Barton Engineers

Report

Structural Survey

27 Russell Square

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Introduction

Barton Engineers have been asked to carry out a structural survey of this property by Birkbeck, University of London, who it is understood are the current leaseholders of the building. The property comprises a five storey Georgian terrace house, including a lower ground floor below street level. The high floor to ceiling heights and deep plan make this property one of the larger types of Georgian terrace house typical of the Bloomsbury area of London. The property was inspected for the purposes of preparing this report by Bob Barton of Barton Engineers on 25th February 2016. However, a number of previous inspections and opening up explorations had been carried out previously by Barton Engineers during January and February 2016.

The specific purpose of this structural survey was to establish the general condition of the structure of the property, and specifically to investigate the deformations and cracking witnessed at second and third floor levels, and to make recommendations on any repairs necessary to make good these structural problems.

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Observations

Description

The property at 27 Russell Square is Grade Two Listed, and the listing notes state that the property is part of a terrace of five listed buildings, consecutively numbered 25 to 29 Russell Square. According to the listing notes the terrace was built in or around 1814, by James Burton, who was one of the most important developers in Georgian London and who was responsible for a large number of Bloomsbury properties. The listing notes refer only to the front facades of the terrace and, specifically, to the semicircular arched doorways, gauged brick window lintels, recessed sash windows, the continuous stone and ironwork balconies, and the rusticated stucco render to the ground floor storeys. Specific mention is also made to the fluted Doric half columns adjacent to the front door and also the cast iron railings and lamp-holder outside number 27 Russell Square. It is clear from the listing description that the heritage significance of the property is largely due to the facade, its relationship to the terrace, and its position at the north west corner of Russell Square.

The interior of the property has been much altered since its original construction, although the original stone cantilever staircase is still in place from upper ground to second floor level. However, this stair has suffered significant deformations and has been fully propped by a late Twentieth Century steel support structure comprising steel rolled section stringers set beneath the original stone structure.

Roof

The roof of the building comprises two slate clad pitched roofs, set between projecting party walls that contain long chimney stacks. The ridges of the two roofs run from party wall to party wall, so forming a central valley and outer gutters behind brick parapet walls at the front and rear. Access to the central valley is gained via an access staircase within Number 28 Russell Square, and a step over the reduced level party wall between 28 and 27 Russell Square. Access to the front and rear gutters can only be gained via ladders loose laid on top of the roof pitches and, at the time of our survey, it was only possible to make a visual survey of the front roof gutter from the roof ridge line. Within the central valley are three roof lights and one access door enclosure providing access into the rear roof space. The front roof space can be accessed via an access hatch in the ceiling of the corridor to the third floor below.

1. View of Roof:

The condition of the roof slates was generally good, although a significant moss build up had occurred on the east slope of the west or rear roof. A number of slates appeared to have been replaced over the years, and it is probable that the roofs have been re-clad at some point within the last thirty years or so. The ridges seemed to be clad in concrete tiles, and again these appeared in good condition. The flashings into the raised chimney stacks appeared to comprise lead that was then clad in a cement render, although lead was only visible at the base of the render. There were significant gaps between the top of the vertical render and the chimney masonry behind in many locations, and it is possible that water ingress has occurred along this joint line in all areas of the roof.

2. View of Typical Flashing To Slate Roof:

The rear of the parapet wall to the front of the building could only be viewed by looking over the ridge of the roof (as described above). It comprised a low wall that was rendered, and with a continuous lead flashing that lapped over the asphalt upstand forming part of the gutter. Concrete or stone coping stones capped the brickwork wall. The parapet appeared in good condition and there were no obvious structural defects visible.

3. View of Front Parapet From Roof Ridge:

The chimney stacks set on top of both the north and south party walls appeared in reasonable condition structurally, and were topped by light cream coloured ceramic chimney pots with highly decorative patterning, suggesting that these elements were part of the early Nineteenth Century construction. However, the render to the chimney stacks was in poor condition in most areas; a bituminous paint on the outer surfaces had flaked away in most areas, and cracking of the render in a crazed pattern, with parts of the render beginning to spall off, seemed to be typical of its general condition. The coping areas of render around the chimney pots were in better condition, and it is likely that this element was still providing the appropriate level of weather protection.

4. View of Chimney Stack and Pots:

At the rear of the building the south party wall follows the line of a larger rear extension to Number 28 Russell Square, and contains another chimney stack that is constructed of stock brickwork without any render. The chimney appeared as though it may have been rebuilt at some point in the Twentieth Century, but it also seemed to have been rebuilt with a kink in the plan length, probably caused by rebuilding on the line of the previously deformed chimney stack structure. There were no obvious signs of ongoing defects within this chimney stack.

5. View of Rear Chimney Stack.

The roof lights comprised a combination of timber framing with single panels of glass, some patent glazing, and also some steel W20 type glazing. All of the glass used was of a single glazed Georgian wire type, and the flashings and putty surrounds were in very poor condition generally, suggesting significant water ingress was likely to have occurred through all roof lights. The steel clips holding the glass were also corroded and the roof lights generally were in need of refurbishment. It was noted that asbestos warning stickers had been attached to the glass panels. The access doorway into the west roof space was a timber structure with a timber boarded door panel that fitted badly and was also a probable source of water ingress.

6. View of Rooflight Detail.

The valley gutter and front gutter appeared to comprise an asphalt roofing membrane, which also appeared in poor condition with numerous folds and local blisters. It was presumed that the rear gutter was of a similar construction but this could not be confirmed during our visit as no visual access was available to the rear slope of the roof.

7. View of Gutter.

The internal structure of the pitched roofs comprised king post timber trusses supporting purlins and then rafters, with ceiling joists spanning between the trusses. There seemed to be three trusses within each roof; one in the centre and two adjacent to the party walls, all spanning from the external walls onto the central spine wall of the building. All appeared to good condition. Within the rear roof pitch was an open channel lead lined gutter that received stormwater from a central gulley in the valley gutter. This internal gutter then appeared to have a central gulley, with an overflow that fell to the rear of the building. This internal gutter also presumably received stormwater from the front gutter. It was impossible to establish how the inner gulley then distributed stormwater, although it was noted that the rear elevation appeared to have two outlets for stormwater; one at the rear parapet gutter level and another some 450 millimetres below, possibly receiving the inner gulley via another pipe within the third floor ceiling zone.

8. View of Roof Truss.

9. View of Internal Open Channel Rainwater Gutter.

Third Floor

The layout of the third floor comprises three rooms at the front of the building, all opening onto a corridor running along the spine of the building that also contains doors through the party walls at each end, opening into the adjoining houses of the terrace. Off the corridor in the middle of the plan is a staircase lobby giving access to the floor below and, accessed from doors off that lobby, are three rear rooms and also another small room adjacent to the north party wall. The roof lights are all set above the corridor or staircase lobby, and a large downstand is visible along the length of the corridor ceiling, that contains the central roof gutter and surrounding structure.The wall running along the west side of the central corridor probably supports the roof structure, although it is likely that other structural supports exist within the plan of the third floor.

A number of significant structural defects were visible within the third floor, and these can be characterised by a severe deformation or sag of the corridor floor, and the floors in adjacent rooms, all downwards towards the centre of the building's plan. Following a similar pattern of deformation, cracks and deformations within the partition walls were observed in this storey, with the worst damage occurring in the walls of the front offices.

Within the central corridor itself, the partition on the east side of the corridor contained a long crack at its junction with the ceiling, that was its widest (5 to 7 millimetres) in the centre of the building, and then narrowing and returning along downstands towards each end of the corridor. As noted above, there was also a pronounced sag in the floor along the length of the corridor, with the lowest point being in the centre of the building. There was also a drag in the wallpaper finish at the north end of the corridor where the west partition joined the party wall for its full height.

10. View of Corridor Wall Cracking At Third Floor.

All three of the front rooms at third floor level had sloping floors, and all sloped downwards towards the corridor. Also the two dividing partitions between these rooms exhibited severe cracking, with cracks starting at the mid height of the partitions near the front facade and then rising and following the wall to ceiling junction. In some instances these cracks were 10 to 12 millimetres wide. These rooms also showed signs of water ingress having occurred, and damage repairs around the underside of the front parapet wall and the lintels

over the windows. Recent damp penetration appeared to have occurred in the ceiling of the south room, in the corner adjacent to the party wall.

11. Internal Partition Cracking At Third Floor.

Similar damage seemed to have occurred in the rear rooms at this floor, with cracking of ceiling to wall junctions typical in all rooms, as well as historic damage and repairs being visible in the ceilings. Within the small room adjacent to the north party wall, the party wall itself contained diagonal cracks, and the floor sloped consistently with the floor of the corridor outside.

Within the staircase void to the floor below, the south party wall contained significant cracking with two distinct cracks starting in the centre of the panel and travelling upwards and outwards towards the upper corners of the wall. There were clearly ongoing movements in both party walls at this level.

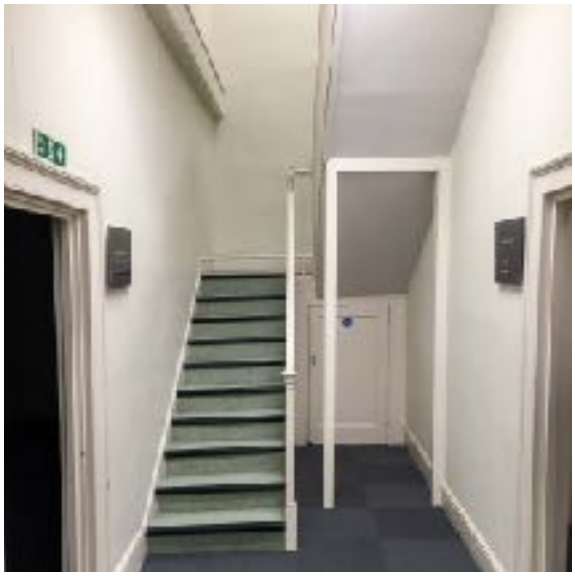
12. View of Cracks In Party Wall At Third Floor.

Opening up revealed that the floor joists at this level all span in a direction from party wall to party wall. Also that the partitions dividing the rooms at the front of the building sit on the floor boards and so there is no specific structure beneath these partition walls. Extensive notching of floor joists to allow service pipe and cable distribution was also noted, and in some instances 40% of joist depths had been removed.

13. View Showing Notched Joists in Third Floor.

Second Floor

The timber staircase down from the third floor had clearly suffered deformation, and also significant horizontal cracks existed in the east wall of the stair enclosure at the level of the third floor, with cracks of up to 10 millimetres wide being visible. It appeared that the partition wall of the second floor had come away from that of the third floor level above.



14. View of Staircase And Cracks To Wall.

The room layout of the second floor is similar to that of the third, with the only significant difference being that the main staircase down through the building occupies the space of one of the rear rooms in the north west at third floor level.

The floor of the main corridor in the second storey also sloped downwards toward the centre of the building, although this deformation was not observed in the west part of the central corridor space containing the stair well from the third floor; in other words on the west side of the spine wall. The rooms to the east of this corridor at the front of the building showed similar signs of damage to those in the floor above. Extensive cracks to the partition walls were observed, with diagonal cracking within the walls and also at wall to wall, and wall to ceiling junctions, in all three rooms. However, in general the widths and extent of cracking was less than that observed in the third floor above.

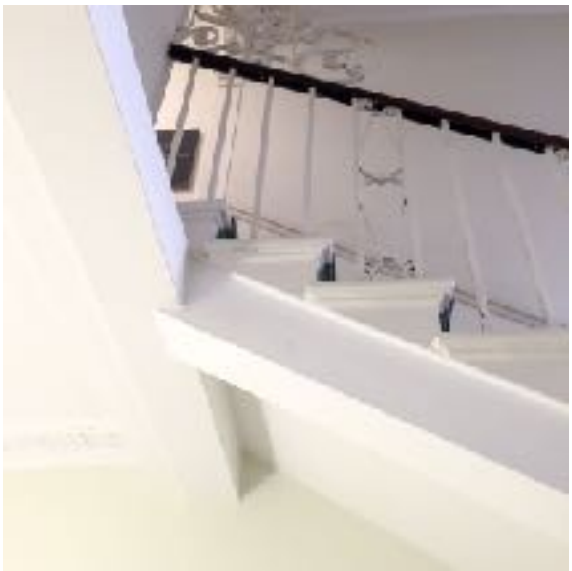
The rooms on the west, or rear side of the building, also contained some damage, but this was more typical of that seen in buildings of this age and type of construction, with minor cracks and repairs in the ceilings, and also minor cracks in the wall to ceiling junctions. Some of the partitions between rooms in this area contain large glazed lay lights, but all of which appear free from damage.

Opening up revealed that the floor joists forming the floor to the corridor of the third floor above were effectively unsupported for the full width of the building, a span of nearly eight metres. The downstands over the corridor, assumed to be structural beams supporting the floor above, were found to contain no structure. It was also established that the floor joists in the second floor at the front of the building spanned between the front wall and the spine wall, and not from side to side as all other floors within the rest of the house. This meant that the spine wall below, at first floor level, was a structural wall. Extensive notching of floor joists was also encountered within the second floor structure.

First Floor

The room layout at this level comprises at large room at the front of the building, extending for the full width between party walls, and another large room at the rear. The only other space in the plan comprises the main staircase void. All rooms contained a high level of plaster decoration with ornate cornices present in every room and also decoration around all door openings.

Access between second, first, and upper ground floor was via a cantilevering stone staircase with iron balustrade. This staircase exhibited local deformations at second floor level, and in other areas, and had been repaired by the addition of a steel structure beneath the stonework comprising a series of carriage beams spanning between walls at landing and floor level, and forming stringers beneath the stone flights. These repairs, whilst somewhat unsympathetic to the appearance and heritage significance of the staircase, appeared effective in providing adequate structural support.



15. View of Staircase.

Within the staircase area at first floor was observed a large diagonal crack above the doorway into the rear main room. This crack appeared recent and corresponded with the central pier moving downwards at this storey level.

16. View Of Crack In Wall At First Floor.

Both the rear and front main rooms at first floor level had been recently decorated and refurbished, although it was clear in both rooms that significant structural movements had occurred in the spine wall running across the centre of the plan, and these deformations were accompanied by hairline cracking. The pattern of deformations suggested that the wall had dropped downwards relative to its ends. All floors were level.

Opening up within the first floor of both the front and rear rooms at this level revealed that there was no significant structure beneath the spine wall within the first floor construction, and certainly none that would adequately support the loading inevitably applied from above, given the current configuration of the structure and the need to span over the ground floor space. Opening up works also revealed that there was a double wall construction within the first floor spine wall, with two lines of timber studwork set within the wall, and it is likely that none of this work was part of the original construction. Extensive notching of timber joists was again observed at this floor level.

Ground Floor

The room layout at this level was similar to that of the first floor storey. However this floor also contained the entrance door hallway and it was also noted that the spine wall between the front and rear rooms did not match the plan location of the spine wall seen in all of the upper floors above. It was clear that it had stepped back toward the rear of the building by a metre or so. All rooms contained a high level of plaster decoration, as seen in the rooms at first floor. There were also access doorways into the adjacent houses of the terrace; a door into Number 26 Russell Square in the inner entrance hallway and staircase area, and also in the rear room party wall a door into Number 28 Russell Square.

In the entrance hallway there was considerable cracking around the entrance door framing, and also in the ceiling above the entrance door, although the two areas of damage did not seem obviously related. The pattern of ceiling cracking was typical of movements occurring within the floor joists due to dynamic loading, and that has resulted in diagonal cracking of the ceiling where it is effectively stiffened by the cornices, and by being at the corner of the room. The inner entrance corridor displayed signs of historic deformations having occurred, with deformations in the internal dividing wall between the hallway and front main room suggesting that the wall had dropped downwards. There was a fanlight over the inner entrance door that appeared of a late Victorian or early Twentieth Century style, and it appeared that the fan light postdated the historic movements and deformation.

17. Internal View of Fanlight Over Entrance Hallway.

Within the front room there were obvious signs of deformation in the spine wall, although any cracking had been made good. There were cracks in a projecting return wall on the south party wall. This return created a shallow full height cupboard space, and was reflected by an identical return in the opposite wall. It is probable that these returns correspond with the location of the spine wall above, and therefore the cracking could be related to structural movements.

The rear room contained cracks at the junction between the spine wall and south party wall for much of the junction's height. There were also cracks visible in the wall over the door into this room within the internal partition, although these cracks appeared to follow lines in plasterboard junctions. The floor in this room also contained a slope towards the rear of the room in the south west corner, although this slope was slight and not as severe as that seen in the upper floors of the building.

An extension to the building at the rear contains one room at upper ground floor level, and this room was free from significant structural defects.

Opening up within the upper ground floor construction revealed that the floor joists span from side to side, as they do in most other areas of the house. There was no obvious reason for the deformation within the floor of the rear room.

Lower Ground Floor

The basement or lower ground floor storey followed the same plan layout as the upper ground floor, although the front room was subdivided into three separate spaces by internal partition walls. The rear of these three front rooms has a masonry vaulted ceiling and this would have been part of the original construction of the house, used as a cold store space. The stair down to the lower ground floor also appeared to be of stone construction but of a much simpler form, and contained within partition walls. Beneath the pavement and front entrance steps were brick vaulted structures; all appeared in good condition structurally but all displaying signs of damp ingress.

The rear courtyard had been infilled with a single storey extension containing two further rooms. All of these rooms contained few if any structural defects, with only very minor plaster cracking visible around door and window frames. However, there were signs of deformation and fine cracking in the main corridor hallway in the centre of the building corresponding with the spine wall junctions in the upper floors.

Rear Facade

The rear facade of the building comprises simple brickwork construction with gauged brickwork flat arched lintels over all windows, and iron balcony structures at the rear of the first floor windows. The rear elevation, when viewed from the rear ground floor level, showed extensive signs of repairs and rebuilding works, with a considerable range of different brickwork and pointing colours. However, no obvious current or ongoing defects were visible. It was noted that a steel plate and tie bar had been inserted into the third floor level to the north side of the rear wall, suggesting that some movement had occurred previously, although nothing appeared obvious during the survey.

There is a steel or iron fire escape providing access to a flat roof over the lower ground floor extension, and also to a door in the rear facade. This staircase appeared in poor condition, and a tread had been replaced with a timber plank in the lower flight. The rear walls of the yard at the rear of the house appeared in good condition and were free from defects.

18. View of Rear Facade.

Front Facade

The front facade of the building is generally of London Stock Brick construction with gauged brick flat arches over the windows. A cornice of render or stone extends across the full width of the facade at third floor window cill level, and the upper and lower ground storeys are rendered. A semicircular arch forms a fanlight over the main entrance door and ornate columns and a lintel are set over the entrance door. A continuous stone balcony structure cantilevers from beneath the first floor windows, and extends across most of the width of the house. Iron railings guard the lower ground lightwell, and a lamp holder is set to the south of the front door steps. This iron lamp holder is mentioned in the listing notes, and is clearly of heritage significance.

Whilst there are signs of minor and local repairs in the brickwork, the front facade of the building appears free from significant structural defects.

19. Front Elevation.

Conclusions

Our conclusions can be grouped into two sections; those that relate to the severe deformations of the third and second floor, and those that relate to general building condition. Our general opinion is that, despite the apparent severity of the damage in the upper floors, the building is safe and there is no danger of collapse in the short term. Also there is no reason to stop using the building as is being done currently.

Third, Second, and First Floor Defects

The sagging deformations of the third floor are due to a lack of support from the structure below; floor joists are effectively spanning the full width of the building within the corridor and this span is too long for the joist size, and this problem is made worse by the reduced section sizes created by notches for services. It is probable that historic ill advised structural alterations have created this situation. Because the floor joists at this level are too flexible to perform properly, any repairs to finishes will simply reoccur as the floor deflects under live loads.

The second floor structure in the front half of the building is the only area where joists span from front to rear, rather than from side to side as elsewhere. It is impossible to know why this is the case, and it is possible that this area was altered at some point. However, this span direction means that the spine wall at first floor level below becomes a key part of the building structure, and investigations have been unable to find any significant structure within this wall, and certainly none that would be capable of supporting such loading.

The alterations probably made at second floor level have resulted in the floor joists at this level also being subject to high loads, particularly as the partitions at this level effectively support the loads from the third floor. The result is that these floor joist are also suffering excessive deflections, and this problem is also further exacerbated by notching of joists.

The first floor spine wall has been much altered and repaired, and there are still signs of significant deformation within this wall, as well as ongoing minor cracking. The central pier at the north end of the first floor spine wall, is an important structural element. The alterations in the structural load path that would have taken place above this area have probably caused structural movements and damage, and it is likely that the diagonal cracking seen in the first floor wall to the staircase enclosure, the deformation in the ground floor entrance hallway, and the minor cracking in the lower ground floor, are all related to this issue. It is also probable that some settlement has also occurred in this wall due to foundation movements; such movements are very common in this type of property.

The cracking witnessed in the ground floor front and rear rooms are also likely to be related to the changing in load paths within the floors above.

General Building Condition

There are a number of elements at roof level and at the rear of the building that are in a poor condition, and that will require repairs or replacement in the near future if damage to the primary structure is not to occur. Specifically the areas of concern are:

- Gutter roofing membranes generally.
- Flashings to slate roofs.
- Rooflight glazing weather seals.
- Timber cladding and doors to roof access entrance.
- Render to chimney stacks.
- Rainwater distribution at roof level, including the open channel gutter within the roof space.
- Rear ground floor fire escape.

The other area where structural defects manifested themselves was in the upper parts of both party walls, where diagonal cracking was seen in the third floor storey at the centre of the party walls. It is likely that this diagonal cracking is due to movement in the upper section of wall, and it is possible that some expansion and contraction of the walls has occurred in the area between the main chimney breasts, where the party walls are thinner and braced by the much thicker chimney breasts on either side. The attached sketch shows the locations of the cracks in relation to the party wall elevations and chimney breast locations. The addition of structural stitches in this area may improve the strength of the party wall and reduce the likelihood of further cracking.

Recommendations

We make the following recommendations for repair works to correct the structural defects at third, second, and first floor levels. These repairs will need to be carried out to prevent ongoing damage to finishes in this area, and to ensure that the floors are returned to a serviceable condition.

1. Install a new steel lintel within the third floor to reduce the span of the floor joists over the second floor corridor. This new steel beam will span onto new timber studs inserted within the second floor partitions, and will need to be carefully installed so as to ensure that the third floor joists are properly bearing onto it. Some jacking upwards of the third floor joists could be undertaken to re-level the third floor corridor.
2. Install new steel framing within the second floor to provide support to the second floor partition walls at the front of the building that are, or should be, supporting the third floor joists. This framing would comprise two beams under partition lines and also a new steel beam beneath the spine wall. The new spine wall beam would span between the south party wall and the central spine wall pier.
3. Install a new column within the central pier at first floor level. The structure of this pier needs to be fully examined and strengthened to ensure that a robust structure is created in this element, and that it is capable of transferring loads down through the building.
4. Concrete stitches are installed within the party walls at the upper levels to prevent further differential movements within the walls.

There are a number of elements at roof level and at the rear of the building that are in a poor condition, and that we would suggest will need repairs or replacement in the next few years. Specifically the areas that we recommend require attention are:

- Gutter roofing membranes generally; renewal with a matching Sarnafil type membrane system, or perhaps a lead equivalent that would provide a more robust and longer lasting solution.
- Flashings to slate roofs; investigate condition and renewal.
- Rooflight glazing weather seals; renew and possibly consider replacement of rooflights with a more conventional Velux type system rooflight.
- Timber cladding and doors to roof access entrance; re-clad and replace door with a higher performance alternative.
- Render to chimney stacks; repair or replace render.
- Rainwater distribution at roof level, including the open channel gutter within the roof space; upgrade the existing system with a sealed pipe in pipe alternative to prevent any future issues.
- Rear ground floor fire escape; replace with modern steel alternative, or remove if no longer required.

This survey and report has been prepared and written by Bob Barton (BSc Hons CEng FIStructE FICE FConsE GradDiplBldgCons AA), Director of Barton Engineers Ltd.

This report has been independently checked and approved by Bart Kolodziejczyk (MEng CEng MIStructE), Design Engineer of Barton Engineers Ltd.