Form

38 Glenloch Road, London NW3 4DN

CONSTRUCTION METHODOLOGY STATEMENT IN SUPPORT OF PLANNING APPLICATION

Job No: 172904

Date: January 2019

Prepared by Chartered Engineer: Rob Markovits C.Eng.M.I.Struct.E

Revision: P2

Residential

Commercial

Conservation

Retail

Education

Art

Hotels

Period

Form

Date 09/01/2019

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Structural Construction Methodology Statement

Revision: v.P2

Contents

PREAMBLE

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Form has undertaken over 300 projects involving subterranean development, both new build and retrospective, using numerous techniques and sequences of construction. This extensive design, site and local geology/hydrology experience has positioned the practice as one of London's leading subterranean engineering design consultants.

Many of our subterranean projects are in the London Boroughs of RBKC, Westminster, Camden, Hammersmith & Fulham and Wandsworth, making us familiar with the most recent requirements of subterranean development.

Form has designed multi-level basements using techniques including open dig, underpinning (mass and 'L' shaped R.C. special foundations), temporary and permanent steel sheet piling, temporary and permanent concrete piled retaining walls, top down construction and tunnelling.

TERMS OF REFERENCE

We were appointed by, McKays Estates, to prepare a Structural Methodology Statement in support of a planning submission for the refurbishment and sub-structure works at 38 Glenloch Road, London NW3 4DN.

Executive Summary

This document provides evidence to satisfy the requirements of a 'Basement Construction Plan' as defined in Camden's planning guidance documents CPG4 and Policy A5 in the Camden 'Local Plan'.

Extract Descriptions of Key Aspects from Camden's CPG4 and Policy A5 in the Camden 'Local Plan'	Reference Location within this Report	Compliance to Camden Policy
A. A thorough **desk study** is included in the text of the CMS report and details information regarding' a. Site history b. Property age c. The site survey d. Geology and ground conditions e. Hydrogeology f. Historic river courses g. Underground Infrastructure	Section 2 Section2 Appendix A Section 3 Section 4 Section 5 Section 7, 8	✓
B. An appraisal of the existing **building structural arrangement** including alterations and defects. A review of the condition of adjoining and adjacent buildings.	Sections 2, 3, 9 and Appendix A	✓
C. An assessment of a **site specific, ground investigation report** that includes ground water levels, and **trial pit information** describing existing foundation designs, materials and levels, at those walls influenced by the proposals.	Section 3 and Appendix C	✓
D. Details of the engineering design at detailed proposal stage a. Ground conditions and ground water b. Existing trees c. Existing infrastructure d. Drainage e. Flooding f. Loading g. Structural Engineering drawings including information such as construction sequences, foundations, and stability design	Section 3 and Appendix C Section 6 Sections 7 and 8 Sections 5 and 8 Sections 5 and 8 Appendix E Sections 10,11, and Appendices A,B,E	✓
E. An analysis of the upper aquifer and how the basement may impact groundwater flow	Sections 4 and 5	✓
F. Details of flood risk, surface water flooding, and drainage strategy. Reference to a site specific flood risk assessment.	Sections 4 and 5	✓
G. An assessment of expected short term and long term ground movement and the resulting effects on adjoining and adjacent properties. Design and construction to limit damage to all buildings to Category 1 as defined in CIRIA Report C580.	Section 12, and Appendix D	✓

Introduction

1.0 Introduction

This report has been prepared as a supporting document to the planning application for the redevelopment of the existing property at 38 Glenloch Road. The proposals involve the extension of the existing lower ground floor to form a single storey basement, demolition of rear load bearing masonry, extension of the rear ground floor, and some alterations to the existing interior design.

This report predominantly presents an outline structural scheme for the construction of the new substructure but also touches on the modifications to the superstructure.

Limitations

This report and the structural information produced to date has been based on visual inspection of the building and review of the proposed architectural plans. Trial pits and boreholes have been completed by “Jomas” to inform the foundation design. As the works proceed, a full survey of the existing structural elements will be carried out to determine the most suitable structural solution.

2.0 The Site and Existing Building

The existing building is a Victorian terrace house located on the North side of Glenloch Road adjacent to Tudor Close in the London Borough of Camden. The property is not listed but is within the Belsize Park conservation area and is laid out over five storeys including lower ground floor and construction is typical for its age. Load bearing brickwork walls built off small corbelled foundations support timber floors and a timber pitched roof. The rear garden contains some large trees and basic landscaping, the site also avoided damage during the second world war.

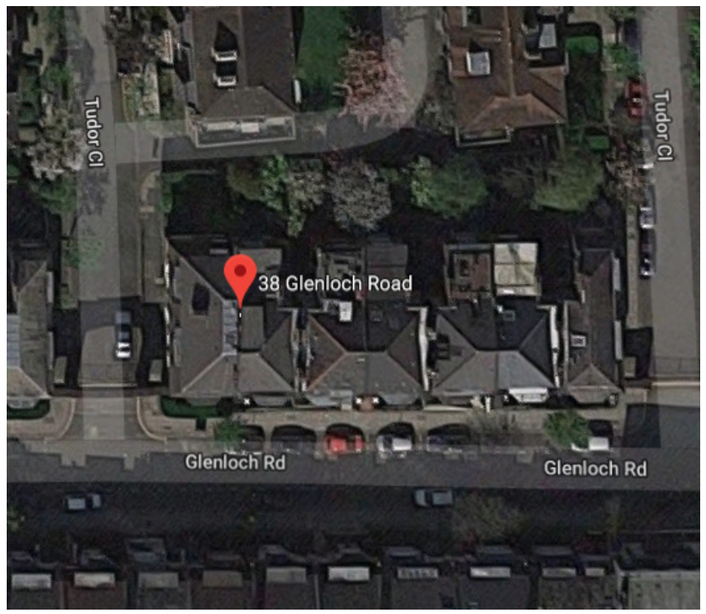

Figure 1 – Bird’s Eye View of Property

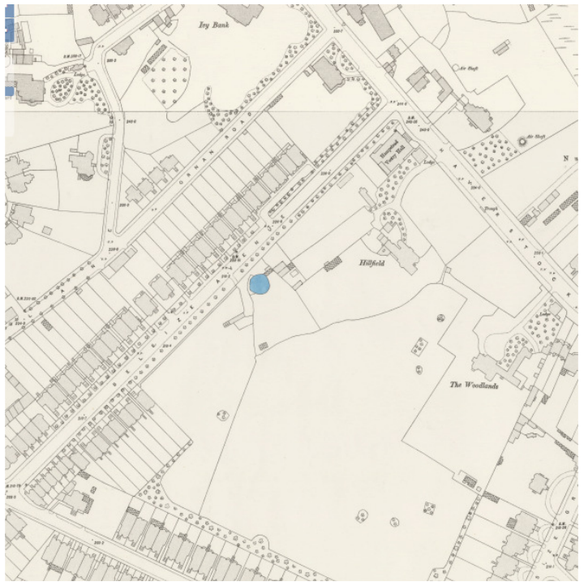

Figure 2 – 1893 Historical Site Map

Figure 3 – 1947-1964 Historical Site Map

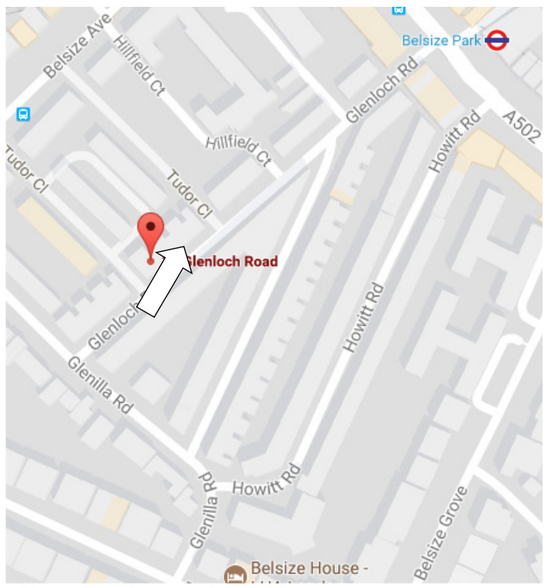

Figure 4 – Current Street Map

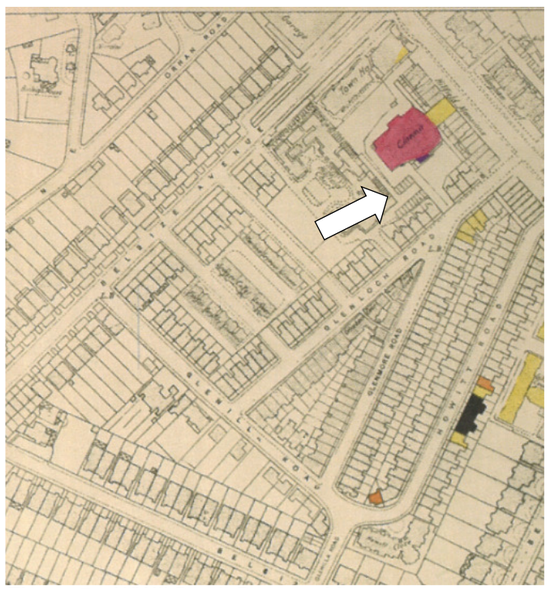

Figure 5 – WWII Bomb Damage Map

Site Information

3.0 Ground Conditions/Geology

A check on the British Geological Survey website indicates that the site is underlain by London Clay strata though superficial deposits were not recorded. This is corroborated by a search of local historic boreholes, the nearest being at Belsize park Station and Eton Avenue.

Site specific borehole and trial pit information completed by "Jomas" has confirmed the ground conditions comprise made ground to around 1.65m, above London Clay to 5.45m. The site investigation report is included in **Appendix C**.. A bearing capacity of 90kN/m^2 shall be used for the preliminary design of foundations as this is typical minimum value for London Clay that is used. As the design proceeds beyond planning sampling and laboratory testing shall be used to confirm the soil parameters required for the design of the new foundations

The high plasticity associated with London Clay means long term heave forces and movement must be considered in the detailed design.

The construction methods proposed within this report and associated structural proposals are appropriate for the geology and are capable for supporting the structural loads of the subterranean development, the techniques that will be used for the construction are well established in the industry.

Summary of Borehole Log at 59 HT	
Description of Strata	**Depth**
Made Ground Grey, clayey, sand, occasional cobbles of brick and gravel particles.	0.0m – 1.3m
Clay Light brown CLAY. (London Clay Formation)	1.3m – 5.45m

Slope stability

The site is not cut into the side of hills or valleys therefore slope stability is not considered to be a problem.

4.0 Hydrogeology

The site is underlain by Unproductive strata (formerly non-aquifer) of London Clay Formation. Unproductive strata are rock or drift deposits with low permeability that have negligible significance for the water supply or river base flow.

The Environment Agency website indicates that the site is not located within an Environment Agency Source Protection Zone (SPZ).

A ground water table was not encountered as stated in the SI report. However seasonal variations in ground water are to be expected and the contractor will be required to have considered suitable remediation measures during excavations & general basement works.

The main chalk aquifer is estimated at around 100m below ground level and as a result the structural works will not influence or present a meaningful risk to the aquifer and general hydrogeology under the site.

5.0 Hydrology

A desk top study and review of "The Lost Rivers of London" indicates that one of the nearest watercourse to the site is approximately 0.6km to the West, an old waterway known as "Tyburn" which has its source in the West Hampstead area of London and then flows through Swiss Cottage and then to Regent's Park.

The "Westbourne" also runs around 0.9kM away to the West of the site into the Thames at Battersea.

Specialist consultants, "GeoSmart" have prepared a site-specific flood risk assessment. Reference should be made to this report for detailed flood risk information however the conclusions state that the site has negligible risk from surface water flooding, and a 'very low' risk of flooding from rivers or the sea.

Due to the soil conditions being London Clay, excavations in this stratum will not have an adverse affect on the ground water flow in this area.

6.0 Arboriculture

Landmark Trees have completed a site-specific tree report. This report has confirmed that the proposed basement works do not adversely affect trees which are to remain. During the works, tree protection is to be installed and if any curtailing of roots is required this is to be carried out in line with the recommendations within the tree report.

7.0 Underground Structures

It can be seen from **Figure 6** below that the LUL Northern Line runs approximately 200m to the East of the site. As these are not within proximity the client is not required to advise London Underground asset protection department to check alignments and agreed works will not affect any existing tunnels or access shafts. No other underground structures, tunnels or vaults are expected near the proposed works. A Groundwise utilities search has been undertaken and no major issues are foreseen, see Appendix.

Figure 6- Proximity of LUL Northern Line to the Site

8.0 Existing Utilities and Underground Drainage

Water

A Thames Water Asset Location Search has been undertaken by “GeoSmart” and is included in the FRA. Thames Water confirmed that flooding has not occurred as a result of surcharging surrounding sewers however reference should be made to the report for more detailed information.

It is to be established whether any gas or electrical services run under the site. If so they will be diverted.

If required, services will be diverted and replaced to modern day standards where necessary as determined by the Mechanical and Electrical Engineer for the project. All services that are required to pass through new structure will be sleeved and articulated accordingly to allow for future movements and settlements of the surrounding structure.

Below Ground Drainage

As the extent of hard standings are not proposed to be increased, the flow rate into public sewers in terms of foul or storm runoff is not expected to increase significantly and therefore the existing utilisation of the public sewer will not be altered by the development. Refer to the Architect’s drawings for further detail of below ground and surface water drainage.

9.0 Boundary Conditions

The site is east facing on Glenloch Road and the road junction with Hall road is around 200m to the North. The property has two adjoining owners in addition to facing the footpath facing Glenloch Road.

Western (Rear) Boundary

The western boundary of the property is formed by the rear garden wall and fencing shared with the Tudor Close Estate roadways. The basement works do not impact upon this wall.

Eastern (Front) Boundary

The front boundary of the property is formed by the footway of Glenloch Road. There is an existing single storey lightwell immediately adjacent to the footpath. As the lightwell levels are to remain as existing, the basement works do not impact upon the retaining walls against the footpath.

Northern Boundary

The northern boundary of the property is formed by the party wall shared with 36 GR. The basement works include underpinning this wall.

Southern Boundary

The southern boundary is formed by the party wall shared with 40 GR. The basement works include underpinning this wall.

Figure 7: Western (Rear) boundary

Figure 8: Northern Boundary

Figure 9: Eastern, Northern and Southern Boundaries

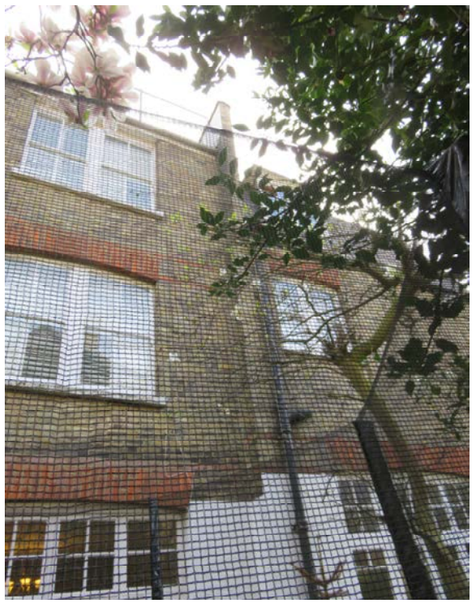

Figure 10: Southern Boundary

Development Proposals

It is proposed to substantially refurbish the existing property and construct a basement beneath the main building which involves extending the existing lower ground floor 2m beyond the rear façade to form a rear lightwell adjacent to the garden. In addition to the subterranean works, the proposed modifications to the existing structure include demolition of rear masonry at ground floor to first floor and load bearing studwork adjacent to the stairs at ground and first floor. Steel framing shall be used to provide stability to the superstructure where alterations to existing stability structure occur.

10.0 Sub-Structure & Basement Construction

The proposals for the basement construction take account of the development proposals as indicated on the architect's drawings, anticipated ground conditions, the stability of the neighbouring properties, health and safety considerations and the physical constraints of the site. (See drawings in **Appendix A** for proposed structural arrangement).

11.0 Temporary Works Systems and Principals to be used on each part of the works

It is intended to reduce the slab level at lower ground floor to increase headroom to ground floor and extend this basement level towards the rear of the site by installing reinforced concrete underpinning in a staged sequence around the perimeter. The basement is to be founded over a reinforced concrete ground bearing slab. At ground floor, composite slabs span to a grillage of steel beams that in turn span to steel columns that bear over the base slab. Steel framing is also required at first floor to achieve the ground floor interior design layout.

Before excavation works begin the ground works contractors must provide detailed method statements for the works and temporary propping to the basement for approval by the engineer.

Site works begin with the installation of temporary piles, as set out in the sequence drawings, L(30)01 and A(30)01 to A(30)04. Temporary steel framing to first floor should then be set out to bear over the temporary piles, allowing for demolition of ground to first floor masonry. Demolition of existing ground to first floor masonry can be completed following installation of this temporary steelwork.

A combination of mass concrete and reinforced concrete underpinning is constructed in a staged sequence to each perimeter wall of the superstructure and excavations are backfilled with soil when each underpin is complete. The reinforced concrete underpinning forms the earth retaining lining required for basement stability against lateral earth and groundwater pressures as well as surcharges at ground level. A 200mm RC retaining wall lines the mass concrete foundations towards the rear of the party wall shared with 40GR due to the existing foundation levels. The underpinning requires additional temporary propping at high level and just above basement level until completion of the raft slab and ground floor slabs. Mitigation against water ingress must be provided at the underpinning due to the staged construction sequence and good workmanship will be employed to minimise seepage and a cavity drainage system will be installed for all retaining walls

The base level, raft slab is constructed after final excavation work. This slab must be designed to resist any heave induced after excavation and hydrostatic uplift if groundwater is present. Based on the ground investigation for 38 GR minimal ground water is expected, however, the contractor should have a plan in place for de-watering.

Steel beams and columns to first floor are installed after the raft slab is complete. At this stage the temporary steelwork can be taken out and temporary piles demolished to base slab level. The ground floor composite slabs are the installed to prop the RC lining wall at high level and provide a working platform on which to commence final superstructure works.

12.0 Potential Ground Movement and Monitoring of Adjoining Properties

Based on experience from many similar projects within the London boroughs of Camden, RBKC and Westminster, monitoring during basement works typically records maximum vertical and horizontal movements of 5mm. We therefore expect the category of movement to be a category 1 of the Building Damage classification table based on Boscardin and Cording / Burland et al. See **Appendix D.** We have extensive experience of underpinning and will visit the site periodically during the works to ensure it is being carried out to our specifications. Appointing a contractor experienced in basement works is advised as most ground movement following excavation can be attributed to the quality of work and sequencing. A ground movement assessment has also been commissioned to further alleviate concerns regarding excessive ground movement and shall be included with the overall planning submission.

Monitoring of the surrounding buildings will be carried out during the works to assess possible movements and the findings will be reported to the adjoining surveyors periodically. The details of the monitoring regime will be agreed with the adjoining owners' surveyors as part of the party wall approval process. Form will produce a monitoring specification which will form part of the party wall documentation. This will detail, amongst other things, the frequency of monitoring, tolerances and location of monitoring points. Monitoring points will be placed in multiple locations at high and low levels to monitor vertical and lateral movement of all structures within the zone of influence of the works. Trigger levels will be suggested and agreed with the adjoining owners' surveyors. These trigger levels will set out quantities of settlement at which the adjoining owners will be notified and works on site reviewed by the project engineer. Refer to Appendix F for monitoring specification.

13.0 Excavation of Soil

The soil shall be excavated and transferred to normal 7m skips kept within a suspended parking bay in front of the house. The excavation will be undertaken by small excavators and transferred to the skip to the front of the site using conveyors through the front lightwell. The footpath and street adjacent to the site will be cleaned each evening. The frequency of vehicle movement will be confirmed by the chosen contractor and approved by the council before works commence. Further information on the management of site activities is detailed in the Construction Traffic Management Plan.

All works, particularly the sub-structure, are to be carried out in a manner which minimises any noise and vibration that may affect the neighbouring properties.

The engineer will make a site visit at each of the points detailed in the sequence of construction. The ground worker will provide detailed method statements for the works and temporary propping to the basement for approval by the engineer prior to commencement of the works.

No Significant ground water is expected during the excavations as ground water was not struck during the investigations. However, in the event any perched water is encountered during excavation, the following simple methodology could be adopted by the specialist basement contractor:

- Excavate a localised sump of 1.0x1.0x1.0m at a lower level of the excavation being carried out.
- A timber perforated plywood shell will be constructed as a box to support the perimeters of any temporary working sump and placed within the sump zone.
- Any ground water will naturally be drawn to the sump area and from that point, a 50mm diameter suitable water pump will be introduced, with a 50mm discharge hose which will be taken to the nearest manhole for water disposal.

14.0 Waterproofing and Drainage systems

Reinforced concrete liner walls will be designed as a water retaining structure in accordance with BS 8007 and detailed with hydrophyllic strips at all concrete joints in order to prevent water ingress. An internal cavity drainage system will also be included in order to ensure a dry, grade 3 environment complying with BS 8102:2009.

Sump pumps and drainage will be required to remove any water ingress from the cavity drain system and these will be designed by an appointed M&E consultant.

15.0 Demolition, Recycling, Dust/Noise Control & Site Hoarding

The demolition works are to take place within the hoarded confines of the site. Any scaffolding on the site perimeter is to be clad with monoflex sheeting above the 6 foot plywood hoarding line to minimise any dust or debris from falling onto the neighbouring streets.

Materials such as stock-bricks, re-useable timbers, steel beams etc are to be recycled where possible.

To minimise dust and dirt from demolition, the following measures shall be implemented:

- All brickwork and concrete demolition work is to be constantly watered to reduce any airborne dust.
- Demolished materials are to be removed to a skip placed in front of the site which will be emptied daily.
- The pavement to the front of the property is to be washed and cleaned down each day.
- Any debris or dust / dirt falling on to the street and public highway will be cleared as it occurs by designated cleaners and washed down fully every night.

Building work which can be heard at the boundary of the site will not be carried out on Sundays and Bank Holidays and will be carried out within working hours as agreed with the council.

Rubbish Removal and Recycling:

An important part of the site management process involves site cleansing, rubbish removal and recycling.

To reduce and manage site waste:

- All material removed from site is to be taken to waste recycling stations and separated for recycling where possible. Records of the waste recycling will be provided by the recycling stations.
- Waste types to facilitate recycling activities.
- All Duty of Care and other legal requirements are complied with during the disposal of wastes.
- Suppliers are to be consulted to determine correct / appropriate disposal routes for waste products and containers.

It will be the responsibility of each contractor to keep the site area under his control safe from build-up of rubbish.

16.0 Superstructure

The proposed architectural layouts involve removing internal loadbearing walls, some of which currently contribute to the stability of the building. Where loadbearing walls are to be removed, support to floors will be reinstated by the installation of steel beams and columns. Where these walls contribute to the stability of the structure, steel box frames are to be installed to mimic the stabilising action of the removed walls. These will be designed to resist wind and notional horizontal forces.

17.0 Appendix A

- Preliminary Form Structural Drawings

172904 - L(30)01	PROPOSED TEMPORARY PILES AND STEELWORK AT GROUND AND FIRST FLOOR	P1
172904 - A(30)01	PROPOSED SEQUENCE OF CONSRUCTION SHEET 01 OF 04	P1
172904 - A(30)02	PROPOSED SEQUENCE OF CONSRUCTION SHEET 02 OF 04	P1
172904 - A(30)03	PROPOSED SEQUENCE OF CONSRUCTION SHEET 03 OF 04	P1
172904 - A(30)04	PROPOSED SEQUENCE OF CONSRUCTION SHEET 04 OF 04	P1
172904 - L(23)01	EXISTING AND PROPOSED L.G. FLOOR PLAN	P1
172904 - L(23)02	EXISTING AND PROPOSED GROUND FLOOR PLAN	P1
172904 - L(23)03	EXISITNG AND PROPOSED FIRST FLOOR PLAN	P1
172904 - L(23)04	EXISITNG AND PROPOSED SECOND FLOOR PLAN	P1
172904 - L(23)05	EXISITNG AND PROPOSED THIRD FLOOR PLAN	P1
172904 - L(23)06	EXISITNG AND PROPOSED ROOF FLOOR PLAN	P1
172904 - A(28)01	PROPOSED SECTION A	P1
172904 - A(28)02	PROPOSED SECTION B	P1
172904 - A(28)03	PROPOSED SECTIONS C AND D	P1

18.0 Appendix B

- Underpinning Specification**:**

To be read in conjunction with the Preliminaries and General Conditions.

WORKMANSHIP: The work shall be carried out in accordance with the Engineer's drawings and instructions and to the approval of the Architect and the Building Control Officer. This specification is intended to be used for mass concrete underpinning.

Any other sequence of operations or method of working proposed by the Contractor is to be submitted to the Architect and copied to the Engineer and agreed in writing a minimum of 14 days before work is to be commenced on site.

CONTRACTORS RESPONSIBILITIES: The Contractor shall be responsible for the safety of the underpinned structure and provide all necessary shoring, strutting and bracing to ensure its safety and stability at all times.

SERVICES: The Contractor is also to carry out a survey of the property and adjacent area to establish the location of obstructions such as service runs or drains. Any obstruction found is to be brought to the attention of the Architect / Engineer. The Contractor is to allow for any temporary support to the services or obstructions during the underpinning.

CONSTRUCTION SEQUENCE: The underpinning is to be undertaken in short sections not exceeding 1 metre in length. The underpinning is to be undertaken on a 'hit and miss' sequence as shown on the drawings.

No adjacent pin is to be excavated until a minimum 48 hours after the adjacent pin has been cast and packed up.

The Contractor is to provide drawings marked up to show the proposed sequence of underpinning a minimum of 14 days before work is commenced.

EXCAVATIONS: Excavation shall be to the depth and width shown on the drawings. However, where tree roots are encountered new underpins are to extend 600mm below the last trace of any root activity. The sides of the excavations shall be adequately shored and propped to prevent subsidence or slip of the soil. Soil faces behind the pin and at the formation level shall be undisturbed.

Any soil faces behind the underpinning that require to be retained shall be by precast concrete poling boards. The boards are to have holes to enable the void behind the boards to be grouted up. The poling boards are to be measured as left in.

INSPECTIONS: All excavations are to be inspected by the Engineer and/or the Building Control Officer. Minimum notice of 24 hours is to be given when excavations are ready for inspection.

PREPARATION: The sides of the completed pin are to be thoroughly cleaned and scabbled to the satisfaction of the Engineer.

The soffit of the existing footings is to be levelled off and cleaned of all loose or detrimental material.

No projecting partitions of the existing footings are to be trimmed except as shown on the drawings or directed by the Engineer.

The Contractor must provide shear keys.

Allow for 150 deep x 100 wide shear keys across width of scabbled interfaces at 1m maximum vertical centres. Minimum 2 per face. Form in timber or polystyrene.

ANTI-HEAVE PRECAUTIONS: Before carrying out concreting introduce anti-heave precautions in the form of clay master as directed by the Engineer to the faces of the excavation.

PLACING CONCRETE: The concrete for the underpinning is to be mass concrete and poured continuously to 75mm below the soffit of the existing footing. The concrete is to be fully compacted using a mechanical vibrator.

The top 75mm of the pin is to be filled to the full depth and width of the void with a well rammed C35 concrete using 5mm – 10mm coarse aggregate and “Conbex 100” expanding admixture by Messrs Fosroc UK Limited in accordance with their instructions. The filling of this void is to be undertaken 24 hours after the mass concrete has been poured.

CONCRETE GRADE: On works where a full specification has not been provided, a FND2 mix should be used. This has characteristic 28 day strength of 35N/mm² and is suitable for Class 2 sulphate soils.

OVER-EXCAVATION: Except where noted otherwise on the drawings, areas of over-excavation are to be backfilled with a granular material and compacted in 225mm layers to provide a stable sub-base compatible with the final finishes.

SPOIL: The contractor will include in his prices for the removal of all spoil arising from the works which is not suitable for backfilling purposes.

RECORDS: A full record of each section underpinned is to be kept on site and readily available for inspection by the Engineer or Building Control Officer.

GUARANTEE The Contractor is to provide a 10 year insurance backed guarantee for the underpinning works.

19.0 Appendix C

- Soil Investigation

20.0 Appendix D

- Building Damage Classification Table

Classification of visible damage to walls (after Burland et al*, 1977, Boscardin and Cording, 1989; and Burland, 2001)*

Category of damage	Description of typical damage (ease of repair is underlined)	Approximate crack width (mm)	Limiting tensile strain ε_{lim} (per cent)
0 Negligible	Hairline cracks of less than about 0.1 mm are classed as negligible.	< 0.1	0.0–0.05
1 Very slight	Fine cracks that can easily be treated during normal decoration. Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection.	< 1	0.05–0.075
2 Slight	Cracks easily filled. Redecoration probably required. Several slight fractures showing inside of building. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows may stick slightly.	< 5	0.075–0.15
3 Moderate	The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable linings. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows sticking. Service pipes may fracture. Weathertightness often impaired.	5–15 or a number of cracks > 3	0.15–0.3
4 Severe	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Windows and frames distorted, floor sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes disrupted.	15–25 but also depends on number of cracks	> 0.3
5 Very severe	This requires a major repair involving partial or complete rebuilding. Beams lose bearings, walls lean badly and require shoring. Windows broken with distortion. Danger of instability.	usually > 25 but depends on number of cracks.	

Notes

1. In assessing the degree of damage, account must be taken of its location in the building or structure.
2. Crack width is only one aspect of damage and should not be used on its own as a direct measure of it.

21.0 Appendix E

Design Philosophy and Preliminary Calculations

22.0 Appendix F

Utilities Search and Movement Monitoring