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BUILDING DESIGN PARTNERSHIP

PEARS BUILDING

NOTE ON MOVEMENTS ASSOCIATED WITH EXCAVATION

REVISION 1

January 2015

1 Introduction

It is proposed to construct a new building (the Pears Building) on the Royal Free Hospital site. The new building will be partly on the site of the existing car park and partly in a currently undeveloped area. Where the new building is on the existing car park footprint, there is very little excavation required. However, the southern part of the building will require around 7m of excavation and in the areas to the north-west of the new building around 5m of excavation outside the footprint of the car park is required.

This note assesses the impact of these excavations on the LINAC building, immediately adjacent to the deeper excavation, and St Stephen's Church, to the north-west of the site.

2 Heave assessment

Ground heave in the vicinity of the excavations has been modelled using the computer program PDISP. This requires an assessment of soil stiffness parameters.

In the ground investigation (RSK, 2014), underneath a covering of Made Ground, London Clay was encountered for the full depth of the boreholes. The London Clay is likely to be relatively thick in this area of London. The ground investigation indicates that the undrained shear strength, c_u, of the London Clay is around 70kPa near the surface (at around 70mOD) and increases with depth. In the PDISP analyses, the undrained stiffness, E_u of the clay has been taken to be given by $450c_u$, increasing to 225MPa at 0mOD, which was taken to be the base of the London Clay and a rigid boundary to the analyses.

Figures 1 and 2 show contours of short term movement at the end of excavation. These are both for the same analysis, but Figure 1 shows contours of movement in the immediate vicinity of the site, while Figure 2 shows movements in the vicinity of St Stephens Church.

The proposed building will be supported on piles. Consequently, there will be very little movement of the ground in the long term and so movements of buildings outside the site footprint should be negligible in the long term.

3 Impact on buildings

3.1 LINAC building

The LINAC building is piled and the wall closest to the site currently acts as and has presumably been designed as a retaining wall for the soil which will be excavated for the new construction. The excavation may result in some small lateral movements of the building as the soil pressure is removed. It is presumed that this would simply be reversing movements that occurred in the early life of the building when the soil was placed against the wall.

The short term potential heave movements in Figure 1, suggest that the ground will try to heave by up to around 10mm immediately adjacent to the proposed development. It should be noted that elastic analyses such as those carried out here tend to exaggerate the magnitude of movements outside the immediate area of loading or unloading.

Drawings of the LINAC building do not suggest that there is any compressible/collapsible material under its basement slabs. Consequently, the potential heave will be manifest as an increase in pressure under the basement slab adjacent to the excavation. Depending on the current conditions, this may simply serve to reduce the current pile loads and result in very little movement of the building, or it could result in all of the potential heave being manifest as movement of the building.

The LINAC building substructure appears to be fairly robust and surrounded by solid concrete walls. Consequently, it is considered unlikely that the maximum ‘free’ heave would manifest as movement of the building and that the worst case movement might be of the order of 5mm, occurring as a tilt across the width of the building, with very little distortion. Consequently, any resulting damage to the existing building should not exceed damage category 0 (negligible) of the damage classification shown in Figure 3. The impact of the potential tilt (approximately 1:2500) on any equipment should be considered.

There will be a partial reversal of any movements following loading associated with the new building and associated earthworks. In the long term, movements should be negligible.

3.2 St Stephen's Church

Short term movements as a result of unloading due to excavation as they might apply to St Stephen's Church are shown in Figure 2. These indicate that movements should not exceed ½mm. In addition, it should be noted that elastic analyses such as those carried out here tend to exaggerate the magnitude of movements outside the immediate area of loading or unloading, so the actual movements should be even less than this.

In addition to movements associated with unloading of the ground, there is also the potential for lateral and vertical movements associated with inward movement of the ground around retaining structures. While the form of the retaining structure to be used for the proposed excavations is currently not finalised, it is useful to look at the movements around excavations in the database of observed movements in CIRIA report C580 (Gaba et al, 2003).

These indicate that horizontal and vertical movements reduce to zero within a distance of four times the excavation depth from the line of the wall. The nearest point on St Stephen's Church is around 22m from the 5m deep excavation and over 40m from the 7m deep excavation. Consequently the church is more than four times the excavation depth away from the excavation and so movements associated with the formation of the excavation should be negligible provided the excavation is well supported.

Temporary works support to the 5m excavation should provide a moderately high stiffness system as considered by CIRIA report C580; this could be achieved by an embedded retaining wall and propping system, with movements of the wall restricted such that the movement of the head of the wall does not exceed 5mm, while the movement of any part of the wall does not exceed 20mm. If these limits are observed then movements around the excavation should fall within the envelopes of movements suggested by C580, which indicate negligible movement at a distance of 20m from the wall.

There will be a partial reversal of any movements following loading associated with the new building. In the long term, movements should be negligible.

Consequently it is considered that damage to the church resulting from construction of the Pears Building should not exceed damage category 0 (negligible) of the damage classification shown in Figure 3.

4 References

RSK. 2014. RFT Institute of Immunology and Transplantation, NW3 2PF. Geo-environmental and geotechnical site assessment. Report ref: 27119-01 (00).

Gaba, A R, Simpson, B, Powrie, W & Beadman, D R. 2003. CIRIA C580: Embedded retaining walls – guidance for economic design.

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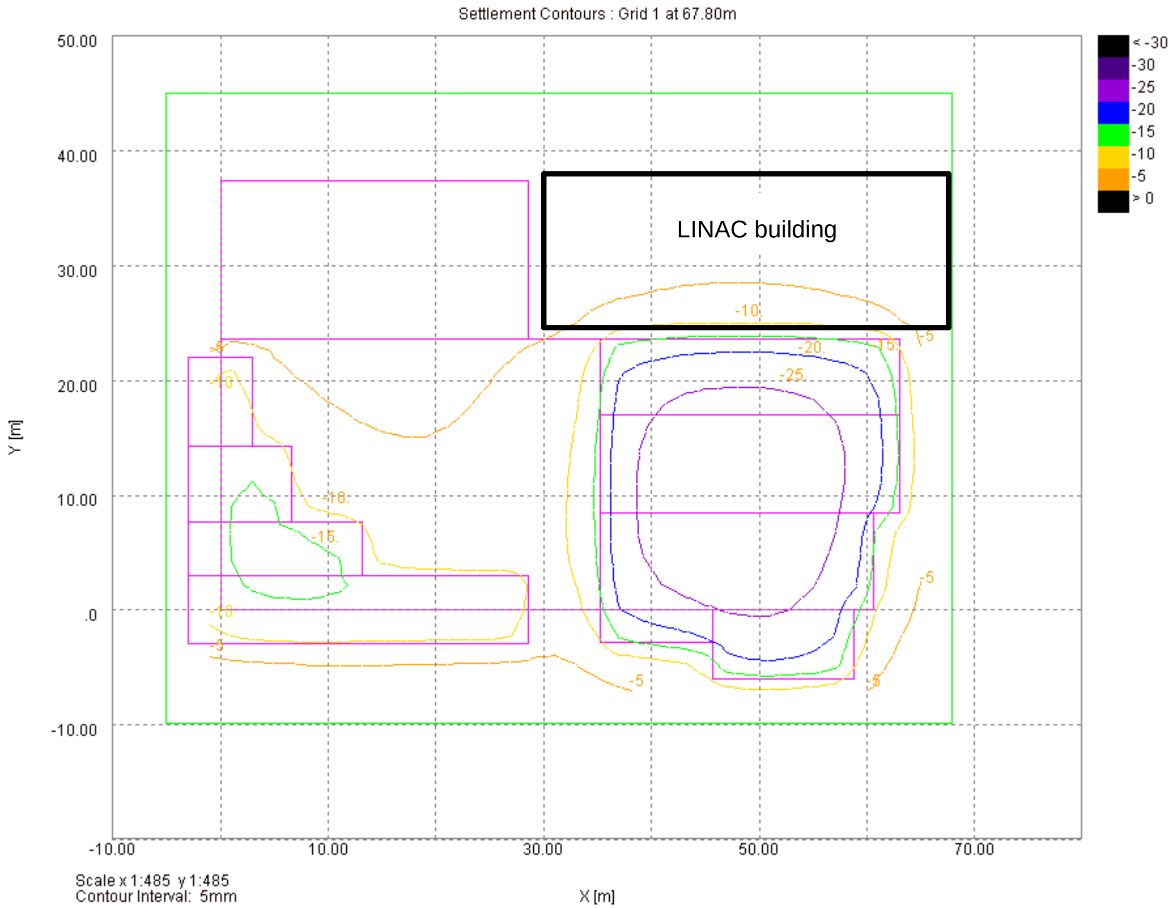
FIGURES



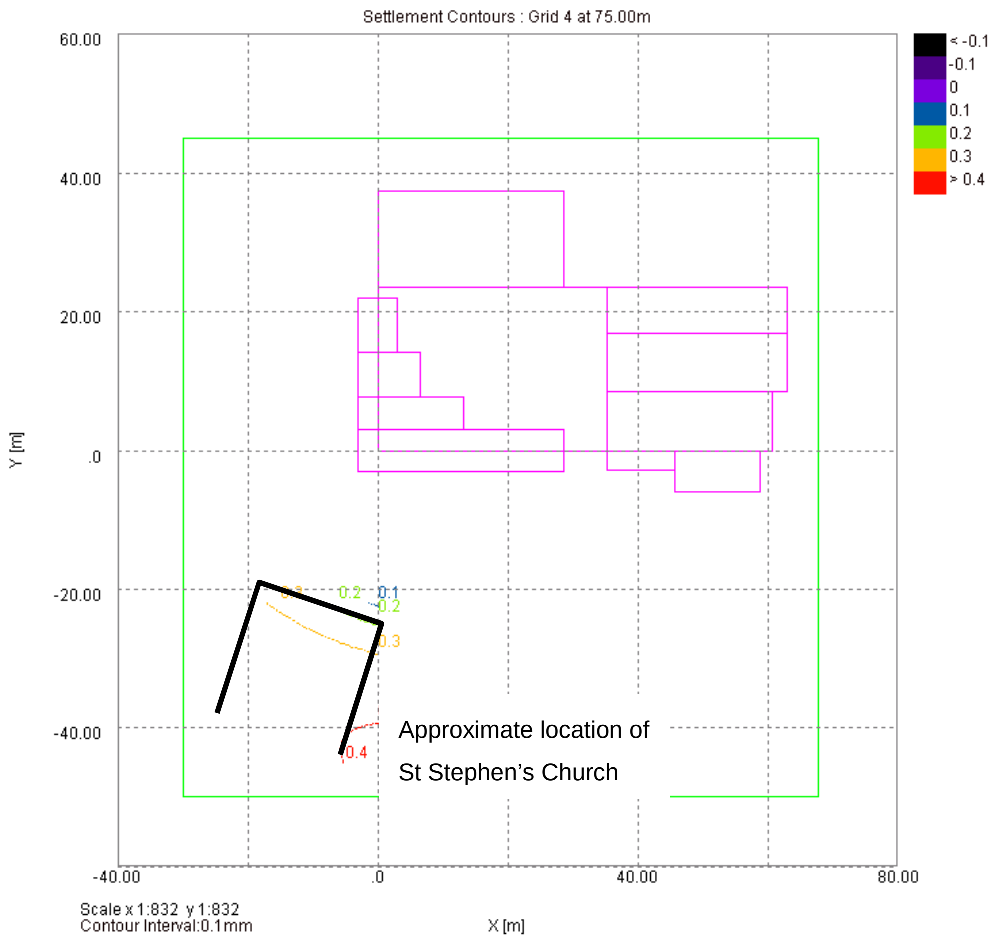
Building Design Partnership

Pears Building

Heave contours: excavation, short term

Figure

1



	Building Design Partnership Pears Building	**Figure** **2**
	Heave contours: excavation, short term	

Category of damage	Limiting tensile strain [%]	Normal degree of severity	Description of typical damage (Ease of repair is printed *italic*) Note: Crack width is only one factor in assessing category of damage and should not be used on its own as a direct measurement of it
0	0-0.05	Negligible	Hairline cracks less than about 0.1 mm
1	0.05-0.075	Very slight	*Fine cracks which are easily treated during normal decoration.* Damage generally restricted to internal wall finishes. Close inspection may reveal some cracks in external brickworks or masonry. Typical crack widths up to 1 mm.
2	0.075-0.15	Slight	*Cracks easily filled. Re-decoration probably required. Recurrent cracks can be masked by suitable linings.* Cracks may be visible externally and *some repointing may be required to ensure weathertightness.* Doors and windows may stick slightly. Typical crack width up to 5 mm.
3	0.15-0.3	Moderate[1]	*The cracks require some opening up and can be patched by mason. 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. Typical crack widths are 5 to 15 mm or several up to 3 mm.
4	>0.3	Severe	*Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows.* Windows and door frames distorted, floor sloping noticeably[2]. Walls leaning[2] or bulging noticeably, some loss of bearing in beams. Service pipes disrupted. Typical crack widths are 15 to 25 mm but also depends on the number of cracks.
5		Very severe	*This requires a major repair job involving partial or complete rebuilding.* Beams lose bearing, walls lean badly and require shoring. Windows broken with distortion. Danger of instability. Typical crack widths are greater than 25 mm but depends on the number of cracks.

[1] Note: Boscardin & Cording (1989) describe the damage corresponding to the tensile strain in the range 0.015 - 0.3%. as 'moderate to severe'. However, none of the cases quoted by them exhibit severe damage for this range of strains. There is therefore no evidence to suggest that tensile strains up to 0.3% will result in severe damage.

[2] Note: Local deviation of slope, from the horizontal or vertical, of more than 1/100 will normally be clearly visible. Overall deviations in excess of 1/150 are undesirable.

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Classification of potential building damage (from Gaba et al, 2003)

Figure

3