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STRUCTURAL & REPAIR NEEDS ANALYSIS
44 Downshire Hill, London NW3 1NU

A **Background:**

1 The building has been monitored for movement 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 (now 160mm differential). 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

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 subsurface moist clays on which the building shallow footings stand was assessed in the 1995 opening up as 15,000kg/m² to 20,000kg/m² or 150>200kN/m². Given the width of the existing spine wall footings = 40cm, the safe bearing capacity of 1m linear of footing would be maximum of 0.4 x 200kN = 80kN. The total actual live and dead loads on 1m linear of the spine wall footings are 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 carry 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 takes roof loads from both sides.

3 The footings are also very shallow and bedded in relative unstable plastic surface clays making them prone to cyclical movement when there are seasonal moisture changes.

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

5 the footings are composed of the same soft London stock bricks bedded in saturated flexible lime mortars. These footings have little lateral structural strength and are inherently weak. This weakness enables the building walls to slowly settle differentially and adapt to change with minimal cracking. Unfortunately this weakness and poor structural cohesion limits the footings ability to uniformly re-distribute the upper loads evenly along sections of footings. When sections of footings differentially settle to such an extent as has happened along the spine walls, the flexible lime mortar cannot accommodate the movements and sections of wall shear apart.

6 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 come apart with some sections acting as individual columns. In this sense the wall and footings in this area have failed irreversibly.

7 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 (see drawings 53023-1 and 53023-2 for locations). 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.

8 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).

9 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 late 2015.

10 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).

11 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 An extensive survey of condition and repairs was carried out in October 2015. These repair 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. That upper repair work is extensive and a further application is being prepared but will take time to prepare.

2 These investigations have resulted in a far more extensive upper defect and repair schedule being identified.

3 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.

4 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 installing supplementary footings of greater strength, depth and width under the existing splayed brick footings.

5 This will be done by installing hand dug traditional segmented massed concrete pins with concrete joining cleats to minimise vibration and further damage to the existing structure and finishes.

6 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 fairly stable or settled slowly and evenly. However, the further fresh movement over the last 12 months, accelerated over the last 6 months, has resulted in localised foundation and wall failure. This, combined with the now extensive list of recently found upper fabric failures means that position has radically changed and the foundations require immediate repair to prevent further damage to the upper parts and possible localised element failures at Garden floor wall and ceiling level.

7 Initially it was proposed to underpin only a limited a section of the spine wall on the basis that minimum intervention was the best policy for a relatively weak structure.

8 The extensive upper damage and the amount of recent lower differential settlement observed means that position cannot continue to be tenable and it has been concluded 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.

9 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.

10 Furthermore the front façade is known to be friable and showing signs of instability. Works to #44 should therefore take into account that weakness and be avoided nearby if possible.

11 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.

12 To minimise the impact on adjacent properties underpinning works should take place from within the existing kitchen and family rooms. Both these rooms have modern concrete floors that will have to be removed and replaced to current standards.

13 These proposals are therefore to partially replace the footings in the house less both common boundary walls. See drawing 53035-1, underpin Sequencing - Option 5b. these works are limited to repair of the foundations only and any associated floor and service reinstatement,

14 It must be stressed that these essential repairs cannot be delayed and must be completed within the next few months to avoid further degradation of the heritage asset.

Scott MacGregor
26 March 2016