Royal Free London NHS Foundation Trust

Fleet Road – Boundary Wall Instability Due to Proximity of London Plane Tree

W&A Ref: 16-1208-RP01

Initial Structural Engineering Assessment

Introduction

The existing boundary retaining wall is of solid blue engineering brick with recessed mortar joints and a shaped brick on edge coping. Where free standing (not retaining earth), the wall is 215mm thick built in English bond. The wall generally stands approx. 1300mm above the pedestrian pavement and the London Plan stands behind on an earth mound which the wall retains against the pavement.

The trunk of the tree rises only 250mm from the back face of the wall.

The wall has a significant lean towards the pavement, measuring approx. 80-90mm approx. over the height of the wall. Hence, relative to the base of the wall and assuming it to be only 215mm thick, the back of the wall would be only 150mm from the tree trunk. It is probable that the wall is thicker at low level, although this could not be detected. This would mean the back face is either flush or rises beneath the tree trunk.

There are several cracks along the length of the wall where it is acting as a retaining wall. There is significant lateral displacement at these cracks which indicates a loss of bond in the masonry bed joints. The retained load has exceeded the capacity of the wall, which has resulted in sliding of the masonry across the bed joints. This will have further reduced the retaining capacity of the wall.

There is a large crack in the masonry against the tree where the brickwork has an offset in the plane of the wall of approx. 20mm. Additionally, a tapering vertical crack has developed at this point which is largest at the top of the wall, opening to approx. 40mm.

No attempt has been made to excavate behind the wall to confirm the existing construction. Visual examination through the crack at mid height indicates the wall is of masonry construction and may be only 215mm thick brick, in the upper part. This suggests the wall may not have been intended to work as a retaining wall to full height as the current condition and the ground may have become gradually raised as the tree became established. Whilst the tree root system is clearly imposing load on the back of the wall, it will also be binding the ground together making it almost self-supporting under normal conditions. However, in the event of adverse wind loading, the wall will now offer negligible resistance to retain the root system and instability of both the wall and potentially the tree is now highly probable.

Since there is a significant outward lean of the wall, it would not be possible to reconstruct the wall without significant pruning of roots, even if it were possible to reconstruct the wall to the original wall thickness.

Temporary Safety measures

The following are options for temporary measures to minimise the risk of harm in the event of collapse of the wall only.

i. Do nothing – the risk of collapse of the wall is high due to the existing deflection and cracking which has resulted in loss of strength and instability. This option cannot be recommended on grounds of health and safety, risk of injury and potential claims against the Trust.

ii. Close the footpath and divert pedestrians to the footpath on the opposite side of the road. Prop the wall with temporary raking shores. This would present difficulties to pedestrians as there are no crossing points in close proximity. Footfall on the west side footpath is significantly greater.

iii. Install a temporary cantilever trench sheet pile wall in front of the existing wall. This would require construction outside of the Trust boundary line and result in significant reduction in the available footpath width. There is a high risk that the installation of these temporary works might destabilise the wall and cause collapse during the process of this work. Existing buried services beneath the footpath may require diversion or prevent this option from being viable.

iv. Stabilisation of the wall face may be achieved by specialist nailing / ground anchor techniques which would involve diagonal drilling through the wall and earth bank, anchoring temporary steel facing plates to deep ground anchors behind the wall. This would also result in work from the outside face of the wall. Projecting plates and numerous anchorages would be an obstruction, hazard and hindrance to pedestrians unless a secondary protection screen was mounted in front of the work which is likely to result in significant loss of footpath width. Some damage to tree roots is likely to result from this method which may also lead to development of planes of weakness in the soil. These may have significant impact on the resistance of the tree to wind loading. Further specialist advice should be sought to determine whether this method could be viable.

Options for Permanent Reconstruction of the Boundary Wall

The following options for reconstruction of the retaining wall have been considered:

Option 1

Conventional gravity masonry retaining wall; The space required behind the wall for thickening and foundation construction sufficient to ensure stability of the wall under normal soil pressure is insufficient and the necessary excavation would result in excessive pruning of the root system and building beneath the tree trunk which would not be safe or viable.

Option 2

Conventional reinforced concrete retaining wall; In order to maintain the wall within the RFH demise, it would be necessary to construct a toe behind the wall which would have a similar impact as the gravity masonry wall structure option.

Formation of a toe in front of the wall might be considered viable if construction outside of the RFH demise is permitted by the council, however the required width may exceed the footpath width and there may be mains services running beneath the pedestrian pavement that preclude this option.

Further investigation of existing buried services installations would be required.

Option 3

Construction of a steel sheet or bored pile retaining cantilever retaining wall; This would involve removal of the existing masonry wall and associated foundation prior to installation of the piles.

Due to the lean of the existing wall, significant trimming of the existing ground and root system will be required to clear space for the sheet pile wall profile above ground level which is likely to be at least 300mm wide.

Typically sheet piles are driven twice as deep into the ground as they stand high and thus for 1.5m wall height, piles approx. 4.5m long will be required. The equipment required to drive the piles would require further 2-3m headroom. This arrangement of the piles and equipment will thus require approximately 8m headroom which will require significant pruning of the existing tree for the rig to gain access to drive the piles and move sequentially along the entire length of the wall.

This method will involve noise and vibration during the process of pile driving. Access for the rig and wall construction will require closure of the path and partial possession of the roadway.

Option 4

Construction of a king post pile wall. This method would require driving of H section piles at probably 2.4 – 3.0m spacing along the line of the existing wall following demolition and clearance of the wall. These would be driven in to cantilever out of the ground with drop in precast panels spanning horizontally between the king post H piles. The size of the piles would be determined by the retained load and pile spacing and is likely to be 250 – 300mm wide.

The benefit of this method would be that pile driving would not be necessary continuously along the wall and thus the H piles could be positioned to avoid piling against the main trunk and possibly reducing the amount of pruning required.

This method will also involve noise and vibration during the process of pile driving. Access for the rig and wall construction will require closure of the path and partial possession of the roadway.

Conclusions and Recommendations

The existing boundary wall has been heavily overloaded by the adjacent plane tree. It appears the wall was possibly not originally designed or constructed to support the earth filling where the tree now stands.

Severe cracking and deformation of the wall has been caused by excessive pressures from the ground and tree roots behind the wall.

The earth and tree root pressure has resulted in displacement of the wall across bed joints at low level and significant lateral deflection of the wall causing significant vertical incline.

The wall is currently in an unsafe condition and could collapse without warning which could result in serious injury to persons using the public footpath or vehicles on the highway.

Options for temporary remediation have been considered. 'Do nothing' cannot be recommended due to the risks of collapse. Temporary closure of the footpath and raking shoring would result in pedestrians having to cross the road with incumbent risks and remedial retaining solutions would result in significant reduction on the available footpath width.

Temporary stabilisation of the existing wall will result in significant disruption and probably temporary closure of the existing footpath due to the space required for the installation of temporary support piles or ground anchors.

An operation risk assessment is recommended to consider the most practical and viable option and possibly explore alternative options.

A number of permanent wall options have been considered. Construction of conventional gravity retaining walls will require significant excavation behind the wall and removal of root growth. Thus is likely to be unacceptable, possibly damaging to the tree and reducing the resilience of the tree to resist wind loading.

A king post cantilever retaining wall appears to be the most feasible structural option. However, the amount of trimming back of roots and pruning of the tree to facilitate access for the piling rig and wall construction may be prohibitive in terms of maintaining vigour and wind resistance the tree. Even this option is likely to result in reduction in resilience of the tree and stability following the work is likely to be significantly diminished.

We recommend consideration be given to removal of this tree due to the high risk of collapse either in the temporary or permanent conditions.

David Wareham BSc (Hons) C.Eng MICE FConsE
Wareham & Associates ltd

19th January 2017

Photo 1: *View along boundary showing tree standing high on ground behind brick retaining wall.*

Photo 2: *Close proximity of tree trunk to rear of boundary wall at ground level.*

Photo 3: *Tapering crack in masonry wall adjacent to tree.*

Photo 4: *Lateral displacement of brickwork at low level.*

Photo 5: *Offset of wall at tapering crack adjacent to tree trunk.*

Photo 6: *Excessive crack width at top of wall adjacent to tree.*