STRUCTURAL ENGINEERING STATEMENT

With regards to

ANCILLARY WORK RELEVANT TO THE EXTENSION FOR A
SUBTERRANEAN HABITABLE ACCOMMODATION

Project:
77 Woodford Square, London W14 8DS

Client:
Mr Shahan Tendjoukian

Date: November 2014
3512/NE
CONTENTS

- Outline structural statement
  1. Scope
  2. Introduction and background
  3. Proposed sequence of works
  4. Engineering commentary
  5. Executive summary

- Appendix
  1. Background Information
  2. Underpinning specification
  3. Supporting Structural calculations
  4. Structural drawings

This document is to be read in conjunction with the following prepared by others:-

- Engineering information for 8 Addison Road
- Site Investigation
OUTLINE STRUCTURAL STATEMENT

Concerning
Proposed Residential Development at

77 Woodsford square, LONDON W14 8DS

1) SCOPE OF WORK

The purpose of this document is limited to providing an engineering assessment, solution and coordination for the resolution of issues arising out of work that has been undertaken by the contractors in connection with No 77 Woodsford Square and its proximity to No 8 Addison Road and identify any future works. It is the intent that this document is deemed to satisfactorily resolve issues raised by the representatives for No 8 Addison Road so that works currently suspended can recommence promptly.

It is understood that the two issues raised are:

A. The stability of the party fence wall
B. Impact on the piled retaining wall built at No 8

This document does not supersede or replace any prior design for the main permanent structure for the forming of the new habitable space at No 77 which remains the responsibility of the project engineer. Neither does this document seek to provide any commentary on the works already undertaken or anticipated to the two adjoining attached properties in Woodsford Square i.e. either side of the party wall.

The principal Chartered Structural Engineer who prepared this document is Nick Edelsten C.Eng., M.I.Struct.E. of Chess Structural Consultants, 28 Station Road, Watford, WD17 1JU. This practice has extensive experience of similar structures.

The following statement sets out in general terms the design philosophy that will be adopted in carrying out the basement construction of the project and any steps necessary to mitigate adverse structural effects on other structures nearby.

2) INTRODUCTION & BACKGROUND

At some time during the summer excavation work commenced on the scheme. This involved the underpinning of the party fence walls with a reinforced concrete retaining structure to the adjoining Woodsford Square properties which to date has been partially completed.

With respect to impact on No 8 Addison road, the intended scope of the works was that the new subterranean development would be no closer than approx. 1.3m from the existing party fence wall. No 8 was undertaking their own subterranean development at the time that included the forming of a piled retaining wall close to the party fence wall. However No 77’s contractor, without consent, began excavations and underpinning to the party fence wall itself to fulfil the clients wish for a level garden. By August he had completed one pin in reinforced concrete, half raised the retaining wall on an adjacent pin and just commenced excavation for a third.

Upon this information becoming known, the partially completed excavation was backfilled and subsequently all work ceased.

Party wall surveyors subsequently sought to regularise the situation.

At an early meeting (prior to this practice becoming involved) it is understood that the best engineering advise was that the remainder of the party fence wall be underpinned in the same manner as had been commenced. However consent for special foundations was not forthcoming and therefore it had been since agreed that the reinforced elements of underpinning must be removed.
As simple removal and backfilling will potentially subject the remaining party fence wall to significant risk of settlement, it has been agreed that a mass concrete underpin must be formed extending along the entire length of the boundary. The permanent habitable basement will be constructed in the originally intended location.

3) PROPOSED SEQUENCE OF WORKS

Refer to additional information appended to this report

UNDERPIN #1
1. Carefully break out RC wall and base insofar as it extends as an RC base under the PFW beneath Pin 1 exposing the underside of the original party fence wall foundation (i.e. remove recent drypacking. Cut off all projecting reinforcement.
2. Excavate over full height to line with back (No 8 side) of existing foundation.
3. Provide any temporary trench sheeting as may be necessary to stabilise the excavations.
4. Bottom out extended ground exposed by removal and if necessary (such as if water ingress occurring) lean mix blind bottom of trench.
5. Install formwork to prevent overspill onto No 77 site
6. Cast new mass concrete underpin using FDN1 Class concrete to no more than half height of full underpin.
7. Once concrete has lost fluidity, second lift can be cast.
8. Drypack
9. Backfill in 200mm compacted layers using inert compactable fill

UNDERPIN #2
1. Excavate 1.0m length to form underpin beneath ex foundation to depth no higher than a 45° line from the proposed formation level of the permanent works.
2. Repeat as above steps 3-9

REMAINING UNDERPINS
1. Underpins 3, 5, 6 & 7 as #2, pin 4 as pin 1

BASEMENT
1. Form basement foundations and walls in sequence as a series of underpins A to F ensuring backfill placed in step 9 above is fully retained during the excavation.
2. Once each section of wall is installed place temporary diagonal shore to ensure stability until permanent roof slab can be cast to provide propped cantilever configuration.

ANCILLARY
1. Form conventional strip footings and place decorative lining walls to conceal exposed concrete.
2. Backfill for form final garden level.

Contractor has advised that the process of forming the 7 No underpins will take approx. 40 days.

4) ENGINEERING COMMENTARY

By forming the stabilisation of the PFW as a series of 1.0m underpins the risk of disturbance to the ground of No 8 is minimised. There is negligible scope for lateral movement in the narrow strip of retained ground remaining and therefore the already installed piles will be unaffected by the scheme. That the permanent basement is constructed as a propped cantilever further minimises any risk of lateral movement.

Partial underpinning creates the potential for differential settlement and cracking in the wall. However given the ground conditions this is considered a low risk and has been quantified in the appended calculation.
By ensuring all excavations are backfilled on a pin by pin basis, the requirement for temporary propping other than such as may be required on an ad-hoc basis to prevent trench collapse is removed.

The permanent PFW underpinning will be of sufficient mass to act as a mass/gravity retaining wall to retain the difference in garden levels between No 8 & 7. The lining wall therefore is not retaining, but merely decorative.

5) EXECUTIVE SUMMARY

- The techniques involved in the construction of the underpin and basement are well established and will be carried out by competent contractors.

- By constructing as a series of underpins, the risk to adjacent structures is minimised.

- Appropriate risk assessments to be prepared by the main contractor to ensure a safe working environment on a site that has potentially dangerous H & S issues.

Nick Edelsten C.Eng., M.I.Struct.E.

7th November 2014
APPENDIX

BACKGROUND INFORMATION

Site as of 27th October

Partially complete corner in vicinity of proposed pin #1
UNDERPINNING SPECIFICATION

Underpinning is a hazardous operation and therefore appropriate H&S steps must be taken by the contractor.

Excavate in sequence as shown on plan, approximate length of each excavation to be 1.0m. Depth of excavation to be as indicated on drawings subject to ground conditions encountered, but founded onto good firm dense sand/gravel strata.

Remove all loose material/clinker from the underside of the existing foundation.

Time between excavation and placing of concrete to be kept as short as possible, but no longer than 24 hours unless by prior agreement. The excavations are to be protected from both weather and collapse, are to be kept clean and dry, and must be inspected by the appropriate authority. The concrete is to be placed immediately after this inspection. Any collapse of the trench, standing water or softened trench base is to be removed and cleaned out prior to the placement of the concrete.

After placing concrete in a "pin" allow 48 hours min. for the concrete to cure before excavating an adjacent pin.

Pins to be cast using min. min. ready-mixed grade FND1 to BS8500 (i.e. min C28/35).

Incorporate 6 No. 600x10mm mild steel dowel bars between each pin (ie. 300mm embedment into each pin), 3 top, 3 bottom. For safety and access reasons and provided that they are returned to straight when casting, these bars may be bent out of the way during excavation. Minimum cover to all reinforcement to be 100mm. Alternately use fully keyed “joggle joints”.

After concrete has cured, gap between underside of existing foundation and underpinning block to be filled with 1:2 cement/sharp sand, mixed as dry as possible with "Conbex 100" cement additive, consolidated by ramming with a suitable blunt instrument until the space is completely filled. Proprietary materials to be used in accordance with the manufacturer's instructions. After completion of grouting allow a minimum of 48 hours to cure before excavating an adjacent pin.

Backfill to underpinning access trench to be compacted quarry rejects or other approved material compacted in 200mm layers.

MINIMISING RISK OF DIFFERENTIAL SETTLEMENT

Due to the extensive scope of the works, there is a risk that some differential settlement may occur in the short term following completion of the foundation works.

Where new excavation is carried out, the ground onto which new foundations are to be cast should be mechanically compacted to achieve a similar density and ground bearing capacity to the existing under foundation ground. A 50mm lean mix concrete blinding layer should be applied to the excavated surface immediately upon completion unless casting of concrete is to proceed immediately.

All vertical excavated faces are assumed to be unstable as a result of excavations. All loose material is to be removed and trench sheet shoreed and propped against the face to ensure its stability. Prior to the placing of stem reinforcement all voids behind the sacrificial trench sheeting are to be filled using a weak mix fluid grout to ensure that no air pockets will be present following the casting of the concrete walls.

The underpinning sequence and procedures should be strictly adhered to.
SUPPORTING CALCULATIONS

UNDERPINNING

Consider mass concrete underpin as a gravity retaining wall that is retaining no more than 1.1m. Ignore concrete below non retaining height (treat as cracked).

Although occurring in the Kempton Park gravel comprising (low to med plasticity) cohesive soils, as this is bearing onto the concrete underpin bearing in the granular material, treat as granular.

Try foundation 600mm wide

From BS8004 Medium density gravel = 200-600kN/m² GBP conservatively adopt a value of 150kN/m² note that by inspection a more conservative values could be adopted due to cohesion likely to be developed on the stem of the concrete underpinning.

From P17 of SI settlement moderate <18mm

Load from masonry wall = 4.50x2.7= 12.2kN/m

Although domestic loading surcharge of 1.5kN/m² would be deemed reasonable, conservatively adopt a value of 2.5kN/m²

Check underpinning as a strip

**STRIP FOOTING ANALYSIS AND DESIGN (BS8110-1:1997)**

Strip footing details

- Width of strip footing; \( B = 600 \) mm
- Depth of strip footing; \( h = 4900 \) mm
- Depth of soil over strip footing; \( h_{soil} = 0 \) mm
- Density of concrete; \( \rho_{concrete} = 23.6 \) kN/m³
Load details
Load width; \( b = 220 \text{ mm} \)
Load eccentricity; \( e_p = 0 \text{ mm} \)

Soil details
Density of soil; \( \rho_{soil} = 20.0 \text{ kN/m}^3 \)
Design shear strength; \( \phi' = 30.0 \text{ deg} \)
Design base friction; \( \delta = 30.0 \text{ deg} \)
Allowable bearing pressure; \( P_{bearing} = 150 \text{ kN/m}^2 \)

Axial loading on strip footing
Dead axial load; \( P_G = 12.2 \text{ kN/m} \)
Imposed axial load; \( P_Q = 0.0 \text{ kN/m} \)
Wind axial load; \( P_W = 0.0 \text{ kN/m} \)
Total axial load; \( P = 12.2 \text{ kN/m} \)

Foundation loads
Dead surcharge load; \( F_{Gsur} = 0.000 \text{ kN/m}^2 \)
Imposed surcharge load; \( F_{Qsur} = 2.500 \text{ kN/m}^2 \)
Strip footing self weight; \( F_{swt} = h \times \rho_{conc} = 115.640 \text{ kN/m}^2 \)
Soil self weight; \( F_{soil} = h_{soil} \times \rho_{soil} = 0.000 \text{ kN/m}^2 \)
Total foundation load; \( F = B \times (F_{Gsur} + F_{Qsur} + F_{swt} + F_{soil}) = 70.9 \text{ kN/m} \)

Calculate base reaction
Total base reaction; \( T = F + P = 83.1 \text{ kN/m} \)
Eccentricity of base reaction in \( x \); \( e_T = (P \times e_p + M + H \times h) / T = 0 \text{ mm} \)

Calculate base pressures
\( q_1 = (T / B) \times (1 - 6 \times e_T / B) = 138.473 \text{ kN/m}^2 \)
\( q_2 = (T / B) \times (1 + 6 \times e_T / B) = 138.473 \text{ kN/m}^2 \)
Minimum base pressure; \( q_{min} = \min(q_1, q_2) = 138.473 \text{ kN/m}^2 \)
Maximum base pressure; \( q_{max} = \max(q_1, q_2) = 138.473 \text{ kN/m}^2 \)

Material details
Characteristic strength of concrete; \( f_{cu} = 30 \text{ N/mm}^2 \)

Calculate base lengths
Left hand length; \( B_L = B / 2 + e_p = 300 \text{ mm} \)
Right hand length; \( B_R = B / 2 - e_p = 300 \text{ mm} \)

Calculate rate of change of base pressure
Length of base reaction; \( B_x = B = 600 \text{ mm} \)
Rate of change of base pressure; \( C_x = (q_1 - q_2) / B_x = 0.000 \text{ kN/m}^2/\text{m} \)

Calculate minimum depth of unreinforced strip footing
Average pressure to left of strip footing; \( q_L = q_1 \times C_x \times (B_L - b / 2) / 2 = 138.473 \text{ kN/m}^2 \)
Minimum depth to left of strip footing; \( h_{Lmin} = (B_L - b / 2) \times \max(0.15 \times [(q_1 / 1 \text{ kN/m}^2)^{1/4} (f_{cu} / 1 \text{ N/mm}^2)]^{1/4}, 1) \)
= 190 mm
Average pressure to right of strip footing; \( q_R = q_2 \times C_x \times (B_R - b / 2) / 2 = 138.473 \text{ kN/m}^2 \)
Minimum depth to right of strip footing; \( h_{Rmin} = (B_R - b / 2) \times \max(0.15 \times [(q_2 / 1 \text{ kN/m}^2)^{1/4} (f_{cu} / 1 \text{ N/mm}^2)]^{1/4}, 1) \)
= 190 mm
Minimum depth of unreinforced strip footing; \( h_{min} = \max(h_{Lmin}, h_{Rmin}, 300 \text{ mm}) = 300 \text{ mm} \)

PASS - Unreinforced strip footing depth is greater than minimum
Check in mass concrete retaining condition

**RETAINING WALL ANALYSIS (BS 8002:1994)**

**Wall details**
- Retaining wall type: Unpropped cantilever
- Height of retaining wall stem: \( h_{\text{stem}} = 1100 \text{ mm} \)
- Thickness of wall stem: \( t_{\text{wall}} = 600 \text{ mm} \)
- Length of toe: \( l_{\text{toe}} = 0 \text{ mm} \)
- Length of heel: \( l_{\text{heel}} = 0 \text{ mm} \)
- Overall length of base: \( l_{\text{base}} = l_{\text{toe}} + l_{\text{heel}} + t_{\text{wall}} = 600 \text{ mm} \)
- Thickness of base: \( t_{\text{base}} = 200 \text{ mm} \)
- Position of downstand: \( l_{\text{ds}} = 0 \text{ mm} \)
- Thickness of downstand: \( t_{\text{ds}} = 200 \text{ mm} \)
- Height of retaining wall: \( h_{\text{wall}} = h_{\text{stem}} + t_{\text{base}} + d_{\text{ds}} = 1300 \text{ mm} \)
- Depth of cover in front of wall: \( d_{\text{cover}} = 200 \text{ mm} \)
- Depth of unplanned excavation: \( d_{\text{exc}} = 0 \text{ mm} \)
- Height of ground water behind wall: \( h_{\text{water}} = 0 \text{ mm} \)
- Height of saturated fill above base: \( h_{\text{sat}} = \max(h_{\text{water}} - t_{\text{base}} - d_{\text{ds}}, 0 \text{ mm}) = 0 \text{ mm} \)
- Density of wall construction: \( \gamma_{\text{wall}} = 23.6 \text{ kN/m}^3 \)
- Density of base construction: \( \gamma_{\text{base}} = 23.6 \text{ kN/m}^3 \)
- Angle of rear face of wall: \( \alpha = 90.0 \text{ deg} \)
- Angle of soil surface behind wall: \( \beta = 0.0 \text{ deg} \)
- Effective height at virtual back of wall: \( h_{\text{eff}} = h_{\text{wall}} + l_{\text{heel}} \times \tan(\beta) = 1300 \text{ mm} \)

**Retained material details**
- Mobilisation factor: \( M = 1.5 \)
Moist density of retained material; $\gamma_m = 18.0 \text{ kN/m}^3$
Saturated density of retained material; $\gamma_s = 21.0 \text{ kN/m}^3$
Design shear strength; $\phi' = 24.2 \text{ deg}$
Angle of wall friction; $\delta = 18.6 \text{ deg}$

**Base material details**

Moist density; $\gamma_{mb} = 18.0 \text{ kN/m}^3$
Design shear strength; $\phi'_b = 24.2 \text{ deg}$
Design base friction; $\delta_b = 18.6 \text{ deg}$
Allowable bearing pressure; $P_{bearing} = 150 \text{ kN/m}^2$

**Using Coulomb theory**

Active pressure coefficient for retained material
$$K_a = \frac{\sin(\alpha + \phi')^2}{(\sin(\alpha))^2 \times \sin(\alpha - \delta) \times [1 + \sqrt{\sin(\phi' + \delta) \times \sin(\phi' - \delta') / (\sin(\alpha - \delta) \times \sin(\alpha + \beta))}]} = 0.369$$

Passive pressure coefficient for base material
$$K_p = \frac{\sin(90 - \phi'_b)^2}{(\sin(90 - \delta_b) \times [1 - \sqrt{\sin(\phi'_b + \delta_b) \times \sin(\phi'_b) / (\sin(90 + \delta_b))}]} = 4.187$$

**At-rest pressure**

At-rest pressure for retained material; $K_0 = 1 - \sin(\phi') = 0.590$

**Loading details**

Surcharge load on plan; $\text{Surcharge} = 2.5 \text{ kN/m}^2$
Applied vertical dead load on wall; $W_{\text{dead}} = 12.2 \text{ kN/m}$
Applied vertical live load on wall; $W_{\text{live}} = 0.0 \text{ kN/m}$
Position of applied vertical load on wall; $l_{\text{load}} = 300 \text{ mm}$
Applied horizontal dead load on wall; $F_{\text{dead}} = 0.0 \text{ kN/m}$
Applied horizontal live load on wall; $F_{\text{live}} = 0.0 \text{ kN/m}$
Height of applied horizontal load on wall; $h_{\text{load}} = 0 \text{ mm}$

**Vertical forces on wall**

Wall stem; $W_{\text{wall}} = h_{\text{stem}} \times t_{\text{wall}} \times \gamma_{\text{wall}} = 15.6 \text{ kN/m}$
Wall base; $W_{\text{base}} = l_{\text{base}} \times t_{\text{base}} \times \gamma_{\text{base}} = 2.8 \text{ kN/m}$
Applied vertical load; \[ W_v = W_{\text{dead}} + W_{\text{live}} = 12.2 \text{ kN/m} \]
Total vertical load; \[ W_{\text{total}} = w_{\text{wall}} + w_{\text{base}} + W_v = 30.6 \text{ kN/m} \]

**Horizontal forces on wall**

Surcharge; \[ F_{\text{sur}} = K_a \times \cos(90 - \alpha + \delta) \times \text{Surcharge} \times h_{\text{eff}} = 1.1 \text{ kN/m} \]
Moist backfill above water table; \[ F_{m,a} = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{\text{eff}} - h_{\text{water}})^2 = 5.3 \]
Total horizontal load; \[ F_{\text{total}} = F_{\text{sur}} + F_{m,a} = 6.5 \text{ kN/m} \]

**Calculate stability against sliding**

Passive resistance of soil in front of wall; \[ F_p = 0.5 \times K_p \times \cos(\delta_b) \times (d_{\text{cover}} + t_{\text{base}} + d_{\text{ds}} - d_{\text{exc}})^2 \times \gamma_{\text{mb}} = 5.7 \]
Resistance to sliding; \[ F_{\text{res}} = F_p + (W_{\text{total}}) \times \tan(\delta_b) = 16.0 \text{ kN/m} \]

**Overturning moments**

Surcharge; \[ M_{\text{sur}} = F_{\text{sur}} \times (h_{\text{eff}} - 2 \times d_{ds}) / 2 = 0.7 \text{ kNm/m} \]
Moist backfill above water table; \[ M_{m,a} = F_{m,a} \times (h_{\text{eff}} + 2 \times h_{\text{water}} - 3 \times d_{ds}) / 3 = 2.3 \text{ kNm/m} \]
Total overturning moment; \[ M_{\text{ot}} = M_{\text{sur}} + M_{m,a} = 3.0 \text{ kNm/m} \]

**Restoring moments**

Wall stem; \[ M_{\text{wall}} = w_{\text{wall}} \times (l_{\text{toe}} + t_{\text{wall}} / 2) = 4.7 \text{ kNm/m} \]
Wall base; \[ M_{\text{base}} = w_{\text{base}} \times l_{\text{base}} / 2 = 0.8 \text{ kNm/m} \]
Design vertical dead load; \[ M_{\text{dead}} = W_{\text{dead}} \times l_{\text{load}} = 3.7 \text{ kNm/m} \]
Total restoring moment; \[ M_{\text{rest}} = M_{\text{wall}} + M_{\text{base}} + M_{\text{dead}} = 9.2 \text{ kNm/m} \]

**Check stability against overturning**

Total overturning moment; \[ M_{\text{ot}} = 3.0 \text{ kNm/m} \]
Total restoring moment; \[ M_{\text{rest}} = 9.2 \text{ kNm/m} \]

**Check bearing pressure**

Total moment for bearing; \[ M_{\text{total}} = M_{\text{rest}} - M_{\text{ot}} = 6.1 \text{ kNm/m} \]
Total vertical reaction; \[ R = W_{\text{total}} = 30.6 \text{ kNm/m} \]
Distance to reaction; \[ x_{\text{bar}} = M_{\text{total}} / R = 201 \text{ mm} \]
Eccentricity of reaction; \[ e = \text{abs}((l_{\text{base}} / 2) - x_{\text{bar}}) = 99 \text{ mm} \]

Reaction acts within middle third of base

Bearing pressure at toe; \[ \rho_{\text{toe}} = (R / l_{\text{base}}) + (6 \times R \times e / l_{\text{base}}^2) = 101.8 \text{ kN/m}^2 \]
Bearing pressure at heel; \[ \rho_{\text{heel}} = (R / l_{\text{base}}) - (6 \times R \times e / l_{\text{base}}^2) = 0.3 \text{ kN/m}^2 \]

**CHECK SETTLEMENT**

Proposed Foundation pressure = 140kN/m²

From Craig Soil Mechanics

s/q = 0.06 (for a 0.6m foundation width in medium dense soils)

therefore s = 0.06 x 140 = 8.4mm (i.e. low)

Check theoretical settlement for existing foundation:

Pressure = (12.2+24x0.6x0.3)/0.6 = 28kN/m²

s/q = 0.11 (for a 0.6m foundation width in medium loose soils)

therefore s = 0.11 x 28 = 3.1mm (i.e. low)