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date: 01 January 2016
ref: 160101 Structural Need 1 sm530

STRUCTURAL & REPAIR NEED ANALYSIS

44 Downshire Hill, London NW3 1NU

A **Background:**

1 The building has been monitored for movement by myself since 1984 when purchased by Mr. & Mrs. Leifer. With the exception of a small rear extension added in 1995, the layout and configuration of the building has remained the same.

2 The ground floor reception rooms have had an historic diagonal slope down to the left rear of the building. This has been caused by gradual differential settlement over a considerable time. The rear LH corner section of the walls of the garden floor Family room floor (P5 & P9 on drawing 53023-1) has always been the focus of settlement and associated cracking of the walls above.

3 In 1988 no obvious cause could be found for that instability and consequent differential settlement.

4 Cracking in a number of walls was found and as this appeared slight and the building structure appeared relatively stable it was felt that the building should be monitored for movement and remedial action taken only if settlement resumed and the building fabric weakened to a point where the building's stability was impaired.

5 Any remedial works carried out in the last 30 years have been relatively small in scope and limited to rebuilding and repairing lintels, window distortions and cutting out and stitching cracks, mainly in the left rear corner and rear wall on all floors.

6 In 1995 when the rear lobby and WC extension was built two things were discovered.

6.1 There was a leaking main drain with associated ground softening in the area just outside the rear façade. This was repaired and sections replaced.

6.2 The existing foundations were narrow splayed brick and very shallow on clay and some made ground. The maximum depth from ground surface to underside of footings in all walls exposed was 360mm. The internal spine wall parallel and adjacent the lower halls only 9" brick with a maximum footing width of 2 x stepped London stock soft bricks with lime mortar on moist plastic clay with a little sand. Adjacent and below this footing is the main drain run, rear to front, in 4" glazed clay bedded in made ground within 60cm from the spine wall and below footing level.

6.3 The maximum safe bearing capacity of the subsoil moist clay with a little sand from the 1995 opening up is 15,000kg/m² or 150kN/m². Given the width of the existing spine wall footings = 50cm, the safe bearing capacity of 1m linear of footing is 75kN. The total actual live and dead loads on 1m linear of the spine wall footings is 90.4kN or 180.8kN/m². Therefore the spine wall footings are clearly inadequate.

B **Structural Flaws & Design Inadequacies:**

1 The design of the building has a number of inherent design flaws due to plan due to a combination of plan layout and differential loadings. The stacking of windows one above the other in the front and rear facades and similar stacking of door openings through the spine wall has created inherent zones of weakness in the structure with consequential load concentrations either side of the multiple openings. Stacking of the openings means stacking and concentration of loads on various points along the footings, especially along the rear section of the spine wall in areas P4 & P7.

2 Also, the spine wall, having footings half the thickness of the front and rear facades has relatively heavier loadings as it also carries loads from both sides, continues right up through the building to act as a flank wall at high level and also taking roof loads from both sides.

3 The combination of stacked openings, small footings, unstable local ground conditions and relatively high structural loadings has meant parts of the house footings are overloaded and unstable.

4 Combined with the small depth and inherent weakness of the splayed brick footings means the footings do not have enough structural cohesion to absorb and re-distribute the upper loads evenly.

5 The spine wall is not acting as a single plane on edge with loads distributed evenly along its length on the subsoil, but due to the combination of stacked openings and weak footings, sections of walls are starting to crack apart with some sections acting as individual columns.

6 These columns P2, P4, P5, P7 & P9 continue to move and settle broadly independent of each other with the column sections P4, P7 and P9 settling most with the greatest differential failures at crack locations 4, 5 and 7. For example see recent crack opening up over the last year at location 4 and as shown in photos 96, 97 and 98 of the GW Schedule of Condition.

7 The spine wall footings are inadequate even if the loads are uniformly distributed. If sections of the spine wall for example, are treated as columns, disregarding uniform distribution, but each bearing directly on the subsoil, the situation is far worse. The loads from Panel Column A (P4) rise to 211kN/m² and from Panel Column B (P7) rise to 234kN/m², clearly indicating totally inadequate footings. (See attached calculations).

8 Over the years, cosmetic filling and redecoration has been carried out repeatedly to cover cracks. The cracking at 4 and 5 is recent and movement in this area has accelerated during 2015.

9 Generally the walls above that area have become more unstable and now require extensive brick stitching as the lower settlement has resulted in movement of the fabric above. The secondary effects at upper levels are that there is now significant cracking and delaminating of the upper plaster decorative finishes. In two upper rooms (Ground floor front and First floor rear) this instability in the lath and plaster & plasterboard ceilings means they need to be replaced (See pages 6 & 8 GW Schedule of condition).

10 A secondary effect on the garden floor of the more extensive settlement in the areas P3, P4 & P5 has been to lower the ground floor ceiling and the head height of the hall entry door into the family room. The ceiling height in the Garden Floor kitchen and family rooms has always been low at less than 2m but now this has dropped to such a level that head clearance is so low that taller occupants now hit heads on areas of the ceiling (1870mm) and have to duck through the hall entry door (1890mm).

C **Main House - Analysis and Proposals:**

1 Some walls need to be repaired and the upper floor ceilings, wall and floor finishes repaired and re-instated and in two cases replaced. These works should be carried out as soon as possible as delay will only lead to greater instability of some areas of plaster finishes. Specifically the ground floor ceiling mouldings. There is also a possibility of failure and plaster falls from the two ceilings mentioned above.

2 While repair and replacement of the upper finishes is straightforward and can be carried out as soon as the upper walls are repaired, their stability cannot be guaranteed without also addressing and eliminating the cause, the structural instability of the foundations.

3 While the walls on the ground and garden floors can be stretched and repaired, the differential settlement can only be halted by providing lower loaded footings with integrity that will evenly carry and distribute the unequal upper structural loadings. That can only be done by removing and replacing the splayed brick footings with new foundations of greater strength and integrity.

4 The splayed brick footings need to be replaced with ground beams to evenly distribute unequal upper loadings. These need to be wider than the existing footings to spread and therefore decrease loadings on the subsoil. As this would be impossible to put in place at one time, so traditional segmented massed concrete pins with top and bottom deformed bar dowels should be used.

5 The default position has always been to monitor and minimise the extent of invasive repairs to the structure. This methodology has been shown to have been the right one for the last 30 years as long as the structure remained stable or settled evenly. However, there has been a further fresh movement over the last 12 months and that combined with the now extensive list of upper fabric repairs means that position has changed.

6 Initially it was proposed to underpin only a limited a section of the spine wall (see attached sketch survey proposal 53020-1) on the basis that minimum intervention was the best policy for a relatively weak structure, however as the entire main drain run had displaced joints and lacked integrity and would have to be replaced, the underpinning proposals were extended to include the whole of the spine wall in February 2015 (see drawing 53020-2).

7 Further investigations and recent movements have resulted in a far more extensive upper defect and repair schedule being identified and the conclusion drawn from the defects found and the settlement observed is that the future integrity of the upper structure and finishes can only be protected by replacing the inadequate footings under the front, rear facade walls, the inner cross wall as well as the spine wall.

8 The common wall with #43 has relatively new footings to the rear under the #43 rear addition. The front of the common wall is only 3 not 4.5 storeys high and less heavily loaded than the #44 spine wall. Piers P3 & P8 are integral to and act with the common wall with #43 with the zone of weakness and cracking along the entrance halls and rear stairwell on lines 2 and 7. As a result the common wall with #43 is stable with little evidence of settlement or cracking and requires no underpinning.

9 The common wall with #45 is as tall as the spine wall at 4.5 storeys but with the chimneybreasts much wider and has the advantage of larger splayed footings of the chimneybreasts both sides. Again loadings are lower and there is no evidence of settlement and little cracking.

10 Current proposals are therefore to replace the footings in the house less both common boundary walls. See drawing 53022-11, underpin Sequencing - Option 4.

11 Given the amount of existing floor removal necessary to carry out the foundation replacement works, the opportunity would be taken to reduce the garden floor levels slightly (260mm) in parts of the lower hall, kitchen and family room. Although more ceiling height would be desirable, this is a compromise and considered the minimum necessary to re-instate a habitable ceiling height to that floor of 2250mm clear while still being able to insert 2 x minimal steps in the rear hall, each riser 130mm. Any less or having a single step would be a trip hazard.

12 Structural floor slabs with raised edges along both common boundary walls would be laid to enable the floor height reduction, insertion of floor insulation while minimising the impact of those reductions on the retained existing footings. Screeds will be minimal and limited to 20mm self levelling.

13 The detailed methodology, scope and specification of proposed works is set out in the Revised Specification for Underpin & Repair dated 23 Dec15.

14 Structural loading calculations and replacement footing dimensions are also attached as Structure Calcs 1.

D **Front Steps & Lobby - Analysis and Proposals:**

1 The front lower porch and steps are not original to the house but were reconstructed pre 1988 prior to the current ownership. The recycled London stock bricks used, the lower front door and frame and the sawn York slab steps used indicate this was rebuilt post 1960. the exact date of reconstruction is not known.

2 This area was poorly rebuilt and the lower lobby ceiling is not waterproof. The area is damp and mouldy at all times of the year and suffers from water penetration around the main drainage interceptor pit located just inside the front gate at the base of the upper entrance steps.

3 This main drainage pit is some 3m deep and shares a common rear wall with the streetside wall of the lower lobby. This area is permanently damp and there has been some structural movement and permanent laying water in the soil duct along the boundary wall in the lower lobby for years. This appears to be subsurface groundwater which also comes through the front retaining wall under the adjacent brick bin store. This has proved impossible to eliminate with the situation made worse by the limited access possible and the number of pipe and drain penetrations.

4 The only way to deal with this and eliminate water penetration is to take down the steps over, rebuild the porch wall in matching recycled London stock bricks, rebuild the floor, inner lining walls and roof as a thin structural shell over full tanking and insulation, replace the main drain under and tank the upper surface of the new structural ceiling prior to replacing the main steps and parapet as was.

5 There will be a little loss of internal space because of the provisional of tanking and insulation but the front steps, parapet and lower lobby will have the same look and external dimensions as previously.

6 The only differences will be that the service door and frame to the lower lobby will be replaced and set 200mm lower and the well outside the lower service door will be lowered 250mm with a lower step added in matching natural York stone. This lowered well will also prevent flooding as happens on occasion currently.

7 The existing front garden wall and parapet shared with #43 will be protected and retained as is. No underpinning will be required.

8 Any front stone paviors or step treads that have to be removed for works will be location measured prior to removal, numbered, stored in the rear yard, protected, covered and returned and reset to their original pattern and location.

9 The front lower porch, steps and common garden wall are separate structurally from the main house. Carrying out both sets of works simultaneously will allow for hidden, flexible waterproof joints to be incorporated around drains and services where they penetrate the main house as well as between the main house and porch lobby structures to allow for differential movement.

10 Details of the construction and methodology for the rebuilding of the front lobby, waterproofing and steps are as per attached drawings and Revised Specification for Underpin & Repair dated 23 Dec15.

Scott MacGregor
01 January 2016