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11th July 2018

Addendum to Basement Impact Assessment
24 Heath Drive, London, NW3 7SB

This addendum is supplementary to, and should be read in conjunction with, our Basement Impact Assessment (BIA) report dated 2nd March 2018 (Ref: GGC17597/R2.3).

1 Introduction

1.1 In section 10.6 of our Basement Impact Assessment (BIA, Ref: GGC17597/R2.3), No.25 Heath Drive was identified as the more susceptible to damage from the construction of the proposed basement beneath No.24 (compared with the adjacent No.23), due to both its proximity to the proposed basement, and the results of the PDISP analyses, which indicated that maximum settlement will occur alongside No.25. As a result, separate damage categories were previously carried out for both the front wall of No.25's garage, and the main rear/internal wall of No.25.

1.2 Camden's auditors for BIAs, Campbell Reith Hill LLP, have asked for additional assessments to be carried out in order to confirm that the potential for damage to No.23 Heath Drive as a result of the construction of the proposed basement beneath No.24 would also be within acceptable limits. These damage category assessments have considered movements arising from the two-storey part of the proposed basement beneath the north-east side of No.24, as well as movements arising from the proposed perimeter Bored Pile Wall (BPW) at the rear of the house.

2 Additional Damage Category Assessments

2.1 As outlined in our BIA (Ref: GGC17597/R2.3), the neighbouring properties of No's 23 and 25 Heath Drive do not adjoin No.24. The superstructure of No.23 is broadly similar to No.24, and both No's 23 and 25 have attached single-storey garages on their north-eastern sides. No.25 has a broadly similar cellar to No.24, which is located beneath the northern corner of the main part of the house (plan available). No.23 is also thought to have a cellar, but its exact location and dimensions are unknown; based on the location of the stairs on the ground floor plan taken from Camden Council's planning website (see paragraph 2.10 of GGC17597/R2.3), it is also likely to be located beneath the northern corner of the main part of the house, similar to No.24's (this interpretation of the location of the cellar beneath No.23 is a correction of paragraph 10.6.3 of our original BIA). No.24's proposed basement will be located within approximately 3.70m of No.23 at its closest point, based on Form SD's Proposed Basement Plan (Drg No.162637/L(17)02/P3). At No.23, the worst case scenarios will occur at the property's front and rear walls, since these walls are approximately perpendicular to the proposed basement beneath No.24 and are closest, respectively, to the double depth part of No.24's basement and to the BPW. Since the exact position of No.23's cellar is unknown, the beneficial effect it will create by decreasing the differential foundation depth between No's 23 & 24 has been ignored, resulting in a 'worst case' scenario being analysed.

2.2 For the front wall of No.23, the PDISP analyses indicated that the settlements will radiate further from the proposed footprint of No.24's basement towards No.23's footprint in Stage 1, which therefore represents the worst case stage. Although the PDISP analyses indicated that settlement movements were greatest alongside the front wall of No.23, a damage category assessment has also been carried out for the rear wall of No.23, to analyse movements associated with the installation of the BPW at the rear of No.24. For the rear wall of No.23, the PDISP analyses indicate that Stage 4 represents the worst case stage, since the beneficial heave movements were shown to radiate a shorter distance from the proposed footprint of No.24's basement towards No.23's footprint.

2.3 Separate damage category assessments have been undertaken for both the front and rear walls, which considered:

- ground movements arising from the vertical stress changes, as assessed by the PDISP analyses (see BIA Section 10.5);
- ground movements alongside the proposed underpins caused by relaxation of the ground in response to the excavations; and
- Ground movements alongside the proposed BPW from installation (rear wall only).

Ground movements associated with the construction of retaining walls in clay soils have been shown to extend to a distance up to 4 times the depth of the excavation.

<u>Front wall of No.23:</u>

2.4 The front wall of No.23 includes two two-storey bays, located either side of the front entrance, however these were ignored for this damage category assessment. As a result, a single wall extending the full width of the property was modelled, so that a worst case scenario was analysed. The relevant geometries are summarised below:

Depth of foundations = 1.0m (assumed) below ground level at front of No.23.
Ground level at front of No.23 = 88.74m AOD (scaled from drawings)
Depth of excavation beneath ground level at No.23 = 88.74 – 81.48 = **7.26m**
Width of zone of affected soils = 7.26 x 4 = **29.04m**
Width of No.23's front wall (L) = **14.94m** (closest point located **4.30m** from No.24's basement; see Figure 1 below)
Height (H) = 6.70 + 1.00 = **7.70m** (wall height + foundation)
Hence L/H = **1.94**.

2.5 Thus, for the anticipated (theoretical) horizontal displacement of **10mm** (increased pro rata for a typical two-storey deep basement, as a worst case scenario, based on a typical value of 5mm for a single-storey basement, with a depth of around 3.5m), the strain beneath the front wall of No.23 would be in the order of $\varepsilon_h = 3.44 \times 10^{-4}$ (0.034%).

2.6 The maximum settlement predicted by the PDISP analysis adjacent to the front wall of No.23 was 4mm in Stage 1, though very similar movements were also predicated in stages 2 & 3 (see Figure G3 in Appendix G). This must be combined with the settlement caused by relaxation of the ground alongside the basement in response to excavation of the underpins, which can be estimated using the settlement profile for the worst case (low stiffness) scenario presented in Figure 2.11(b) of CIRIA Report C580. The settlement profiles are then summed to find the maximum deflection, Δ. Figure 1 presents these settlement profiles for No.23's front wall. The maximum Δ = 1.94mm, which represents a deflection ratio, $\Delta/L = 1.30 \times 10^{-4}$ (0.013%).

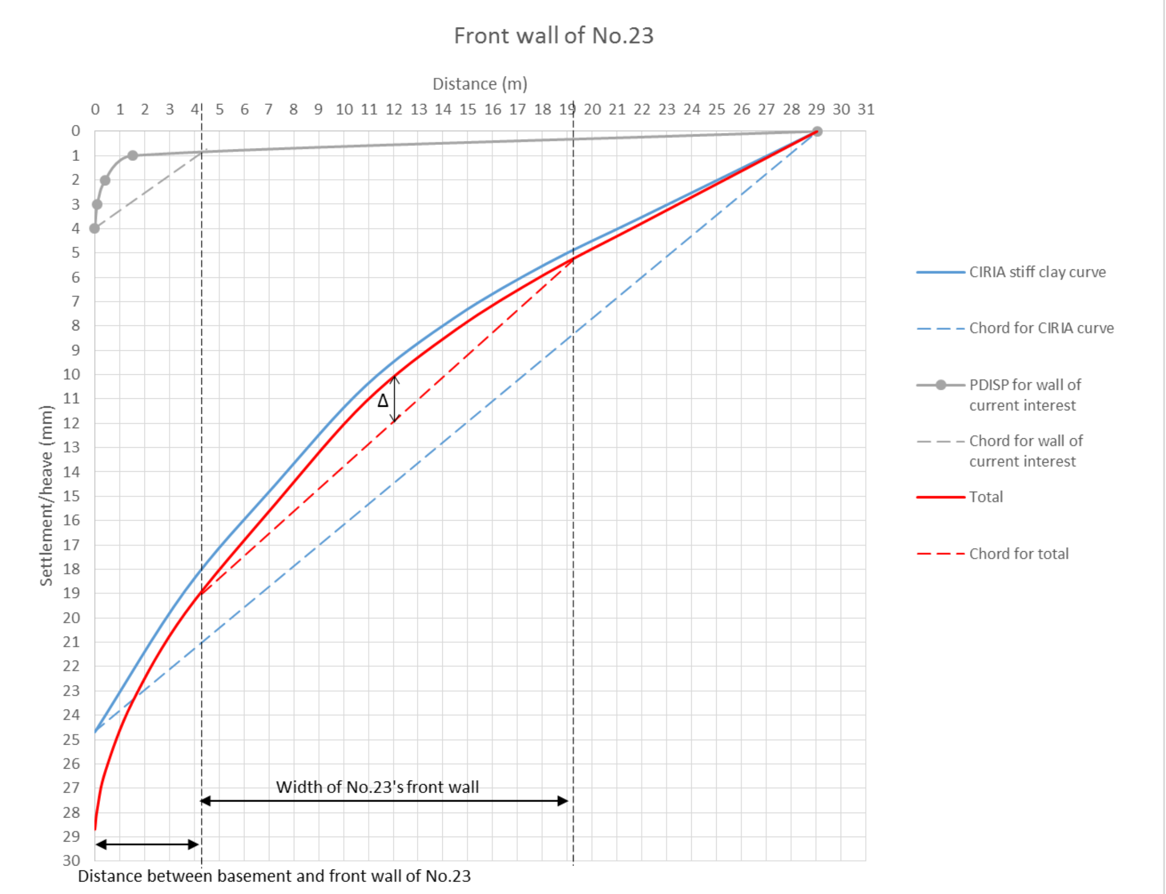

Figure 1: Displacement profile for front wall of No.23.

2.7 Using the graphs for L/H = 2.0, these deformations represent a damage category on the boundary between 'very slight' (Burland Category 1, ε_{lim} = 0.05-0.075%) and 'negligible' (Burland Category 0, ε_{lim} = 0.00-0.05%), as given in CIRIA SP200, Table 3.1, and illustrated in Figure 2 below.

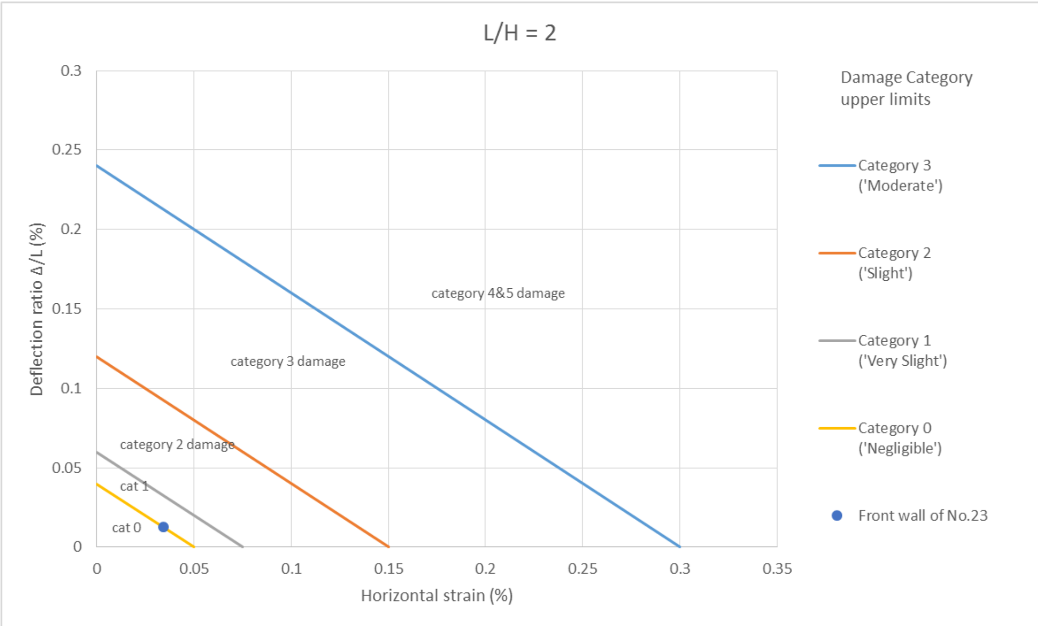

Figure 2: Damage category assessment for front wall of No.23.

<u>Rear wall of No.23:</u>

2.8 At the rear of No.23 is a two storey rear projection on its north-east side, and a small single storey bay on its south-west side. For this damage category assessment, the rear wall of No.23 has been modelled as extending the full width of the property, including the rear projection, to reflect a possible 'worst case' scenario. The relevant geometries, using a similar methodology as above, are summarised below:

Depth of foundations = 1.0m (assumed) below ground level at rear of No.23.

Ground level at rear of No.23 = 89.45m AOD (scaled from drawings)

Depth of excavation beneath ground level at No.23 = 89.45 – 82.61 = **6.84m**

Width of zone of affected soils – pile installation = 13.0 x 1.5 = **19.5m**

Width of zone of affected soils – excavation = 6.84 x 4 = **27.36m**

Width of No.23's rear wall (L) = **14.94m** (located **4.50-19.44m** from nearest bored pile around No.24's basement pool)

Height (H) = 6.20 + 1.00 = **7.20m** (wall height + foundation)

Hence L/H = **2.08**

Bored Pile Walls:

2.9 Some ground movement is inevitable when basements are constructed, even when using bored pile walls. Ground movements alongside the piles have been assessed using relationships developed from empirical case history data published in CIRIA's report C580 (Gaba et al, 2003). That report noted that "*ground movements cannot be predicted accurately, but it is possible to estimate them based on … an empirical approach* …" as presented in the following paragraphs. The movements in ground supported by a bored pile wall are highly dependent on the stiffness of the support system as a whole. For the proposed 'bottom-up' construction method to be classified as 'High support stiffness' (as used for the damage category assessment below), an appropriate construction sequence will need to be followed, with temporary props installed at high level that can equal the stiffness of the RC roof slab. Alternatively a 'top-down' construction method could be implemented, with the RC roof slab cast prior to excavation.

2.10 CIRIA Report C580 presents charts which relate measured ground surface movements alongside bored pile retaining walls in stiff clays to pile installation (Figure 2.8 therein) and excavation in front of the wall (Figure 2.11). These charts are based on measurements taken perpendicular to a continuous run of BPW, whereas No.23's rear wall is offset by approximately 2.1m (closer to Heath Drive) from the end of the bored pile wall. While the basement does continue forward from the BPW, the offset from the BPW means that the displacements likely to be experienced are expected to be lower than the values predicted from the CIRIA charts.

2.11 As the site is underlain by London Clay, use of a full secant BPW will not be necessary; a combination secant/contiguous wall, with the female piles taken down only as far as the formation level, would provide a significant cost saving so that wall configuration has been analysed. For 'high support stiffness' walls designed and constructed in accordance with best practice, the estimated ground surface movements resulting from installing a secant/contiguous bored pile wall to an estimated depth of 13.0/7.0m below the ground level at the rear of No.23, and then excavating to a depth of 6.84m below the ground level at the rear of No.23, would be as given in Table 1 (allowing for the 4.5m offset between No.24's proposed basement and the rear wall of No.23). Mean values between the secant and contiguous BPWs were used for the installation displacements. Where the CIRIA data gave linear design 'curves' the predicted displacements were calculated pro-rata to the length of No.23's rear wall. The 13.0m pile depth has been estimated because, under standard UK practice, the design analyses for bearing piles are undertaken by the piling contractor.

Table 1: Potential approximate ground movements below rear wall of No.23 (at 4.5-19.44m from bored pile wall)		
High support stiffness – 6.84m depth of excavation / 13.0m deep wall		
Ground surface movements due to:	**Horizontal movement**	**Vertical movement**
Bored pile wall installation:	Reading from graphs: 0.039% of wall depth = 5.07mm	0.045% x 14.94/(2*13.0) = 0.026% of wall depth = 3.36mm
Excavation in front of wall:	0.15% x (14.94/27.36) = 0.082% of excavation depth = 5.61mm	Max 0.075% of excavation depth = 5.13mm
Totals:	**10.68mm**	**8.49mm**

2.12 Following the same methodology as used for the underpins (in paragraphs 2.5 to 2.7) the strain beneath No.23's rear wall would be in the order of $\varepsilon_h = 7.15 \times 10^{-4}$ (0.072%).

2.13 The upper bound lines for vertical movements in response to installation of a bored pile wall (secant or contiguous) in stiff clays are linear, so will generate no deflection. The High support stiffness graph was used to estimate the deflection likely to occur in response to excavation of the basement alongside the bored pile wall; this graph predicts a settlement trough alongside the retaining wall, though as No.23's rear wall will be 4.5m from the end of the BPW, the nearest corner of No.23's rear wall will be in the base of the trough, beyond which the curve is almost linear. When the separation between the bored pile wall and No.23's rear wall is taken into account (4.5 to 19.44m), the maximum deflection Δ = 0.68mm, which represents a deflection ratio, $\Delta/L = 4.55 \times 10^{-5}$ (0.005%).

2.14 Using the graphs for L/H = 2.0, these deformations represent a damage category of on the boundary between 'slight' (Burland Category 2, ε_{lim} = 0.075-0.15%) and 'very slight' (Burland Category 1, ε_{lim} = 0.05-0.075%), as given in CIRIA SP200, Table 3.1, and illustrated in Figure 3 below. In practice, as these analyses have not allowed for the offset between the rear wall of No.23 and the nearest end of the BPW, it is considered that Category 1 will be applicable to No.23's rear wall.

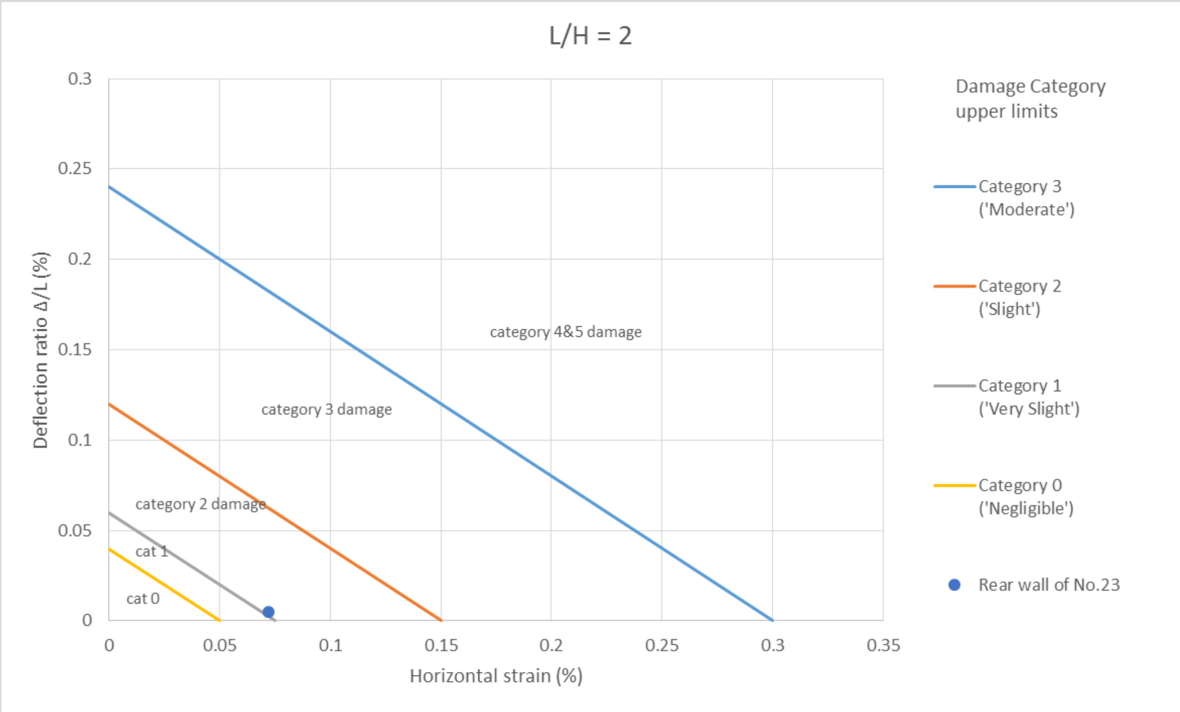

Figure 3: Damage category assessment for rear wall of No.23.

2.15 Use of best practice construction methods, as outlined in Section 10.4 of our BIA, will be essential in order to ensure that the ground movements are kept in line with the above predictions.

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