EXETER
COLLEGE
OXFORD

A New Quad at Walton Street

Ruskin Building Structural Intervention Statement

March 2013

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Exeter College, Oxford – Walton Street Site
Structural Interventions to the Ruskin Building

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1 Introduction

This report considers the structural implications of the proposals to re-model the 1913 Ruskin Building as proposed by Alison Brooks Architects as an integral part of the redevelopment of the Ruskin College Campus fronting Walton Street and Worcester Place, for Exeter College Oxford.

Stockley are appointed to Exeter College Oxford as Structural Engineers and are working in collaboration with Alison Brooks Architects on the development project.

The re-development of this site comprises the construction of 90 new student bedrooms, new Fellows' suites, teaching facilities, an auditorium, archive store, café and two new external quadrangles. The buildings that were constructed after the original 1913 Ruskin building are to be demolished with new buildings constructed in their place. This includes the later addition (1930's) to the Ruskin building.

The 1913 Ruskin building, although not listed, is in a conservation area and has historic value. The objective is to retain as much of the historically important elements of this building for incorporation into the new development.

The Ruskin building is to accommodate the main entrance to the college facility, off Walton Street in its current position, some teaching and learning spaces within the ground floor, the electrical substation in its current location at basement level, and student bedrooms / Fellows' suites in the upper levels, including the roof space above eaves level.

Section 2 of this report considers retaining the existing 1913 Ruskin Building, and summarises the structural works needed to this building. Sections 3 & 4, describes an alternative approach, which is to retain just the front facades of the 1913 Ruskin Building and re-construct the internal structure and rear facades. Section 5 considers the environmental impact of retaining the existing Ruskin Building vs Re-constructing the Ruskin Building keeping the front facades.

This report is to be read in conjunction with the report "1913 Ruskin Building - Building Appraisal" by Stockley, dated February 2013. This report is a factual description of the building structure, a condition survey, and a description of the changes required to this building in order to achieve current Building Regulations compliance for its intended use.

2 Implications of Retaining the 1913 Ruskin Building Structure

Alison Brooks Architects' proposals for the 1913 Ruskin Building comprises an opening-up of the spaces at ground floor level, relocating the stairwell at the Walton Street end of the building, retaining the substation room in the basement, and re-profiling the roof envelope to accommodate fellows' suites and student bedrooms.

The Architect has confirmed that current Building Regulations dictate the following important changes to the existing building :

- A lift is required to provide access to the upper levels of the building;
- The existing corridors at upper levels have a clear width of typically 1245mm between existing steel columns. For compliance with Part M of the Regulations, these walls need to be a minimum of 1500mm for DDA access, so the existing corridor column arrangement is unworkable;
- Both staircases within the existing building do not comply with Part K or Part M of the Regulations, as they are too narrow at 846mm and 1100mm respectively. 1200mm is the minimum width required for compliance. In addition, none of the existing stairs provide wheelchair refuge points (1400mm x 900mm on plan), nor will they accommodate the flow during a fire evacuation. There is currently not a protected lobby on every floor, and bedrooms are currently accessed off the southern stair protected lobby at 2nd floor level. For these reasons the staircases and adjacent layouts need re-constructing;
- DDA compliant bedroom provision is not currently provided in the existing arrangement, nor is adequate bathroom provision for the student rooms. Within the existing building depth there is insufficient room to accommodate these requirements without a significant reduction in the number of student bedrooms.
- The existing masonry facades require 150mm depth of internal insulation to comply with energy performance requirements of Part L;

  By increasing the depth of building footprint along the Worcester Place wing from (internal dimensions) 9,790mm to 10,290mm, compliant corridor widths, adequate bathroom provision, thermal insulation and DDA compliant bedrooms can be accommodated.

We have considered the structural implications of these proposals on the basis that the 1913 Ruskin building facades and internal floor structure is retained where possible.

2.1 Ground floor

The structural works required are:

Restore the original floor structure in the entrance lobby by removing the later-added raised floor.

Introduce a new steel goalpost frame along the gable end of the 1913 building where it abuts the 1930's extension. This is to replace half of the gable end wall which is being removed, and will need to extend full height.

Introduce a new steel goalpost frame within the rear elevation of the Walton Street wing, below the balcony feature, where the structural wall is removed.

Replacement of a majority of the existing filler joist floor at ground floor level at locations where the floor is being lowered. This will be re-constructed as a reinforced concrete slab.

Reduced level excavation under the north-eastern corner of the building (Walton Street, Worcester Place) where there is no existing basement, in order to accommodate lowered ground floor.

Cut back and replace filler joist floor adjacent to Worcester Place (rebuilt) gable end to accommodate new riser. Because of the direction the filler joists span, this will involve rebuilding a substantial portion of that floor structure.

Remove sections of brickwork adjacent to the new colonnade, between principal brick piers, and make good brickwork locally.

Relocate the stairwell at the Walton Street gable end, incorporating new services riser.

These works are significant and very intrusive, with little of the existing structure at this level being left untouched.

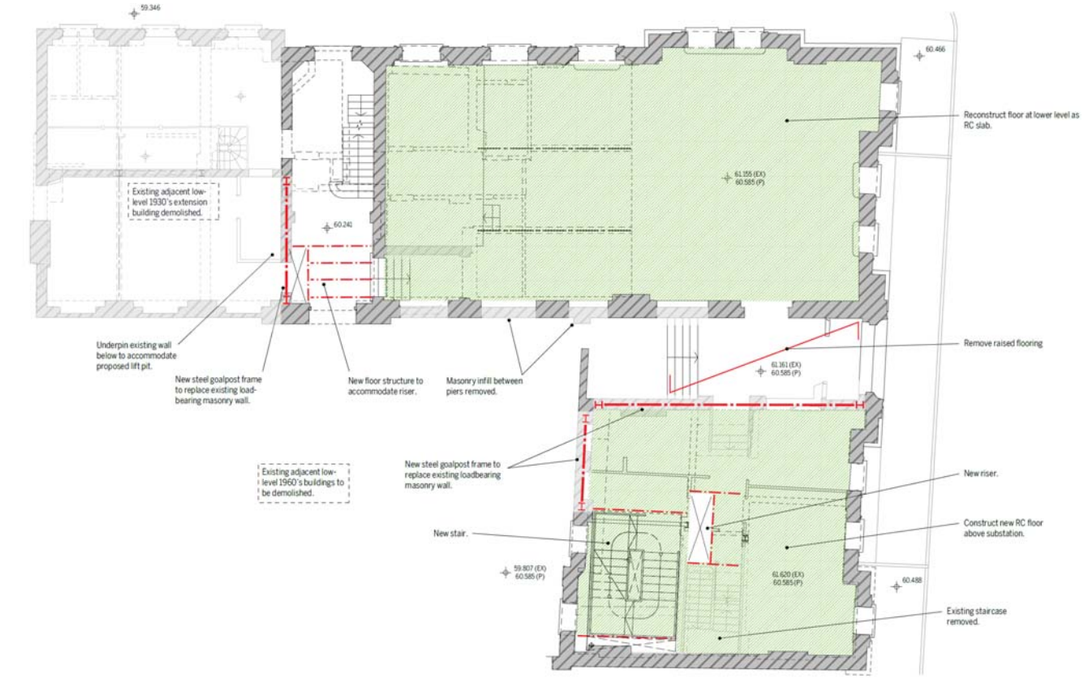


Figure 1: Ruskin Building Ground Floor Interventions

2.1 First Floor and Upper Floors

The existing corridor walls have steel columns buried within their depth. These columns are laterally restrained by mid-storey height horizontal rails. This structural arrangement constrains locations of door openings and risers. Where doors into bedrooms and riser locations can't be accommodated within this current structural arrangement, the horizontal steel rails have to be removed, and the existing steel columns stiffened with supplementary vertical structure resulting in larger column section size.

The corridor clear width between steel columns is typically 1245mm, which is below 1500mm minimum clear width required by current Building Regulations Part M. Retaining the existing steel column arrangement would therefore result in compromised layouts non-compliant with Building Regulations.

Filler joist floors are locally re-constructed to accommodate service risers and the new stairwell at the Walton Street gable end. The extent of reconstruction is shaded green on the following plans.

A major structural wall with chimney stacks within the Walton Street wing, running from front-to-back, is to be removed. Floor structures will have to be locally re-supported with new steel downstand beams and local making good of floors. The temporary works required will need carefully designing and installing, with the sequence of works starting from roof level downwards.

To provide enough floorplate depth from front façade to rear façade in order to accommodate DDA compliant bedrooms, adequate bathroom provision and insulation to the existing walls to comply with thermal performance criteria in Building Regulations Part L, the rear façade would need moving back by circa 500mm. The works described in this section retain the rear façade, resulting in a compromised, non-compliant Building Regulations proposal.

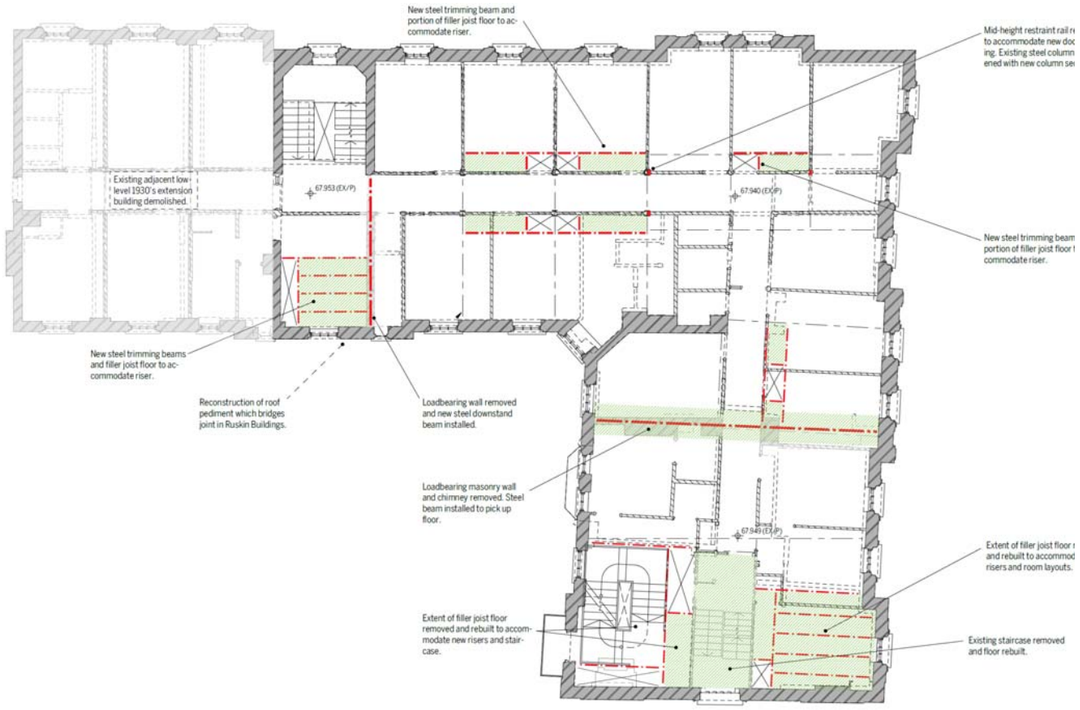


Figure 2: Ruskin Building Typical Upper Floor Intervention

These works at first floor, and upper levels generally, are significant and very intrusive, and result in a compromised arrangement for corridors, student rooms, and non-compliance with current Building Regulations.

2.2 Basement

The existing basement space under the Worcester Place wing needs reducing in level to accommodate the plant room, and most internal structural walls will need removing. Substantial underpinning of existing structural walls will be needed to achieve the new basement slab level, and to accommodate the new lift pit in the footprint of the demolished 1930's extension.

Excavation within the existing retained building and substantial underpinning to structural walls is feasible, but risks damage to the existing structure.

2.3 Roof Pediment to Rear Elevation

The rear elevation to the Worcester Place elevation, where the 1930's extension is toothed into the original 1913 building, has a pediment at roof level which abridges this interface. This would need to be carefully removed and the top of the brick elevation in this area, underneath the proposed eaves level, locally re-built.

Furthermore, the join between between the 1930's extension and original 1913 building is crudely toothed together and deviates in position down the building façade. Retaining the 1913 rear façade as existing and making good where it abuts the proposed extension block in this location is complex.

Figure 3: Roof Pediment on internal facade junction between original 1913 Ruskin building and 1930's extension

2.4 Walton Street Gable End

It can be seen from figures 1 and 2 that at all levels of the building it is necessary to re-construct the floor structures adjacent to this gable end. Given the temporary stability of the stairwell and gable end wall, serious consideration should be given to de-constructing both the wall and chimney stacks from roof level downwards, and re-constructing the wall and stairwell in its new location from basement level.

2.5 Roof structure

The roof envelope is to be re-modelled in order to accommodate student bedrooms and Fellows' suites. The existing roof structure is supported off internal loadbearing corridor walls, and it is not possible to re-use in the proposed re-configuration. The proposal is therefore to replace the existing roof structure with steel framing to suit the new envelope.

3 Re-Construction of 1913 Ruskin Building

Section 2 of this report describes the implications of retaining the existing building structure to the 1913 Ruskin building in accommodating the proposed re-development proposals. The implications are significant with substantial intervention to parts of the existing filler joist floor structures, internal chimney stacks, internal structural walls and openings through the rear façade walls. This approach results in a compromised scheme which does not comply with current Building Regulations.

For this reason, we have considered an alternative structural approach, which is to retain the external facade walls to Walton Street and Worcester Place, and re-construct the internal structure and rear facades.

The new internal structure would be framed in order to readily accommodate the proposed layouts and to provide future flexibility in use, hence extending the life of the building.

This solution is to carefully de-construct the internal structure from roof level down to basement level, behind the existing Walton Street and Worcester Place façade walls. A temporary façade restraint frame is erected as part of this de-construction process to stabilise and protect the existing facades.

Behind the existing facades a new in-situ reinforced concrete frame from basement level through to 4th floor level is constructed. The retained façade structures are then laterally restrained back to this new internal structure. A new rear façade structure, constructed as a high quality, highly insulated façade, is supported off the new concrete frame, is erected.

The following figures show the proposed structural arrangement at each floor level.

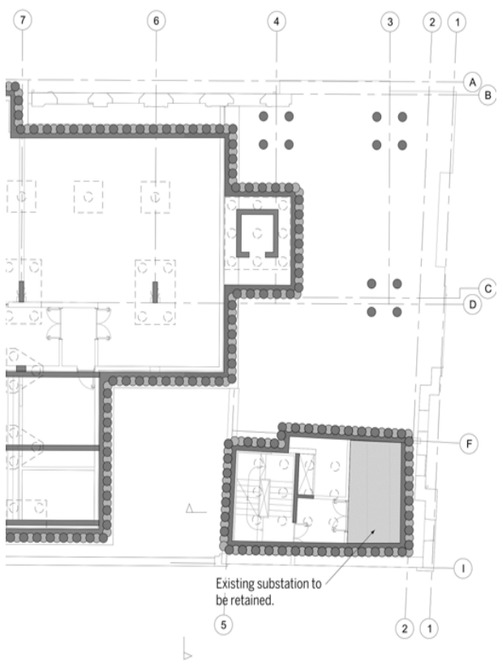


Figure 4: Proposed Basement Level

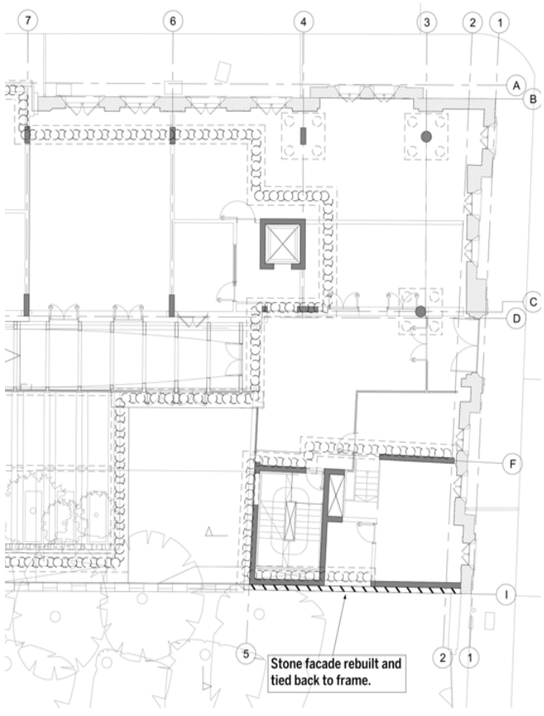


Figure 5: Proposed Ground Floor Level

At basement level at the Walton Street gable end the existing substation room has to be retained, lowered in level slightly, and will house new electrical plant. New columns or walls cannot be placed within this space, meaning that the support to the floors over has to be incorporated into the inside face of the gable end wall.

It is not practical to restrain this gable end wall in the temporary condition in the same way as the front facades, because:

- New vertical support around the basement substation columns/walls has to be incorporated into this wall, meaning a new piled foundation;
- Temporary stability of the tall and ornate chimney stacks is too risky. The solution would be to carefully de-construct these elements, record the bricks and stonework, set aside for storage and re-construct;
- The floors and stairwell at each level behind this wall are to be reconstructed, meaning that the support within the gable end wall and new foundation is required.

Therefore façade retention of this gable end wall is not possible, and the proposed solution is to carefully de-construct the gable end wall. The stone elements at ground to first floor would be taken down, cleaned up, numbered and stored prior to being rebuilt and restrained back against the new internal RC frame.

The existing brickwork in the gable end wall is unsympathetically re-pointed in cement mortar, meaning that separating out the bricks for cleaning and re-use is likely to be impractical. Brickwork above first floor level would therefore be rebuilt using reclaimed bricks to match the existing. The rebuilt brickwork would be one brick thick to match the existing brick bonding pattern and restrained back to the new RC frame with a filled cavity between to improve thermal performance.

Between ground and first floor level, the wall would be rebuilt using natural stone supported off the new internal frame, providing a consistency with the appearance of the front facades.

The chimney stacks would be rebuilt using the original materials, cleaned and logged as per the stonework at levels below.

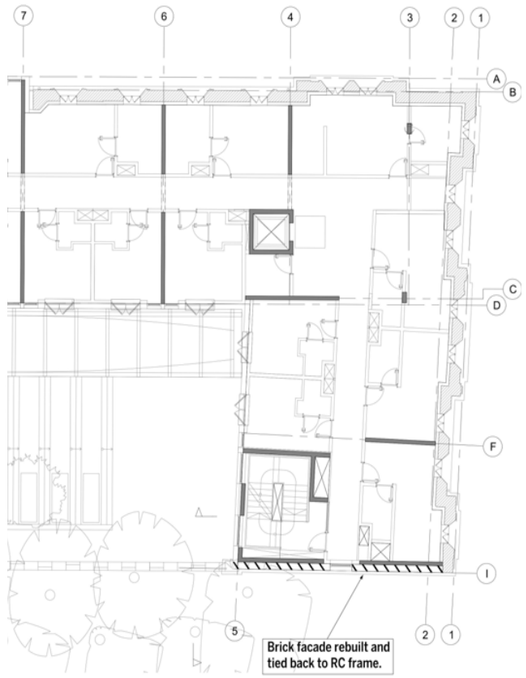


Figure 6: Proposed First Floor Plan

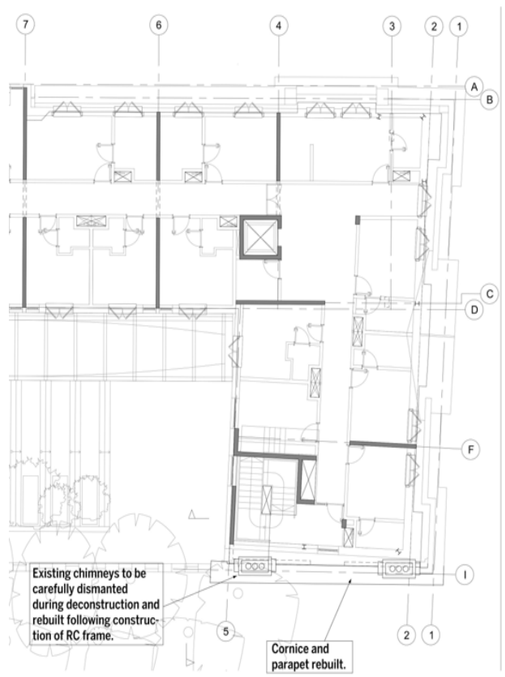


Figure 7: Proposed Third Floor Plan

The roof structure is re-constructed in its new form using steel framing, supported off the new concrete frame. The stone elements forming the parapets to the gable end are rebuilt, and carefully toothed in to the repaired parapet along the retained Walton Street and Worcester Place façade, thus reading as a complete piece.

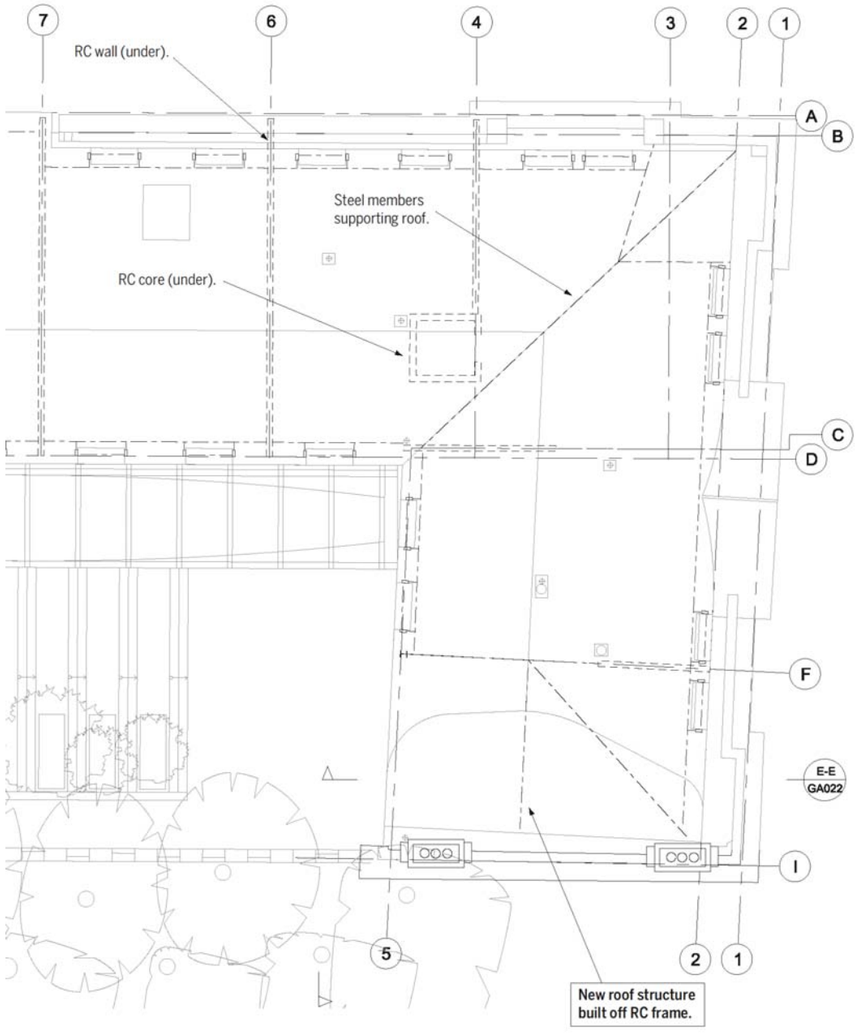


Figure 8: Proposed Roof Level

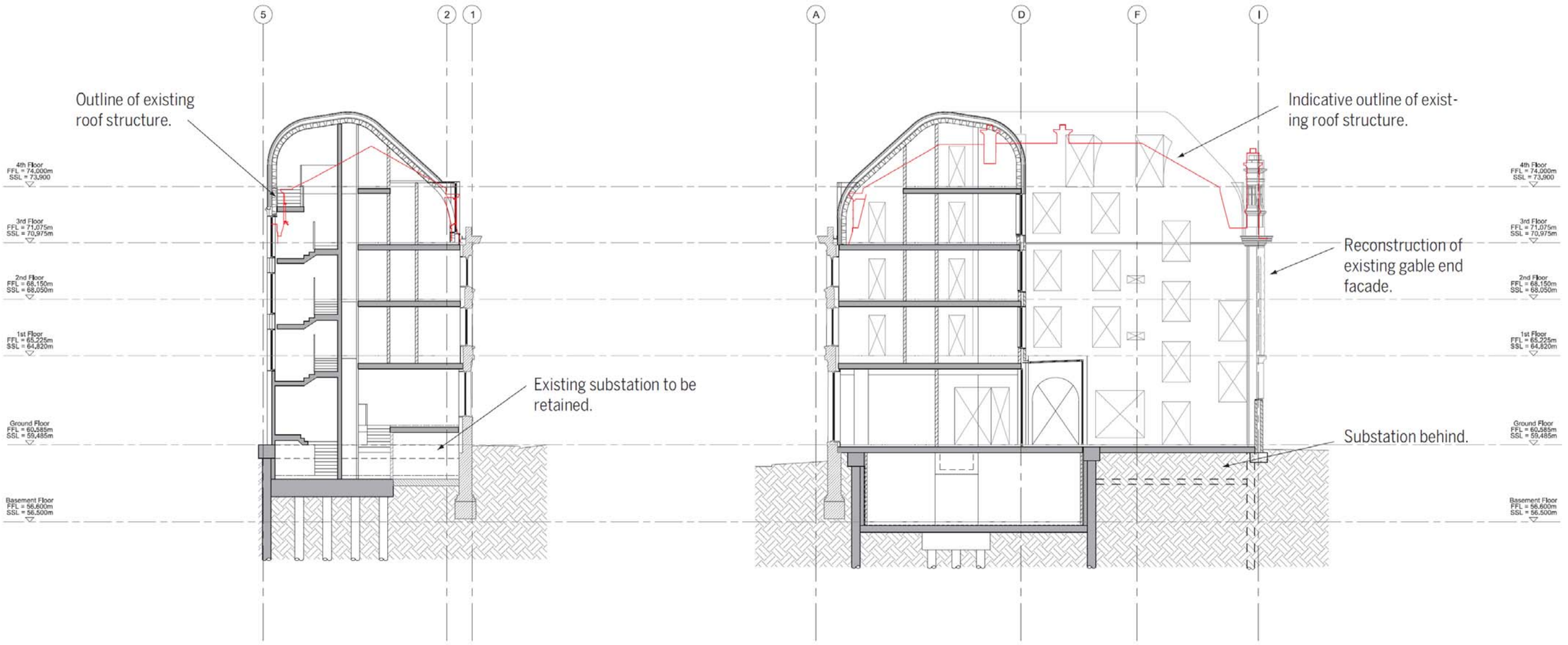


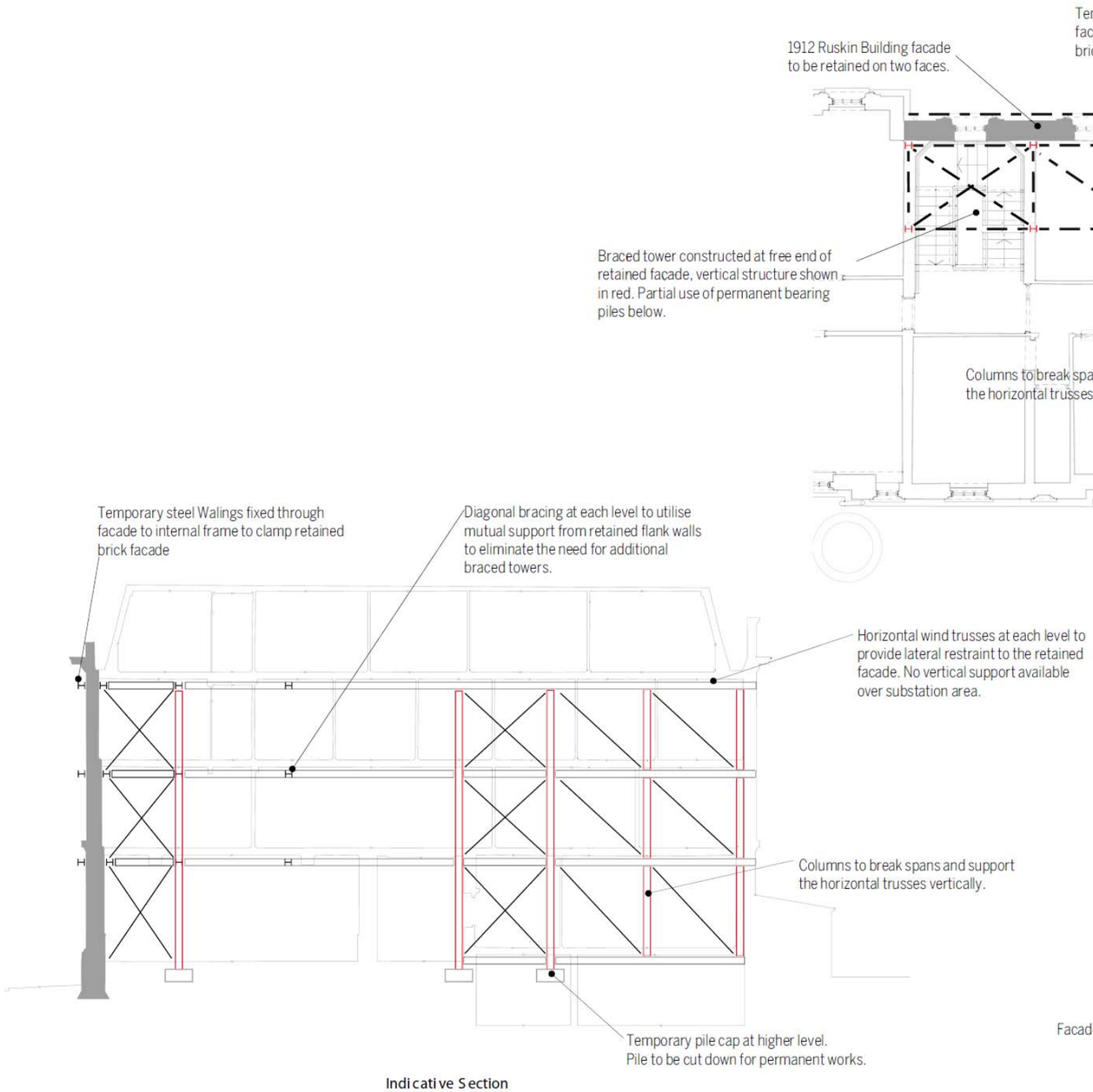
Figure 9 Proposed Sections

4 Sequence of De-construction and Re-construction

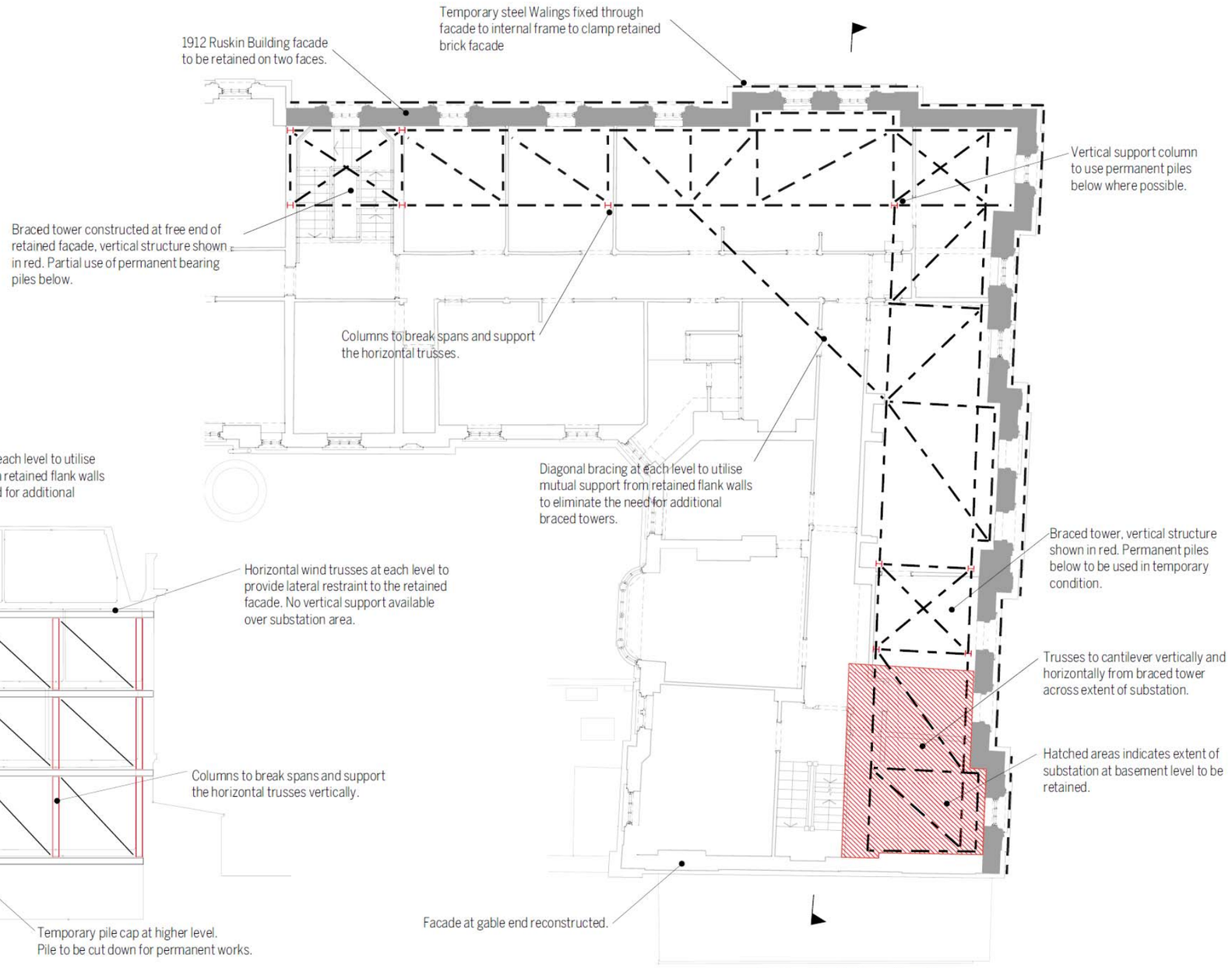
An indicative sequence of works is detailed on drawings (SK) 094 – (SK) 097 contained within the appendix of this report, below is a brief synopsis of the indicative sequence phases;

- Create access to courtyard through the 1960's building garages, courtyard to be used as site compound and working area.
- Demolish 1980's library structure and crush suitable arisings for backfilling basement and courtyard areas to piling mat level, cart any unsuitable or surplus material from site.
- Demolish 1980's garden room and crush suitable arisings for backfilling basement and courtyard areas to piling mat level, cart any unsuitable or surplus material from site.
- Demolish 1980's residential block and crush suitable arisings for backfilling basement and courtyard areas to piling mat level, cart any unsuitable or surplus material from site.
- Demolish 1960's block and crush suitable arisings for backfilling basement to piling mat level.
- Demolish 1930's Ruskin Building Extension and crush suitable arisings for backfilling basement to piling mat level, cart any unsuitable or surplus material from site. Care is to be taken at the junction with the existing 1913's façade which is to be retained
- Carefully deconstruct the 1913 Ruskin Building whilst installing temporary façade retention scheme and crush suitable arisings for backfilling basement and courtyard areas to piling mat level, cart any unsuitable or surplus material from site.
- Build temporary substation in courtyard and decommission existing substation
- Install piles and create basement level
- Construct new substation in existing location and re-commission
- Construct RC frame and roof whilst removing temporary façade retention scheme and tying existing façade into frame
- Install cladding and fit-out building

Figure 10 shows an indicative proposal for an internal façade restraint frame to be installed prior to de-construction of the internal walls and floors.



Indicative Section



Indicative Plan Taken at First Floor

Figure 10: Building Reconstruction – Indicative Temporary Works Scheme

5 Environmental Engineering Appraisal by Max Fordham LLP Engineers

5.1 Embodied Carbon of Construction vs Ongoing Carbon in Use

The following graph shows some example scenarios comparing the initial and future projected carbon emissions associated with new build solutions (solid lines) vs refurbished building solutions (dashed lines). The ongoing carbon emissions trends shown here are representative of the ongoing fuel costs, ignoring price fluctuations.

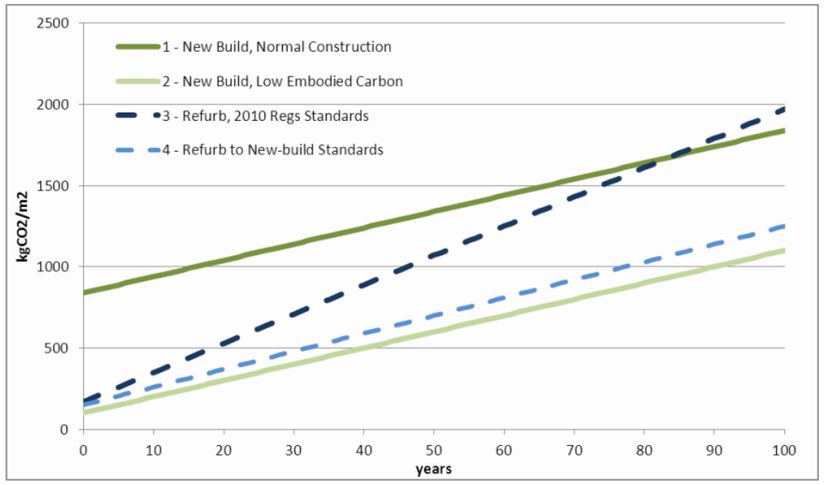


Figure 11: Embodied Carbon vs. Carbon in use

Scenario	New Build or Refurb	Fabric Standards	Materials	Notes
1	New Build	Exemplar	Normal	Long time before it is better than refurbishment, due to higher relative embodied carbon of construction.
2	New Build	Exemplar	Low Carbon	Use natural materials (particularly timber) and certain low embodied energy concrete products.
3	Refurb	Part L 2010	Normal	Minimise loss of floor area. Poor long-term option.
4	Refurb	Exemplar	Normal	Breathable insulation. 2ndry triple-glazing. Disconnect slabs from walls to avoid thermal bridging. Build out internal walls for additional insulation. Compromise on daylighting.

Sources: UPP student accommodation benchmarking, Simon Smith presentation, Trinity College refurbishment modelling figures, Green Guide to Specification.

In the above table, "exemplar" fabric standards are near-passivhaus, and at least 2013 Part L Building Regs. "Part L 2010" fabric standards are those required to meet the current Part L without bettering it.

5.2 Commentary

We are taking a whole-life approach to the building design, designing on the basis that the building fabric will stay in place for >100 years.

Option 3, which is equivalent to retaining the existing Ruskin Building structure, is clearly unsatisfactory as it is bettered by all other options in the medium-long term. Future legislative changes and fuel price increases will make option 3 even more inefficient compared to the other options.

Option 4, which is equivalent to retained front facades and re-constructed fabric behind, requires very careful control over all thermal bridging and gaps in the airtightness of the envelope. All existing thermal bridges are removed by creating an entirely new and independent support structure for the internal rooms, and a new internal lining. The highest standards of insulation and airtightness may still not be within reach without entirely overcladding the building from the outside,.

Both refurbishment options are likely to require more maintenance on the building fabric (more materials, more emissions) sooner than façade retention options 1 and 2, due to retention of existing building fabric. This represents a future increasing cost and risk.

The possibility to reduce the initial embodied carbon associated with a new-build depends largely on use of natural materials, or where not practical low carbon materials.

A new building offers greater design flexibility, and better options for daylighting and natural ventilation. Carbon is not the only issue: a sustainable building is one which is fit for purpose, comfortable to occupy and to operate.

According to this analysis new-builds can achieve a similar level of capital carbon and better long-term associated carbon, whilst offering a better design solution, when compared to refurbishments. In the conservation and planning context of this project the new build (re-construction) option will incorporate retained front façades for the existing 1913 building. Option 2 is the model proposed.

The long-term cost of a building always eventually outweighs the capital cost. Accounting for ongoing energy costs, fuel price inflation, maintenance costs and the intangible cost of an uncomfortable environment; the argument for renewing the building fabric (even with a retained façade) and providing a new appropriate layout, we feel is convincing.

Note also the Oxford University Carbon Management Plan relevant strategic objective:

To take a whole life approach to assessing the carbon and cost benefits of carbon reduction measures, as well as considering future fuel supply security and sustainability.

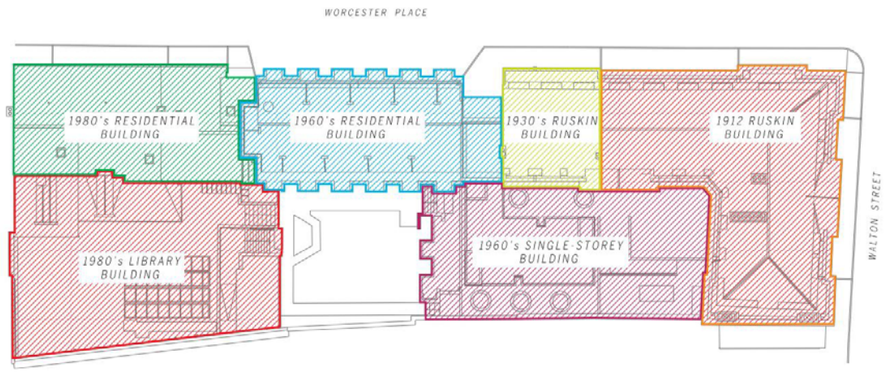
6 Conclusions

The structural implications of retaining and adapting the existing 1913 Ruskin Building are significant and very intrusive, and would result in a compromised scheme which does not comply with Building Regulations. This is not an acceptable solution to the Client, Exeter College.

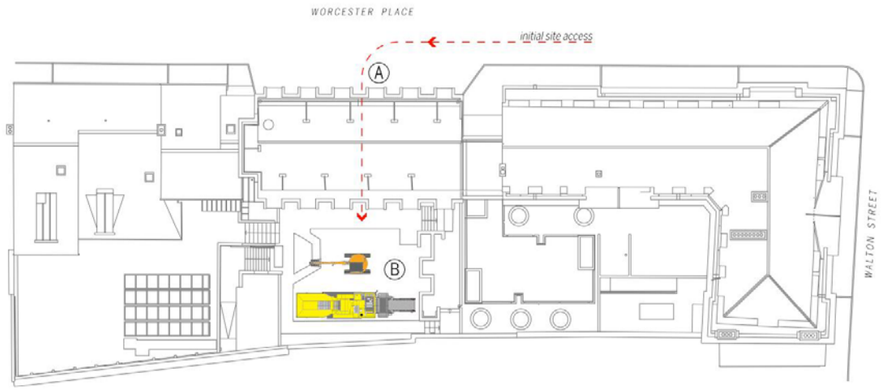
The environmental appraisal of Ruskin Building refurbishment versus re-construction concludes that the re-construction solution is the more sustainable solution in the long term.

The proposed solution is therefore to re-construct the 1913 Ruskin Building, retaining the front facades which are of historical value. The following section describes the sequence of works proposed across the site.

7 Assumed Sequence of Construction

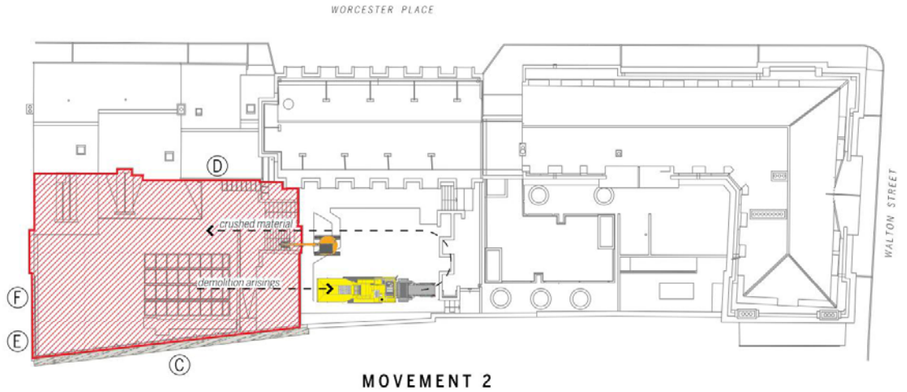


KEY PLAN



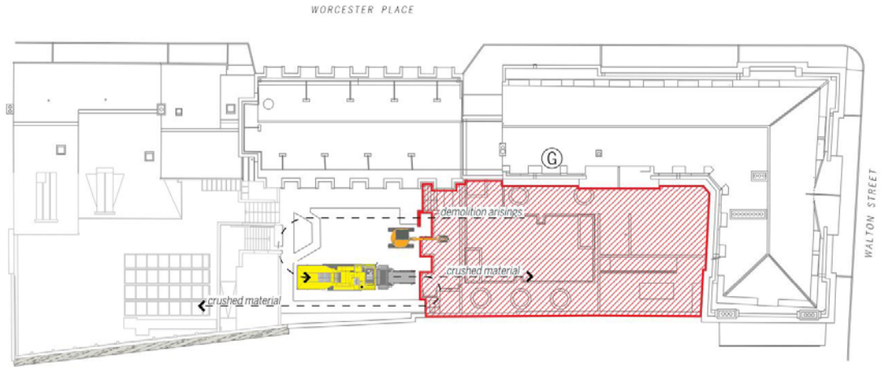
MOVEMENT 1

Create access to site through 1960's parking bay at ground floor by removal of brick infill panels



MOVEMENT 2

Demolish 1980's Library Building and grub out base slabs and foundations. Demolition arisings crushed and used to back-fill library basement to form piling mat.



MOVEMENT 3

Demolish 1960's Library Building and grub out base slabs and foundations. Demolition arisings crushed and used to back-fill library basement to form piling mat.

A.
Existing brick walls removed at ground level to provide through-access from Worcester Place to existing central courtyard.

B.
Anticipated plant to be: crushing plant, small dumper and excavator with pecker.

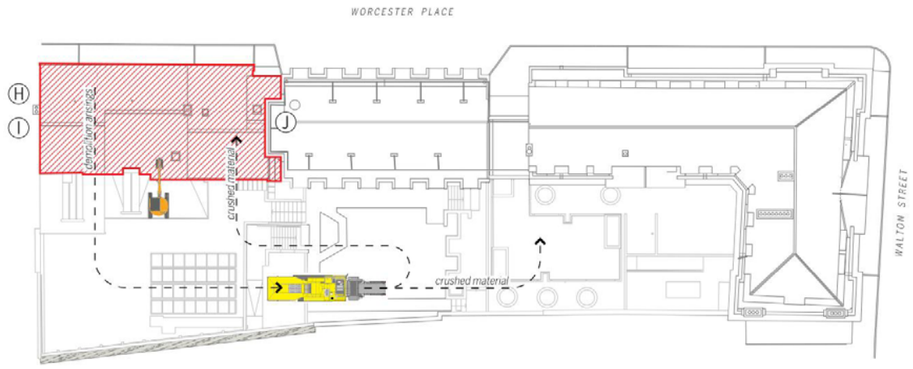
C.
Temporary works to existing stone boundary wall to Contractor's details and design.

D.
1980's Library and Residential Buildings separated by movement joint along line shown.

E.
Void visible between existing Library and adjacent Worcester College building therefore assumed buildings are structurally independent (to be confirmed by Contractor on site).

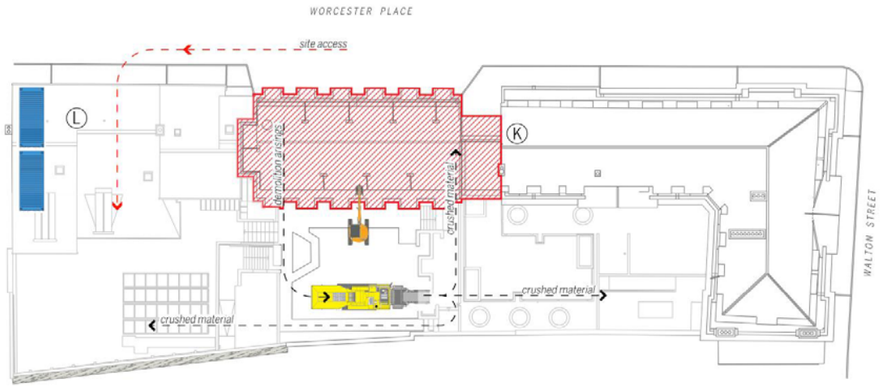
F.
Weatherproofing to exposed face Contractor's details (if required).

G.
1960's Single Storey Building RC structure is tied into Ruskin Building masonry wall. Any temporary works required during demolition to Contractor's design.



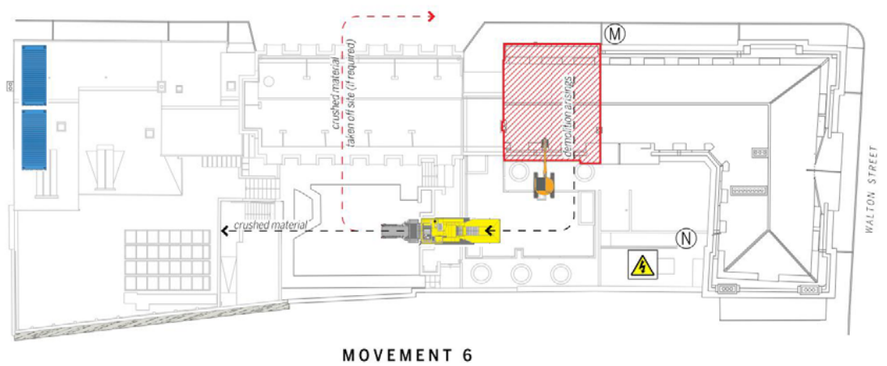
MOVEMENT 4

Demolish 1980's Residential Building, grub out base slabs and foundations. Crush arisings and backfill library basement and/or courtyard to form piling mat.



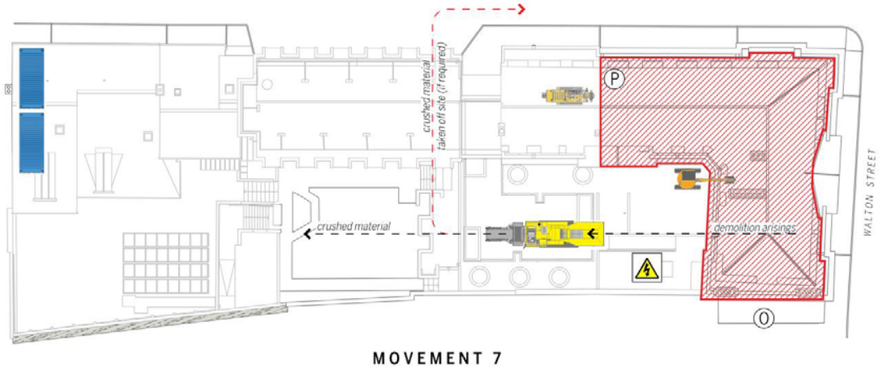
MOVEMENT 5

Demolish 1960's Residential Building, grub out base slabs and foundations. Back fill basement areas to create piling mat.



MOVEMENT 6

Demolish 1930's Ruskin extension including facades. Grub out base slabs and foundations, and back-fill to piling mat level or cart off arisings as required.



MOVEMENT 7

Deconstruct structure behind front facade of 1912's Ruskin Building. Install temporary works to each floor to restrain facades and grub out base slabs and foundations. Back-fill to form piling mat or cart away arisings as required.

H.
Movement joint visible on site between structures. It is assumed that adjacent building is structurally independent - to be confirmed by Contractor on site.

I.
Weatherproofing to exposed face to Contractor's details.

J.
Movement joint visible between 1980's and 1960's structures. It is assumed that each building is structurally independent - to be confirmed by Contractor on site.

K.
1960's RC framing to staircase appear to tie into 1930's Ruskin Building masonry wall at location shown. Any temporary works required during demolition to Contractor's details.

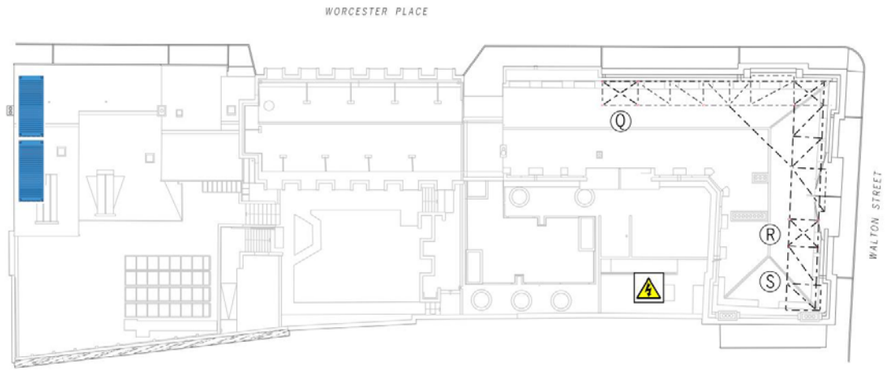
L.
Following demolition of 1980's Residential Building, site access provided through opening created. Space for site accommodation/storage etc. could be provided here.

M.
Carefully demolish facades to minimise damage to adjacent 1912 Ruskin Building retained facade.

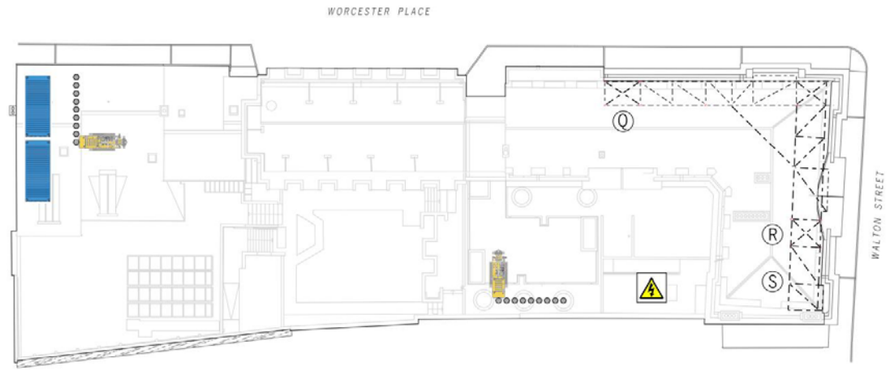
N.
Existing substation to be replaced by temporary substation within courtyard prior to demolition of 1912 Ruskin Building

O.
Carefully deconstruct southern gable end and chimneys of 1912 Ruskin Building to allow for future reconstruction in proposed scheme.

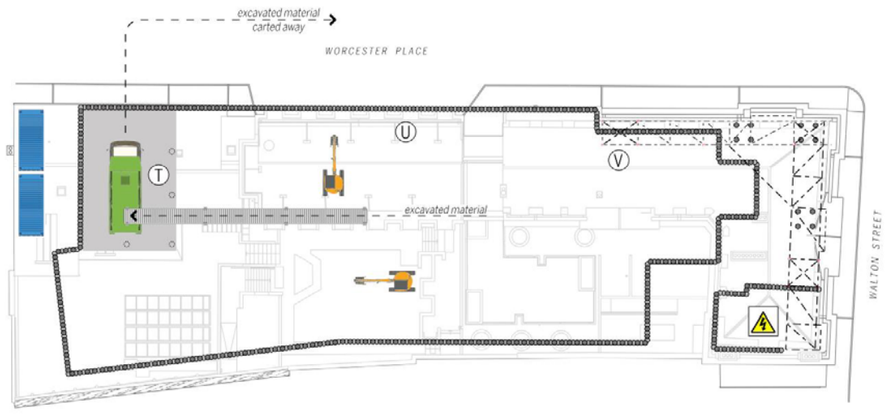
P.
Mini piling rig installs piles to support facade retention structure.



MOVEMENT 8
Facade retention scheme installed, piling mat installed at approximately +60.00m throughout site. Refer to (SK) 021 for indicative scheme details.



MOVEMENT 9
Install perimeter secant piled wall



MOVEMENT 10
Dig out basement to proposed foundation level as required (+55.400m to +56.100m) with material carted away from site. Substation transferred back to basement at southern side of Ruskin Building.

MOVEMENT 11
Construct RC frame and remove facade retention as frame progresses.

Q.
Braced towers which laterally restrain wind trusses at each floor level spanning between.

R.
Southern braced tower sits adjacent to existing/proposed substation location to minimise impact and provide working room.

S.
Wind truss at location shown cantilevers on plan and elevation to restrain facade above existing/proposed substation location.

T.
Temporary working platform at street level erected to accommodate a loading bay to allow excavated material to be removed from site. Platform could be supported plunge columns and perimeter capping beam or alternatively could be formed from graded earth embankment.

U.
Requirement for temporary propping and dewatering to piled wall to Contractor's details.

V.
Potentiallty low headroom and restrictive access around facade retention steelwork. Piled wall construction and temporary works design to be coordinated.

W.
RC frame built up around facade retention towers with wind trusses being removed as each level progresses to maintain lateral restraint to Ruskin Building facade throughout construction of frame. Facade retention towers deconstructed and RC slabs infilled once all wind trusses have been removed.

X.
Southern facade of Ruskin Building rebuilt and tied back to new RC frame.

Y.
Indicative crane position.

Z.
Indicative site storage area located where RC frame extends only to ground floor level (i.e. Auditorium and North Quad).