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Skeel House Structural Appraisal
Kidderpore Avenue Detailed Design Stage
9100-REP-013
11581
For Mount Anvil

Engineering at its Best

Report For

Mount Anvil

Scheme No: 11581

Kidderpore Avenue Detailed Design Stage
9100-REP-013

Skeel House Structural Appraisal

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1.0 Introduction

1.1 This Structural Engineering Appraisal Report has been prepared for Mount Anvil. It considers the structural engineering aspects associated with the proposed refurbishment of Skeel House which is being carried out as part of a redevelopment of the former Westfield College Estate in Kidderpore Avenue, for which A&Q Partnership are acting as Architect. Skeel House is also known as Skeel Library.

1.2 The observations and comments provided in this report are based on walks around the building on 19th June 2014, and during March to May 2016, opening up works carried out in March and April 2016 by ESG, and the following information:

- Existing building survey drawings prepared by Murphy Surveys, reference numbers MSL9992-SH-FPLG, FPB, FPG, FP1, FP2, dated July and August 2014;
- Historic record drawings, received from Mount Anvil on 22nd October 2015
- Heritage Statement by Montagu Evans dated June 2015;
- Architect's proposed layouts – drawing references 9000-DRG-03SK-LG010, GF010, 01010, MZ010, 02010 and RF010;
- Report for Skeel Library Fabric Survey by ESG, dated 28th April 2016, reference STR 642, Issue No. 001 (Draft);
- Factual Site Investigation Report prepared by Soiltechnics dated July 2015
- Arboricultural Report prepared by Crown Consultants, dated 1st July 2015, reference 09166;
- "Preliminary timber decay and damp survey of the Kidderpore Avenue development site – Skeel House", prepared by Hutton and Rostron dated 27th -28th May 2015;
- ""Kidderpore Avenue: Skeel Library timber condition survey", Site Note 35 for 7th to 14th April 2016, prepared by Hutton and Rostron
- Kidderpore Avenue: Skeel Library lintels condition survey", Site Note 36 for 7th to 14th April 2016, prepared by Hutton and Rostron;

1.3 Observations are based on access to all internal areas where the structure was viewed from floor level. By their nature, the opening up works and other observations have been limited in their extent at this stage of the design. It is therefore possible that details of the structure that are later opened up as part of the refurbishment works will be different from that inferred to date.

1.4 The following drawings have been prepared by Tully De'Ath as part of the design development and should be referred in when reading this report:

- 9100-DRG-03SK-LG900 Skeel Library Existing Floor Plans Sheet 1 of 2;
- 9100-DRG-03SK-01900 Skeel Library Existing Floor Plans Sheet 2 of 2;
- 9100-DRG-03SK-LG001 Skeel Library Level LG Proposed Floor Plan;
- 9100-DRG-03SK-GF001 Skeel Library Level GF Proposed Floor Plan;
- 9100-DRG-03SK-01001 Skeel Library Level 01 Proposed Floor Plan;
- 9100-DRG-03SK-MZ001 Skeel Library Level MZ Proposed Floor Plan;
- 9100-DRG-03SK-02001 Skeel Library Level 02 Proposed Floor Plan;
- 9100-DRG-03SK-RF001 Skeel Library Level RF Proposed Roof Plan.

2.0 Historic Development of the Site

2.1 The site forms the former Westfield College campus, associated with King's College London. It contains a number of historic buildings – some of which are listed Grade II. Immediately to the north of the site is Kidderpore Reservoir.

2.2 Kidderpore Hall forms the earliest building on the estate and dates from 1843. It was designed by T Howard for a merchant, John Teil who ran a leather concern in India. John Teil died in 1854 and following several changes of ownership, the house and two acres of ground were bought by Westfield College in 1889

2.3 Westfield College then began a process of developing the grounds for use as a college and halls of residence. The developments included:

i. Maynard Hall was added by the college in 1889. It was designed by Robert Falconer Macdonald and provided expanded accommodation for the college on the site.

ii. Skeel House – also known as Skeel Library – was added in 1903-04 along the southern boundary of the site. It was also designed by Robert Falconer Macdonald and was built to allow Westfield College to be admitted as a teaching school of the University of London. A further building, Dudin Brown House, was added to the east of Skeel Library about the same time. The construction of these two buildings began to define the Quadrangle – a landscaped space to the north of these buildings and to the east of Maynard Hall.

iii. The Chapel was added in 1928/29 towards the north west corner of the site.

iv. Bay House was developed to the east of Kidderpore Hall. The original structure probably dates back to 1889 when it formed the southern end of Maynard Hall. Historic records indicate it was later altered and extended around 1921 and later about 1935. This included works along the main southern elevation and to the rear facing the Principal's Lawn.

v. Lady Chapman was added on the north side of the Quadrangle in c.1927.

vi. Lord Cameron Hall was then added along the eastern boundary of the site in c.1935. The north eastern corner of the site was then developed with the construction of Rosalind Franklin Hall in c.1965. This building abutted the eastern end of Lady Chapman Hall and completed the Quadrangle which exists today.

vii. Queen Mother Hall was constructed to the west of Kidderpore Hall in 1982.

2.4 There is also a timber-framed summerhouse on the site, which is located by the northern boundary by the reservoir.

2.5 Of the 11 existing buildings on the site, five are Grade II listed. This consist of Kidderpore Hall, Maynard House, Skeel Library, the Chapel and the summerhouse.

3.0 Summary of Ground Conditions Generally on the Site

3.1 A site investigation has been carried out by Soiltechnics and is summarized in a Factual Report dated July 2015. The report is based on 10 bore holes, 10 window samples, and 22 exploratory trial pits across the entire site.

3.2 In summary, the ground conditions have been shown to comprise top soil and made ground overlying the Claygate Member with the London Formation at depth.

Strata	Depth (below ground level)	Description
Top soil and Made Ground	0.3m to 1.8m	
The Claygate Member	4.9m and 8.7m	Slightly gravelly silty sandy clay, very sandy clay and silty sand.
London Clay Formation	Proven to 25.8m	Silty clay with occasional shelly material at depth

3.3 Groundwater levels across the site vary between 1.3m and 6.0m. The levels are subject to further monitoring.

4.0 Description of Existing Structure

4.1 The Setting

4.1.1 Skeel House was constructed in 1903/04. It formed the library for Westfield College when it was originally built. It fronts on to Kidderpore Avenue. There are two semi-mature trees close to the front elevation – a 16m tall Maidenhair Tree and a 7m tall Pissards Plum.

4.1.2 The main part of the building is set out over three main floor levels – forming the ground floor, first floor and second floor levels. Both the ground floor and first floor have large single rooms which are served by a central staircase to the rear. Of the two large rooms, the principal room is a double height space at first floor level. This has book presses against the internal wall faces. The room incorporates a perimeter balcony structure at a mezzanine floor to provide access to the book presses at high level.

4.1.3 To the west of the central stairwell is a later extension. This forms additional space at ground and first floor levels and at basement level.

4.1.4 There is a further single storey rear extension to the north of the main block. This sits on the south west corner of The Quadrangle.

4.1.5 The main elevation faces Kidderpore Avenue. It is brick-faced and is dominated by a two-storey bay window. This has brick construction at ground floor level and stone columns and lintels at first floor level. Above the façade is a pitched tiled roof, incorporating dormer windows, with a central lantern extending above.

4.1.6 There are flat roofs above the rear staircase and the extension to the west of the staircase.

4.1.7 When Skeel Library was constructed in 1903/04, there was a bridge link leading across to Maynard House at first floor level. This link is still visible from the Quadrangle, but is obscured from the front elevation by the later extension of the Main Hall within Bay House, carried out about 1934. The rear elevation has also been obscured by the later addition of Dudin Brown to the east of Skeel Library. The central rear staircase is original but the three storey extension to the west of the stairwell was added between 1915 and 1934 according to historic maps. The single storey addition to the rear also dates from post-1915.

4.1.8 The Heritage Statement indicates the building retained is primary function as a library until 1971. Historic drawings from 1972 indicate at that time the ground floor was used as a lecture room and the first floor was used as a Student's Quiet Room. The same drawings show the second floor space was used for flats with bedroom and kitchen spaces.

4.2 Description of Existing Structure – A Summary

4.2.1 The existing structure is summarized on drawings 9100-DRG-03SK-LG900 and 01900.

4.2.2 The building has a cellular load bearing masonry structure. This supports the existing floors which are formed using various forms of construction of different ages, which are described in more detailed below. The building relies on the cellular layout for overall stability. The building has a cellular load bearing masonry structure. This supports the floors and roof structures which are formed using various forms of construction, which are described in more detailed below. The building relies on the cellular layout for overall stability.

4.3 Wall Construction – Main Block

4.3.1 The load bearing walls appear to be of solid brick and stone masonry construction.

4.3.2 On the front elevation, brickwork dominates at ground floor level. The windows at this level are formed externally with brick arches. Stonework predominates across the first floor level of the elevation. It is used both on the bay window and to the window surrounds each side of the bay. The bay window has dressed stone pillars supporting stone lintels. Stone lintels also exist above the side windows at first floor level. The stone surrounds to all the first floor window openings incorporate stone mullions and transoms. At eaves level there is a projecting cornice which appears to be constructed using reconstituted stone masonry. On the south east corner, there is a decorative brick buttress capped with a stone feature.

4.3.3 The rear elevation is formed using brickwork with brick arched window openings. The elevation to the central staircase is capped with a masonry balustrade.

4.3.4 The backing lintels to these window openings have been confirmed as concrete construction where checked by H&R. These are likely to be either concrete encased steel joists or of reinforced concrete construction.

4.3.5 The internal walls at second floor level are load bearing supporting the central lantern and part of the ceiling and roof structure above. The walls appear to also provide lateral stability to the roof structure. These walls are constructed using braced timber studwork.

4.4 Existing Floor Construction – Main Block

4.4.1 The ground floor is formed using timber joists spanning between brick sleeper walls below. The void measures about 600mm deep. The walls are a half-brick width. The foundations to the sleeper walls has not been confirmed.

4.4.2 The first floor structure is of concrete construction. This supports timber battens and floor boards. There are a series of downstand profiles on the soffit of this slab suggesting beam lines. The survey drawings indicate the thickness of the floor slab is about 200mm. Given the floor dates from 1903/04, it is likely to be either a filler joist floor or an early form of reinforced concrete structure. This needs to be confirmed through further non-destructive radar surveys and localized opening up works.

4.4.3 The second floor structure has timber joists supported on steel beams which span front to back across the main library space below. There is a further steel beam forming a bressummer beam across the head of the bay window. The original floor incorporated pugging between the joists but this has been removed over areas of the floor. The joists have been replaced with newer joists towards the front area of this floor level.

4.4.4 The perimeter balcony structure has been exposed locally at mezzanine floor level. This suggests the balcony is formed as a cantilevering reinforced concrete slab.

4.4.5 The landings and staircase are of solid construction, although the details are not known.

4.5 Existing Roof Structure – Main Block

4.5.1 The roof is formed using a timber carpentered roof with common rafters and a ridge plate which are tied together via the ceiling joists and possibly the second floor structure. The roof is boarded and this may be contributing to the stability of the roof.

4.5.2 The central lantern above is a timber frame and appears to take support off the internal walls at second floor level.

4.6 Single Storey Rear Extension

4.6.1 This is a load bearing masonry structure supporting a timber joisted flat roof. There are downstand beams providing support to the roof. The structure has not been investigated in detail given this block is to be demolished as part of the proposed works.

4.7 Existing Foundations

4.7.1 Trial pit investigations by Soiltechnics have exposed the foundations by the bay window along the front elevation and to the rear wall of the single storey rear extension, within the Quadrangle.

4.7.2 The trial pit by the front elevation bay window has revealed the front elevation is founded on a concrete strip foundation which bears on to natural silty clay of the Claygate Member at 1.33m below ground level. The description of the soils indicate tree roots were noted within the made ground up to 1.33m below ground level but not in the bearing stratum below.

4.7.3 The trial pit by the rear elevation of the rear extension has revealed a concrete strip foundation which bears on to natural sandy clay of the Claygate Member at 2.0m below the ground level of the Quadrangle. The description of the soils indicate tree roots were noted within the made ground up to 1.0m below ground level.

5.0 Imposed Floor Loads

5.1 Based on the understanding of how the existing building has evolved over time, most of the existing floors appear to date from 1903/04.

5.2 It is very likely that the structure was designed in accordance with industry guidance that was available at the time. The key documents that existed are noted in the table below together with the classification of loads each document provided.

5.3 Encyclopaedia of Architecture 1881:

	Pounds Per Square Foot (lbs per sq ft)	**kN/m²**
Public Halls in which people only accumulate	128	6.1
Ordinary dwelling houses	100	4.7

5.4 Appleby's Handbook of Machinery 1903:

	Pounds Per Square Foot (lbs per sq ft)	**kN/m²**
Stairs and passages	80 to 90	3.8 to 4.3
Offices, libraries etc.	70 to 80	3.3 to 3.8
Dwelling room floors	56 to 70	2.6 to 3.3
Attic floors	34 to 56	1.6 to 2.6

5.5 As a comparison, the current recommended imposed loads for residential use are as follows:

	kN/m²
Residential floors	1.5
Residential corridors and staircases	3.0

5.6 In addition to these loads, a provisional allowance of 1.0kN/m² should be provided on the floors for lightweight partitions.

5.7 This review suggests the existing floors should be adequate for the proposed imposed loads provided the floors were designed correctly.

6.0 Observations on the Condition of the Existing Structure

6.1 This section of the report summarizes issues which have been observed on site or have been identified in H&R's reports which relate to the condition of the existing structure.

6.2 The building generally appears to be in an average condition for its age and type. Issues which have been identified are linked with the effects of water ingress in to the structure and slight movements which are visible within the bay window along the south facing front elevation. These observations are set out below.

6.3 External Observations – South (Front) Elevation and North (Rear) Elevations

6.3.1 The H&R report on the condition of the timbers highlights areas of the front and rear elevations which have been subject to water penetration and provide the conditions for damp and timber decay.

6.3.2 On the bay window, there are signs that the brickwork joints have opened up very slightly at first floor level. This movement is consistent with slight bowing of the bay window and suggests there may be a lack of horizontal restraint at first floor level. This movement appears historic.

6.3.3 A rainwater pipe at the western end of the front elevation has overflowed in the past for a considerable period of time and staining is visible on the brickwork surface. Blocked down pipes will encourage water to saturate the brickwork which could affect timbers embedded in the wall behind.

6.3.4 On the rear elevation at high level, there are also patches of staining in the brickwork at indicating the wall has suffered from water ingress for a considerable period of time. This could affect timbers embedded in the wall behind. The brickwork around some of the rainwater pipes on the rear elevation is also stained suggesting the wall has become saturated in the past.

6.4 Internal Observations

6.4.1 There are visible signs of water ingress internally. This is most apparent on the ceiling finishes to the western side of the main library room at first floor level where there are damp patches adjacent to the side wall. This suggests water ingress has occurred at roof level above.

6.4.2 H&R have measured the moisture content across areas of the internal spaces and have reported the front and rear elevations have been subject to widespread water ingress, thereby providing the conditions for timber decay.

6.4.3 At roof level, there are signs of historic decay on some of the timbers to the central lantern. Within the roof spaces where the common rafters come down and meet the second floor joists, there are also signs of historic water ingress. This is visible by both the front and rear elevations.

6.4.4 Some of the timber joists at second floor level have been replaced with newer joists. The date of these works is not known but could be associated with historic water ingress. Some joists at second floor level have also been notched to accommodate services.

7.0 Proposed Strategy for Structural Engineering Works

7.1 Given the existing structure is in an average condition for its age and type, it should respond well to the proposed refurbishment. Essentially the building was designed as a college building providing a library and other communal space together with dormitories. The proposed refurbishment will convert the building to residential flats. This use is compatible with the existing structure.

7.2 The proposed refurbishment will involve a limited number of structural alterations. The timber ground floor structure is to be replaced with a concrete floor and the internal load bearing walls at second floor level are to be reconfigured slightly. A few new door openings through load bearing masonry walls are also proposed. Some structural repairs will also be required. The single storey rear extension is to be demolished and some underpinning may be necessary in the basement area to permit the floor level here to be dropped.

7.3 Building Regulations and Extending the Useful Life of the Existing Structure

7.3.1 In accordance with the Building regulations, Bay House will undergo a material change of use. However, the Building Regulations do not identify the specific structural engineering requirements that the existing structure needs to adhere to under Part A of the Building Regulations.

7.3.2 The key structural engineering aspects however are to design all alterations to be sensible in engineering terms and to see that the floors have sufficient strength and stiffness for the proposed use as residential flats. Provided any new partitions are designed to be lightweight timber or metal stud partitions and new sound insulation and fire protection are lightweight, the provisional structural engineering assessment shows it is unlikely the existing retained floors will need to be strengthened for the intended use, provided the condition of the structural elements has not been undermined by previous ill-judged alterations. A further more detailed assessment of the existing floors is being carried out to confirm this.

7.3.3 New structural elements will be designed in accordance with current Eurocodes and British Standards.

7.4 Conservation Engineering Approach

7.4.1 Given Skeel House is listed Grade II it has additional importance linked with its historic and architectural interest.

7.4.2 The engineering strategy for the structural design will therefore aim to limit the impact of the structural works on the historic fabric. Existing structure will be retained where possible and new structural elements – whether related to alterations or repairs - will be designed to be compatible with the historic fabric. They will also be reversible and interpretable for what they are, as part of a proposed 21st century refurbishment. This approach is good in conservation terms but also provides a sensible and economic engineering approach for the works.

7.5 Building Warranty Provider

7.5.1 It is understood the proposed Warranty Provider is Premier. An early meeting should be arranged with Premier to understand what measures they will expect to see implemented structurally as part of the proposed refurbishment.

7.5.2 Examples of work they may require are noted below:

i. The structure is required to have a life of at least 60 years.

ii. The existing foundations may need to be inspected more fully than has been carried out to date in order to demonstrate the building has satisfactory foundations, even though there are little or no signs of differential settlement. If foundations are found to be locally shallower, they may insist on the foundations being underpinned.

iii. If concrete foundations exist, Premier may insist on concrete testing being carried out to demonstrate the concrete is in a reasonable condition and will be able to perform adequately for a further 60 years.

iv. All timbers built in to external walls would need to be checked for decay or infestation. Any affected timbers would need to be replaced. Unaffected timbers will require re-support off joist hangers or removed and re-installed with additional protection from a damp proof membrane.

7.5.3 Of these examples, example iv is the most likely one to be required. It may be a requirement for all embedded timbers and not just those in vulnerable areas.

7.6 Structural Issues Associated with Water Ingress

7.6.1 The main issue which has affected the condition of the existing structure is the effects of water ingress. This is usually associated with gutters and rain water pipes not having a robust design or having been maintained effectively. This allows areas of the elevations to become saturated after periods of heavy rain.

7.6.2 Buildings of this age and type require good cross ventilation within the structure to help maintain its condition. Regular maintenance to keep gutters and rainwater pipes free of blockages and vegetation is also important. The building has also been empty for some time and unheated spaces will also have encouraged damp to migrate.

7.6.3 As such, the most vulnerable areas of the structure are where the rain water pipes exist. These areas coincide with where the condition of the structure is poorest and has been repaired historically. There has been significant water ingress in these areas couple with decay of embedded timbers.

7.6.4 Given this pattern, it is important for the timber repairs now proposed to be detailed such that timbers will not be susceptible to decay in future in the areas highlighted as being vulnerable. This will require embedded timber joists to be either cut back and re-supported off joist hangers or for the ends to be wrapped with a damp proof membrane and ventilated where retained as embedded in the external walls. Timber lintels in vulnerable areas will need to be replaced with concrete lintels and bonding timbers will need to be cut out and replaced with brickwork.

7.7 Existing Concrete Filler Joist Floors

7.7.1 The building may contain concrete filler joist floors. These contain steel or wrought iron ‘I’ sections set between 450mm and 900mm apart and the space between is filled with a concrete infill. Usually this is mass concrete which arches between the iron / steel sections. The mass concrete is often a clinker concrete. It is obvious from its darker appearance compared with normal concrete and on account of the black-coloured aggregate that is used from which the concrete takes its name. This aggregate is often pieces of old coke or slag used in heavy industry.

7.7.2 As with the existing timber floors, it makes sense from a structural engineering and conservation perspective to retain these floors provided they are in a reasonable condition

7.7.3 The acoustic and fire performance of such floors needs to be addressed however. Clinker concrete is often not very dense and so the floors tend to have insufficient mass to meet modern acoustic requirements. The concrete cover to the iron or steel joists is often very small so the joist may not have adequate inherent fire protection. Measures similar to those required for timber floors may therefore be required to address the acoustics and fire compartmentation.

7.7.4 The use of clinker concrete raises two further potential issues. Occasionally clinker concrete can be quite friable and weak. This can raise question marks over its longer term durability – such as its ability to cope with foot traffic along corridors over a 50 or 60 year period. Clinker by its nature can also contain high levels of Sulphur. When it comes in to contact with water, a weak sulphuric acid can develop which can be highly corrosive to the embedded iron or steel sections. A protective waterproof render can be used to address this issue in vulnerable areas such as shower rooms and kitchens where are more likely to occur.

7.7.5 These issues need to be examined in more detail by carry out some concrete testing on the clinker concrete and testing a core sample to check its density and strength

7.8 Proposed Structural Repairs

7.8.1 Based on the observations and opening up works carried out to date, the following structural repairs are expected to be necessary as part of the proposed refurbishment. This list is provisional and will be confirmed once the floors are lifted completely by the builder during the construction phase.

7.8.2 The outline scope of structural repairs to the walls, floors and roof is as follows:

i. Splice repairs to decayed ends of rafters where decayed. Timber wall plates in affected areas will probably need to be replaced too.

ii. Splice repairs to decayed ends of the second floor joists where decayed. New joist ends to be supported via joist hangers are to be isolated from the external wall via a damp proof membrane.

iii. Removal of decayed timber wall plate and bonding timbers and replacement with brickwork. Embedded timber to be removed also from areas which are not decayed but are in areas highlighted as being vulnerable.

iv. Heavily notched joists will need to be strengthening and stiffened by fixing additional joists to the sides of affected joists.

v. Some additional tying works to improve the restraint of the bay window may be necessary to address the movement seen. This will be confirmed following further opening up works.

7.8.3 Whilst not strictly repairs, the following enhancement works are required to the timber floor at second floor level:

i. Solid timber blocking pieces need to be added between joists, where this has not been provided. This is to enhance the stiffness of the floors by improving the ‘load share’ between adjacent joists.

ii. Existing floor joists are to be doubled up along the lines of new partitions to improve the stiffness of the floors on these lines.

iii. It is understood stone and other brittle finishes may be proposed on the timber floors. This approach is not recommended as timber floors and brittle finishes are not compatible with one another and there is a high risk that brittle finishes will crack. A timber joisted floor is - by its nature - lightweight and susceptible to more noticeable deflections than a heavier concrete floor. The volume of timber is also not stable as it will shrink or expand slightly as moisture levels change within the atmosphere. Whilst such issues can be controlled to some degree, they cannot be removed altogether and as such the risk of cracking will remain.

7.8.4 Other structural repairs may become necessary as the building is opened up. Examples include addressing ill-conceived structural alterations that have been carried out in the past and structural features such as openings which are currently concealed behind finishes. The programme for the construction works needs to leave sufficient time to allow the structure to be thoroughly assessed once it is fully opened up so the final scope of structural repairs can be confirmed without causing delay to the works.

7.9 Proposed Structural Alterations

7.9.1 As highlighted above, the proposed refurbishment will include a limited number of structural alterations. The timber ground floor structure is to be replaced with a concrete floor and the internal load bearing walls at second floor level are to be reconfigured slightly. A few new door openings through load bearing masonry walls are also proposed. A provisional allowance for underpinning at basement level has been made as the floor level is to be lowered.

7.8.2 The ground floor is to be replaced to provide a more robust floor construction at this level. The structural design creates a new suspended reinforced concrete floor supported off new strip concrete strip footings and masonry sleeper wall. The new foundations will be supported off the underlying natural ground.

7.8.3 At second floor level, new openings are to be formed in the existing load bearing stud walls. The ceiling structure, part of the roof structure and the lantern will be affected by these works and so new beams are required at ceiling level to maintain the support to the structure above. As the stud walls contribute to the stability of the roof structure, ply sheeting needs to be fixed to one face of the retained walls to maintain the stability of the structure.

7.8.4 The door openings through the load bearing masonry walls at the lower floor levels are to be formed using concrete lintels.

7.8.5 A provisional allowance for underpinning the foundations at basement level has been made. This is to permit the basement floor level to be lowered slightly. Underpinning will only be necessary if the foundations are relatively shallow. This should be checked through trial pit investigations. The new lower floor slab will be formed using a ground bearing reinforced concrete slab.

7.10 New Extension

7.10.1 A new single storey extension is proposed on the footprint of the existing single storey rear extension. This will be formed using a reinforced concrete frame. Piled foundations are proposed given there are mature trees nearby in the Quadrangle and this approach will limit potential damage to tree roots. A perimeter retaining wall is required along the western side where levels are raised.

8.0 Proposed Further Investigations

8.1 The following additional opening up works and other investigations are necessary to assist with the development of the working drawings:

i. The first floor slab needs to be investigated to confirm the form of construction and its condition. This will enable an assessment to be made of the imposed load capacity and to assess whether structural repairs are necessary. A non-destructive radar survey is required initially followed by possible localized opening up works and concrete testing.

ii. Some concrete testing should also be allowed for on the solid floors to extension which sits to the west of the stairwell and on the stairwell itself.

iii. On the front elevation, it is likely the reconstituted stone cornice and stonework incorporates iron ties and cramps. The condition of these should be assessed through a non-destructive radar survey.

iv. The movement of the bay window needs to be explored further by lifting the floor finishes within the bay window at first floor level. It is possible some strapping is required to provide a more positive tie between the floor structure and the bay window.

v. The support of the lantern above roof level needs to be assessed further through further local opening up works of the second floor structure. This is to check whether a steel beam aligns below the central stud wall which runs east to west across this space.

vi. Trail pit investigations are required at basement level to check the depth of existing foundations. These will confirm whether the provisional allowance for underpinning is required or not.

8.2 The programme for the construction works needs to leave sufficient time to allow the structure to be thoroughly assessed once it is fully opened up so the final scope of structural repairs can be confirmed without causing delay to the works.

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