Richmond Hill Campus

Stage 3 Report for LBC Submission

Project no. 1399

Document no. 1399-INT-ZZ-ZZ-RP-S-0003

January 2024

Revision

Date	Suitability	Revision	Comments
12 January 2024	S1	P01	First & Draft Issue
26 January 2024	S2	P02	LBC Submission
30 January 2024	S2	P03	LBC Submission

Quality Assurance Review

Prepared by: Toby Williams — Engineer, MEng (Hons)

Reviewed by: Claire Thomas — Director, MA(Oxf) CEng MIStructE

Date: 12 January 2024

This report is for the exclusive use of the client and should not be used in whole or in part by any third parties without the express permission of Integral Engineering Design. This report should not be relied upon exclusively by the Client for decision making purposes and may require reading with other material or reports.

Integral Engineering Design

84 Walcot Street Bath BA1 5BD
01225 859 657

3.10 Clerkenwell Workshops 27/31 Clerkenwell Close London EC1R 0AT 020 7096 0278

integral-engineering.co.uk

Contents

1. Introduction

Integral Engineering Design has been appointed by Thomas London Day Schools to provide structural and civil engineering design for the redevelopment of Richmond College into a new secondary school, Thomas's College.

This RIBA stage 3 report outlines the key structural and civil considerations, conservation philosophy and design undertaken to date. We welcome feedback from the whole team on this document prior to proceeding.

1.1 Key project contacts

Project Management	Bidwells	Joe Croisdale
Architect	IID Architects	Nick Rich
M&E Engineers	TB+A	Adrian Wordsworth
Quantity Surveyor	Synergy	Paul Hammond
Planning	Savills	Charlotte Jordan
Civil / Structural Engineer	Integral Engineering Design	Claire Thomas
Heritage Consultant	Heritage Information	Dorian Crone

2. Health and safety

Key health and safety risks noted so far are include;

- Build sequence and temporary works associated with constructing single and multi-storey moment frames in the Main Building
- Alterations to existing building generally changing existing load paths.
- UXO medium risk

Our CDM Risk Assessment lists any significant risks that are envisaged during construction or after when maintaining, altering or even demolishing the building. In each case the CDM Risk Assessment will communicate methods for managing or mitigating the risk and will be revised as the design develops. Any remaining, residual risks will also be described. Significant risks included in the CDM risk assessment are defined as those not obvious to a competent contractor or are unusual or difficult to manage.
Risks present during construction will be highlighted on our drawings by a hazard triangle.

We understand that IID architects are the Principal Designer.

3. Low carbon

The role of structural engineering in low carbon design is primarily to reduce the amount of embodied carbon in a development. Reusing an existing building is one of the most effective ways to do this. We will therefore aim to maximise this approach by conserving as much of the original fabric as possible if this avoids the introduction of new structure.

Where new materials are required, these can be specified to be as low carbon as possible/realistic. Timber will be specified to be sustainably sourced. Steel can be reused elements however this is an emerging technique and can require some flexibility with the programme and procurement approach which may not be suitable for this project. The lowest appropriate strength grade of concrete will be adopted and cement replacements such as ground granulated blast slag (GGBS) will be specified.

4. Site

4.1 Site location and description

Richmond Hill Campus is located within the Richmond Hill Conservation Area in the London Borough of Richmond upon Thames in southwest London. The site sits in between the River Thames to the west and Richmond Park to the east. A masonry wall around the site perimeter borders the campus.

The site is primarily accessed by two entrances on Queen's Road to the eastern boundary of the site. The site borders a residential road to the north and a school to the northeast. On the east and southeast boundary of the site there is a modern commercial development comprising of hotels, a spa and restaurants.

Aerial view of site

4.2 History

The main building dates from the 1840s with seven other buildings on site dating from the 19th and 20th centuries. The site was initially purchased by the Wesleyan Methodists in 1841 as the location for the Wesleyan college that would later be known as Richmond College. The adjoining George House wing to the Main Building is an adaptation of the building that predates the Main Building with significant alterations made throughout its history. In 1902 the college became part of the University of London.

In September 1940 more than 30 high-explosive bombs were dropped within 400 yards of the site causing damage to the building. This damage resulted in the loss of pinnacles and turrets which have not been replaced.

When the college was closed in 1972, the campus was transferred to the American International University in London. In 2021 it was announced that the university would relocate to Chiswick in 2022.

4.3 Ground conditions

Information has been gathered from the 1:50,000 British Geological Survey (BGS) maps. The BGS maps show that Richmond Hill Campus is underlain by the London clay formation comprising river deposits in clay and silt, with superficial outcrops of sand and gravel present around the site.

Bedrock geology – London Clay Formation

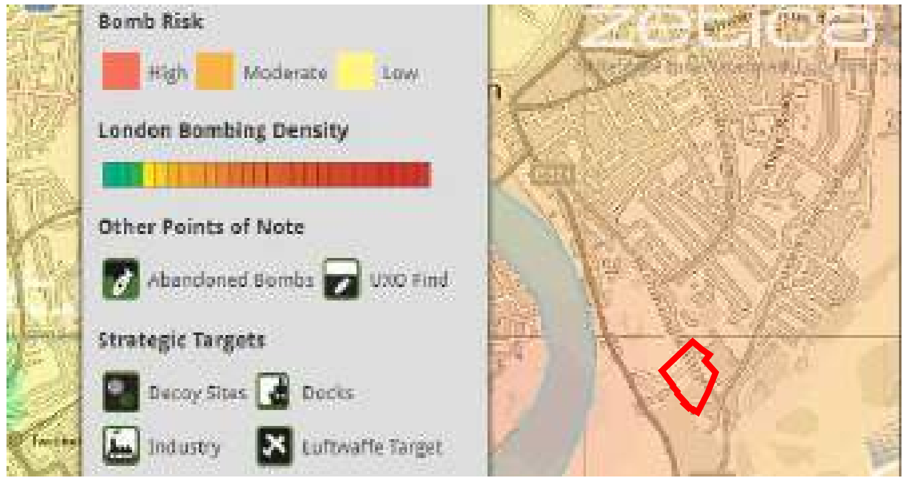

Superficial deposits

Maps from UK Radon show a <1% maximum radon potential within the site and wider Richmond Area. This means that radon protection measures are unlikely to be required.

Extract of UK Radon map

The potential for unexploded ordinance (UXO) on site has been preliminarily assessed by looking at WWII bombing density maps provided by ZeticaUXO. These maps show a 'moderate' bomb risk on site based on the bombing density of the surrounding area during WWII. No abandoned bombs or UXOs have been found on site or within the wider Richmond area previously.

As no significant new foundations are anticipated, other than within the Main Building it is unlikely that further detailed risk assessment will be required. However, this information should be made available to the contractor and has been noted on our CDM risk assessment.



Extract of ZeticaUXO map

4.4 Site investigations

An intrusive site investigation was undertaken on site in December 2023. The work was completed by Land Science who have also been appointed to carry out a geotechnical and geo-environmental assessment of the ground conditions.

The ground investigation included dynamic sampling, trial pitting to expose existing foundations, a soakaway test and plate bearing CBR tests. The results of the investigation are due in the week commencing 22nd January.

5. Flood risk and drainage

5.1 Flood risk

The site lies within flood zone 1 which is low risk, however the red line boundary for planning is more than 1 hectare which usually triggers the requirement to submit a flood risk assessment for planning.

Flood map for planning

The surface water flood map does show some areas to the rear of the main building which are at a high risk of flooding from surface water. This may not be an issue for planning if there are no external works ie the existing situation is being left unchanged, but this is an increasingly prominent requirement with some local authorities. It would also be prudent to discuss this with the school and explore whether they want to make improvements in any case, for example altering ground levels to fall away from the building.

Surface water flood map

5.2 Existing drainage

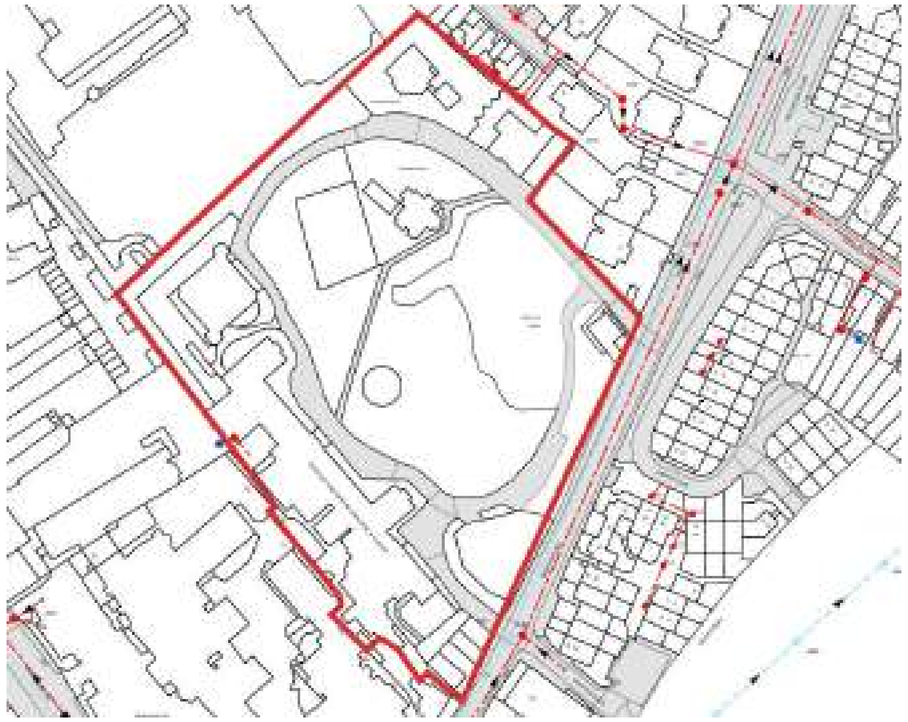
At the time of writing this report a buried services survey has been completed and a CCTV survey has been undertaken. Brunel Surveys were appointed to carry out the CCTV survey which confirms the connectivity of runs shown on the buried services survey. The survey also identifies blockages and repairs required in the existing drainage network.

The CCTV survey suggests that the existing drainage, both foul and surface water, flows by gravity into the Thames Water sewer system in Queen's Road. Predominantly, existing drainage flows out of site adjacent to the Oak Tree Cottage to the east. This includes a combined system which serves the Main Building, Red House, Longley House, Orchard House and Oak Tree Cottage. The public manholes which the networks outfall to are currently unclear and require further investigation.

The Library has a separate surface water system which flows to a hydro brake adjacent to Oak Tree Cottage before discharging into the Thames Water sewer system. An attenuation tank is presumed before the hydro brake but this is not indicated on the buried services survey. Foul water from the Library flows into the combined drainage network mentioned above.

Foul and surface water from George House and Upper and Lower Cottage discharge via two additional combined systems. One exits the site towards Queen's Road between Upper and Lower Cottage. For the other, the trace ends at what is assumed to be a buried manhole approximately half way along the perimeter wall.

Existing drainage issues present in the Main Building have been identified and noted for further inspection during future site visits.



Extract from Thames Water asset map

5.3 Proposed foul drainage

It is understood that the existing underground foul drainage connection points within the buildings and foul drainage routes externally will be reused in the new development. At the next stage it will need to be established whether there is going to be any increase in foul flows as a result of this development which is usually linked to student numbers. We anticipated the flows may be lower because there will be fewer students living on site, but once the numbers of day and boarding students (previously and in the new development) are established a pre-application check will be submitted to Thames Water to check capacity in the foul sewer.

5.4 Proposed surface water drainage

It is understood that the existing underground surface water drainage points and routes will be reused in the new development. There is no increase in impermeable areas anticipated (e.g. new roofs, new hardstandings) so there should not be a requirement to employ a Sustainable Drainage System.

6. Overview of existing buildings

Richmond College includes a number of existing buildings as shown in the adjacent image with brief descriptions and histories below.

6.1 Main Building (1)

The Main Building is Grade II listed dating back to the 1840s. The four-storey building includes a basement level and primarily comprises teaching spaces, student bedrooms and staff and student amenity spaces.

The construction is load bearing masonry with Bath stone façades on all but the rear elevation, which is brick. The floors are assumed to be timber joists spanning between loadbearing masonry walls or primary beams.

The north and south wings were originally three storeys and were extended upwards by one story in the early 1900s. The historic drawings for this work have been retrieved and their accuracy has been confirmed with limited opening up.

At the back of the building (west elevation) several extensions have been added at different times and with varying degrees of architectural merit. A 1930s extension by architect Maufe is probably the most interesting and significant in conservation terms. All the extensions are essentially masonry buildings, with floor structures varying from steel beams and timber joists to masonry vaulting to concrete depending on the age of the building.

In September 1940 more than 30 high-explosive bombs were dropped within 400 yards of the site causing damage to the building. This damage resulted in the loss of pinnacles and turrets which have not been replaced.

A mezzanine floor was added through parts of the building in 1989 approximately matching first floor level elsewhere in the building. This floor is made up timber joists spanning between small steel beams. The beams in turn span between original masonry walls with mid-span support from a steel column.

Generally the building has been looked after and well used so is in good condition structurally. It is noted that architecturally there have been some unsympathetic and poor quality interventions.

6.2 George House (2)

George House pre-dates the Main building and became a service wing once the Main Building was completed. It is a loadbearing masonry building and has been much adapted, leading to a confused structural form internally. Some historic drawings of the alterations have been found and these inform the existing structure drawings.

Site overview of existing buildings

The heritage significance appraisal produced by Heritage Information Ltd suggests the extent of alteration is such that internally the building is unlikely to be significant in conservation terms although the handsome east façade enhances the overall setting of the Main Building. Generally, the building appears to be structurally sound, although it is architecturally shabby.

6.3 Library (3)

The Sir Cyril Taylor Library by Anthony Turrall Architects was constructed in the 1990s and is a four storey (plus basement) concrete frame structure. Further commentary on its existing structure is provided in section 12.1.

6.4 Red House (4)

The Red House is a three-storey (plus basement) Victorian building (circa 1894) located in the centre of the campus. The building is locally listed as it is considered to make a positive contribution to the setting of the principal building and is a Building of Townscape Merit. The structure is a load bearing red-brick masonry construction with timber floors and roof.

6.5 Longley House (5)

This is a single storey masonry building with a pitched roof located on the north boundary of the site. This building has previously been used for student accommodation and common areas.

6.6 Other Buildings

Other buildings on the site include Orchard House (6) and Oak Tree Cottage (7) as well as Upper and Lower Cottages (8). No structural alternations are proposed to these buildings at this stage and so beyond this section no further comments are included in this report.

Orchard House (6) is a two-storey masonry building previously occupied by the president of the university. We understand that this building is judged to be in good condition and ready for use according to Bidwell's initial survey, although we have not been provided with access to date so cannot comment.

Oak Tree Cottage (7) is a single storey building located on the east boundary of the site. It was originally constructed in the 19th century but has since been subject to alterations.

Upper and Lower Cottage (8) are two storey masonry buildings serving as porter's lodges and staff accommodation.

6.7 Perimeter wall (9)

The wall along Queen's Road is approximately 3m high brickwork. A length of the wall is bowing into the street, likely due to nearby trees disturbing the wall's foundations. This should be addressed as a maintenance issue if not part of the initial construction project. Elsewhere, external walls on the site have not been inspected.

7. Conservation principles

All structural work in the grade II listed principal building will be tested against accepted conservation principles. Broadly these can be summarised as:

7.1 Conserve as found

Ideally buildings are retained in their original use with as little change as possible. In this case the use in principle is unchanged – it was designed as an educational establishment and will remain so. However, teaching methods for secondary school students are rather different from methodist ministers and the requirement for larger classroom spaces necessitates some alteration.

The original materials were high quality and built with a level of care and craftsmanship which the design team intend to preserve. The design is evolving as the technical and historic information becomes available and we expect to further reduce the impact on historic fabric in the next stage.

7.2 Minimum intervention

Our objective is to retain as much of the original as possible, balanced against making the structure useable for the future. The minimum intervention principle is most easily met by establishing whether the current structure, with normal maintenance (eg tightening connections) could be considered fit for purpose without further intervention. Investigation, calculation and load testing all have their place in establishing whether a structure can be re-used. Often the original materials and craftsmanship is higher quality than is the norm now, so load capacities can be great than expected.

Where repairs or strengthening are considered essential then, wherever possible, they should be additive and easily read. However, this approach can be tempered by the need for interventions to be visually appropriate. Visible repairs do not always want to “draw the eye” some a greater loss of fabric may be considered, for example in the case of a timber splice connection rather than a steel plate strengthening.

In this case the building appears to have been designed to carry reasonable loads and we do not envisage significant strengthening will be required, for example primary floor beams. Areas which may need strengthening include the third floor in the Main Building which has significantly deflected. Investigation is needed to establish the cause and agree whether any works are required.

If this were a new building there would be a requirement for it to be designed against progressive collapse. This is very rarely required as a retrofit item in an existing listed building however this approach has not yet been agreed with the Approved Inspector.

7.3 Sympathetic, reversible repairs

Our intention would be to use repairs that are simple and robust, though put together with a high degree of craftsmanship as the original building was. The design and opening up has not yet reached the stage of being able to design repairs, but if any are needed they will be designed to be reversible and readable unless there is good reason to move from that principle.

7.4 Retain load paths where possible

Structurally this make sense – if the loads can be kept within known load paths which have been previously loaded then we will not overload the structure locally, creating the potential for differential foundation movements.

One consequence of continued use of the building as an educational establishment is that more classroom spaces are required. Wherever possible these have been located in places that do not require alteration. The notable exception, however, is the north and south wings. In these cases, the proposal is to remove walls, which support chimneys above and provide lateral stability, in order to create a total of 6 new classrooms. This changes the load path as the action of the wall will be replaced with new steel moment frames, which will concentrate the loads at the base, necessitating new foundations at these locations. The architectural merits of this scheme are set out in the architect’s report and are considered to outweigh the structural load path principle in this instance.

8. Design criteria

8.1 Design loading

Variable loading in accordance with BS EN 1991 in key areas would be as follows:

Circulation	4.0 kN/m^2
Classrooms	3.0 kN/m^2
Assembly areas	5.0 kN/m^2
Libraries	4.0 kN/m^2
Storage areas	5.0 kN/m^2
Roof (access only)	0.6 kN/m^2
Roof (maintenance access)	1.5 kN/m^2
Plant rooms	7.5 kN/m^2

In addition, some floors would be designed for an additional load of 1.0 kN/m^2 to allow for light weight partitioning between rooms where appropriate.

These load requirements are based on current standards and are likely to be tempered by agreement with the Client, Conservation Officer and Approved Inspector based on the anticipated use of the building. We would not normally expect to strengthen floors in an existing building if the use is unchanged, unless there is good reason. Reasons to strengthen would include:

- Concern about safety
- Concern about performance (e.g. uncomfortable deflection)
- Significant additional load (for example additional load to create acoustic separation)

However, in the proposed scheme some areas of the Main Building include a change of use from bedrooms to classrooms. Due to the limited opening up works which have been able to take place so far, it has not yet been possible to assess the capacity of existing structure in these locations.

8.2 Design life and fire

The design life of the building structure will be 50 years. The structure will be designed to resist characteristic wind loads occurring over this period. Any new reinforced concrete elements will have cover to reinforcement specified to meet this design life. Any whole life embodied carbon assessments should be conducted based on this life span. The fire protection requirement is assumed to be 60 minutes based on the building use and size.

9. Robustness and disproportionate collapse

In accordance with Requirement A3 of the Building Regulations 2010, buildings must be designed and constructed so that in the event of an accident the building will not suffer collapse to an extent that is disproportionate to the cause.

However in the case of existing buildings, there is no expectation to make an existing building retrospectively compliant with Requirement A3 unless there is a Material Change of use of the following type:

- The building is used as an hotel or a boarding house, where previously it was not;
- the building is used as an institution, where previously it was not;
- the building is used as a public building, where previously it was not;
- the building is not a building described in classes 1 to 6 in Schedule 2, where previously it was not.

For all other types of material alterations, not described above, the requirement is that an existing building, which does not comply with Requirement A3 of Building Regulations, is 'no more unsatisfactory' than before building work is carried out. This clause would not be met if the consequence class of a building was to change to a higher risk group.

In their existing condition, the building type and occupancy of the Richmond Hill Campus buildings vary across the site. These are described below:

- Main Building: five storeys, used for education and boarding
- George House: three storeys, used for education
- Library: five storeys, used for education and a library
- Red House: 3 storeys, used for education
- Longley House: Single storey, used for education and boarding

Therefore, with reference to Table 11 in Building Regulations Approved Document A shown adjacent, the Main Building, George House, Library and Red House are categorised as consequence class 2b, while Longley House is consequence class 2a.

In the proposed scheme the buildings are to continue being used in the same way – a mixed use of education and boarding. Because of this there is not considered to be a Material Change of use or an increase in the consequence class of the buildings which would trigger a need for retrospective compliance with Requirement A3 of Building Regulations. Instead, they must remain 'no more unsatisfactory than before' work is carried out.

The exception is Longley House where there will no longer be boarding accommodation. This could be deemed a Material Change of use, but is not considered significant since the building is only single storey.

Our suggested approach will need to be agreed with the approved inspector overseeing the design of the proposed scheme.

As an alternative, a systematic risk assessment based approach could be carried out to consider the actual risks and their possible impacts on the buildings. An assessment would be made of the current level of robustness against disproportionate collapse and of strengthening required to any at-risk areas. Where work is undertaken there is also enhancement that can be made through good practice detailing of joints and interfaces.

This is considered to be pragmatic and sympathetic approach to overcome the significant challenge of designing against disproportionate collapse whilst conserving the heritage value of the buildings. Upgrading the historic fabric to meet current standards for disproportionate collapse by installing horizontal and vertical ties would require extensive interventions which would have an unacceptable impact on the listed status of the building.

Table 11 Building consequence classes

Consequence Classes	Building type and occupancy
1	Houses not exceeding 4 storeys
	Agricultural buildings
	Buildings into which people rarely go, provided no part of the building is closer to another building, or area where people do go, than a distance of 1.5 times the building height
2a Lower Risk Group	5 storey single occupancy houses
	Hotels not exceeding 4 storeys
	Flats, apartments and other residential buildings not exceeding 4 storeys
	Offices not exceeding 4 storeys
	Industrial buildings not exceeding 3 storeys
	Retailing premises not exceeding 3 storeys of less than 2000m² floor area in each storey
	Single-storey educational buildings
	All buildings not exceeding 2 storeys to which members of the public are admitted and which contain floor areas not exceeding 2000m² at each storey
2b Upper Risk Group	Hotels, blocks of flats, apartments and other residential buildings greater than 4 storeys but not exceeding 15 storeys
	Educational buildings greater than 1 storey but not exceeding 15 storeys
	Retailing premises greater than 3 storeys but not exceeding 15 storeys
	Hospitals not exceeding 3 storeys
	Offices greater than 4 storeys but not exceeding 15 storeys
	All buildings to which members of the public are admitted which contain floor areas exceeding 2000m² but less than 5000m² at each storey
	Car parking not exceeding 6 storeys
3	All buildings defined above as Consequence Class 2a and 2b that exceed the limits on area and/or number of storeys
	Grandstands accommodating more than 5000 spectators
	Buildings containing hazardous substances and/or processes

Notes:

1. For buildings intended for more than one type of use the Consequence Class should be that pertaining to the most onerous type.
2. In determining the number of storeys in a building, basement storeys may be excluded provided such basement storeys fulfil the robustness requirements of Consequence Class 2b buildings.
3. BS EN 1991-1-7:2006 with its UK National Annex also provides guidance that is comparable to Table 11.

Extract from Building Regulations Approved Document A, Table 11

10. Main Building

10.1 Existing structure

Sketches SK079 to SK089 in appendix A show the existing structure determined from preliminary survey drawings and site visits to date. It has not been possible to carry out further opening up work in the Main Building and so much of the existing structure is assumed and will need confirming once the work has been completed.

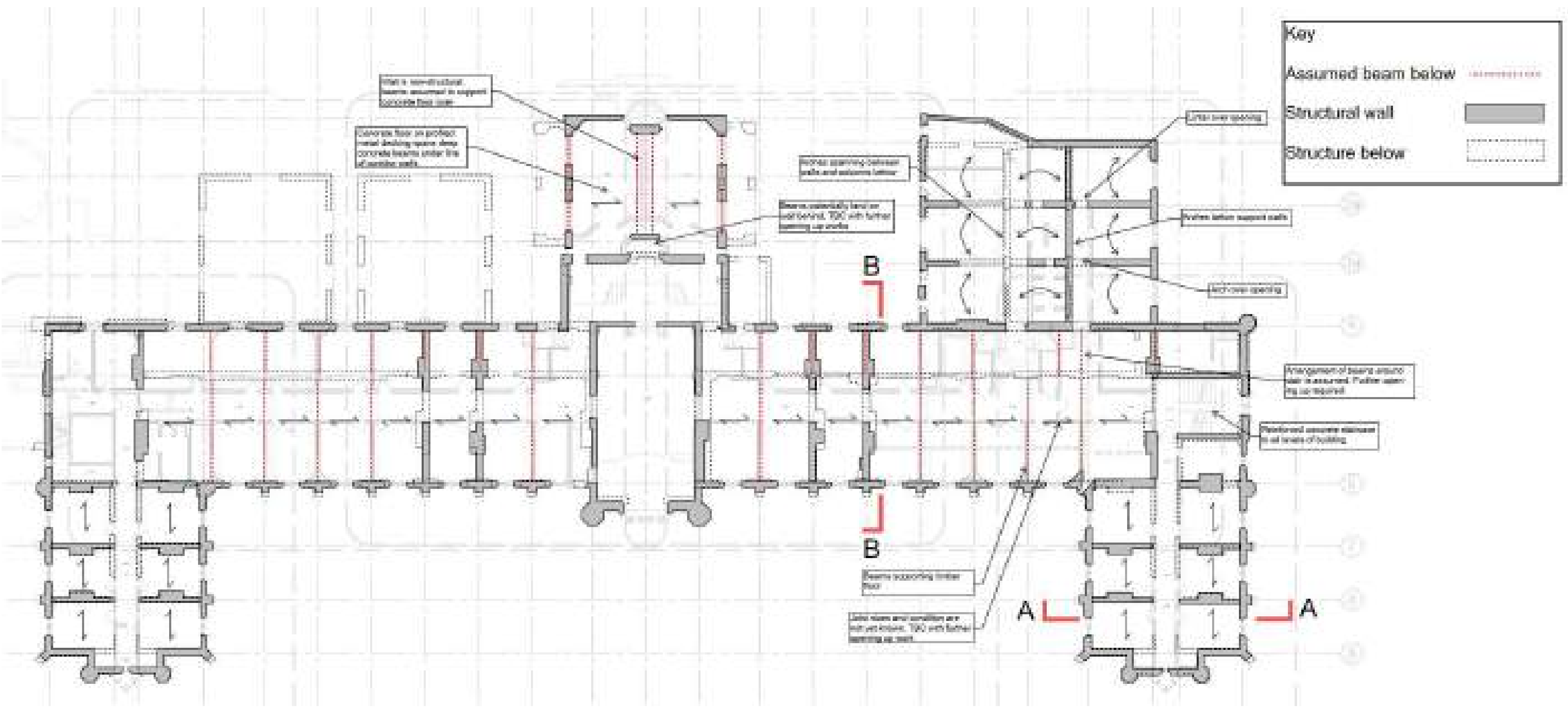
The Main Building primary structure is load bearing masonry with timber floor joists. Internal structural walls have been identified by visiting the site and examining the floor plans. There are some key structural lines across the building which support the chimneys and provide lateral stability. From initial investigations there is no evidence of significant issues with the condition of existing timber within the building as it has generally been well maintained.

In the wings of the buildings the floor plan is consistent from the ground floor to the roof. The direction of joist spans for the ground, first and second floors may be spanning between the structural lines on the chimney breasts but this is not confirmed. The third floor structure has been seen through initial opening up work and is confirmed to be as shown on the 1903 plans. Sections in SK079 show the configuration of these chimney supporting walls.

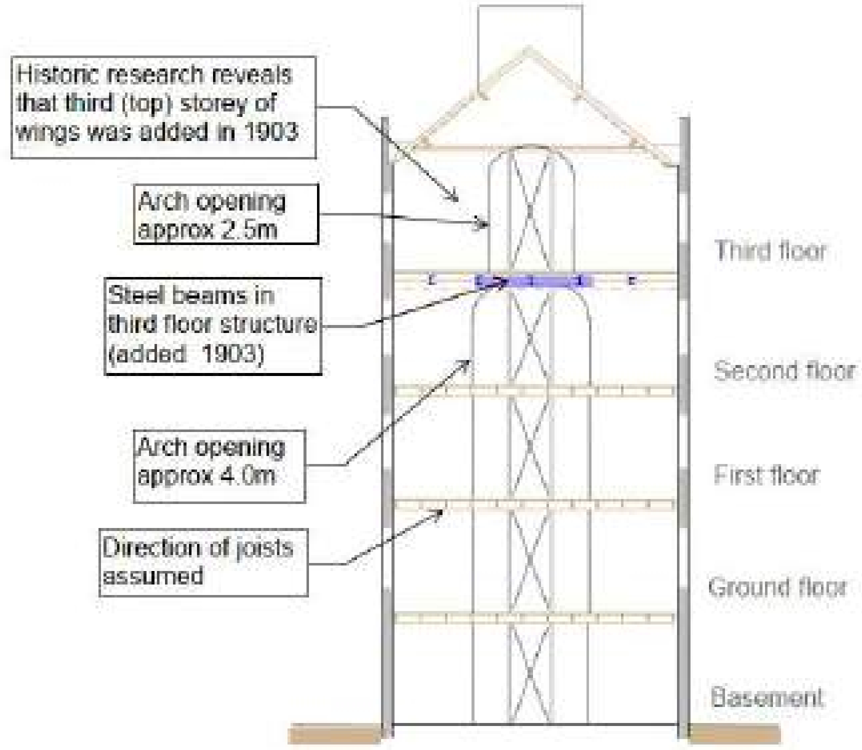
Two mezzanine floors (now know as first floor level) have been added above the ground floor breaking up what was previously a double height space. The mezzanine in the north length of the building is formed of 100x100 SHS beams spanning from corridor wall to steel column at mid span to front elevation. Timber joists span between the beams. This forms the slender structure required for suitable headroom, but we note there is poor acoustic separation between the ground and mezzanine levels. The mezzanine is assumed identical in the north and south halves of the building.

Extensions to the rear (west face) of the Main Building vary considerably in date and construction technique. Of greatest architectural merit is the 1930s library extension by Maufe (previously adapted to form office space). This extension is situated to the north end of the rear facade. At basement level two central columns support downstand beams over, which span between the columns and external walls. It is assumed that these form frames in both directions which provide lateral restraint to the external masonry walls. Structural walls at ground floor level sit over the beams, which in turn support vaulted ceilings forming the second floor. At second floor level are a series of structural walls supported on the lines of walls and arches below. Over these is a flat roof.

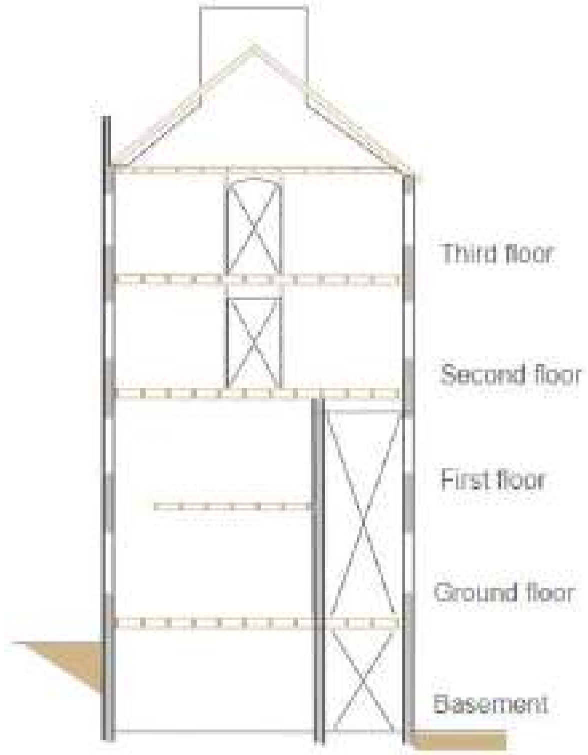
The central extension to the rear of the Main Building is a masonry, presumed cavity, wall construction supporting concrete floor slabs on metal deck possibly from the 1980s. The span across the central extension is divided by two concrete downstand beams positioned centrally. Other extensions to the south end of the Main Building are masonry and timber from 1903.



Extract from SK083 showing Main Building general layout with currently assumed beam and timber joist spans



Section A-A



Section B-B

10.2 Proposed structure

Sketches SK60 to SK62 and SK70 to SK74 in appendix B show the structural alterations required to achieve the proposed scheme.

The most significant alterations to the Main Building are the removal of walls including the fireplaces and chimney breasts along the main length of the building and in the wings. These walls are responsible for supporting the first, second and third floors, as well as the chimneys. These walls also provide stability against lateral (wind) forces.

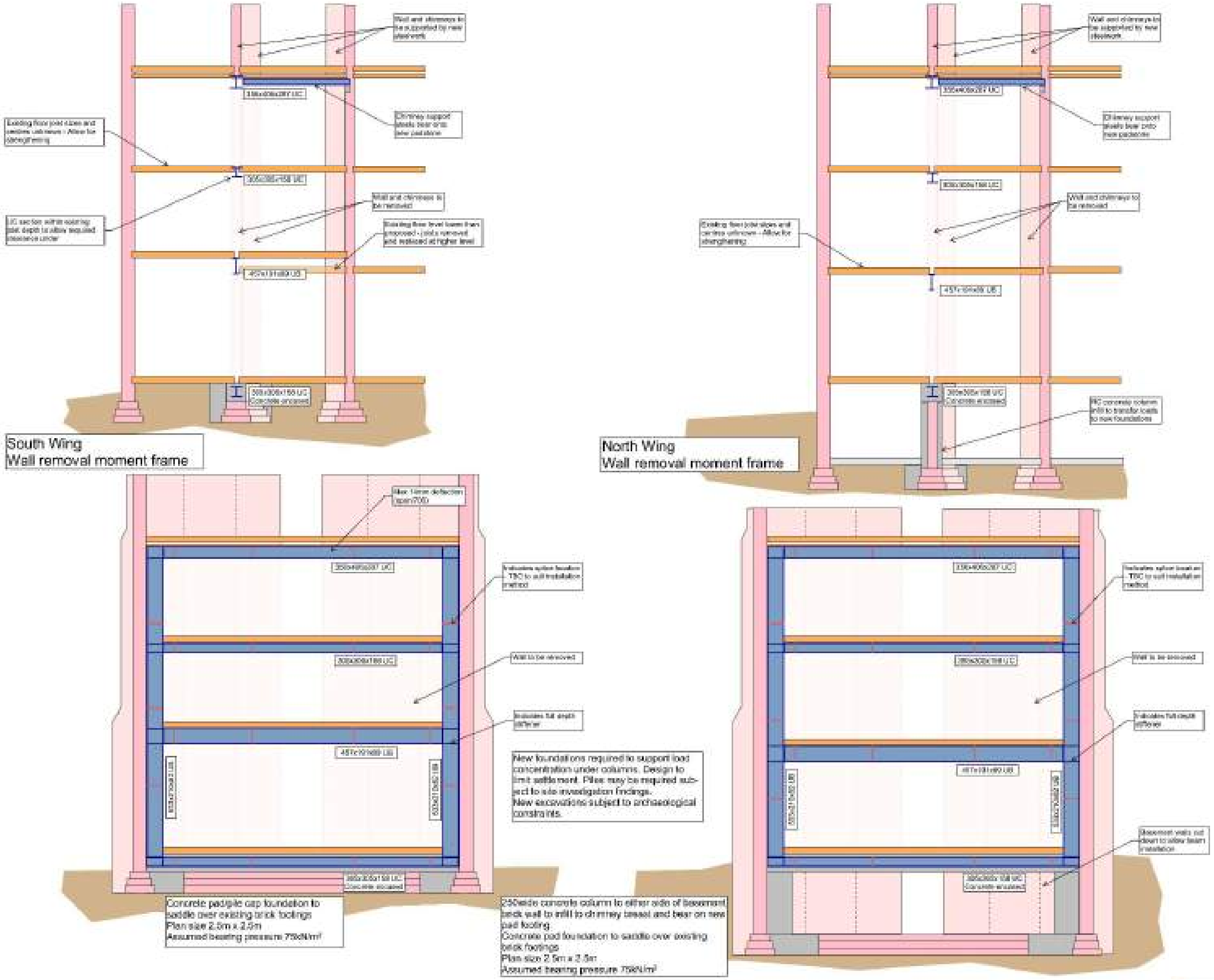
10.2.1 North and south wing alterations

In the north and south wings, the first line of internal cross walls and chimneys will be removed from ground to 3rd floor. The chimneys and partition wall are to remain above 3rd floor up into the roof and chimney stacks.

To replace the walls in the wings of the building it is proposed that a steel moment frame is placed at each of these locations. As the frame is placed inside an existing masonry structure, restricting lateral movement of the steel columns is significant and largely dictates the sizes of the proposed members. A sway deflection limit of 5mm and a vertical deflection limit of 15mm has been used for the design.

In order to achieve the required headroom in the rooms UC sections have been adopted. To achieve the same stiffness as the UBs in the stage 2 design the weight of these sections has increased as a result of the change to UC sections.

The key challenge of introducing a steel moment frame in these locations is the method and sequencing required to position the larger steel members in the building. Two possible installation methods are described in sections 10.2.2 and 10.2.3, although the actual construction method will need to be determined by the contractor. Due to the size of the proposed steel beams, these members would have to be spliced to allow them to be handled in manageable sections. The downside of splices is that they introduce more bolted connections and this reduces the stiffness of the overall frame. The reduced stiffness will need to be assessed once the number of splices is confirmed. Heavier or larger section sizes may then need to be adopted.



Sections through north and south wing moments frames

Initial splice designs have been undertaken to assess the visual and spatial impact of the connections.

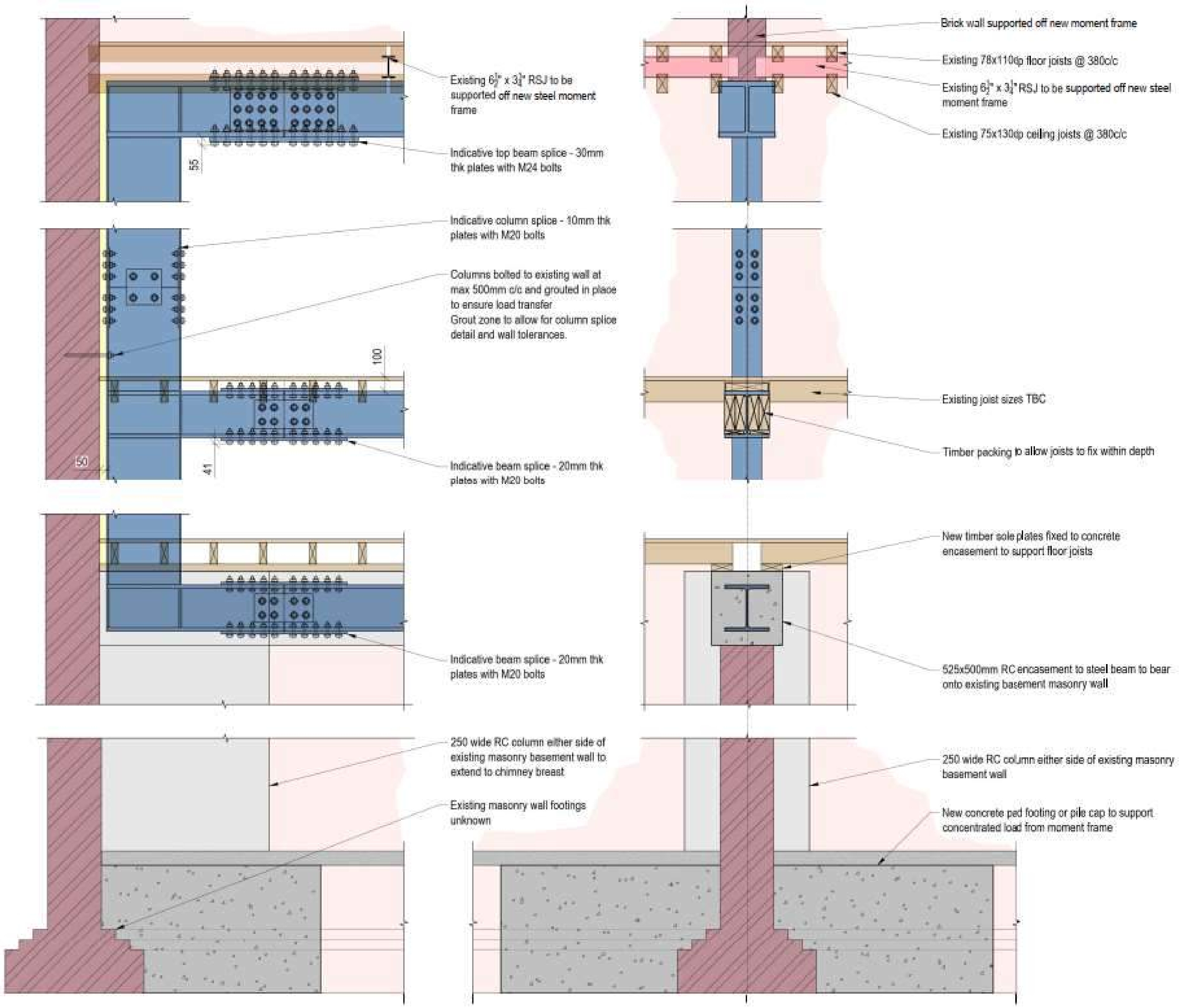
The rooms are to be used as classrooms. The moment frame has therefore been designed for a 3.0kN/m^2 variable load.

The moment frame and the increased variable loading lead to high concentrated loads under the new columns. It is proposed to provide new foundations to account for these loads. No site investigation data is currently available, so an initial pad footing design has been based on an assumed allowable bearing pressure of 75 kN/m^2.

In the northern wing there is a basement. Here a pair of concrete columns are proposed to straddle over the existing basement wall and sit on the new extended footing at basement level.

To maintain the required lateral stiffness a bottom steel member is provided. This also helps to transfer some of the vertical loading back into the existing wall/footing under. It is proposed to concrete encase this beam. It is noted that in the northern wing the bottom spreader beam will significantly impact on head height in the central basement corridor.

If openings for service distribution are required they will adversely impact on the stiffness of the moment frame and increase section depths. Therefore, service routes should be kept outside of steel members. New services will need to be routed below or above the beams and this will require careful coordination to avoid creating local headroom issues.



North wing moment frame details, including indicative splice connections, basement works and foundations

10.2.2 North and south wing installation
Option 1: Maintain chimney

The following section outlines a possible method for installing the north and south wing steel frames with chimney brickwork at 3rd floor maintained during the works. To achieve this needle propping will be required. This option has the least impact on the historic fabric.

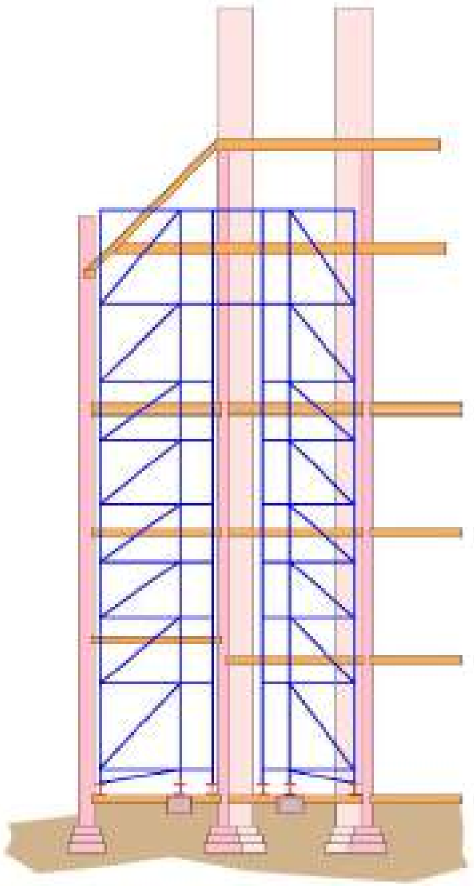
10.2.2.1 Step 1 – External scaffold

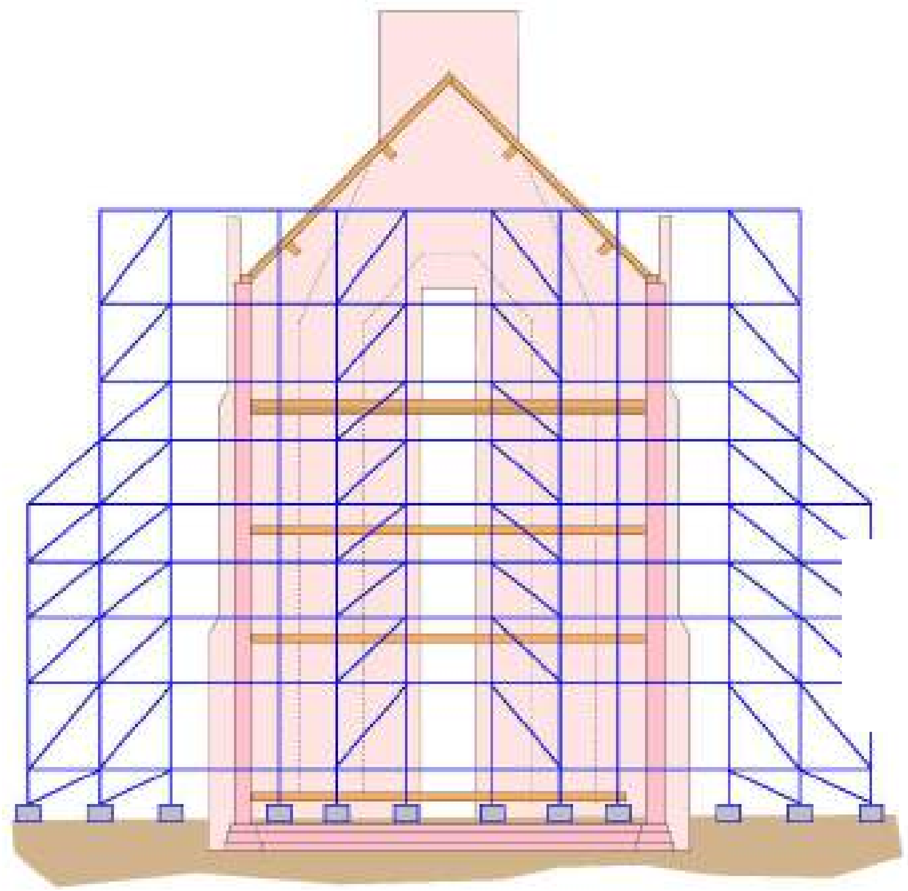
Remove windows and install scaffold.

External scaffold to be designed to provide lateral stability. Scaffold to clamp to existing masonry wall no bolted or anchor connections. Therefore, windows will need to be removed on both sides of wall at each floor level to allow clamping detail around the window reveals.

Large lateral loading may require temporary pad foundations or screw piles as the loads on the external scaffold will be considerable.

Full birdcage scaffold within the retained walls to allow access for steel install. Floorboards and joists removed and stored for reinstatement.





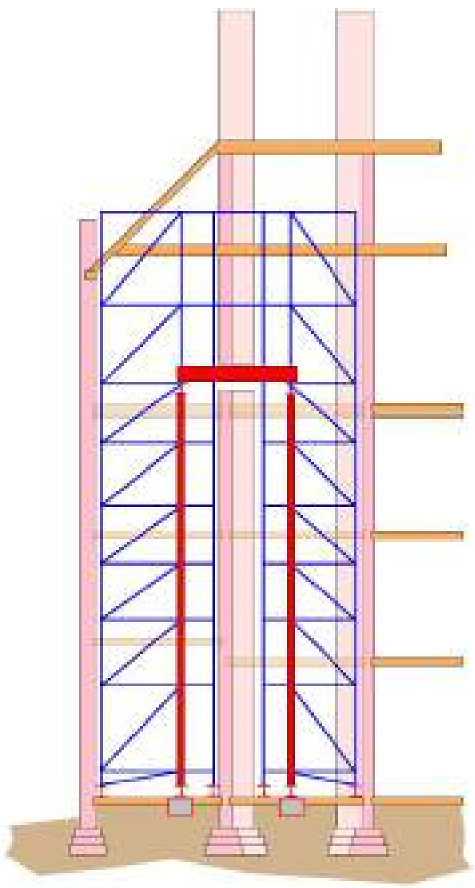
10.2.2.2 Step 2 – Needle prop chimney

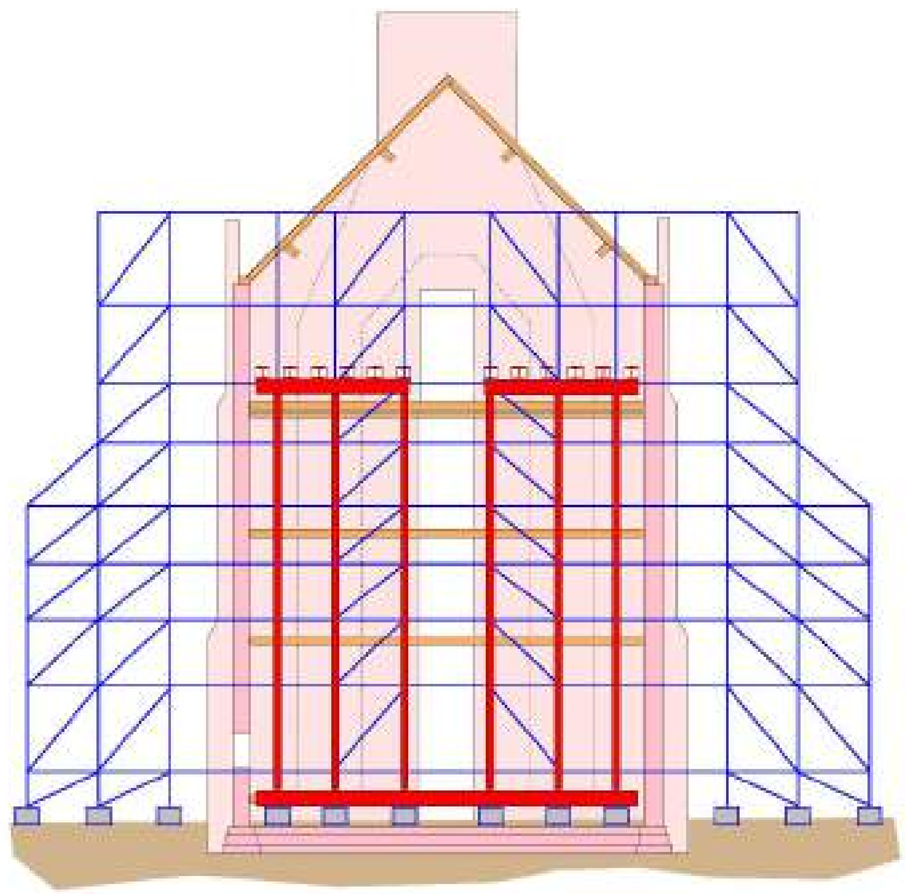
Install spreader beam in basement on needle prop lines.

Install vertical props through building.

Form openings for needle propping above 3rd floor joists.

Insert needle props, assumed 254UCs at 500c/c (larger if needed later in process to lift in steel sections)





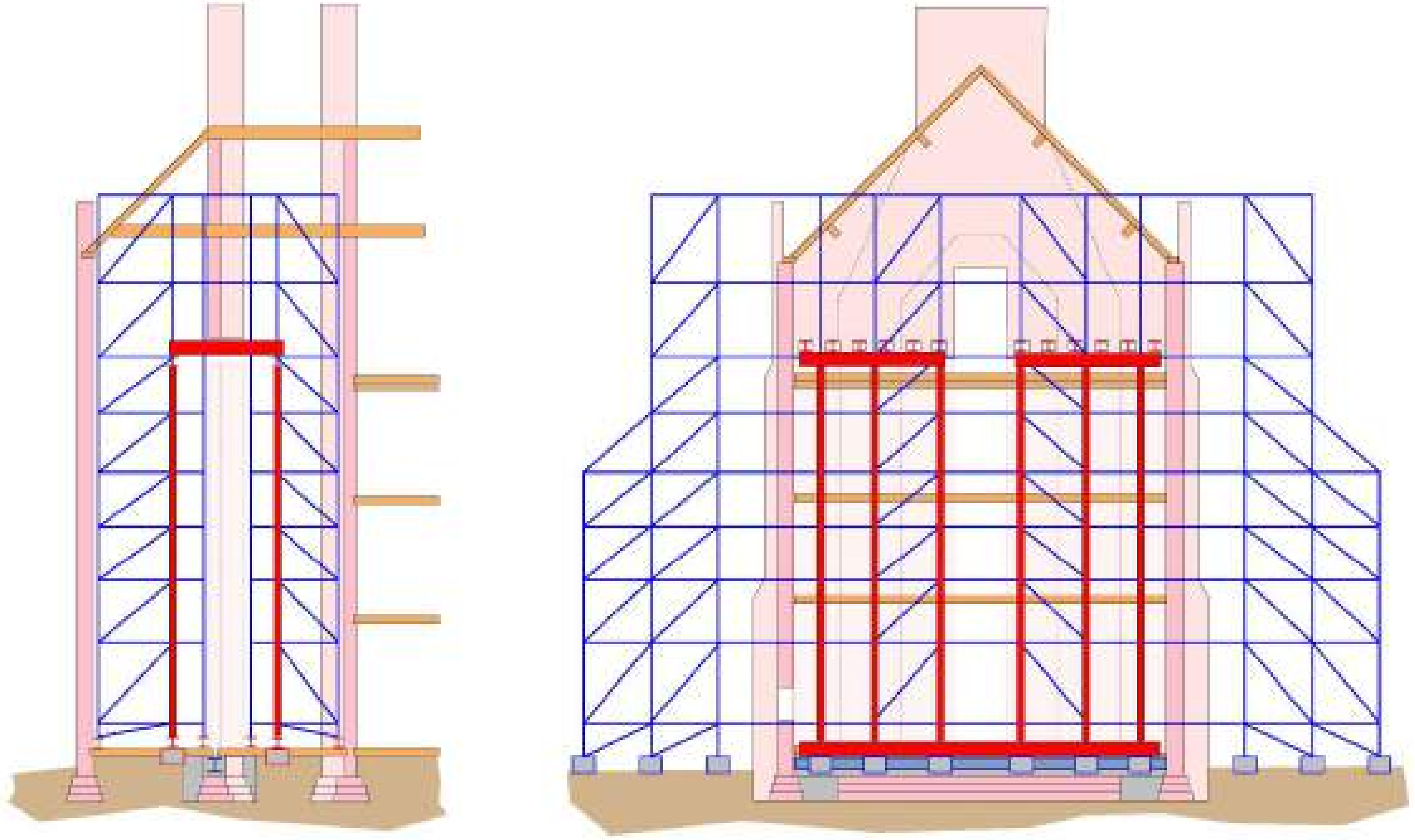
10.2.2.3 Step 3 – Demolish walls and remove existing floors
All joists and floorboards to 1st, 2nd & 3rd floors removed carefully and stored for reinstatement including the rolled steel joists at third floor level.

Masonry cross wall removed.

Make good any damage to external/cross wall intersection where toothed in bricks removed.

Form hole in external wall at ground level to allow new steelwork to be passed between lines of needle propping. This needs to be done carefully so stones can be reused when reinstating.

Install ground floor steel beam including concrete encasement.



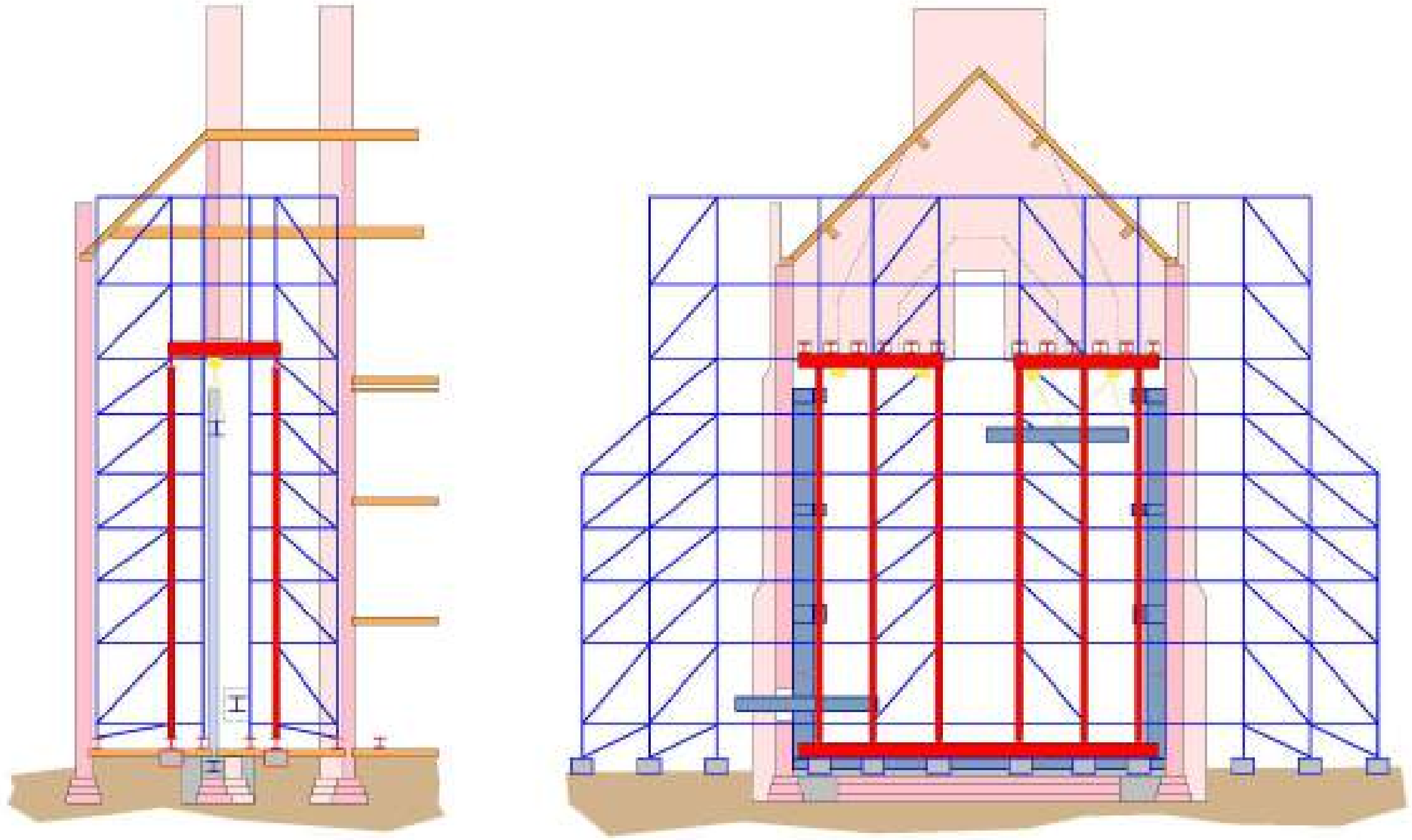
10.2.2.4 Step 4 – Install new steelwork
Columns delivered through opening in wall and rotated upright.

Installed single floor at a time and spliced. Noted each section weighs approximately 300kg.

Primary beams need to be manoeuvred in between the needle propping. Then lift into place using lifting equipment attached to needle props. Expected section weight 800-900kg if in three sections.

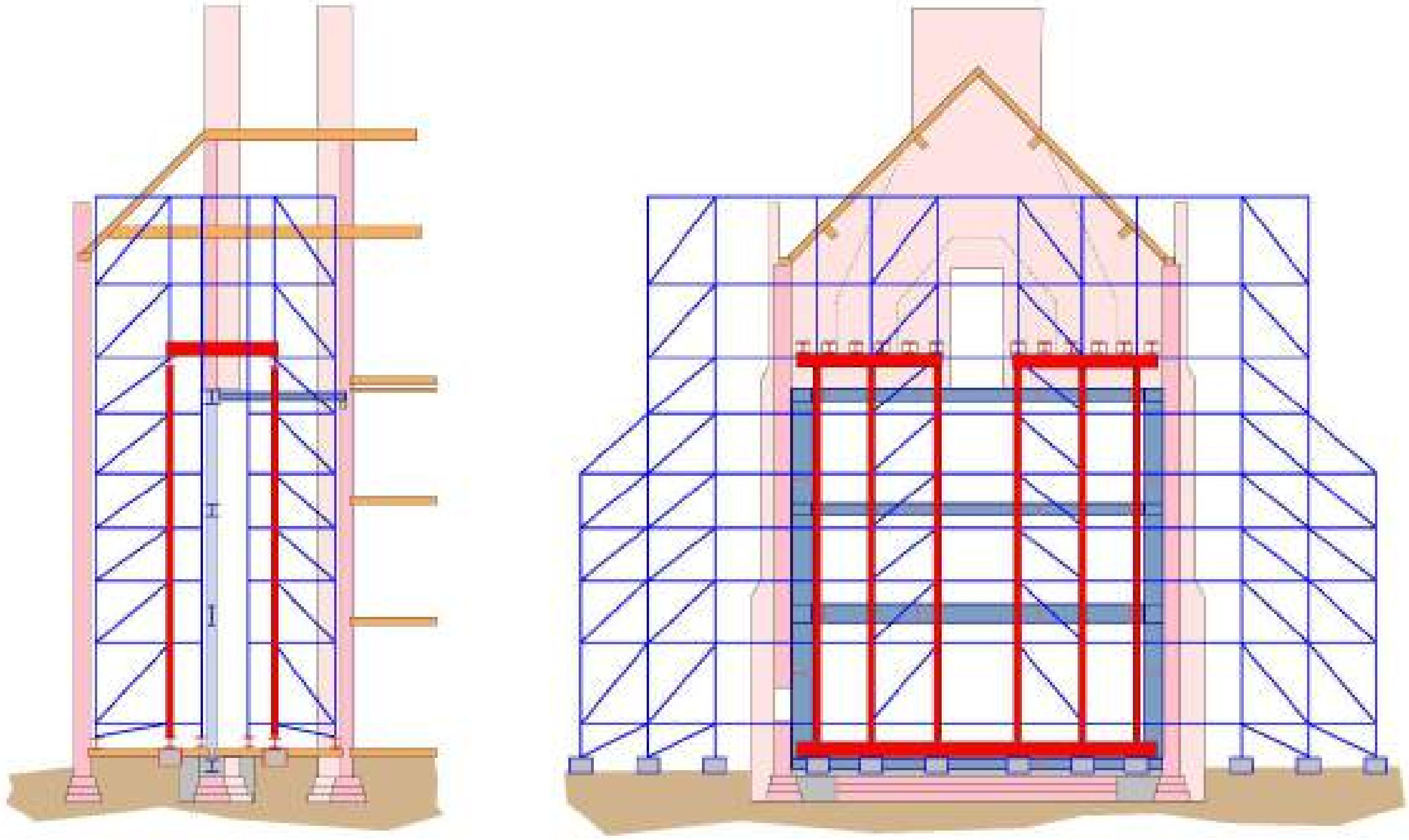
If level of slip and size of bolted splice plates not acceptable then splices to be formed with on site welding.

Columns bolted and grouted to external walls once beams installed and levelled.



10.2.2.5 Step 5 – Rebuild brick to sit on new steelwork
Steels to support front of chimney installed including padstone to remaining cross wall.

Masonry dry packed and infilled down to top beam to allow load transfer from needle props to new works.



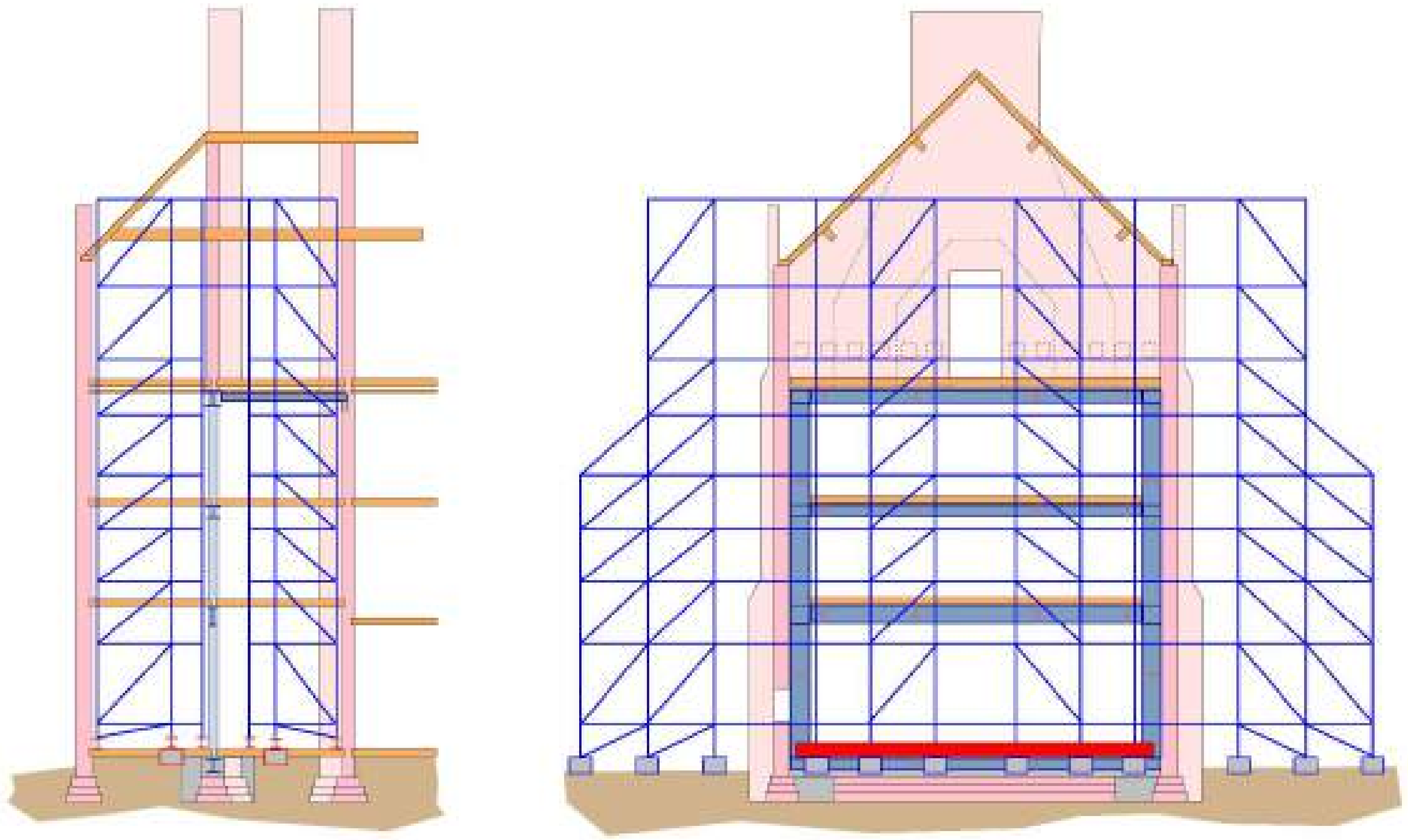
10.2.2.6 Step 6 – Reinstall floors
Needle propping removed.

Openings for needle propping bricked up.

Any cracks to chimney assessed and repaired.

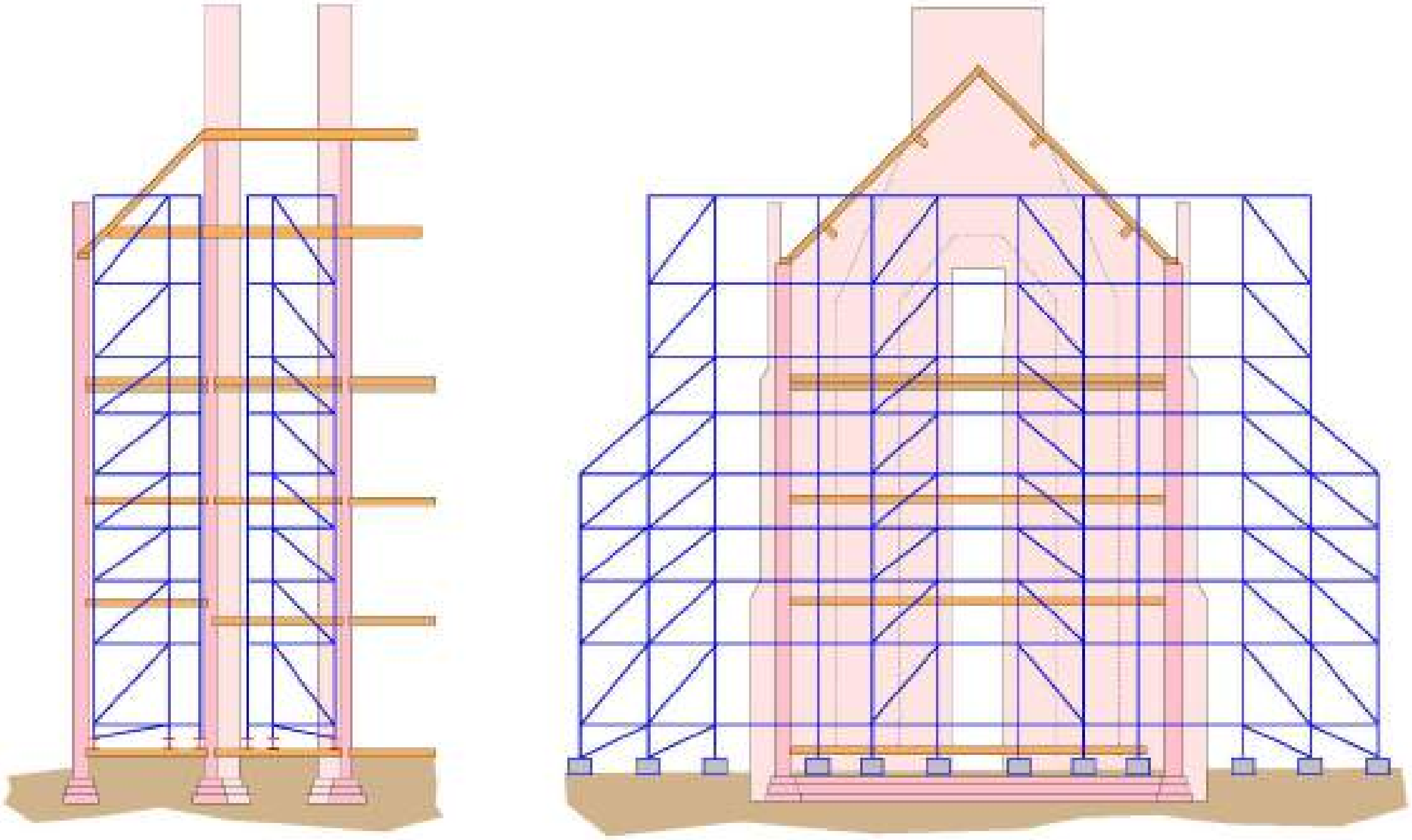
Original steel beams, timber joists and floor boards reinstalled, with modifications to bearing where required.

10.2.2.7 Step 7 – Remove Scaffold
Scaffold dismantled.



10.2.3 North and south wing installation
Option 2: Remove and rebuild chimney and roof

This section outlines an alternative method for installing the north and south wing steel frames where the 3rd floor chimneys and roof are removed and then rebuilt. This would allow the steelwork to be craned into position rather than being passed through a hole in the external masonry wall at ground level and lifted into place. However, this option has a greater impact on the historic fabric.

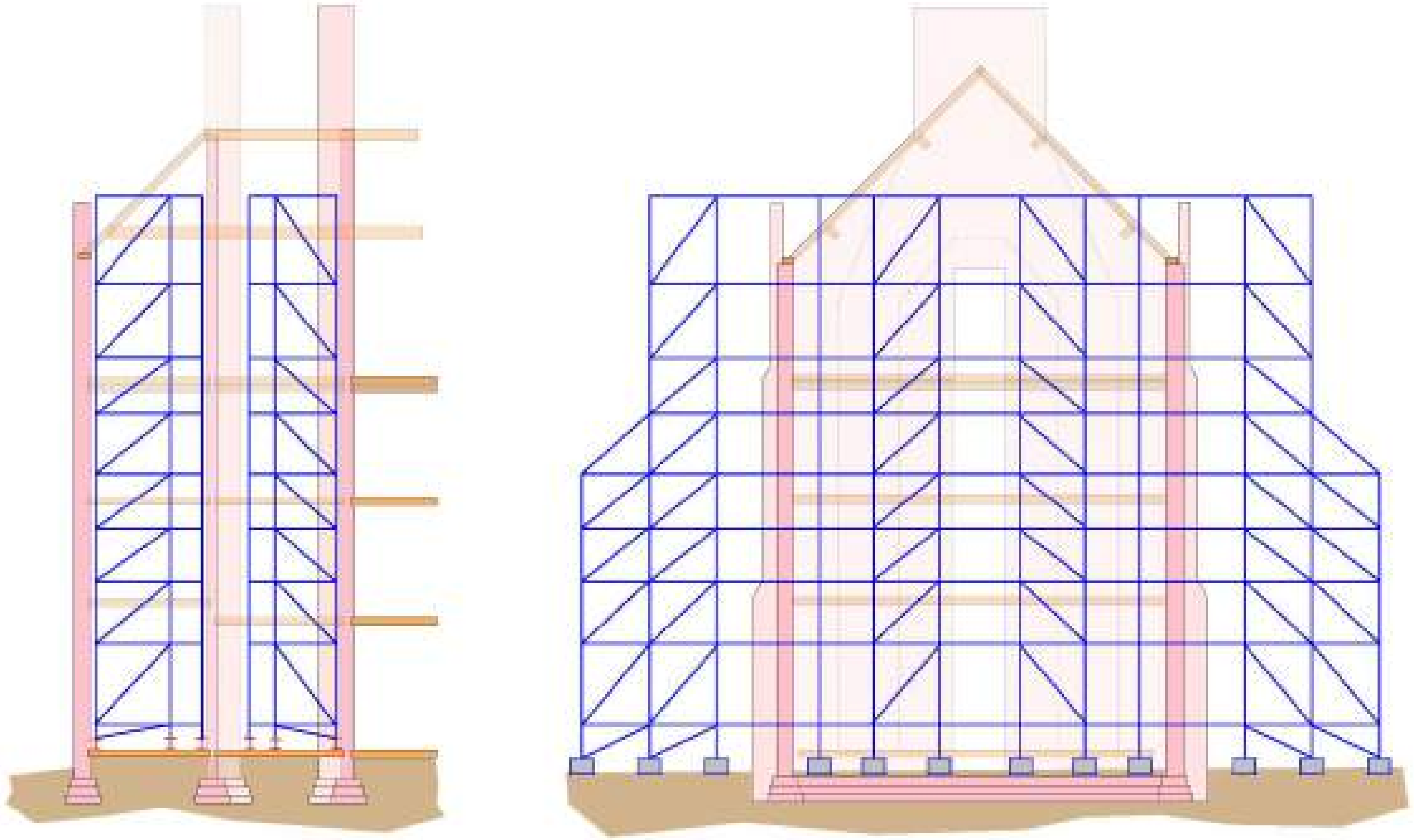


10.2.3.1 Step 1 – Scaffold

External scaffold to be designed to provide lateral stability. Scaffold to clamp existing masonry wall no bolted connection. Therefore, windows will need to be removed on both sides of wall at each floor level to allow clamping detail around the window reveals

Large lateral loading may require temporary pad foundations or screw piles as the loads on the external scaffold will be considerable.

Full birdcage scaffold within retained walls to allow access for works.



10.2.3.2 Step 2 – Remove roof, floors and dismantle chimneys

Roof and chimneys dismantled carefully, numbering external visible masonry units to allow rebuild at later date.

Note large number of flues mean that chimney brickwork likely fragile.

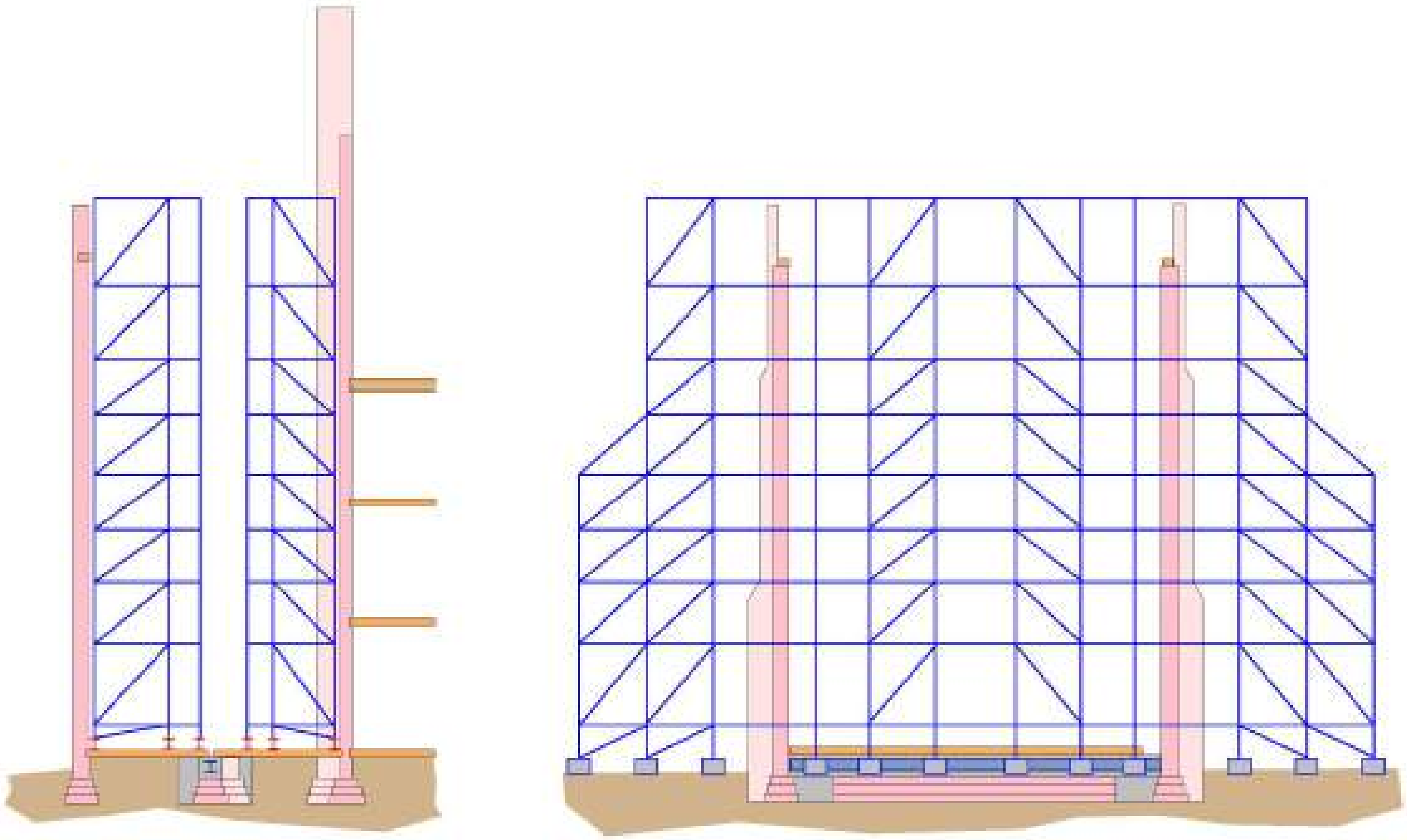
All joists and floorboards to 1st, 2nd & 3rd floors removed carefully and stored for reinstatement.

Existing steel beams at third floor removed and carefully stored for reinstatement.

Masonry cross wall removed. Make good any damage to external/cross wall intersection where toothed in bricks removed.

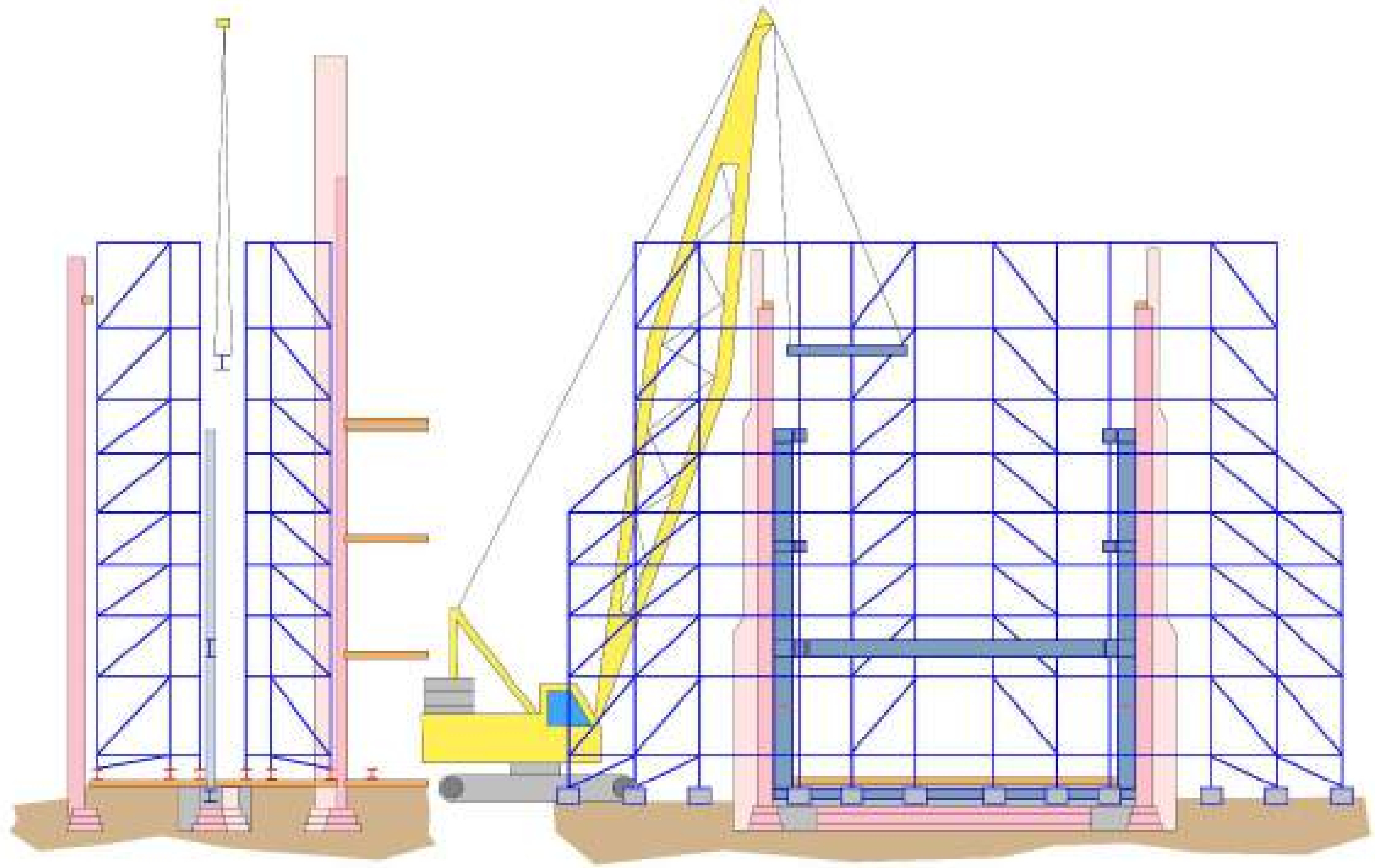
10.2.3.3 Step 3 – Foundations and ground beam
Install the foundations and ground beams.

Concrete encasement to ground beam.



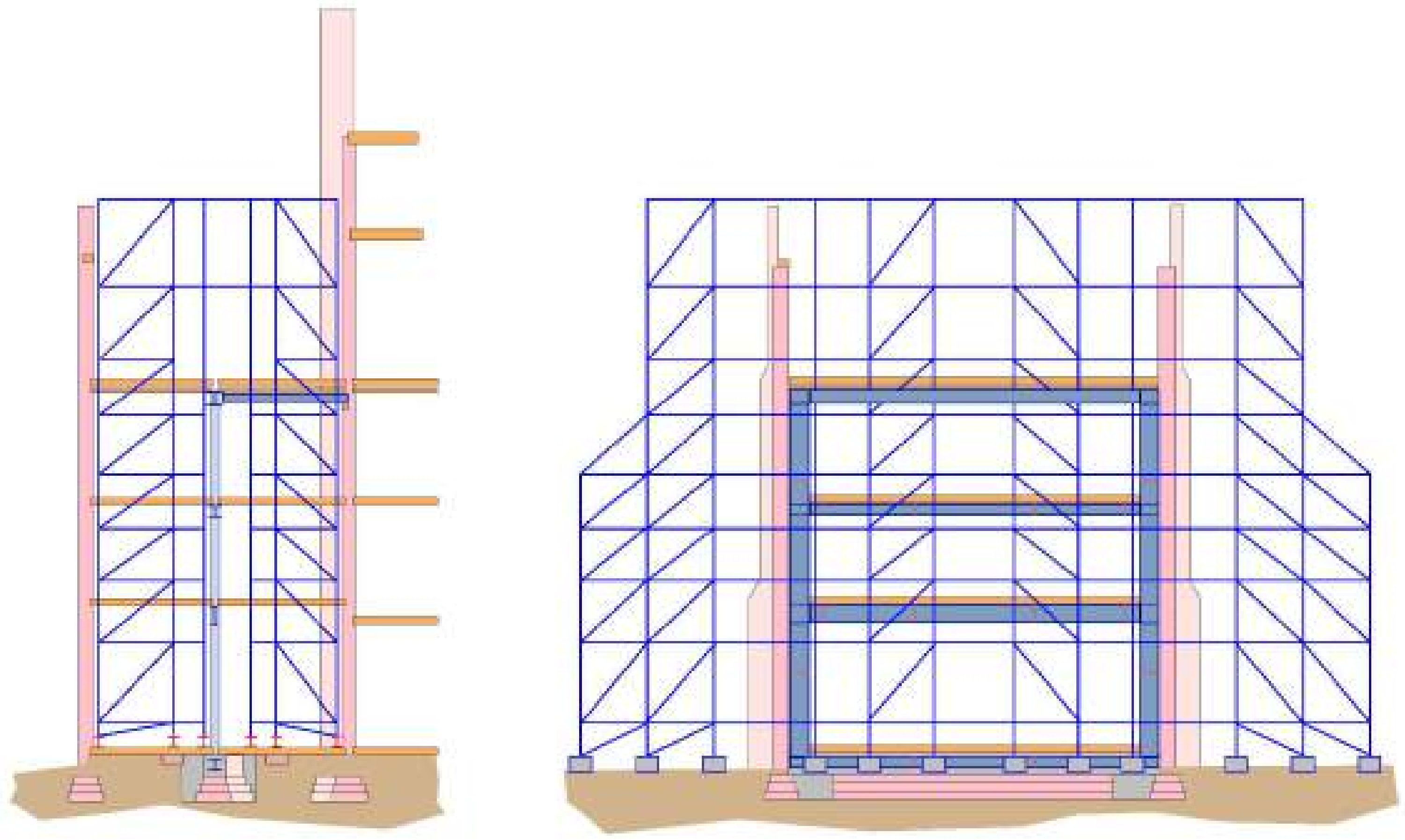
10.2.3.4 Step 4 – Install steelwork
New steel craned into place. Larger lengths of steel can be used (relative to “chimney retained” option) and splices minimised according to delivery and crane restraints.

Columns bolted and grouted to external walls once beams installed and levelled.



10.2.3.5 Step 5 – Replace existing floorplates

Original timber joists and steel beams reinstalled, with modifications to bearing where required.



10.2.3.6 Step 6 – Rebuild chimneys

Cross wall at third floor, chimneys and roof rebuilt off new supporting structure using original external masonry and new bricks where non exposed.

10.2.3.7 Step 7 – Remove Scaffold

Scaffold dismantled.

10.2.4 Main length of building alterations

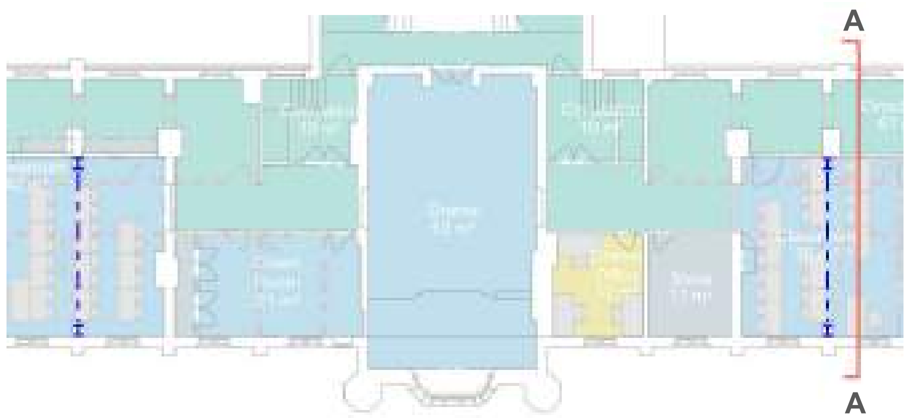
Along the main length of the building, further portions of structural masonry wall and chimney breasts are to be removed at second floor.

The existing masonry wall has an opening towards the rear of the building up to second floor and an opening in the centre at the second and third floors, forming a central corridor.

The proposals include moving the corridor from the centre of the building towards the rear of the building at second floor. The proposed openings for the new corridor can be formed with new lintels over if they can be contained without disturbing the fireplaces above. The central opening at second floor will be blocked up with fully toothed in masonry.

Where the wall needs to be completely removed as it interferes with a classroom space, the wall will be replaced with a full moment frame at second floor level. The design criteria and necessary considerations for moment frame are similar to those discussed in section 10.2.1 regarding the steel frames proposed in the wings of the Main Building.

The bottom beam of the moment frame is to sit within the depth of the existing second floor structure, while the top beam will sit below the existing third floor structure. The size and span direction of the existing timber joists at these levels are to be confirmed but they are anticipated to span perpendicular to the proposed steel frame. The existing timber joists are to be reinstated following the installation of the steel frame.



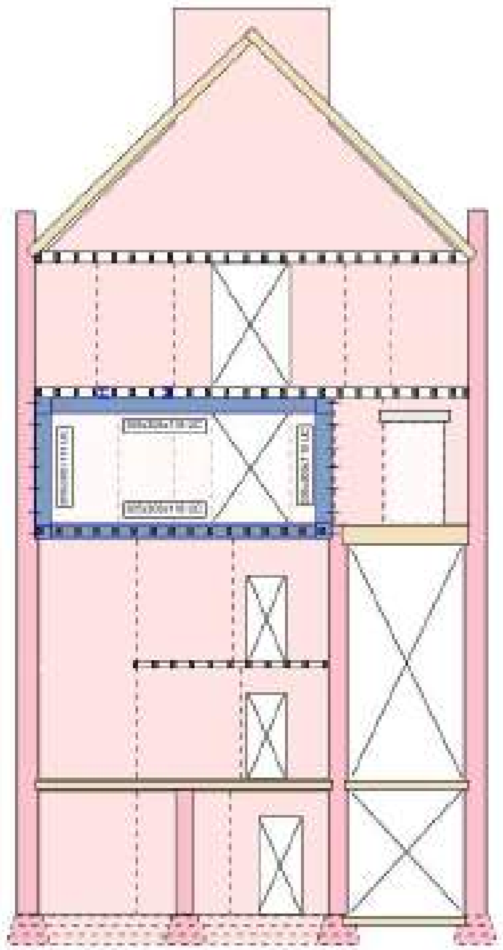
Extract from SK73 showing locations of proposed steel frames at 2nd floor

The installation method and sequencing is a key consideration for the proposed frame. Similarly to the works occurring in the north and south wings, an external scaffold designed to provide lateral stability in the temporary condition will be required. With appropriate propping of the third floor wall and chimney breast, a portion of roof and floors could be removed to allow steels to be craned into position from above, before the original fabric of the floors and roof are reinstated. Alternatively, windows could be temporarily removed to provide access for steels to be loaded in and lifted into position. As with the wings, the actual sequence and temporary works will be determined by the contractor.

To support the chimney breasts following the removal of the chimneys at second floor level, a series of steel beams are to be placed at third floor level (shown on SK074).

10.2.5 Maufe extension alterations

In the Maufe extension a series of walls, anticipated to be structural, are to be removed at second floor level. It is assumed that these walls provide support to the flat roof over as well as laterally restraining the external masonry walls.

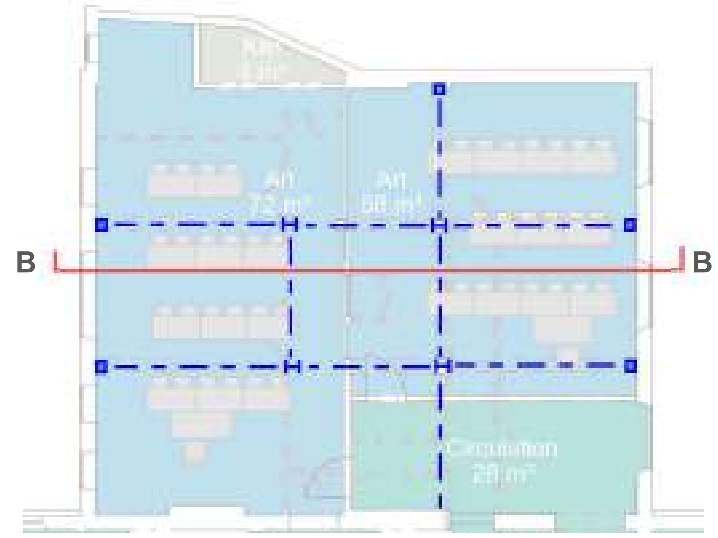


Section A-A: Extract from SK62

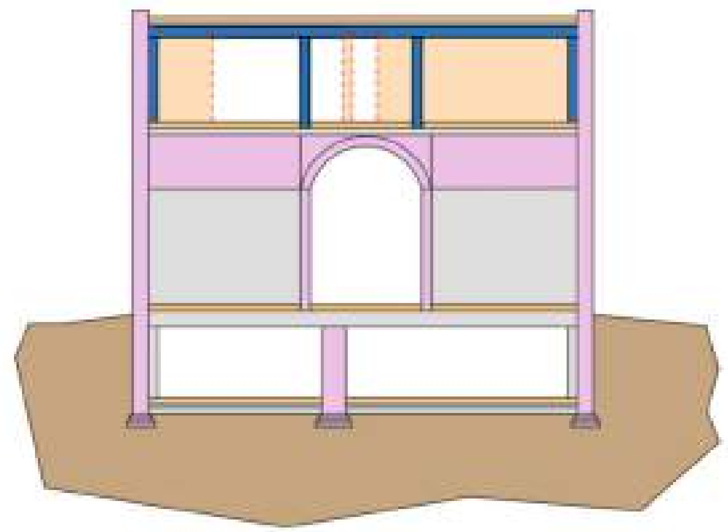
Therefore, at second floor new steel is required at each line where walls are removed. As shown below, the proposed internal columns at second floor have been positioned to align with the sides of the vaults below, in order to avoid transferring load onto the existing arches. A detail will be required to hide the column baseplates within the floor finishes zone.

The external walls between second and third floor are anticipated to provide sufficient lateral stability to the top storey, assuming the roof acts as a diaphragm. Because of this the proposed steel frame is required to support the roof only. SHS windposts are also required to restrain external walls where internal walls are being removed.

We note that because of the temporary works required to achieve the proposal, it may be most effective to remove the existing roof and second floor walls first, before installing the proposed steel frame and then rebuilding the roof over. This allows steels to be craned into place from above. Scaffold will be needed to support the external walls temporarily.



Extract from SK73 showing Maufe extension proposed steel framing at 2nd floor



Section B-B: Extract from SK63

11. George House

11.1 Existing Structure

Sketches SK086 to SK089 in appendix A show the existing structure of George House determined from preliminary survey drawings and site visits to date. In George House preliminary opening up has taken place but further opening up of the existing structure is required.

Compared to the Main Building, the George House structure is less uniform due to a series of previous alterations to the building. The front (east) façade of the building is the most complete section of architectural merit and is consistent along the length of the building. The extension to the rear of George House is a later addition and is only two storeys. Many of the walls in this extension are not structural internally. Throughout George House there are also several single storey extensions, forming corridors and individual rooms.

George House is a load bearing masonry structure and preliminary opening up reveals the floors to be a rib and pot construction. The interior structural walls are not in the same location at all levels with concrete downstand beams providing support to some of the structural walls at the upper levels.

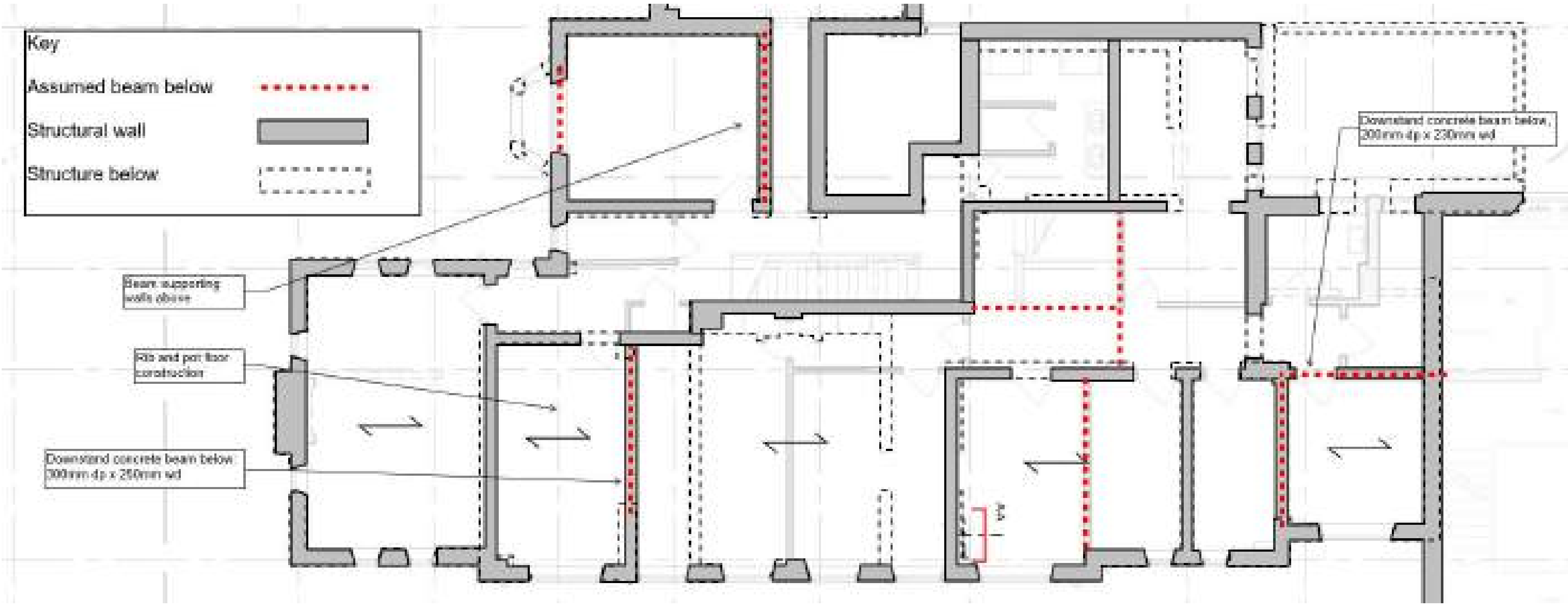
George House first floor build up from initial on site investigations

11.2 Proposed Structure

Sketches SK64 and SK70 to SK74 in appendix B show the structural alterations required to achieve the proposed scheme.

In George House many of the non-structural walls will be removed to create open spaces for classrooms. Where a structural vertical loadbearing wall is removed a new steel beam will replace the action of the former masonry wall. Windposts may be required to provide lateral support to external walls where partitions are being removed. A small area of timber joist infill floor is required at first floor level where a staircase is being removed.

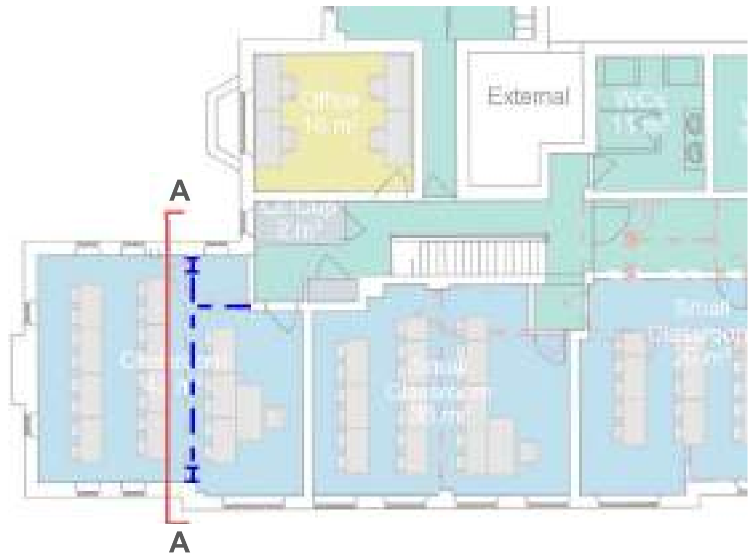
The most significant alteration to George House is the removal of a structural stability wall from ground to roof level, located to the south end of the building. It is proposed that this structural wall is replaced with a steel moment frame with design criteria similar to that described in section 10.2.1 regarding the steel frames proposed in the wing of the Main Building.



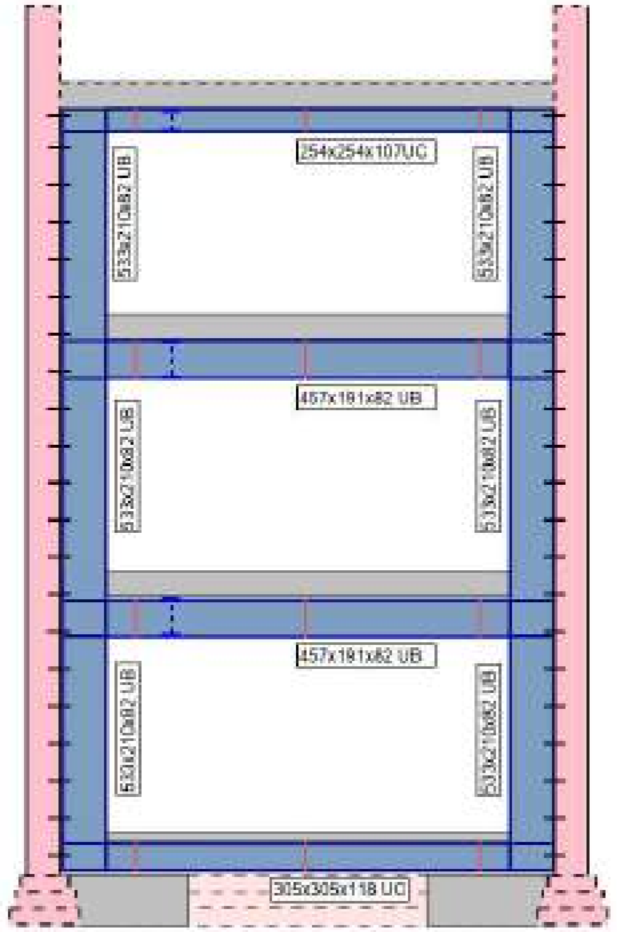
Extract from SK87 showing general layout of existing George House structure. Note: spans of rib and pot floors assumed

According to information gathered from the point cloud survey the available headroom in George House is generally greater than in the Main Building, allowing for UB sections to be utilised at ground and first floor. The headroom reduces at second floor level and so a UC section has been used at this level.

The installation method and sequencing is a key consideration for the proposed frame. An external scaffold designed to provide lateral stability in the temporary condition will be required. With appropriate propping, steels to be craned into position from above through openings forming in the floors, ideally through the 'pots'. The steel beams would then be loaded in through window openings at each level and lifted into position. If openings are formed through the roof, consideration would need to be given to reinstatement of roof finishes and waterproofing as disruption may void its warranty.



Extract from SK072 showing location of proposed steel frame



Section A – A: Extract from SK64

12. Sir Cyril Taylor Library

12.1 Existing structure

The Sir Cyril Taylor Library is a four-storey concrete frame structure. The floors are formed of RC flat slabs anticipated to be 300mm thick which span between external walls and four internal concrete columns. Raised floors are currently in place on top of the slabs. A lift shaft exists between ground and second floor and penetrates the RC floor slabs. There are concrete walls within the stair cores and around the main lift shaft but the stability system is unclear.

The building was originally designed as a library. In accordance with BS 6399-1:1996 Loadings for buildings it is assumed that the structure has been designed for the following variable load:

Reading rooms with book storage, e.g. libraries

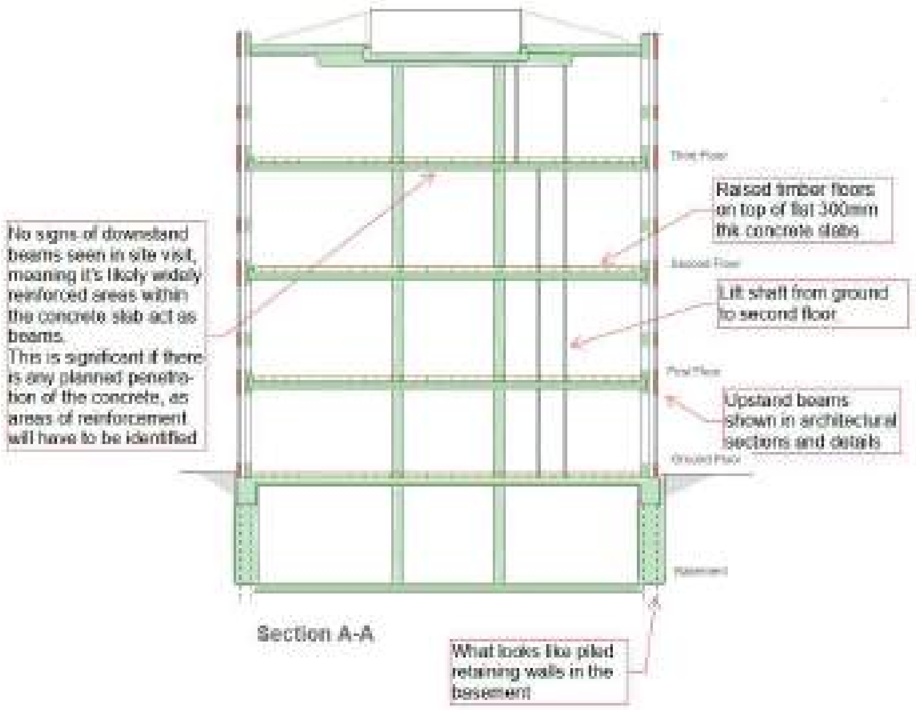
Uniformly distributed load	4.0kN/m^2
Concentrated load	4.5kN

Partitions

Uniformly distributed load	1.0kN/m^2

Plant rooms, boiler rooms, fan rooms, etc., including weight of machinery

Uniformly distributed load	7.5kN/m^2
Concentrated load	4.5kN



Extract from SK14 of existing section through Library building

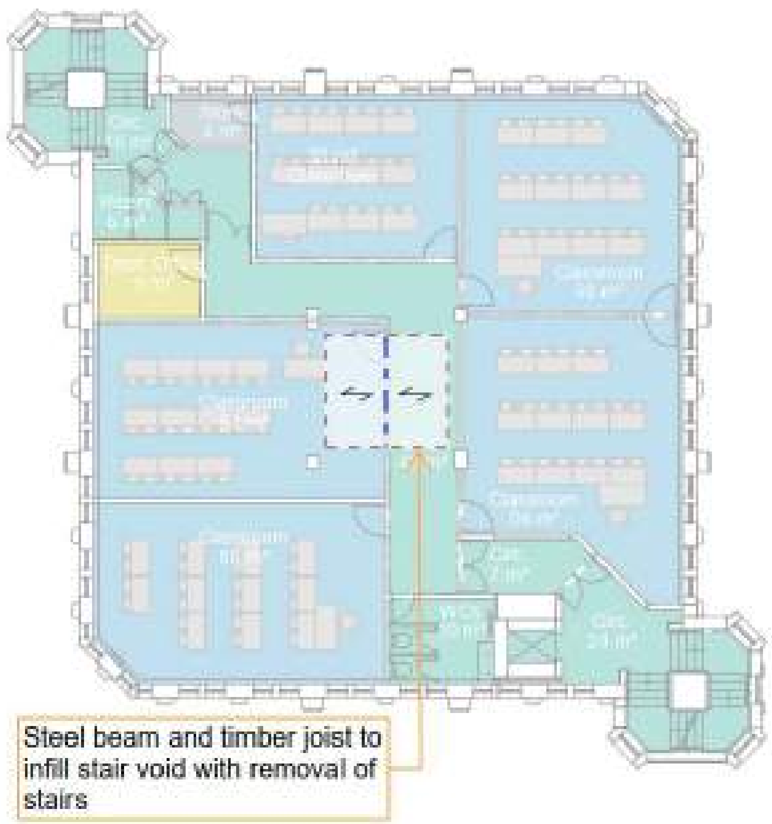
No downstands are visible in the slab soffits. It is therefore likely that heavily reinforced beam strips exist within the slab. Records of architectural details show RC upstand beams at each level to the slab perimeter within the slab external wall zone.

The building also includes a basement with its perimeter formed of embedded pile retaining walls.

See sketches SK008 to SK014 in appendix A which present the existing structure of the library as anticipated following examination of drawings and initial site inspections.

12.2 Proposed structural alterations

It is proposed that partitions considered to be non-structural are removed and therefore the proposals to the library involve minimal structural change. The change in use from a library to classrooms reduces the variable loads.

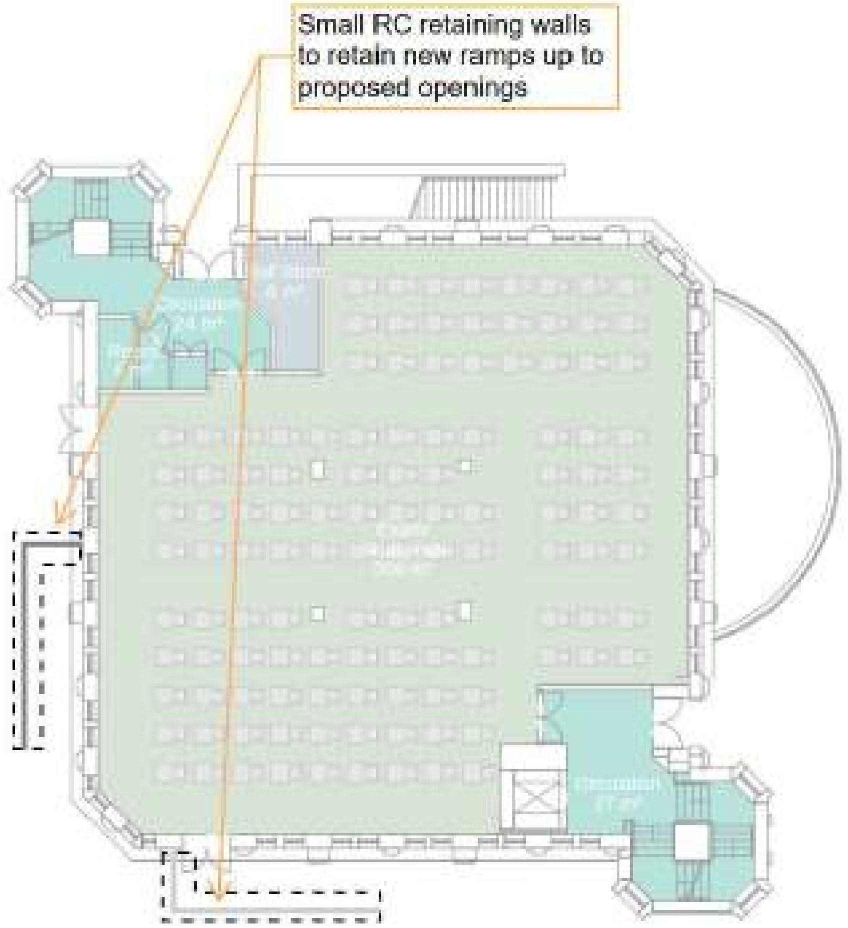


Extract from SK75 showing stair infill structure in Library building

As noted, it is likely that heavily reinforced beam strips exist within the slabs. This will be significant for any new penetrations proposed through the existing concrete floors.

The removal of the central staircore from ground to second floor will require infill structure. At first floor a steel beam is proposed to divide the void span in two as well as being positioned below the new partition line. Timber joists will be used to infill the void.

At ground floor two new doorways are proposed which require new ramps externally. Small RC retaining walls will be required to retain these ramps.



Extract from SK75 showing stair infill structure in Library building