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# TECHNICAL NOTE 01 – GROUND MOVEMENT & IMPACT ASSESSMENT DUE TO UNDERPINING & LOCAL EXCAVATION

| | | | |
|---|---|---|---|
| Project Name | Camden Town Hall | Project No. | 4254 |
| For the attention of | London Borough of Camden | Date | 22/07/2020 |

## 1.1 Introduction

The aim of this Technical Note is to provide justification on the movement caused by the underpinning operation and trench sheeting technique at the basement of Camden Town Hall Project. The proposed development comprises the refurbishment and repurpose of the existing building with alterations and minor works at the basement level and to the superstructure.

As part of the recent site investigations/discoveries reports, a new pad foundation has been found to be clashing with the new lift pit for lifts PL2&PL3. Therefore, it is necessary to underpin the existing footing to avoid any undermining during the lift pit construction. Also, a trench shoring system has been proposed in the temporary condition when forming new lifts or attenuation tanks to minimise impact on nearby the existing foundations. Figure 1.1 below indicates the position of the underpinning in red in relation to the basement plan of the site.

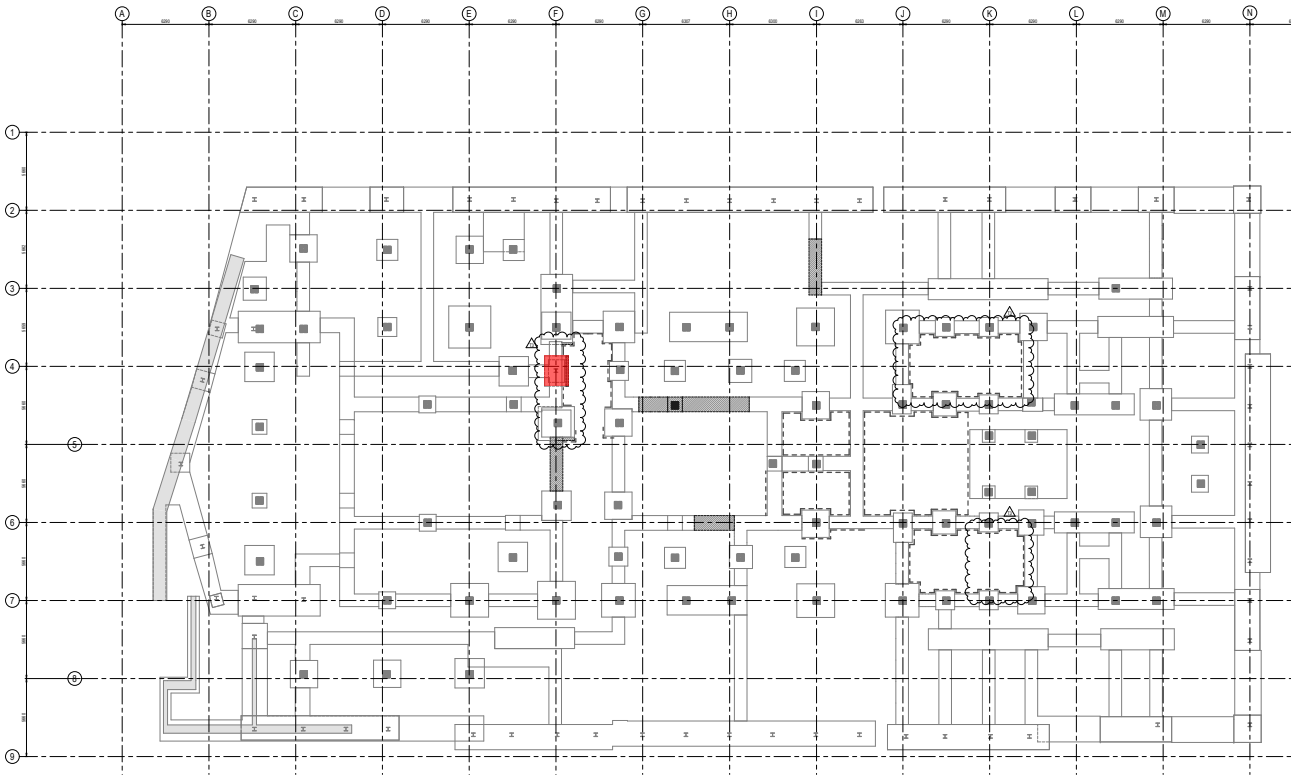

**Figure 1.1 Basement key plan highlighting position of the underpinning extent**

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Underpinning is a simple technique that involves excavating a segment of ground below the existing foundation in controlled stages, to a depth where suitable bearing strata exists. The excavation is filled with concrete and allowed to cure before the next 'pin' is excavated. To transfer the building load safely to the new pin, a dry sand cement packing mortar is rammed in between the new and old foundation.

The proposed construction sequence is shown as follows:

1. Excavation below existing pad footing in a hit and miss sequence
2. Formation of the 6 pins to form the underpinning, as per above hit and miss sequence
3. Local demolition of the existing pad footing where clashing with the lift pit
4. Excavation to the required depth to form new lift pit
5. Formation of the lift pit (foundation and walls)

The pins are to be formed of mass concrete, extending to the same depth as per the new lift pit foundation.

In the case of excavating the new lift pits nearby existing foundation levels, a trench shoring system has been proposed in order to avoid undermining the existing foundations, to carry out excavation works safety and to limit ground movement. Figure 1.2 below indicates in blue dotted line the location of the proposed trench sheeting in relation to the basement plan of the site.

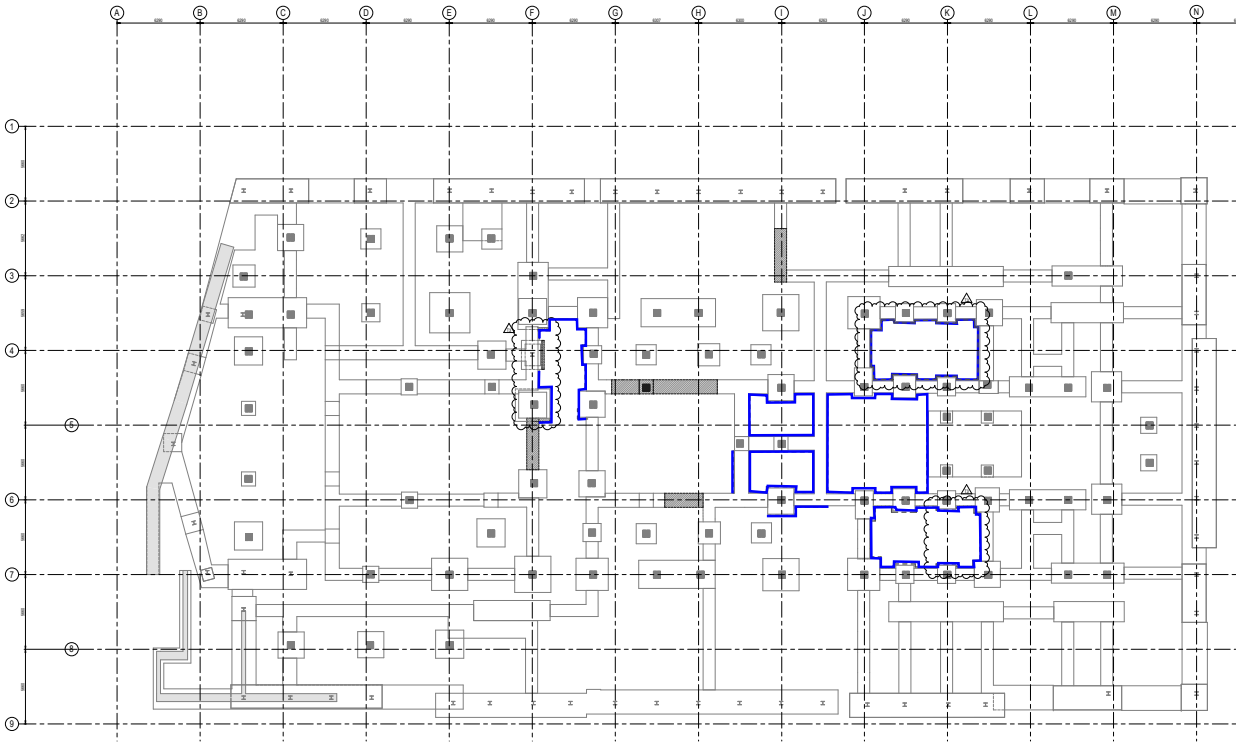

**Figure 1.2 Basement key plan highlighting the extent of the trench sheeting.**

The proposed construction sequence is shown below:

1. Excavation to max 1 m below basement level
2. Installation of the sacrificial sheet piles or similar to form the box
3. Installation of a temporary horizontal prop
4. Excavation to the required depth
5. Formation of the lift pit (foundation and walls)

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# 1.2 Ground Movement and Damage Impact Assessment due to underpinning

During the underpinning process it is inevitable that the ground movement will occur due to changes in load path as elastic heave/settlements will manifest in response to the stress changes in the soils.

Behaviour of the ground will depend on the quality of workmanship and suitability of the methods used, and as such worst-case predictions for movement are typically adopted as per industry guidance. In consideration of the above, with the underpinning being carried out by a qualified and experienced contractor the ground movement for such works are expected to cause an additional settlement to the column of no more than 6mm.

For the column under consideration this predicted movement is less than L/500, where L is the distance to the nearest column. This criterion is a common practice check for differential settlements that will not cause any significant impact to an existing structure.

This predicted ground movements can be related to potential damage to masonry walls and finishes might suffer by considering the strains and the angular distortion which may be generated using the method proposed by Burland (2001, in CIRIA Special Publication 200) along Section 1-1 (as indicated below).

The damage category assessment is undertaken as follows:

- The deflection ratio Δmax= 6mm < 3400mm/500= 6.8 mm (where SPAN/500 is the limiting allowed deflection)
- Limiting Tensile strain, $\varepsilon_{lim}$= 6mm/ 3400mm= 0.0017

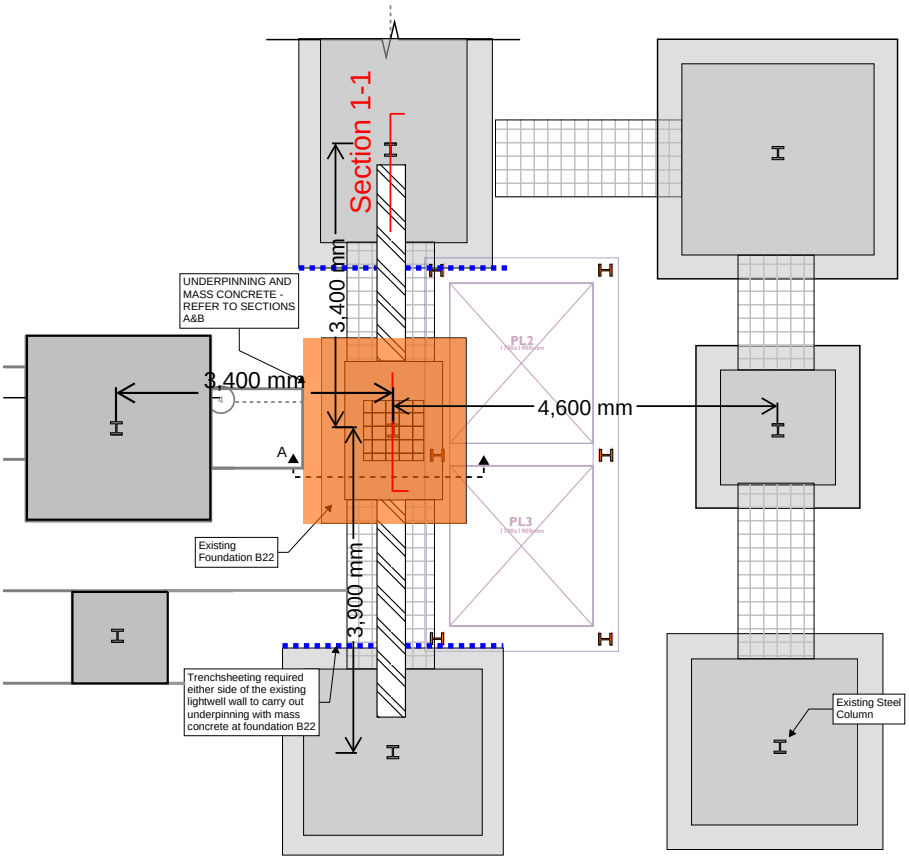


**Figure 1.3 Plan showing the distance of the underpinning to the adjacent foundations**

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Using the damage category ratings and graphs given in CIRIA SP200, for L/H = 0.5 (defined in Section 3.9), these deformations represent a damage category of 'very slight' (Burland Category 1), as illustrated in Table 1.1 below.

| Category of damage | Description of typical damage (ease of repair is underlined) | Approximate crack width (mm) | Limiting tensile strain, $\varepsilon_{lim}$ (%) |
|---|---|---|---|
| 0 Negligible | Hairline cracks of less than about 0.1 mm are classed as negligible | <0.1 | 0.0 to 0.05 |
| 1 Very slight | **Fine cracks that can easily be treated during normal decoration.** Perhaps isolated slight fracture in building.<br>Cracks in external brickwork visible on inspection | <1 | 0.05 to 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.<br>Doors and windows may stick slightly. | <5 | 0.075 to 0.15 |
| 3 Moderate | **The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable lining. Repointing of external brickwork and possibly a small amount of brickwork to be replaced.**<br>Doors and windows sticking.<br>Service pipes may fracture.<br>Weathertightness often impaired. | 5 to 15 or a number of cracks >3 | 0.15 to 0.3 |
| 4 Severe | **Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows.**<br>Windows and frames distorted, floor sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Services pipes disrupted. | 15 to 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.<br>Windows broken with distortion.<br>Danger of instability. | Usually >25, but depends on numbers of cracks | |

**Table 1.1 Classification of visible damage to walls (after Burland et al, 17977, Boscardin and Cording, 1989; and Burland, 2001)**

The vertical and horizontal strains derived from the above method indicate the calculation of the damage assessment. Based on the results (the deflection ratio and the horizontal tensile strain) and the damage category diagram according to the CIRIA guide (Figure 1.4) the theoretical building damages for the adjacent structure and finishes is acceptable.

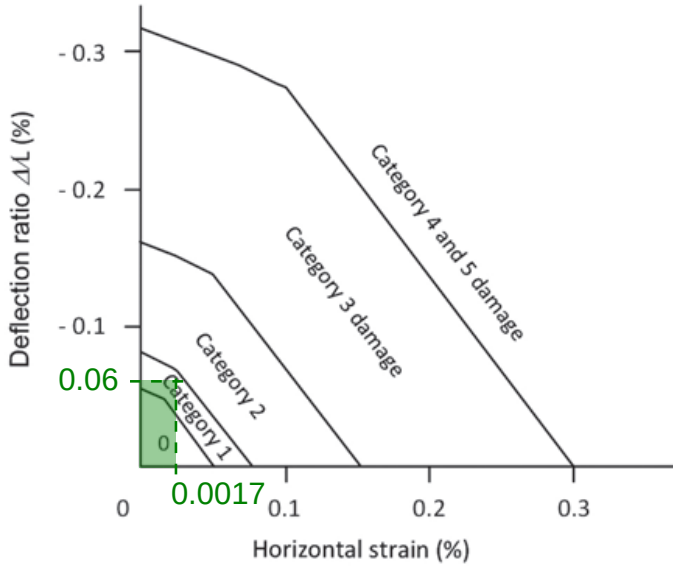


**Figure 1.4 Damage category diagram showing relationship between defection ratio and horizontal tensile strain for section 1-1**

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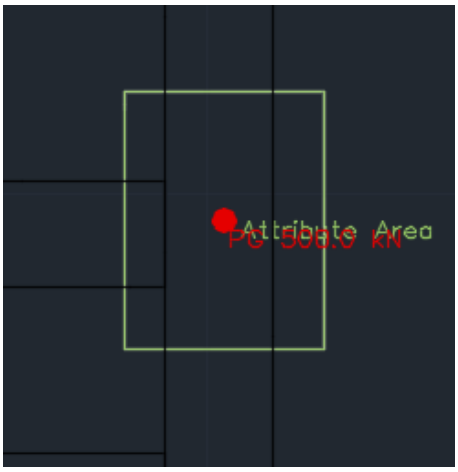
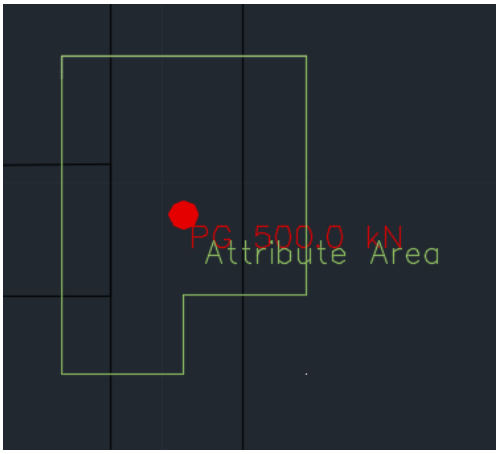
Use of best practice construction methods will be essential to ensure that the ground movements are kept in line with the above predictions. Pre-construction condition surveys are to be completed by the contractor and a system of monitoring adjoining and adjacent structures should be established before the works start.

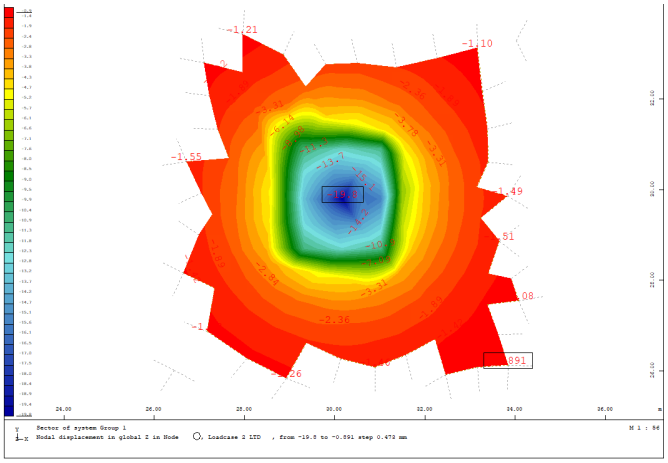
In addition to the above, AKTII have carried an additional analysis to predict the tilt/movement of the pad that is expected, and the outcome is insignificant as shown in the plot results below:



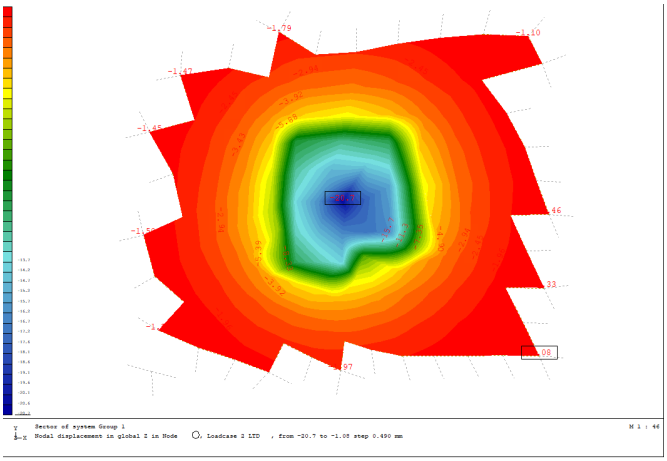

**SOFISTIK ANALYSIS OF THE EXISTING CONDITION**




**SOFISTIK ANALYSIS OF THE UNDERPINNING CONDITION - FORMATION OF CORNER PIN**



**NODAL DISPLACEMENTS OF THE EXISTING CONDITION**



**NODAL DISPLACEMENTS DUE TO UNDERPINNING - FORMATION OF CORNER PIN**

It's worth noting that the above assessments and analyses are conservative since the beneficial influence of ground beams that are connected with the existing pad and the basement slab are not taken into account. The effect of these elements it would reduce any impact due to underpinning to a minimum.

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# 1.3 Ground Movement and Damage Impact Assessment for existing foundations adjacent to excavations

Some local excavations are proposed adjacent to existing pad footings. The proposal is to utilise propped trench sheeting to continuously support the sides of excavations and minimise movements of the neighbouring pads. Worst case considered is where excavations are 0.7m below existing formation.

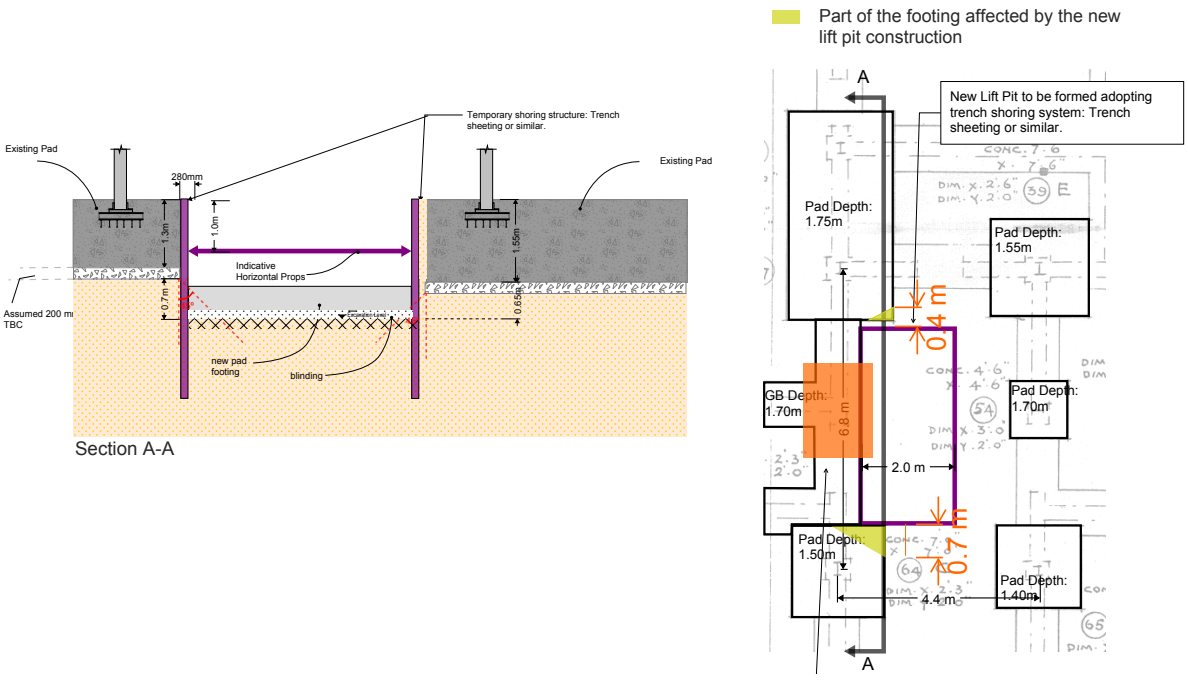


**Figure 1.5 Indicative section and plan of trench shoring system**

Wallap (Embedded Retaining Wall Analysis) software has been used to calculate the horizontal movement of the sheet pile, and Ciria Guide 760 has been used to calculate the resultant vertical settlement. The analysis conservatively ignores temporary props which will be used in practice

The maximum calculated settlement of the existing footing is 4.0mm which equates to a maximum differential settlement of no greater than  L/500. L/500 is a criterion is a common practice check for differential settlements that will not cause any significant impact to an existing structure.