be designed by temporary works contractor.
9. Demolish rear elevation from lower ground to ground floor level
10. Install Steelwork under Rear Elevation
11. Demolish Garden walls
12. Install New RC Retaining walls at the rear and under the garden walls in a 5 stage underpinning squence
13. Remove existing timber floor at lower ground floor
14. Cast the new slab at lower ground floor level, rear extension and garden area.
15. Superstructure structural works
16. Install RC Wall and root barrier to Front Lightwell
17. Cast the New Slab in the front lightwell

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| P01 | Issued for Tender | NYI | CN | TB |
| Rev | Amendment | Date | Drawn | Eng |


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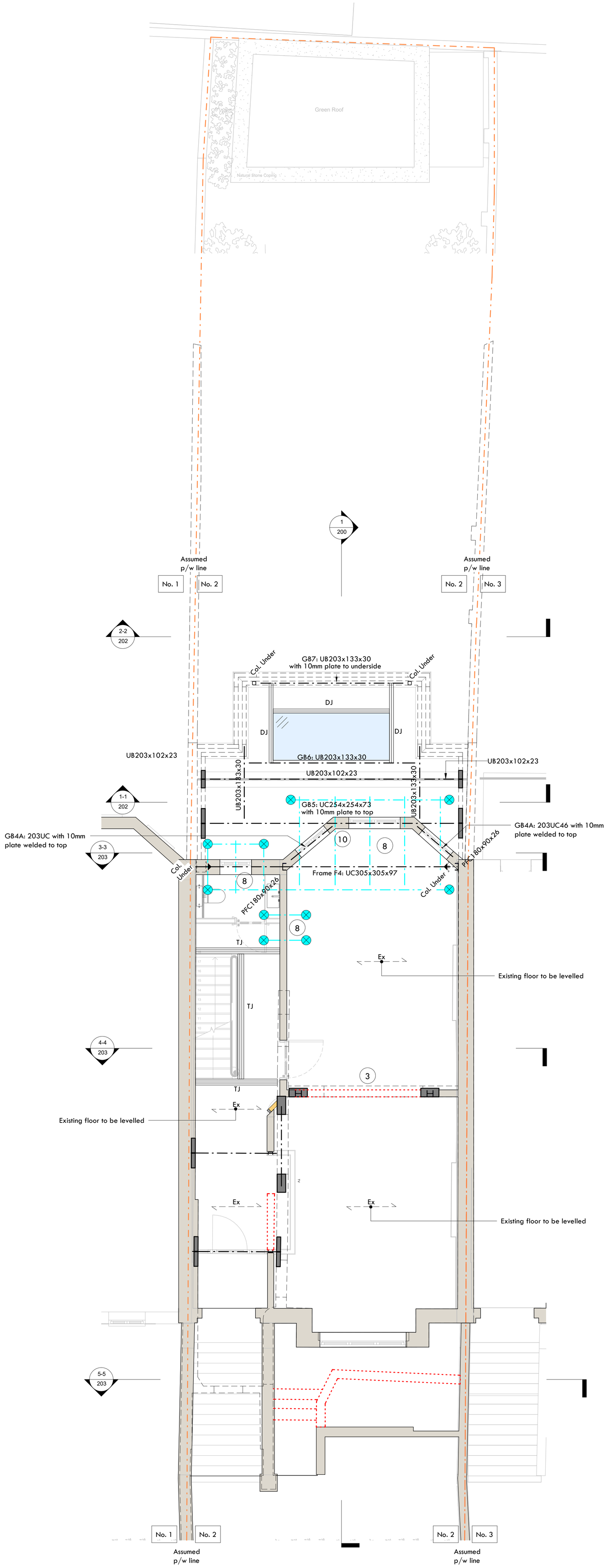
**PRELIMINARY**

| | | |
|---|---|---|
| Client: | | Date: NOV 2023 |
| Project Name: **2 Elsworthy Terrace, N3 3DR** | | Eng: TB / Drawn: CN |
| | | Scale: 1:50 @A1 |
| Drawing title: **Lower Ground Floor Plan** | | |
| Project Number: **223176** | Drawing Number: **S- 700** | Rev: **P01** |

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**INFORMATION RECEIVED:**
This drawing has been developed using information received up to and including
Where information provided to us is incomplete or subject to change, our drawings will need to be updated accordingly.

## TEMP WORKS LEGEND

- Denotes existing structure
- Denotes structure to be demolished
- Denotes Temporary works beams by others.
- Denotes indicative Temporary works props by others.
- Denotes Temporary works foundations by others.

## SEQUENCE

1. Demolish External Terrace
2. Demolish Roof and Mansard
3. Demolish spine wall to Ground Floor
4. Install RC underpins to front vault
5. Strengthen Floors and straps
6. Prop and ply openings on rear elevation
7. Install temporary works foundations
8. Install needle propping to rear elevation. Layout shown for example and to be designed by temporary works contractor.
9. Demolish rear elevation from lower ground to ground floor level
10. Install Steelwork under Rear Elevation
11. Demolish Garden walls
12. Install New RC Retaining walls at the rear and under the garden walls in a 5 stage underpinning squence
13. Remove existing timber floor at lower ground floor
14. Cast the new slab at lower ground floor level, rear extension and garden area.
15. Superstructure structural works
16. Install RC Wall and root barrier to Front Lightwell
17. Cast the New Slab in the front lightwell

| | | | | |
|---|---|---|---|---|
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**PRELIMINARY**

Client:

Date: NOV 2023

Project Name: **2 Elsworthy Terrace, N3 3DR**

Eng: TB | Drawn: CN

Scale: 1:50 @A1

Drawing title: **Ground Floor Plan**

| Project Number | Drawing Number | Rev |
|---|---|---|
| 223176 | S- 701 | P01 |

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## TEMP WORKS LEGEND

- Denotes existing structure
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- Denotes Temporary works beams by others.
- Denotes indicative Temporary works props by others.
- Denotes Temporary works foundations by others.

## SEQUENCE

1. Demolish External Terrace
2. Demolish Roof and Mansard
3. Demolish spine wall to Ground Floor
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6. Prop and ply openings on rear elevation
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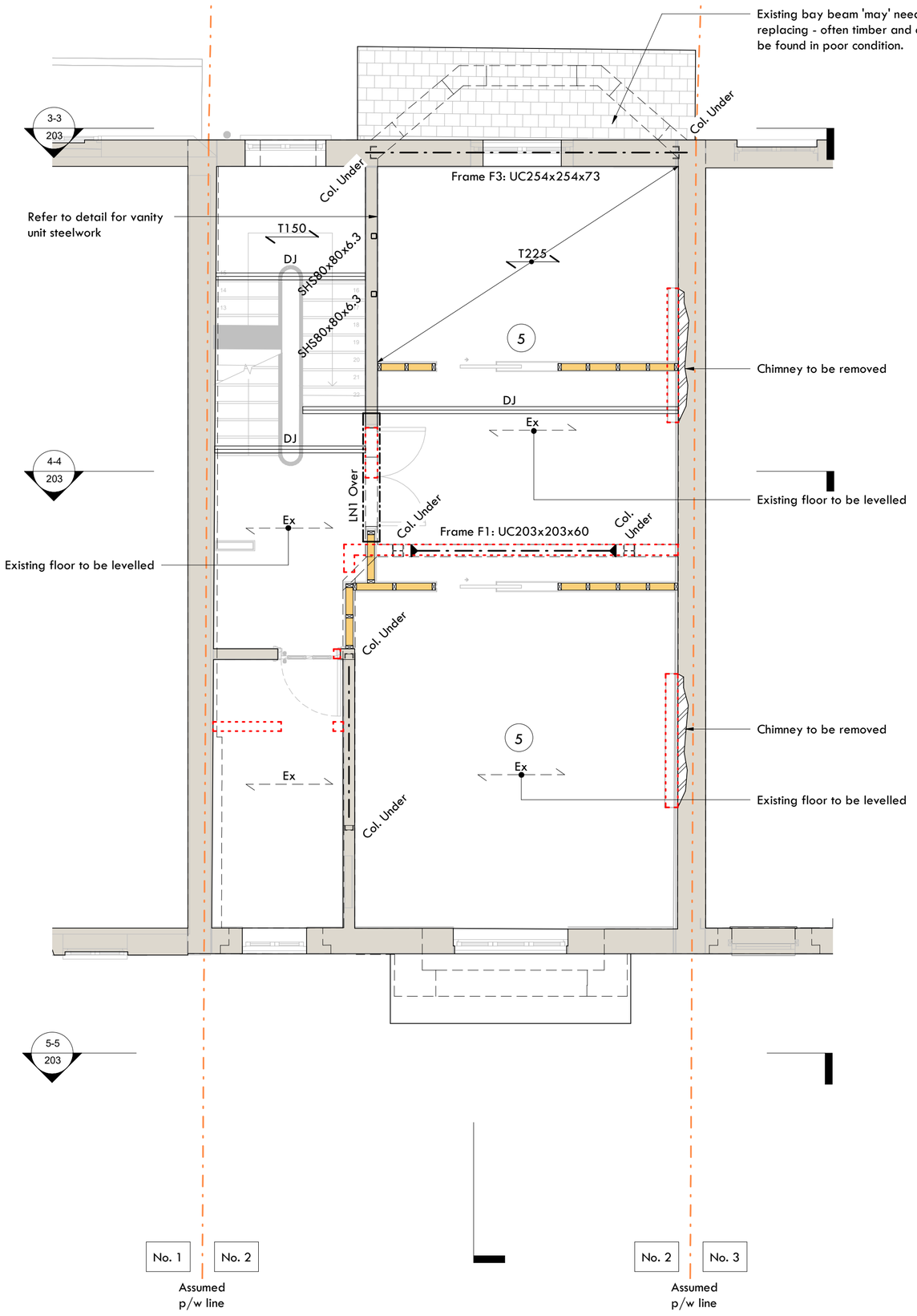
16. Install RC Wall and root barrier to Front Lightwell
17. Cast the New Slab in the front lightwell

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**PRELIMINARY**

Client:

Date: NOV 2023

Project Name: **2 Elsworthy Terrace, N3 3DR**

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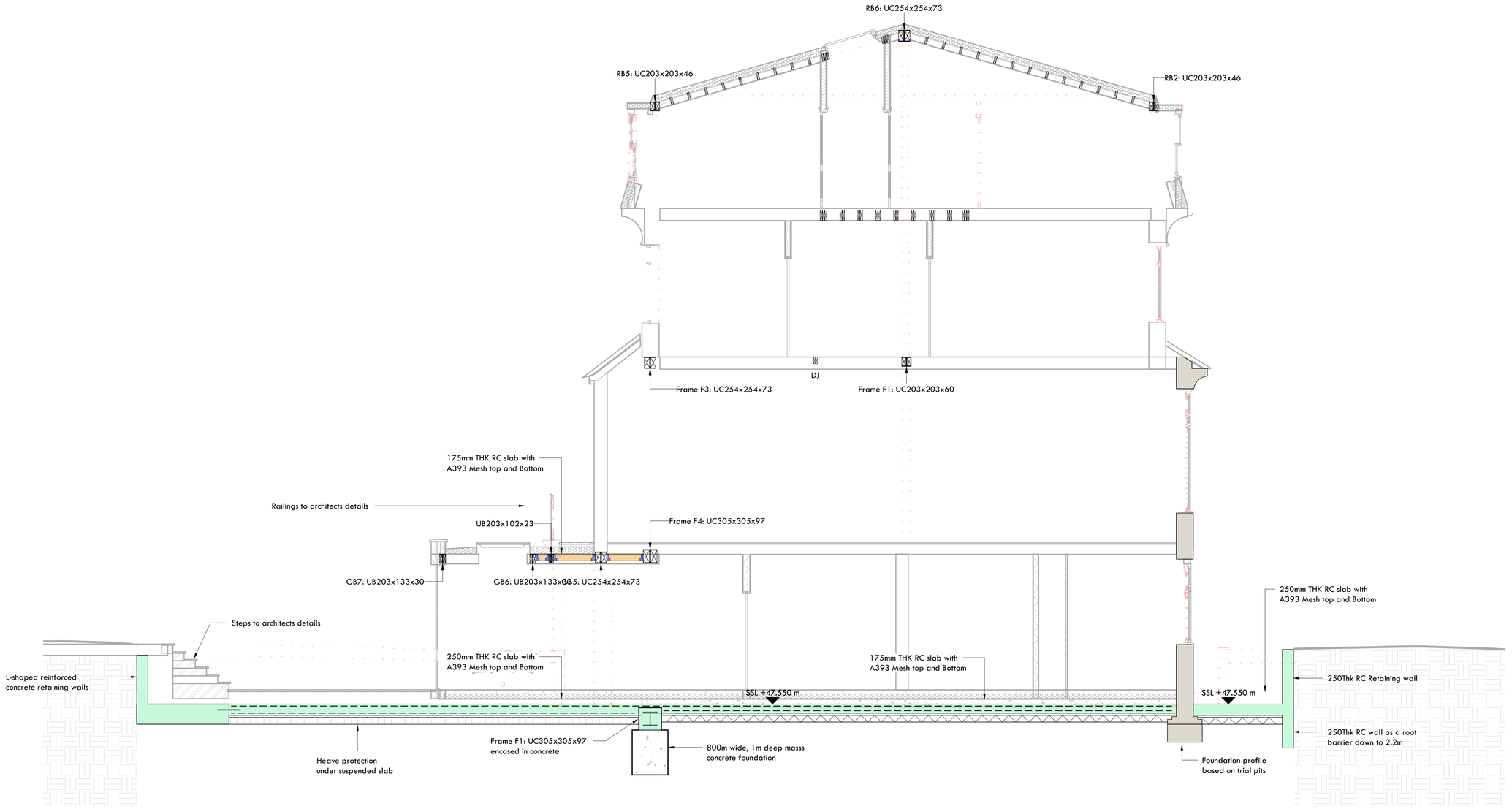
Scale: 1:50 @A1

Drawing title: **First Floor Plan**

| Project Number | Drawing Number | Rev |
|---|---|---|
| **223176** | **S- 702** | **P01** |




## Section A-A

Scale 1 : 50

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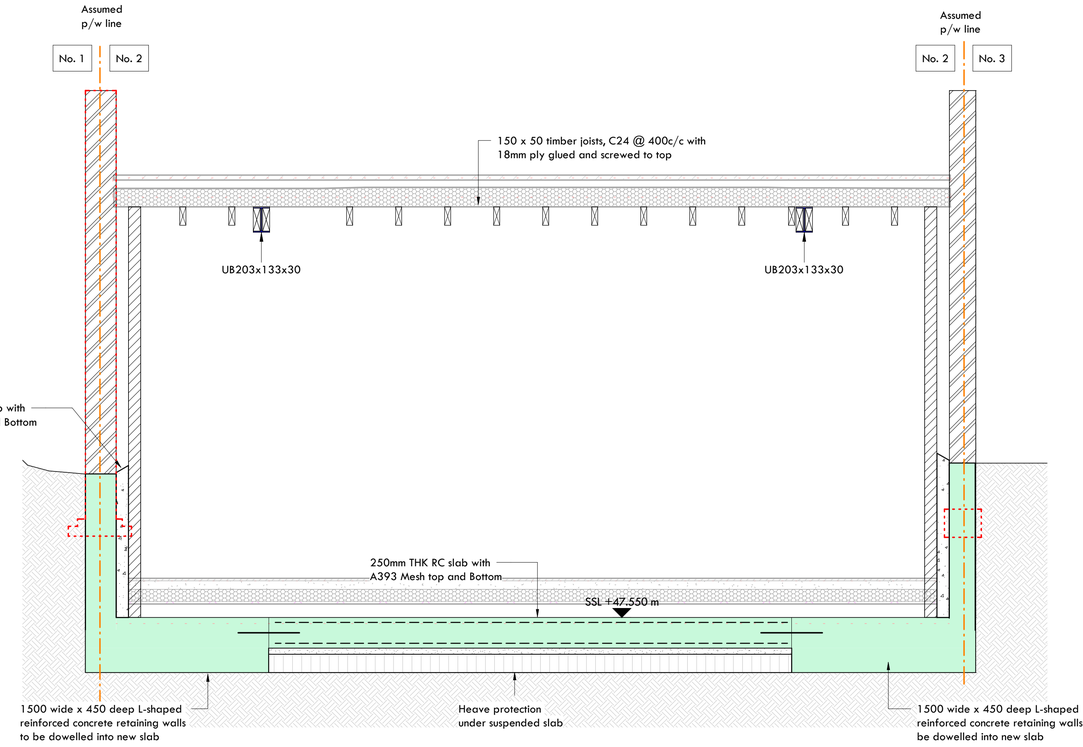
**PRELIMINARY**

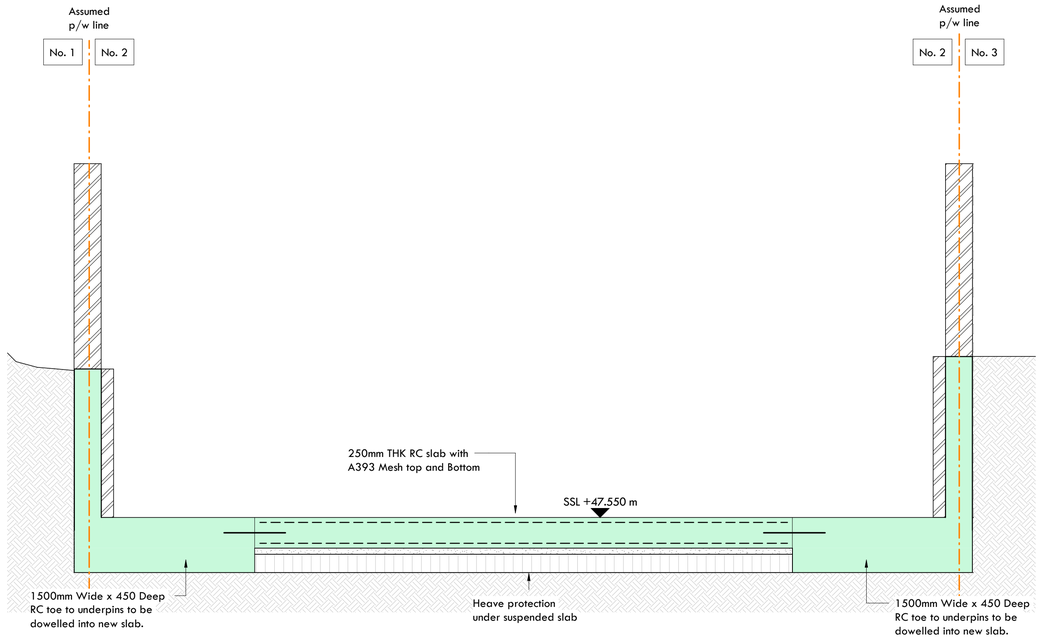
| | |
|---|---|
| Client: | Date: OCT 2023 |
| Project Name: **2 Elsworthy Terrace, N3 3DR** | Eng: TB / Drawn: CN |
| | Scale: 1:50 @A1 |
| Drawing title: **Building Section A-A** | |

| Project Number | Drawing Number | Rev |
|---|---|---|
| **223176** | **S- 200** | **P01** |




## Proposed Extension Section 1-1

Scale 1 : 25




## Proposed Extension Section 2-2

Scale 1 : 25

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Client:

Date: OCT 2023

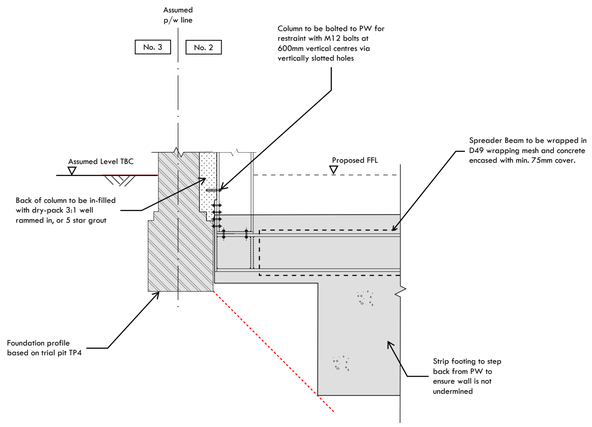
Project Name: **2 Elsworthy Terrace, N3 3DR**

Eng: TB | Drawn: CN

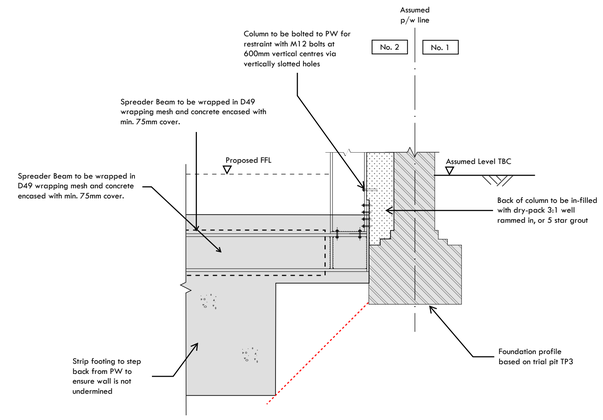
Scale: 1:25 @A1

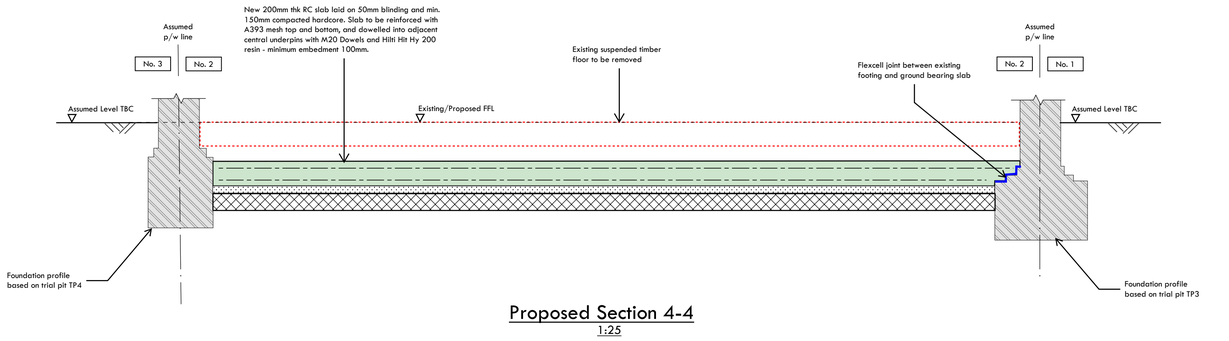
Drawing title: **Proposed Extension Sections**

| Project Number | Drawing Number | Rev |
|---|---|---|
| **223176** | **S- 202** | **P01** |

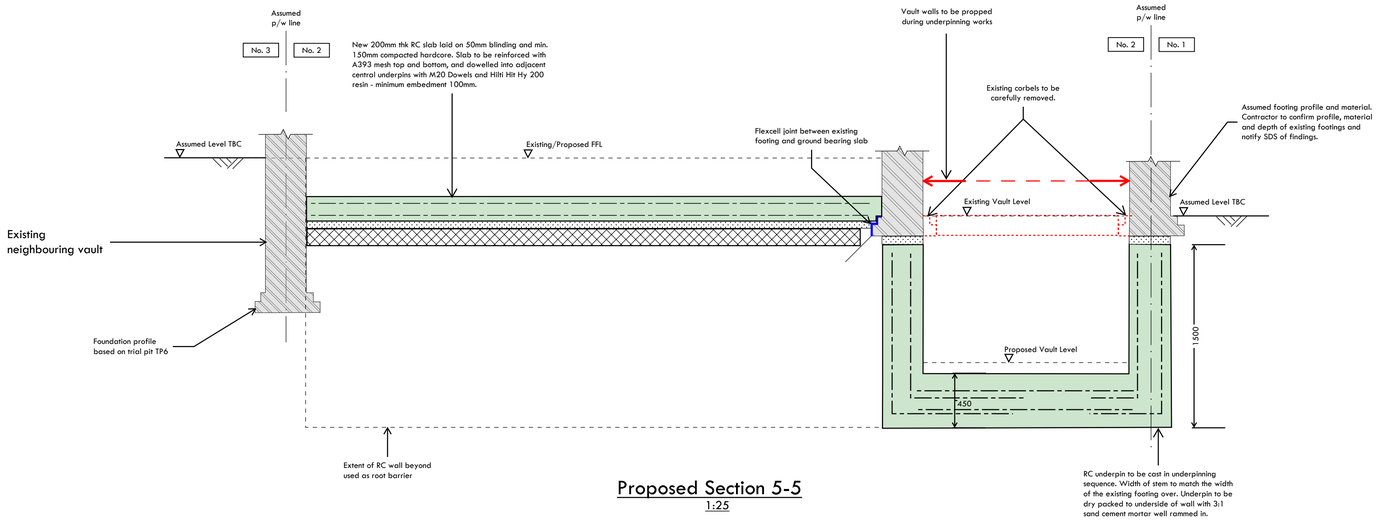



## Proposed Section 3-3
1:25




## Proposed Section 4-4
1:25




## Proposed Section 5-5
1:25

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| Project Name: **2 Elsworthy Terrace, N3 3DR** | Eng: TB / Drawn: CN |
| | Scale: 1:25 @A1 |
| Drawing title: **Proposed Sections** | |

| Rev | Amendment | Date | Drawn | Eng |
|---|---|---|---|---|
| P01 | Issued for Tender | NYI | CN | TB |

| Project Number | Drawing Number | Rev |
|---|---|---|
| **223176** | **S- 203** | **P01** |

## APPENDIX B – Retaining Wall Calculations

## 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 2.9.19

### Retaining wall details

| | | | |
|---|---|---|---|
| Stem type | Cantilever | | |
| Stem height | $h_{stem}$ = **1600** mm | | |
| Stem thickness | $t_{stem}$ = **200** mm | | |
| Angle to rear face of stem | $\alpha$ = **90** deg | | |
| Stem density | $\gamma_{stem}$ = **25** kN/m$^3$ | | |
| Toe length | $l_{toe}$ = **1300** mm | | |
| Base thickness | $t_{base}$ = **450** mm | | |
| Base density | $\gamma_{base}$ = **25** kN/m$^3$ | | |
| Height of retained soil | $h_{ret}$ = **1600** mm | Angle of soil surface | $\beta$ = **0** deg |
| Depth of cover | $d_{cover}$ = **0** mm | | |
| Height of water | $h_{water}$ = **1600** mm | | |
| Water density | $\gamma_w$ = **9.8** kN/m$^3$ | | |

### Retained soil properties

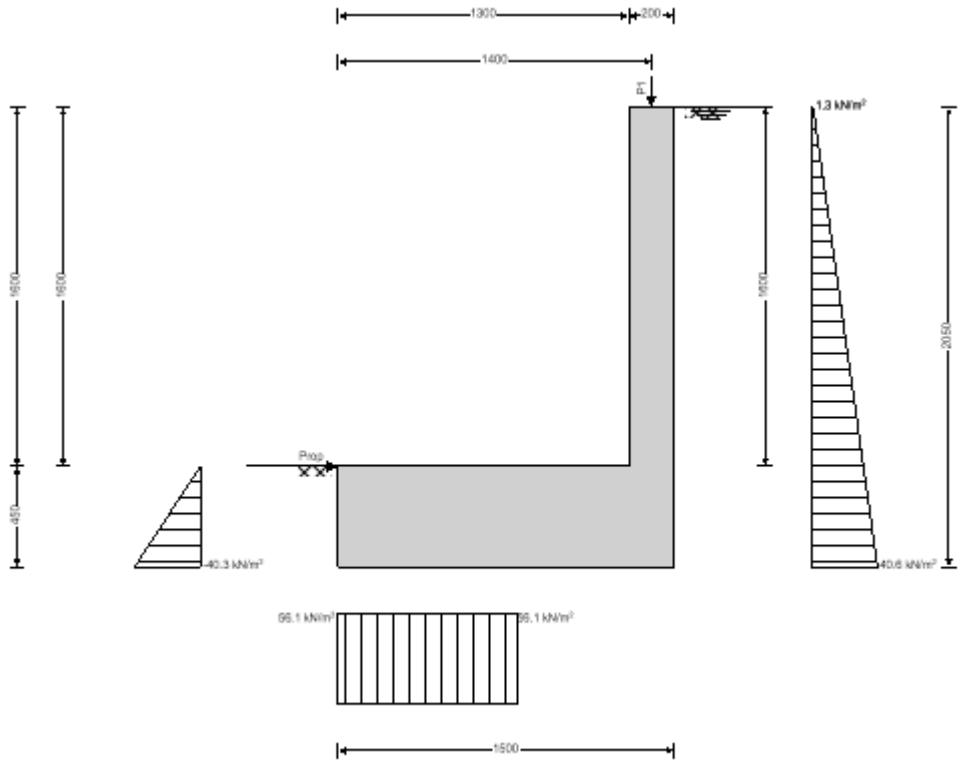
| | |
|---|---|
| Soil type | Medium dense well graded sand |
| Moist density | $\gamma_{mr}$ = **21** kN/m$^3$ |
| Saturated density | $\gamma_{sr}$ = **23** kN/m$^3$ |

### Base soil properties

| | |
|---|---|
| Soil type | Medium dense well graded sand |
| Soil density | $\gamma_b$ = **18** kN/m$^3$ |

### Loading details

| | |
|---|---|
| Variable surcharge load | Surcharge$_Q$ = **2.5** kN/m$^2$ |
| Vertical line load at 1400 mm | $P_{G1}$ = **8.5** kN/m |




General arrangement - sketch pressures relate to bearing check

**Calculate retaining wall geometry**

| | | | |
|---|---|---|---|
| Base length | $l_{base}$ = **1500** mm | | |
| Saturated soil height | $h_{sat}$ = **1600** mm | | |
| Moist soil height | $h_{moist}$ = **0** mm | | |
| Length of surcharge load | $l_{sur}$ = **0** mm | | |
| Vertical distance | $x_{sur\_v}$ = **1500** mm | | |
| Effective height of wall | $h_{eff}$ = **2050** mm | | |
| Horizontal distance | $x_{sur\_h}$ = **1025** mm | | |
| Area of wall stem | $A_{stem}$ = **0.32** m² | Vertical distance | $x_{stem}$ = **1400** mm |
| Area of wall base | $A_{base}$ = **0.675** m² | Vertical distance | $x_{base}$ = **750** mm |

**Design approach 1**

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

| | | | |
|---|---|---|---|
| Partial factor set | A1 | | |
| Permanent unfavourable action | $\gamma_G$ = **1.35** | Permanent favourable action | $\gamma_{Gf}$ = **1.00** |
| Variable unfavourable action | $\gamma_Q$ = **1.50** | Variable favourable action | $\gamma_{Qf}$ = **0.00** |

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

| | | | |
|---|---|---|---|
| Soil parameter set | M1 | | |
| Angle of shearing resistance | $\gamma_{\phi'}$ = **1.00** | Effective cohesion | $\gamma_{c'}$ = **1.00** |
| Weight density | $\gamma_\gamma$ = **1.00** | | |

**Retained soil properties**

Design moist density $\gamma_{mr}' = \mathbf{21}$ kN/m$^3$ — Design saturated density $\gamma_{sr}' = \mathbf{23}$ kN/m$^3$

**Base soil properties**

Design soil density $\gamma_b' = \mathbf{18}$ kN/m$^3$

**Soil coefficients**

Coeff.friction to back of wall $K_{fr} = \mathbf{0.325}$

Coeff.friction to front of wall $K_{fb} = \mathbf{0.325}$ — Coeff.friction beneath base $K_{fbb} = \mathbf{0.325}$

Active pressure coefficient $K_A = \mathbf{0.333}$ — Passive pressure coefficient $K_P = \mathbf{4.977}$

**Overturning check**

**Vertical forces on wall**

Total $F_{total\_v} = F_{stem} + F_{base} + F_{P\_v} + F_{water\_v} - F_{water\_u} = \mathbf{33.4}$ kN/m

**Horizontal forces on wall**

Total $F_{total\_h} = F_{sur\_h} + F_{sat\_h} + F_{water\_h} + F_{moist\_h} + F_{exc\_h} = \mathbf{33.8}$ kN/m

**Overturning moments on wall**

Total $M_{total\_OT} = M_{sur\_OT} + M_{sat\_OT} + M_{water\_OT} + M_{moist\_OT} = \mathbf{30.2}$ kNm/m

**Restoring moments on wall**

Total $M_{total\_R} = M_{stem\_R} + M_{base\_R} + M_{P\_R} = \mathbf{35.8}$ kNm/m

**Check stability against overturning**

Factor of safety $FoS_{ot} = \mathbf{1.185}$

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

**Bearing pressure check**

**Vertical forces on wall**

Total $F_{total\_v} = F_{stem} + F_{base} + F_{P\_v} + F_{water\_v} = \mathbf{45.1}$ kN/m

**Horizontal forces on wall**

Total $F_{total\_h} = F_{sur\_h} + F_{sat\_h} + F_{water\_h} + F_{moist\_h} + F_{pass\_h} = \mathbf{33.8}$ kN/m

**Moments on wall**

Total $M_{total} = M_{stem} + M_{base} + M_{sur} + M_P + M_{sat} + M_{water} + M_{moist} = \mathbf{18.1}$ kNm/m

**Check bearing pressure**

Propping force $F_{prop\_base} = \mathbf{33.8}$ kN/m

Bearing pressure at toe $q_{toe} = \mathbf{56.1}$ kN/m$^2$ — Bearing pressure at heel $q_{heel} = \mathbf{0}$ kN/m$^2$

Factor of safety $FoS_{bp} = \mathbf{1.249}$

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

**Design approach 1**

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

Partial factor set A2

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

Variable unfavourable action $\gamma_Q = \mathbf{1.30}$ — Variable favourable action $\gamma_{Qf} = \mathbf{0.00}$

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

Soil parameter set M2

Angle of shearing resistance $\gamma_{\phi'} = \mathbf{1.25}$ — Effective cohesion $\gamma_{c'} = \mathbf{1.25}$

Weight density $\gamma_\gamma = \mathbf{1.00}$

**Retained soil properties**

Design moist density $\gamma_{mr}' = \mathbf{21}$ kN/m$^3$ — Design saturated density $\gamma_{sr}' = \mathbf{23}$ kN/m$^3$

**Base soil properties**

Design soil density $\gamma_b' = \mathbf{18}$ kN/m$^3$

**Soil coefficients**

Coeff.friction to back of wall $K_{fr} = \mathbf{0.325}$

Coeff.friction to front of wall $K_{fb} = \mathbf{0.325}$ — Coeff.friction beneath base $K_{fbb} = \mathbf{0.325}$

Active pressure coefficient $K_A = \mathbf{0.333}$ — Passive pressure coefficient $K_P = \mathbf{4.977}$

**Overturning check**

**Vertical forces on wall**

Total $F_{total\_v} = F_{stem} + F_{base} + F_{P\_v} + F_{water\_v} - F_{water\_u} = \mathbf{33.4}$ kN/m

**Horizontal forces on wall**

Total $F_{total\_h} = F_{sur\_h} + F_{sat\_h} + F_{water\_h} + F_{moist\_h} + F_{exc\_h} = \mathbf{23}$ kN/m

**Overturning moments on wall**

Total $M_{total\_OT} = M_{sur\_OT} + M_{sat\_OT} + M_{water\_OT} + M_{moist\_OT} = \mathbf{22.7}$ kNm/m

**Restoring moments on wall**

Total $M_{total\_R} = M_{stem\_R} + M_{base\_R} + M_{P\_R} = \mathbf{35.8}$ kNm/m

**Check stability against overturning**

Factor of safety $FoS_{ot} = \mathbf{1.577}$

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

**Bearing pressure check**

**Vertical forces on wall**

Total $F_{total\_v} = F_{stem} + F_{base} + F_{P\_v} + F_{water\_v} = \mathbf{33.4}$ kN/m

**Horizontal forces on wall**

Total $F_{total\_h} = F_{sur\_h} + F_{sat\_h} + F_{water\_h} + F_{moist\_h} + F_{pass\_h} = \mathbf{23}$ kN/m

**Moments on wall**

Total $M_{total} = M_{stem} + M_{base} + M_{sur} + M_P + M_{sat} + M_{water} + M_{moist} = \mathbf{13.1}$ kNm/m

**Check bearing pressure**

Propping force $F_{prop\_base} = \mathbf{23}$ kN/m

Bearing pressure at toe $q_{toe} = \mathbf{42.6}$ kN/m$^2$ — Bearing pressure at heel $q_{heel} = \mathbf{0}$ kN/m$^2$

Factor of safety $FoS_{bp} = \mathbf{1.644}$

*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 2.9.19

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

Concrete strength class C30/37

Char.comp.cylinder strength $f_{ck} = \mathbf{30}$ N/mm$^2$ — Mean axial tensile strength $f_{ctm} = \mathbf{2.9}$ N/mm$^2$

Secant modulus of elasticity $E_{cm} = \mathbf{32837}$ N/mm$^2$ — Maximum aggregate size $h_{agg} = \mathbf{20}$ mm

Design comp.concrete strength $f_{cd} = \mathbf{17.0}$ N/mm$^2$ — Partial factor $\gamma_C = \mathbf{1.50}$

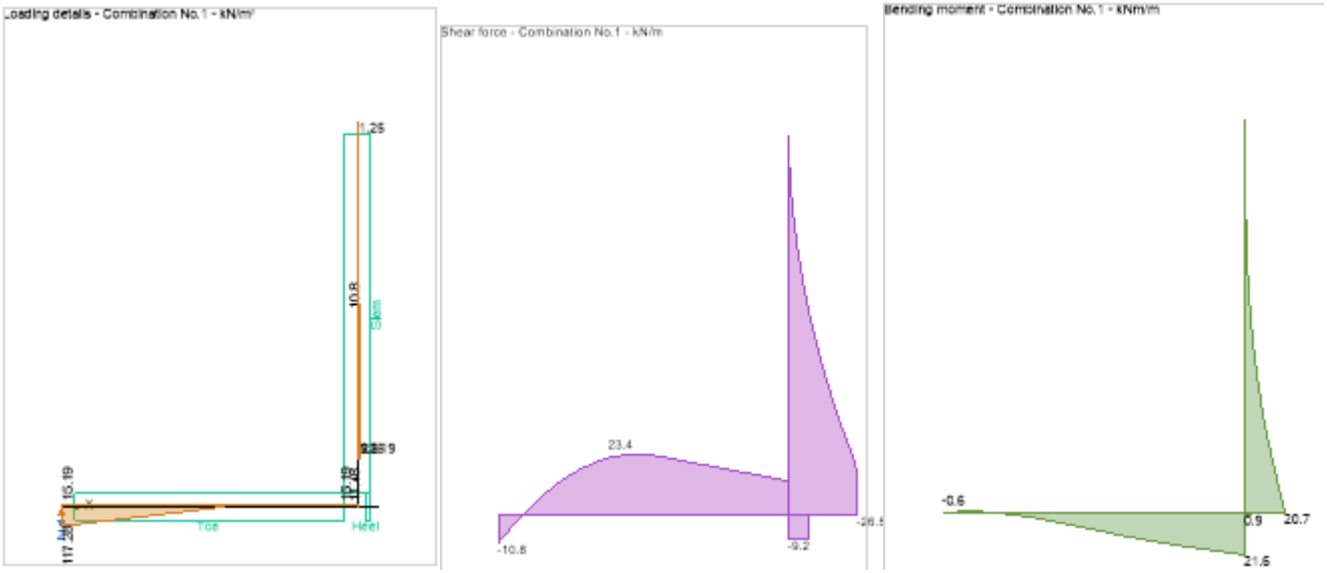
**Reinforcement details**

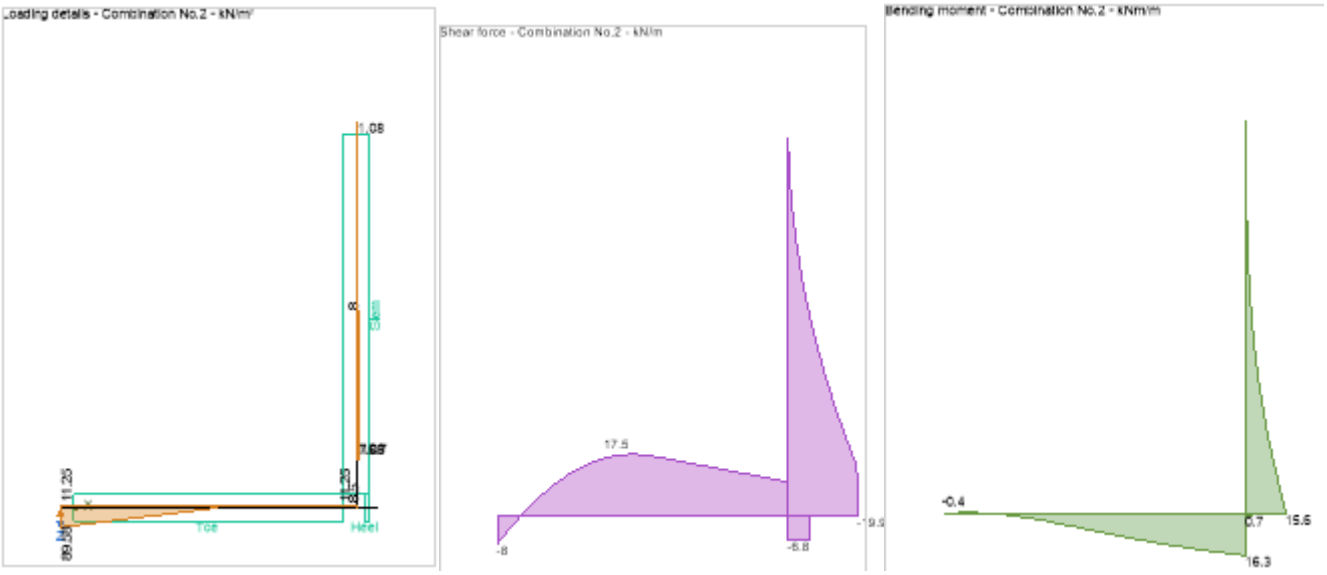
Characteristic yield strength $f_{yk} = \mathbf{500}$ N/mm$^2$ — Modulus of elasticity $E_s = \mathbf{200000}$ N/mm$^2$

| | | | |
|---|---|---|---|
| Design yield strength | $f_{yd}$ = **435** N/mm² | Partial factor | $\gamma_S$ = **1.15** |

**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 = **200** mm

**Rectangular section in flexure - Section 6.1**

| | | | |
|---|---|---|---|
| Design bending moment | M = **14.7** kNm/m | K = **0.023** | K' = **0.207** |

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

| | | | |
|---|---|---|---|
| Tens.reinforcement required | $A_{sr.req}$ = **245** mm²/m | | |
| Tens.reinforcement provided | 10 dia.bars @ 200 c/c | Tens.reinforcement provided | $A_{sr.prov}$ = **393** mm²/m |
| Min.area of reinforcement | $A_{sr.min}$ = **218** mm²/m | Max.area of reinforcement | $A_{sr.max}$ = **8000** mm²/m |

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

Library item: Rectangular single summary

**Deflection control - Section 7.4**

Limiting span to depth ratio 16 Actual span to depth ratio 11

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

**Crack control - Section 7.3**

Limiting crack width $w_{max}$ = **0.3** mm Maximum crack width $w_k$ = **0.248** mm

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

**Rectangular section in shear - Section 6.2**

Design shear force V = **26.5** kN/m

**Rectangular section in shear - Section 6.2**

Design shear force V = **26.5** kN/m Design shear resistance $V_{Rd.c}$ = **78.6** kN/m

*PASS - Design shear resistance exceeds design shear force*

**Horizontal reinforcement parallel to face of stem - Section 9.6**

Min.area of reinforcement $A_{sx.req}$ = **200** mm²/m Max.spacing of reinforcement $s_{sx\_max}$ = **400** mm

Trans.reinforcement provided 10 dia.bars @ 200 c/c Trans.reinforcement provided $A_{sx.prov}$ = **393** mm²/m

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

**Check base design at toe**

Depth of section h = **450** mm

**Rectangular section in flexure - Section 6.1**

Design bending moment M = **20.2** kNm/m K = **0.005** K' = **0.207**

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

Tens.reinforcement required $A_{bb.req}$ = **133** mm²/m

Tens.reinforcement provided 12 dia.bars @ 200 c/c Tens.reinforcement provided $A_{bb.prov}$ = **565** mm²/m

Min.area of reinforcement $A_{bb.min}$ = **556** mm²/m Max.area of reinforcement $A_{bb.max}$ = **18000** mm²/m

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

Library item: Rectangular single summary

**Crack control - Section 7.3**

Limiting crack width $w_{max}$ = **0.3** mm Maximum crack width $w_k$ = **0.16** mm

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

**Rectangular section in shear - Section 6.2**

Design shear force V = **14.6** kN/m

**Rectangular section in shear - Section 6.2**

Design shear force V = **14.6** kN/m Design shear resistance $V_{Rd.c}$ = **161.8** kN/m

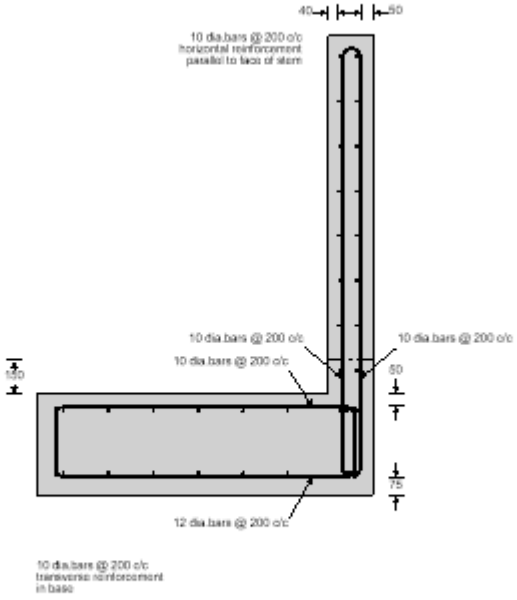
*PASS - Design shear resistance exceeds design shear force*

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

Min.area of reinforcement $A_{bx.req}$ = **113** mm²/m Max.spacing of reinforcement $s_{bx\_max}$ = **450** mm

Trans.reinforcement provided 10 dia.bars @ 200 c/c Trans.reinforcement provided $A_{bx.prov}$ = **393** mm²/m

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




**Reinforcement details**

## 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 2.9.19

### Retaining wall details

| | | | |
|---|---|---|---|
| Stem type | Cantilever | | |
| Stem height | $h_{stem}$ = **1600** mm | | |
| Stem thickness | $t_{stem}$ = **200** mm | | |
| Angle to rear face of stem | $\alpha$ = **90** deg | | |
| Stem density | $\gamma_{stem}$ = **25** kN/m$^3$ | | |
| Toe length | $l_{toe}$ = **1300** mm | | |
| Base thickness | $t_{base}$ = **450** mm | | |
| Base density | $\gamma_{base}$ = **25** kN/m$^3$ | | |
| Height of retained soil | $h_{ret}$ = **1600** mm | Angle of soil surface | $\beta$ = **0** deg |
| Depth of cover | $d_{cover}$ = **0** mm | | |
| Height of water | $h_{water}$ = **1600** mm | | |
| Water density | $\gamma_w$ = **9.8** kN/m$^3$ | | |

### Retained soil properties

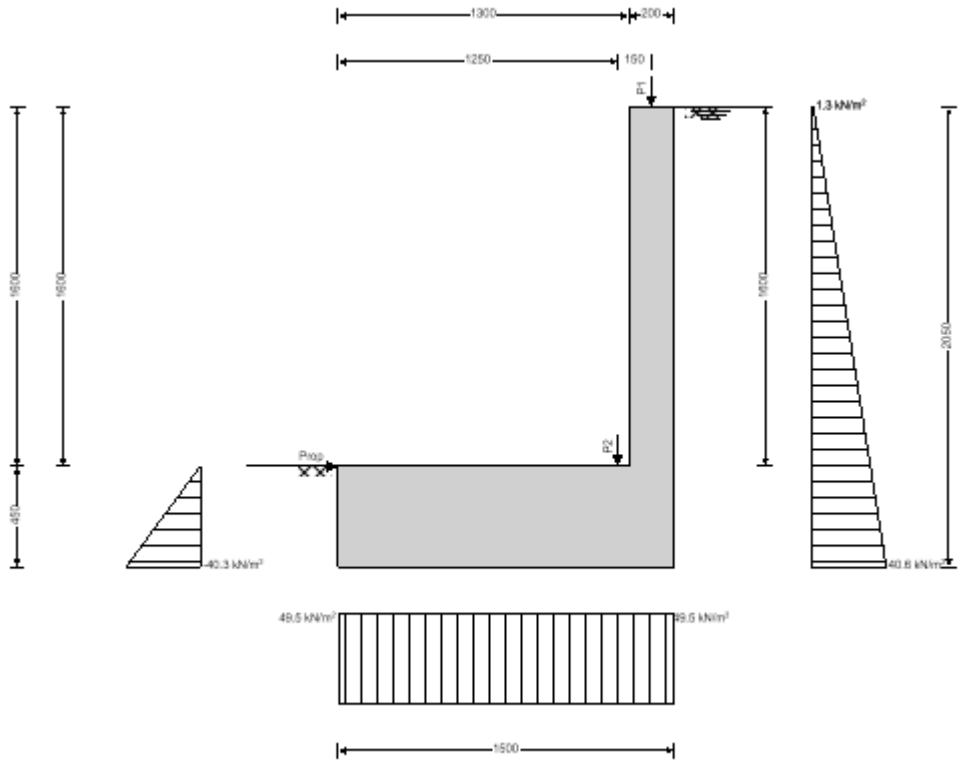
| | |
|---|---|
| Soil type | Medium dense well graded sand |
| Moist density | $\gamma_{mr}$ = **21** kN/m$^3$ |
| Saturated density | $\gamma_{sr}$ = **23** kN/m$^3$ |

### Base soil properties

| | |
|---|---|
| Soil type | Medium dense well graded sand |
| Soil density | $\gamma_b$ = **18** kN/m$^3$ |

### Loading details

| | |
|---|---|
| Variable surcharge load | Surcharge$_Q$ = **2.5** kN/m$^2$ |
| Vertical line load at 1400 mm | $P_{G1}$ = **15** kN/m |
| Vertical line load at 1250 mm | $P_{G2}$ = **15** kN/m |




General arrangement - sketch pressures relate to bearing check

**Calculate retaining wall geometry**

| | | | |
|---|---|---|---|
| Base length | $l_{base}$ = **1500** mm | | |
| Saturated soil height | $h_{sat}$ = **1600** mm | | |
| Moist soil height | $h_{moist}$ = **0** mm | | |
| Length of surcharge load | $l_{sur}$ = **0** mm | | |
| Vertical distance | $x_{sur\_v}$ = **1500** mm | | |
| Effective height of wall | $h_{eff}$ = **2050** mm | | |
| Horizontal distance | $x_{sur\_h}$ = **1025** mm | | |
| Area of wall stem | $A_{stem}$ = **0.32** m² | Vertical distance | $x_{stem}$ = **1400** mm |
| Area of wall base | $A_{base}$ = **0.675** m² | Vertical distance | $x_{base}$ = **750** mm |

**Design approach 1**

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

| | | | |
|---|---|---|---|
| Partial factor set | A1 | | |
| Permanent unfavourable action | $\gamma_G$ = **1.35** | Permanent favourable action | $\gamma_{Gf}$ = **1.00** |
| Variable unfavourable action | $\gamma_Q$ = **1.50** | Variable favourable action | $\gamma_{Qf}$ = **0.00** |

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

| | | | |
|---|---|---|---|
| Soil parameter set | M1 | | |
| Angle of shearing resistance | $\gamma_{\phi'}$ = **1.00** | Effective cohesion | $\gamma_{c'}$ = **1.00** |
| Weight density | $\gamma_\gamma$ = **1.00** | | |

**Retained soil properties**

Design moist density $\gamma_{mr}' = \mathbf{21}$ kN/m$^3$ — Design saturated density $\gamma_{sr}' = \mathbf{23}$ kN/m$^3$

**Base soil properties**

Design soil density $\gamma_b' = \mathbf{18}$ kN/m$^3$

**Soil coefficients**

Coeff.friction to back of wall $K_{fr} = \mathbf{0.325}$

Coeff.friction to front of wall $K_{fb} = \mathbf{0.325}$ — Coeff.friction beneath base $K_{fbb} = \mathbf{0.325}$

Active pressure coefficient $K_A = \mathbf{0.333}$ — Passive pressure coefficient $K_P = \mathbf{4.977}$

**Overturning check**

**Vertical forces on wall**

Total $F_{total\_v} = F_{stem} + F_{base} + F_{P\_v} + F_{water\_v} - F_{water\_u} = \mathbf{54.9}$ kN/m

**Horizontal forces on wall**

Total $F_{total\_h} = F_{sur\_h} + F_{sat\_h} + F_{water\_h} + F_{moist\_h} + F_{exc\_h} = \mathbf{33.8}$ kN/m

**Overturning moments on wall**

Total $M_{total\_OT} = M_{sur\_OT} + M_{sat\_OT} + M_{water\_OT} + M_{moist\_OT} = \mathbf{30.2}$ kNm/m

**Restoring moments on wall**

Total $M_{total\_R} = M_{stem\_R} + M_{base\_R} + M_{P\_R} = \mathbf{63.6}$ kNm/m

**Check stability against overturning**

Factor of safety $FoS_{ot} = \mathbf{2.109}$

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

**Bearing pressure check**

**Vertical forces on wall**

Total $F_{total\_v} = F_{stem} + F_{base} + F_{P\_v} + F_{water\_v} = \mathbf{74.1}$ kN/m

**Horizontal forces on wall**

Total $F_{total\_h} = F_{sur\_h} + F_{sat\_h} + F_{water\_h} + F_{moist\_h} + F_{pass\_h} = \mathbf{33.8}$ kN/m

**Moments on wall**

Total $M_{total} = M_{stem} + M_{base} + M_{sur} + M_P + M_{sat} + M_{water} + M_{moist} = \mathbf{55.7}$ kNm/m

**Check bearing pressure**

Propping force $F_{prop\_base} = \mathbf{33.8}$ kN/m

Bearing pressure at toe $q_{toe} = \mathbf{0}$ kN/m$^2$ — Bearing pressure at heel $q_{heel} = \mathbf{49.5}$ kN/m$^2$

Factor of safety $FoS_{bp} = \mathbf{1.414}$

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

**Design approach 1**

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

Partial factor set A2

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

Variable unfavourable action $\gamma_Q = \mathbf{1.30}$ — Variable favourable action $\gamma_{Qf} = \mathbf{0.00}$

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

Soil parameter set M2

Angle of shearing resistance $\gamma_{\phi'} = \mathbf{1.25}$ — Effective cohesion $\gamma_{c'} = \mathbf{1.25}$

Weight density $\gamma_\gamma = \mathbf{1.00}$

**Retained soil properties**

Design moist density $\gamma_{mr}' = \mathbf{21}$ kN/m$^3$ — Design saturated density $\gamma_{sr}' = \mathbf{23}$ kN/m$^3$

**Base soil properties**

Design soil density $\gamma_b' = \mathbf{18}$ kN/m$^3$

**Soil coefficients**

Coeff.friction to back of wall $K_{fr} = \mathbf{0.325}$

Coeff.friction to front of wall $K_{fb} = \mathbf{0.325}$ — Coeff.friction beneath base $K_{fbb} = \mathbf{0.325}$

Active pressure coefficient $K_A = \mathbf{0.333}$ — Passive pressure coefficient $K_P = \mathbf{4.977}$

**Overturning check**

**Vertical forces on wall**

Total $F_{total\_v} = F_{stem} + F_{base} + F_{P\_v} + F_{water\_v} - F_{water\_u} = \mathbf{54.9}$ kN/m

**Horizontal forces on wall**

Total $F_{total\_h} = F_{sur\_h} + F_{sat\_h} + F_{water\_h} + F_{moist\_h} + F_{exc\_h} = \mathbf{23}$ kN/m

**Overturning moments on wall**

Total $M_{total\_OT} = M_{sur\_OT} + M_{sat\_OT} + M_{water\_OT} + M_{moist\_OT} = \mathbf{22.7}$ kNm/m

**Restoring moments on wall**

Total $M_{total\_R} = M_{stem\_R} + M_{base\_R} + M_{P\_R} = \mathbf{63.6}$ kNm/m

**Check stability against overturning**

Factor of safety $FoS_{ot} = \mathbf{2.805}$

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

**Bearing pressure check**

**Vertical forces on wall**

Total $F_{total\_v} = F_{stem} + F_{base} + F_{P\_v} + F_{water\_v} = \mathbf{54.9}$ kN/m

**Horizontal forces on wall**

Total $F_{total\_h} = F_{sur\_h} + F_{sat\_h} + F_{water\_h} + F_{moist\_h} + F_{pass\_h} = \mathbf{23}$ kN/m

**Moments on wall**

Total $M_{total} = M_{stem} + M_{base} + M_{sur} + M_P + M_{sat} + M_{water} + M_{moist} = \mathbf{40.9}$ kNm/m

**Check bearing pressure**

Propping force $F_{prop\_base} = \mathbf{23}$ kN/m

Bearing pressure at toe $q_{toe} = \mathbf{36.8}$ kN/m$^2$ — Bearing pressure at heel $q_{heel} = \mathbf{0}$ kN/m$^2$

Factor of safety $FoS_{bp} = \mathbf{1.903}$

*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 2.9.19

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

Concrete strength class C30/37

Char.comp.cylinder strength $f_{ck} = \mathbf{30}$ N/mm$^2$ — Mean axial tensile strength $f_{ctm} = \mathbf{2.9}$ N/mm$^2$

Secant modulus of elasticity $E_{cm} = \mathbf{32837}$ N/mm$^2$ — Maximum aggregate size $h_{agg} = \mathbf{20}$ mm

Design comp.concrete strength $f_{cd} = \mathbf{17.0}$ N/mm$^2$ — Partial factor $\gamma_C = \mathbf{1.50}$

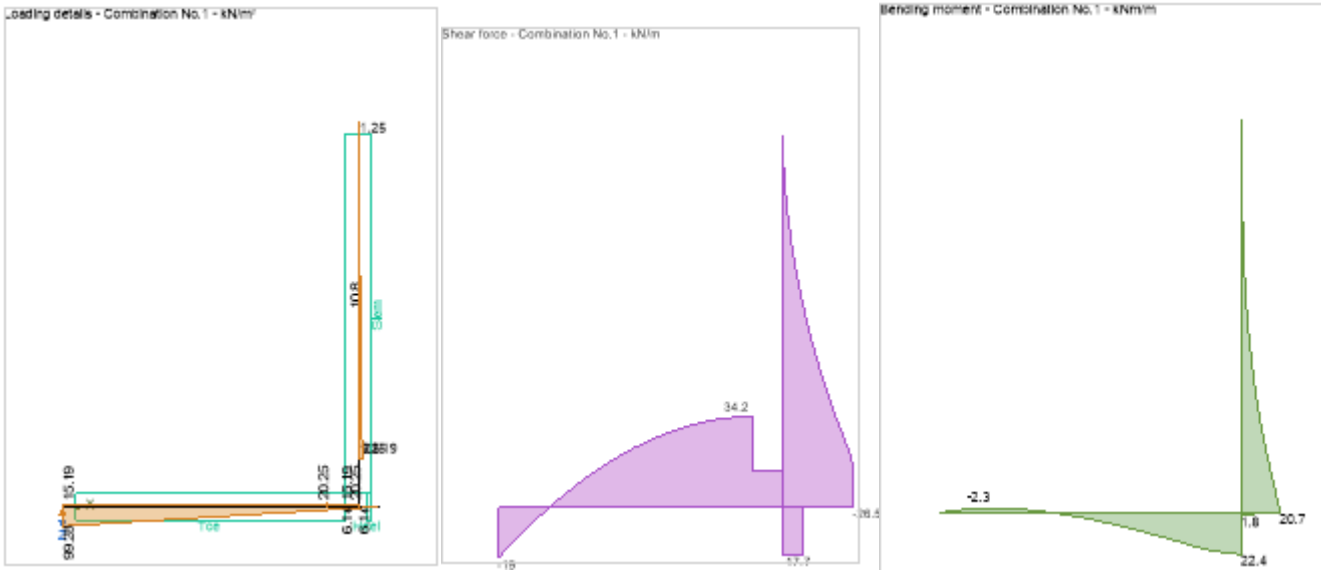
**Reinforcement details**

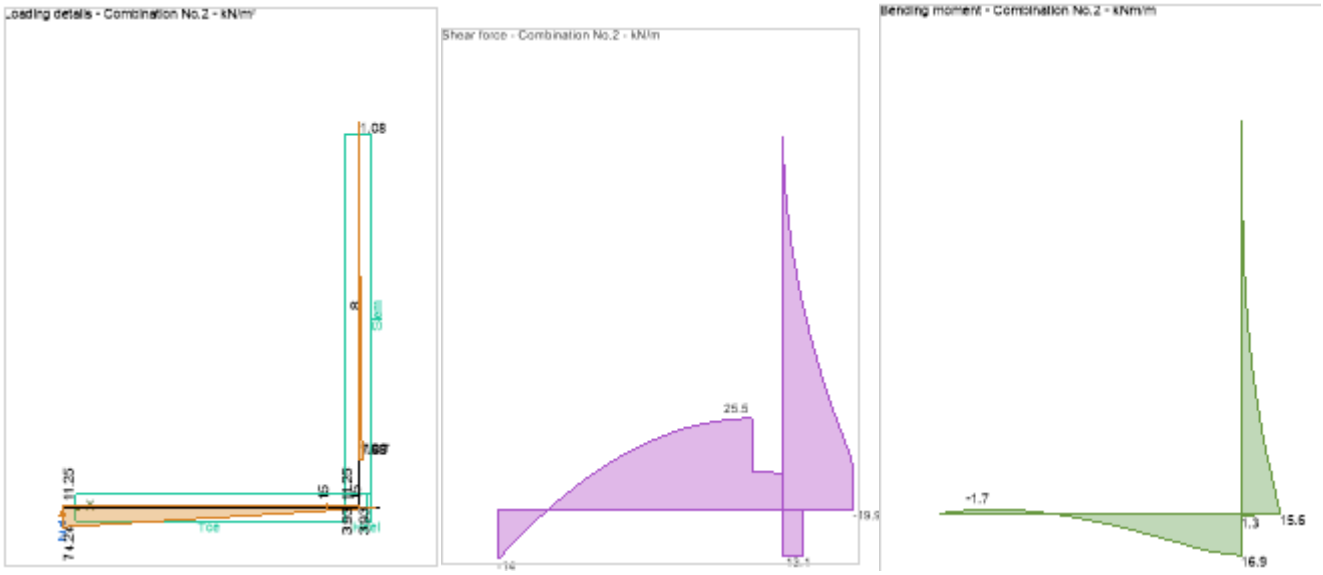
Characteristic yield strength $f_{yk} = \mathbf{500}$ N/mm$^2$ — Modulus of elasticity $E_s = \mathbf{200000}$ N/mm$^2$

| | | | |
|---|---|---|---|
| Design yield strength | $f_{yd}$ = **435** N/mm² | Partial factor | $\gamma_S$ = **1.15** |

**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 = **200** mm

**Rectangular section in flexure - Section 6.1**

| | | | |
|---|---|---|---|
| Design bending moment | M = **14.7** kNm/m | K = **0.023** | K' = **0.207** |

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

| | | | |
|---|---|---|---|
| Tens.reinforcement required | $A_{sr.req}$ = **245** mm²/m | | |
| Tens.reinforcement provided | 10 dia.bars @ 200 c/c | Tens.reinforcement provided | $A_{sr.prov}$ = **393** mm²/m |
| Min.area of reinforcement | $A_{sr.min}$ = **218** mm²/m | Max.area of reinforcement | $A_{sr.max}$ = **8000** mm²/m |

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

Library item: Rectangular single summary

**Deflection control - Section 7.4**

Limiting span to depth ratio 16 Actual span to depth ratio 11

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

**Crack control - Section 7.3**

Limiting crack width $w_{max}$ = **0.3** mm Maximum crack width $w_k$ = **0.248** mm

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

**Rectangular section in shear - Section 6.2**

Design shear force V = **26.5** kN/m

**Rectangular section in shear - Section 6.2**

Design shear force V = **26.5** kN/m Design shear resistance $V_{Rd.c}$ = **78.6** kN/m

*PASS - Design shear resistance exceeds design shear force*

**Horizontal reinforcement parallel to face of stem - Section 9.6**

Min.area of reinforcement $A_{sx.req}$ = **200** mm²/m Max.spacing of reinforcement $s_{sx\_max}$ = **400** mm

Trans.reinforcement provided 10 dia.bars @ 200 c/c Trans.reinforcement provided $A_{sx.prov}$ = **393** mm²/m

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

**Check base design at toe**

Depth of section h = **450** mm

**Rectangular section in flexure - Section 6.1**

Design bending moment M = **21.1** kNm/m K = **0.005** K' = **0.207**

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

Tens.reinforcement required $A_{bb.req}$ = **138** mm²/m

Tens.reinforcement provided 12 dia.bars @ 200 c/c Tens.reinforcement provided $A_{bb.prov}$ = **565** mm²/m

Min.area of reinforcement $A_{bb.min}$ = **556** mm²/m Max.area of reinforcement $A_{bb.max}$ = **18000** mm²/m

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

Library item: Rectangular single summary

**Crack control - Section 7.3**

Limiting crack width $w_{max}$ = **0.3** mm Maximum crack width $w_k$ = **0.167** mm

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

**Rectangular section in shear - Section 6.2**

Design shear force V = **13.9** kN/m

**Rectangular section in shear - Section 6.2**

Design shear force V = **13.9** kN/m Design shear resistance $V_{Rd.c}$ = **161.8** kN/m

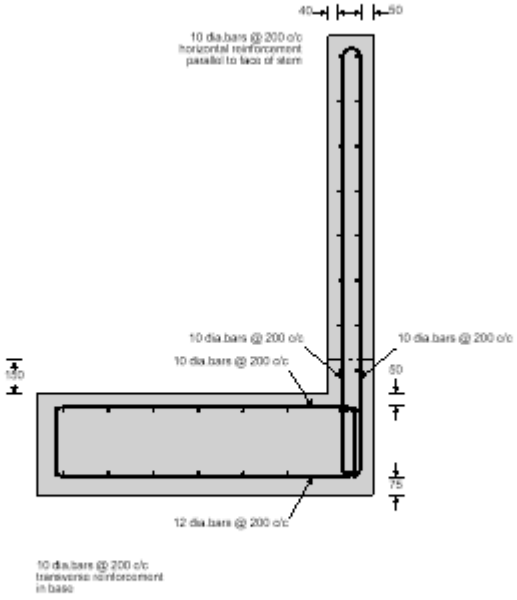
*PASS - Design shear resistance exceeds design shear force*

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

Min.area of reinforcement $A_{bx.req}$ = **113** mm²/m Max.spacing of reinforcement $s_{bx\_max}$ = **450** mm

Trans.reinforcement provided 10 dia.bars @ 200 c/c Trans.reinforcement provided $A_{bx.prov}$ = **393** mm²/m

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




**Reinforcement details**