Structural Feasibility Report

Relating to: Modifications at
XXXX
XXXX
XXXX

Report date: XXXX 2021

ALLCOTT
COMMERCIAL

Project preface

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View of West Entrance

Table of contents

1 Introduction

1.1 Instructions

In accordance with instructions received from XXX Architects on behalf of the client, we have carried out a structural feasibility study for proposed alterations at XXXX church. A visual inspection was carried out on XXXX 2021.

All comments are based on visual inspection only, together with a desk top review of previous surveys and proposed design information from other consultants.

No drainage survey or investigation of the foundations was undertaken as part of our inspection, but limited details of a previous drainage CCTV survey have been provided.

This report describes our understanding of the existing structure and undertakes a preliminary assessment of the structural impact of the proposed works, commensurate with a RIBA 2013 Stage 1/2 level of design. The findings and opinions expressed are based on the conditions encountered and/or the information reasonably available at the date of issue of this document and shall be applicable only to the circumstances envisaged herein.

1.2 Brief

Allcott Associates were instructed to undertake a structural feasibility review to consider phases alterations and modifications throughout the church and ancillary spaces. The key aspects of the proposals requiring structural input are as follows:

- Review and advice on existing cracking to brickwork, particularly in the towers to either side of the West entrance, and to the Southeast stair roof access tower. Cracking has also been recorded previously to areas in the Chancel
- New steps and ramps to the West entrance, Cloisters entrance and Vestry entrance to improve accessibility
- New Raised Floor in the Nave and Aisles
- Improved access from the West lobby into the Nave
- Review of existing ceiling joists above the Lady Chapel, for use as a storage space
- New mezzanine floor to the northwest tower for storage, with access door off the existing balcony
- Potential mezzanine floor to extend the balcony, with associated lift in the southwest tower
- New doorway from the Nave to the Link Building toilets
- Internal wall removals to the Link Building toilets
- Potential single storey extension to the Cloisters

1.3 Basis of Information

Details of the existing structure have been established predominantly from visual inspection, as described in Sections 2 and 3 of this report. Other information referenced in the preparation of this report is as follows:

- *XXXX*
- *XXXX*
- *XXXX*

The history of the building and approximate date of construction has been taken from information collated in the architectural feasibility report.

1.4 Site inspection

Where the terms “right hand” or “left hand” are used, they assume that the reader is facing the front of the property with the main access door situated within the front elevation.

Where relating to structural damage and crack widths the expressions negligible, very slight, slight, moderate, severe and very severe are used they generally mean the following:

Category 0	"negligible"	< 0.1mm
Category 1	"very slight"	0.1 - 2mm
Category 2	"slight"	>2 but < 5mm
Category 3	"moderate"	>5 but < 15mm
Category 4	"severe"	>15 but < 25mm
Category 5	"very severe"	>25 mm

Classification of damage to buildings based on crack widths

The inspection carried out was visual in nature only and was limited to structural elements of the property only. Timber condition and surveying of damp is outside of our scope; please refer to reports prepared by others for details in relation to these issues.

2 Description of the Existing Property

2.1 Location

XXXX Church is located XXXX. The main (West) entrance of the church is accessed off XXXX, whilst a small area of parking adjacent to the Vestry entrance is accessed off XXXX. The external surfaced area outside the Cloisters and Church Hall is accessed off XXXX to the northeast.

The area directly surrounding the church is predominantly residential. The vicarage and vicarage garden are located to the south side of the church.

2.2 Superstructures

The Church was completed in 1930 and is Grade II listed. A detailed description of the church's history can be found in the Architectural Feasibility Report, which includes extracts from *New Churches Illustrated 1926-1936 (pXXXX)* by the Incorporated Church Building Society London. This provides the following description:

Extract from New Churches Illustrated 1926-1936 (pXXXX) by Incorporated Church Building Society London

Of note from this description is that the roof to the Nave and Chancel is supported on arched steel trusses encased in concrete.

General View of the Nave

From investigation by the client, we understand that there is no evidence of steelwork being present within the columns within the Nave, leading us to conclude that the structure predominantly comprises load bearing solid brick walls.

Ceilings are understood to be of timber construction, however some areas (e.g. the southeast stair tower roof) were noted to comprise reinforced concrete construction. The stairs to the southeast and the southwest towers are also of concrete construction.

The floor to the existing balcony is understood to be of timber construction. Deep timber beams span between the external west wall and the wall between the Narthex and the Nave. In turn, these support shallower timber beams which support floorboards and joists above.

Timber Structure to Underside of Balcony

The Historic England Listed Register notes that the Church Hall attached to north side of the church by a brick arcaded cloister was completed in 1929 and was therefore constructed at the same time as the church. No structural modifications are proposed to the church hall itself, therefore it is not discussed further in this report.

Floorboard to Top of Balcony

Front elevation of the Cloisters

The Cloisters incorporate the entrance into the Church Hall, together with toilets, a boiler room and a storeroom. The building is of simple single storey brick construction, with a pitched roof to the front and a flat roof supported on timber joists to the rear above the female toilets. The pitched roof structure comprises cut timbers, and there is evidence of former roof lights, which have since been roofed over and infilled at ceiling level.

Roof Void above the Toilets showing Cut Timber Structure and former Roof Lights

2.3 Ground Floor Construction

The ground floor to the Nave and Aisles is understood to be ground bearing throughout. Given the age of the building, we anticipate that it is of unreinforced concrete construction. The floor to the Nave is predominantly finished with parquet, with tiles to the original central aisle between the pews.

The north and south aisles are finished with a combination of tiles and screed. There are access covers to service ducts beneath these aisles, which contain distribution pipework to the radiators. The ducts are understood to contain asbestos, and the client has advised that due to the impracticality of removing this asbestos, these ducts will be sealed and will become redundant.

Floor to the Nave

Floor to the South Aisle and to the west end of the Nave

A tiled finish is also present to the floor at each end of the Nave. At the junction with the Chancel, the floor level steps up approximate 450-500mm with three stone steps.

Change in Level at East End of the Nave

The XXX Damp and Timber Survey did not include an intrusive investigation of the floor slab, but it noted that:

'From a purely visual inspection of the upper surface, the existing solid floor construction would not appear to meet modern building standards and is unlikely to incorporate an effective damp proof membrane (DPM).

The absence of an effective damp proof membrane (DPM) correctly finished at wall / floor joint intersections is likely to result in ground moisture permeating up through the floor construction creating a damp environment. Adjacent timbers must also be considered at risk from fungal decay.

Decay and wood boring weevil infestations was noted to some of the parquet flooring this is due age and deterioration.'

2.4 Foundations

No investigation of the foundations was carried out and details have not been confirmed. Based on the age and nature of the building, we would anticipate that the foundations take the form of mass concrete trench footings to the walls and mass concrete pad footing in column locations.

With reference to the British Geological Survey 1:50,000 scale maps, the geology beneath the site is identified as follows:

- Bedrock: Sidmouth Mudstone Formation, comprising Mudstone.
- Superficial Deposits: To the northeast side of the church, Glaciofluvial Deposits comprising Sand and Gravel are identified. To the southwest side of the church, no superficial deposits are recorded.

Available historic borehole record in the area typical show varying levels of made ground over sands and gravels, with clays at depth. In many cases, the sand and gravel are described as being clayey. Based on this information, it is possible that the ground conditions at formation vary across the footprint of the building.

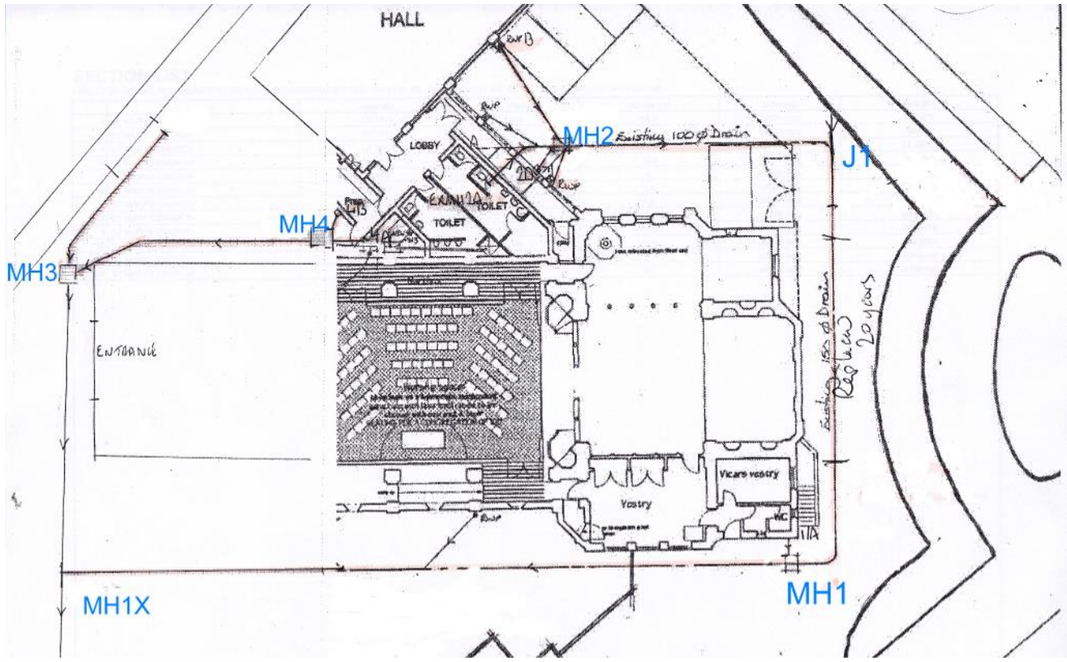
2.5 Below Ground Drainage

Detailed plans of the existing below ground drainage have not been obtained, however a synopsis of a CCTV survey by Lanes for Drains has been provided by the client. It is not known when this survey was carried out.

A sketch provided with the synopsis shows that a combined surface and foul water drain flows in two directions from the north side of the church, around the east and west ends, and meets in a manhole on the southwest corner of the site within the vicarage garden, before running off to thew south. It is presumed that the system connects to the public sewer in Tyburn Road, however this has not been confirmed.

A number of foul and rainwater connections from the church hall and toilets fall to Manhole MH2 in the yard in front of the Cloisters. The pipework is presumed to comprise clay, 100mm diameter towards the top of the runs increasing to 150mm diameter to the runs on the east and south elevations.

The drainage is typically shallow, with a depth to invert of approximate 0.45-0.50m at the top of the runs (Manholes MH2 and MH4), increasing to approximately 1.2m (manholes J1 to MH1X).



Sketch of Existing Below Ground Drainage Routes taken from Synopsis of Lanes for Drains CCT Survey

The Synopsis identifies defects to a majority of the drainage runs, including cracked and displaced pipes, root ingress at joints, and blockages. These were recorded in the following locations:

- 150mm diameter run between the Church Hall kitchen and manhole MH3
- 150mm diameter run between manhole MH 1 and manhole MH1X (35m downstream from MH1)

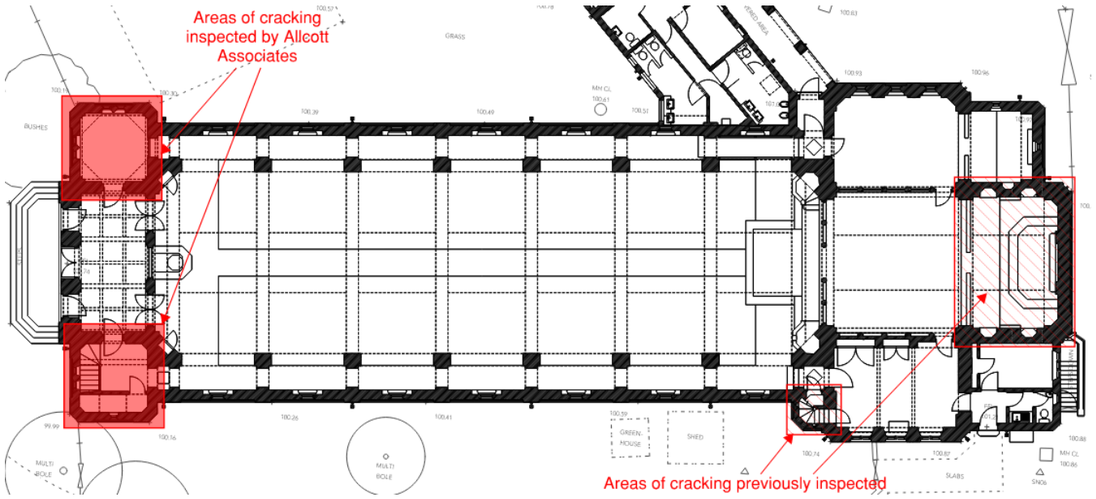
We recommend that the remedial works set out in the Synopsis shall be planned for and actioned in the next year.

2.6 Previous Modifications

Based on our inspection, there is little evidence of previous structural alterations to the Church or the Church Hall. We believe that minor internal alterations have been undertaken in the past to the layout of the toilets in the Cloisters, but nothing that has had a significant impact on the original structural arrangement.

3 Review of Cracking

The following areas of cracking to the external elevations were inspected by Allcott Associates on Monday 13th September 2021. In addition, cracking was also recorded by XXXX in their Quinquennial Inspection report dated October 2019. These areas are included in this section for completeness, but were not inspected by Allcott.



Locations of Cracking to External Elevations

3.1 Northwest Tower

The perimeter walls generally comprise facing brickwork to the outer leaf with commons to the inner face. The thickness of the walls varies, but it believed to typically be in the order of 360mm or 480mm at corners, with no cavity.

To the north elevation of the northwest tower there were no signs of significant cracking to the facing brickwork. A possible slight bulge was noted close to the top of the wall on the northwest corner, corresponding with the level of the roof deck.

Rainwater downpipes and corresponding gullies at ground level were noted to the northeast and southwest corners of the tower.

North Elevation of northwest tower

West elevation of northwest tower

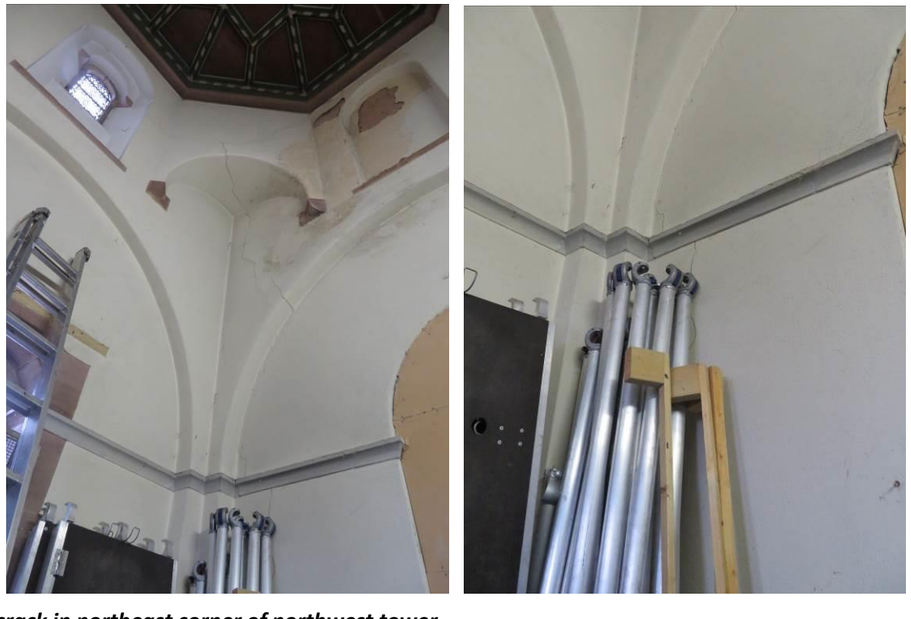
Northwest corner of northwest tower at high level

Parapet to top of north elevation of northwest tower

Internally, the tower is currently a single storey space with no upper floor levels. An approximately vertical crack is present in the northeast corner of the tower, running through the plaster to the inset arch below where the crack runs down to ground.

Vertical crack in northeast corner of northwest tower

The crack is located at the junction with the main north wall to the Nave. It was noted to be slight, measuring approximately 3-5mm in width. At low level there was evidence of previous decorative repairs to the crack, suggesting it is not recent. Signs of previous water ingress were noted to the walls at high level.



Vertical crack in northeast corner of northwest tower

To the west elevation, slight approximately vertical cracks were noted between the upper and lower windows. A single crack was noted running above the upper window to roof level.

Vertical cracks to west elevation of northwest tower

Vertical cracks to west elevation of northwest tower

3.2 Southwest Tower

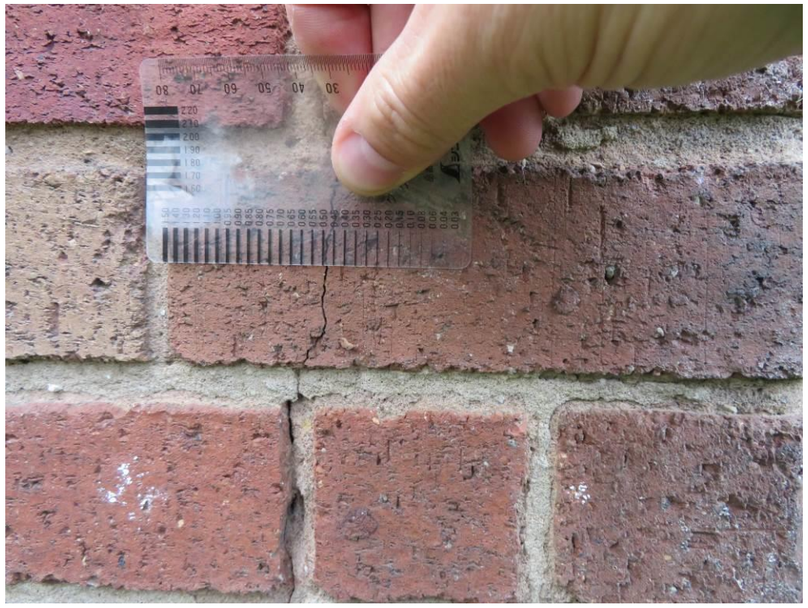
To the southwest tower, a very slight to slight approximately vertical crack was noted in the brickwork between the upper and lower windows on the west elevation.

Vertical crack to brickwork on the west elevation of the southwest tower

On the southern elevation, very slight cracks were noted to the external face of brickwork both beneath the ground floor window and to the eastern corner. In each case, the cracks were noted to be less than 1mm wide.

The crack beneath the window was noted to run diagonally down towards ground level. It did not appear to continue through the brickwork at ground level, however due to weathering of the mortar joints in the brickwork, this was not confirmed.

South elevation of the southwest tower



Measurement of diagonal crack to the eastern corner

Diagonal crack to the eastern corner of the southwest tower

South elevation diagonal crack beneath ground floor window

Weathered mortar joints to brickwork at low level on south elevation

Internally, an approximately vertical crack was noted in the west elevation between the upper and lower windows, reflecting that observed on the external elevation. The crack appeared to be slight, approximately 5mm in width.

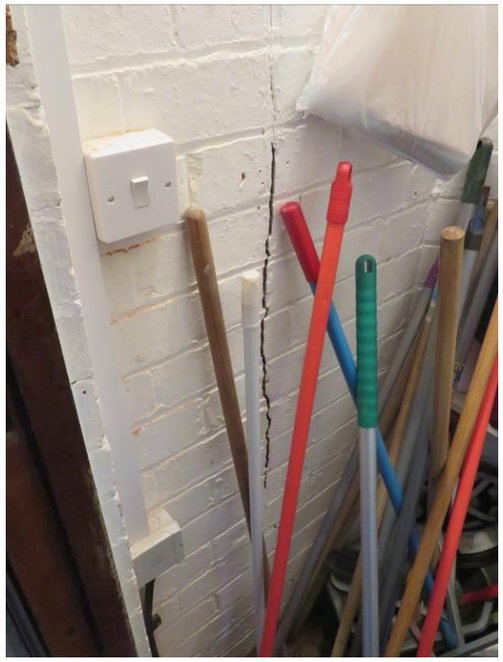
Vertical crack to west elevation of southwest tower

Vertical crack to west elevation of southwest tower

A slight to moderate vertical crack was noted full height of the tower in the eastern corner. In the understairs cupboard, it was measured as 5mm wide.

Full height vertical crack in east corner of southwest tower

Vertical crack in east corner of southwest tower



Vertical crack in east corner of southwest tower

In the same corner of the tower, a gap of approximately 5-10mm has opened up between the quarter landing and the upper flight of concrete stairs. The gap appears to correspond with the crack in the wall, which each part of the stair having moved with the wall it is built into.

Movement between concrete stair treads associated with vertical crack in east corner of southwest tower

Movement between concrete stair treads associated with vertical crack in east corner of southwest tower

3.3 Southeast Tower (Roof Access Stair)

The southeast roof access tower was not inspected by Allott Associates, but the Quinquennial Inspection report by XXXX identified structural defects in this location which require attention, therefore their findings have been replicated here.

The roof to the tower is noted to comprise a concrete slab. The reinforcement in the slab has corroded, resulting in cracking and spalling of the concrete to the soffit.

Spalled concrete and corroded reinforcement to soffit of roof slab in the southeast tower (photo taken from Quinquennial Inspection report by XXXX, dated October 2019)

In addition, vertical cracks were noted in the brickwork to the external elevation of the tower. Cracks were noted to be slight, with a width of approximately 2mm.

Vertical Cracks in southeast tower (photos taken from Quinquennial Inspection report by XXXX, dated October 2019)

3.4 Chancel

The Chancel was not inspected by Allott Associates, but the Quinquennial Inspection report by XXXX identified structural defects in this location which require attention, therefore their findings have been replicated here. Their report records the following:

Cracking was recorded to the east wall to the Chancel Stone plinth behind the altar. Open joints at low level. Cracking to the rendered infill. A horizontal crack runs through to the right hand side of the stone plinth and to the right hand rendered panel and stone string at mid and high level. Clearly there is some movement occurring here. Note: there are some large trees just the other side of this wall which the church is considering felling in the not too distant future. They are taking advice from a tree specialist.

Recessed Stone Sedilia (Eastern end of the south wall) - Evidence of movement within the joints.

Stone Lime Sedilia (Eastern of the two in the north wall) - Cracks between vertical stone dressing and adjacent the render. This has been mentioned in previous quinquennials and cracks in the render have been filled but are opening up again. A watching brief should be kept.

Cracking to masonry behind alter (photos taken from Quinquennial Inspection report by XXXX, dated October 2019)

Cracking in Chancel (photos taken from Quinquennial Inspection report by XXXX, dated October 2019)

3.5 Review of Cracking

All of the cracking observed appears to be historic, however where decorative repairs have been carried out previously the cracks have reoccurred. This is to be expected, as changes in temperature and moisture throughout the year will result in the brickwork and plaster shrinking and expanding.

The vertical nature and constant width of the cracks seen in the northwest and southwest towers suggests that the cracking is most likely to be associated with expansion and contraction of the brickwork, rather than movement in the ground. Thermal movement cracks in walls are usually vertical and a constant width, and they can open and close as the temperature, moisture and humidity levels change throughout the year.

There was no sign of significant vertical displacement to either side of the cracks, which might otherwise indicate ground movement. Furthermore, the cracks in each of these towers follows a similar pattern, suggesting that the cracks have concentrated in the weakest points of the wall (i.e. above and below window openings, and at changes in thickness / level). The cracking was most evident on the internal face of the walls, suggesting that the internal brickwork is more susceptible to thermal effects that the facing brick.

Whilst ground movement does not appear to be the cause of cracking, we note that blocked drains were recorded by Lanes for Drains in the vicinity of both towers (refer to summary in Section 2.5). Therefore, it would be prudent to undertake drainage repairs at the earliest opportunity to eliminate this factor.

The vertical cracks to the southeast tower as recorded by XXXX similarly appear to be the result of thermal movement of the brickwork.

The cracking in the Chancel area as recorded by XXXX takes a different form, with diagonal cracks noted in masonry and above openings. The report suggests that ground movement due the proximity of trees in this location is the cause and recommends a watching brief.

The spalling to the soffit of the southeast tower roof slab is the result of water ingress causing carbonation of the concrete, enabling corrosion of the reinforcement. This has been able to develop over a long period of time, but structural repairs will need to be undertaken at the earliest opportunity to maintain the integrity of the roof slab.

3.6 Recommendations for Repair

<u>Brickwork Repairs</u>

In accordance with BRE Digest 251 *Damage to Low Rise Buildings*, Where the observed cracks are less than 5mm wide this would be categorised as Category Two damage. In this case the suggested remedial works are to undertake decorative repairs only internally and to repoint mortar as required externally.

Where cracks are 5mm wide or more, the cracks fall into Category Three damage in accordance with BRE Digest 251. In these locations it is recommended that crack stitching is undertaken with helical bars across the cracked areas, to both the internal and external faces to stabilise the brickwork. This would typically involve disc cutting a 40-55mm deep chase into the bed joint across a crack. An epoxy resin mortar is then pressure grouted into the open joint, and stainless steel rods are set into place. The following should be noted:

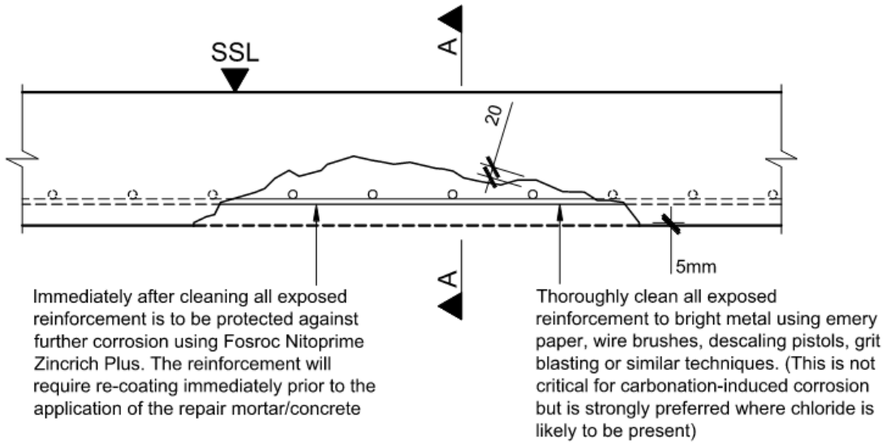
- Height of slot to be equal to full mortar joint height, with a minimum of 8mm.
- HeliBar to be long enough to extend a minimum of 500mm either side of the crack or 500mm beyond the outer cracks if two or more adjacent cracks are being stitched using one rod.
- Normal vertical spacing is 450mm (6 brick courses).
- Where a crack is less than 500mm from the end of a wall or an opening, the HeliBar is to be continued for at least 100mm around the corner and bonded into the adjoining wall or bent back and fixed into the reveal, avoiding any DPC.

Following repairs using stainless steel helical bars, the locations of cracking to the mortar joints in the brickwork should be repointed.

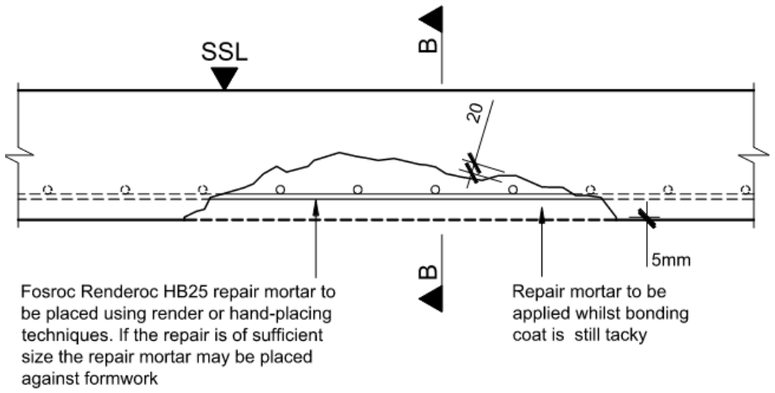
Internally, where paster repairs are to be carried out over cracks the potential for recurrence can be reduced by removing the plaster back to brick locally and applying expanded metal lath (EML) to the surface of the brickwork before patching the plasterwork and redecoration. The EML shall be compatible with the plaster specification.

Concrete Repairs

The soffit of the slab to the southeast tower is to be repaired using a lightweight high build concrete repair mortar. A detailed specification for the repair shall be prepared during the next stage of design, however a summary of the requirements for preparation and repair is set out in the following typical details.



Typical Slab Soffit Repair Preparation



Typical Slab Soffit Repair

Simialrly, following the brickwork repairs to the sourthwest tower, a lightweight concrete repair mortar or resin shall be injecting into the gap between the concrete stair elements to reinstate the bearing between them.

4 Structural Aspects of Proposed Works

4.1 Phase 1 External Works

The Phase 1 external works includes the construction of new steps and ramps to the West entrance, Cloisters entrance and Vestry entrance to improve accessibility. Details of these elements are shown on the following XXXX Architects drawings:

- 1150/3/1010-1014/P1 - West Entrance Steps and Ramp
- 1150/3/1015-1016/P1 – Vestry Steps
- 1150/3/1020/P1 – Cloister Ramp

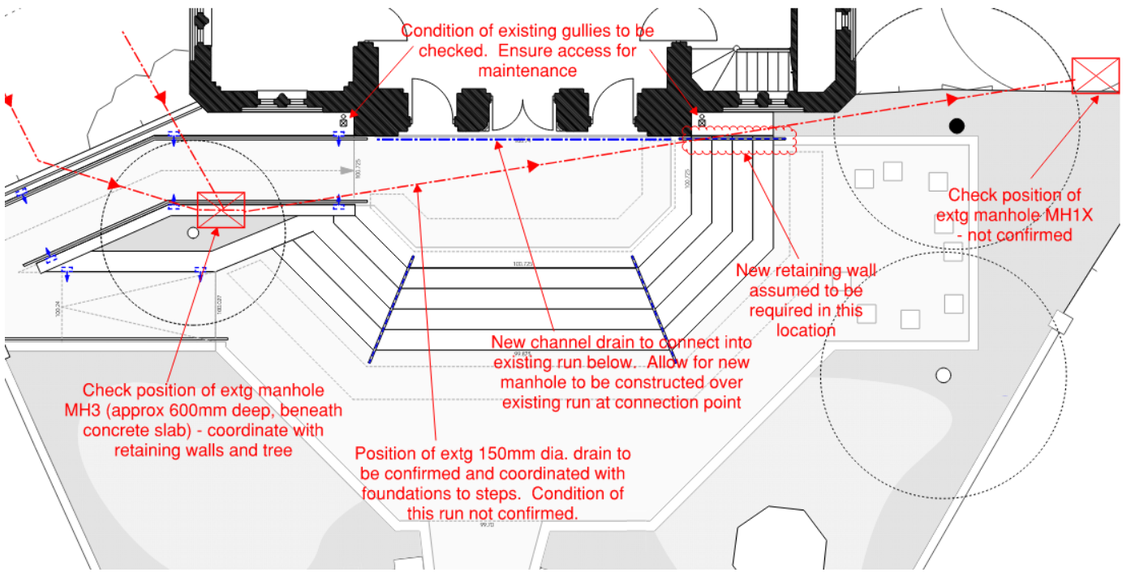
Refer to the following mark ups for structural comments on the proposed details. Brick and blockwork retaining wall elements are to be constructed in accordance with the requirements set out in BRE Good Building Guide GBG27. Structural Requirements are generally as follows:

<u>Foundations to Steps and Retaining Walls:</u>

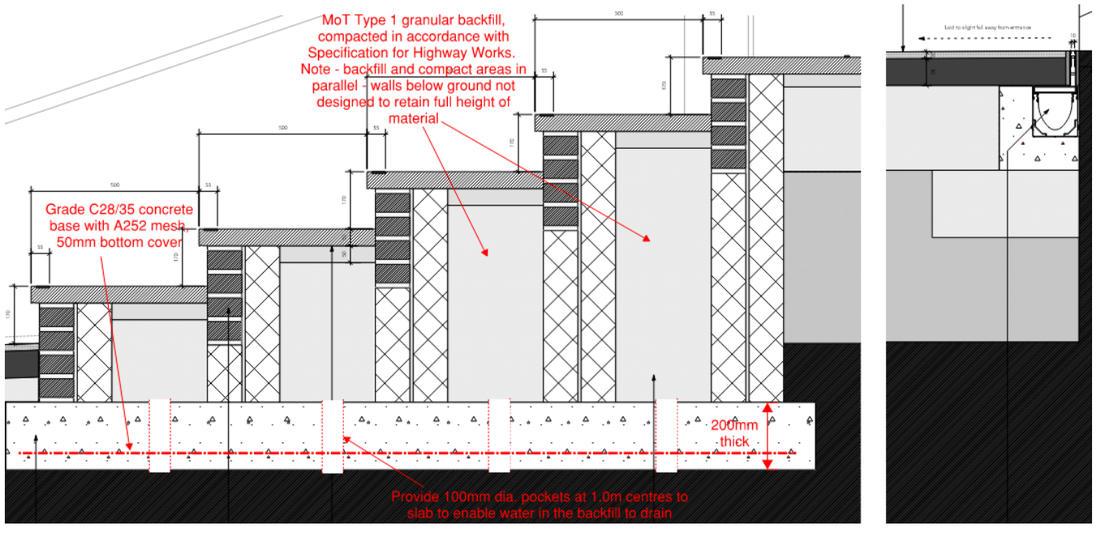
1. Top of foundations to be a minimum of 150mm below ground level, and a minimum thickness of 200mm, or3300mm to retaining elements.
2. From British Geological Survey records, foundations assumed to bear onto clayey sand and gravel. If topsoil or made ground is present at 450mm below ground level, extend depth of footing into natural ground.
3. Concrete to be grade C28/35, with one layer of A252 mesh to the bottom, 50mm cover.
4. Foundations are to be constructed as soon as possible after excavation. All formation to be sealed within 12 hours with a 50mm concrete blinding.

<u>Masonry Notes:</u>

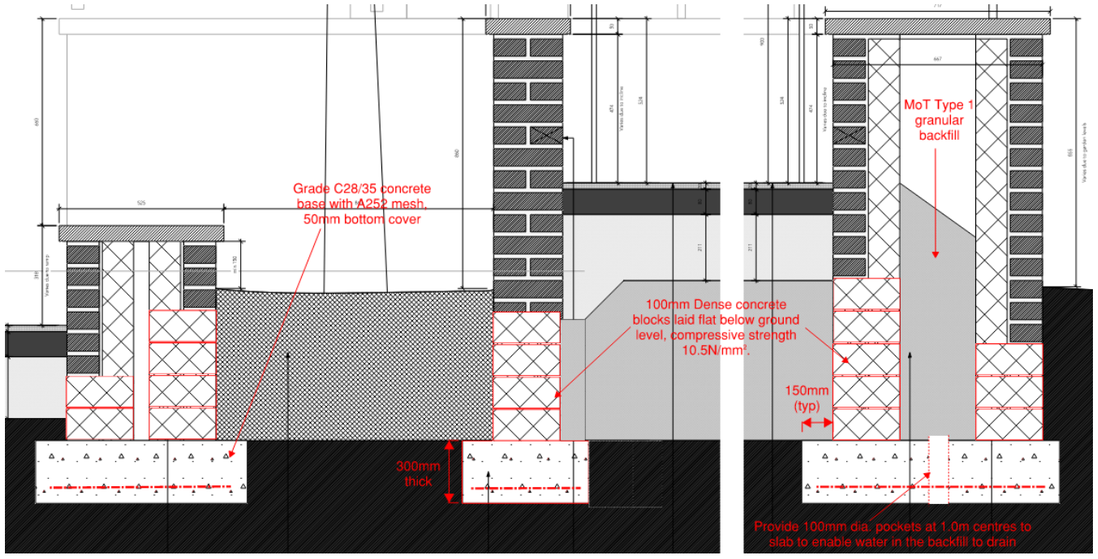
1. Adopt dense concrete 100mm thick blocks with a minimum density of 1700kg/m^3 and a minimum compressive strength of 10.4N/mm^2.
2. All mortar to be designation (ii).
3. Blocks to be laid flat below ground level. Maximum height of retaining element of walls to be 800mm
4. Provide either a bituminous membrane or two coats of bituminous emulsion to rear face of retaining wall elements. Protect the waterproofing with fibre board or similar before backfilling.



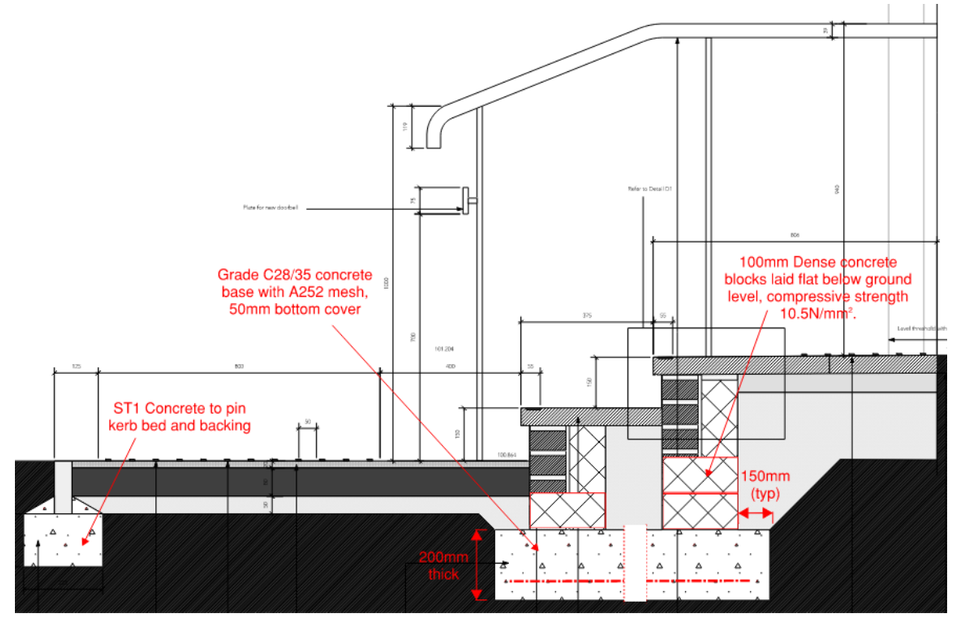
West Entrance Steps and Ramps Plan – marked up comments



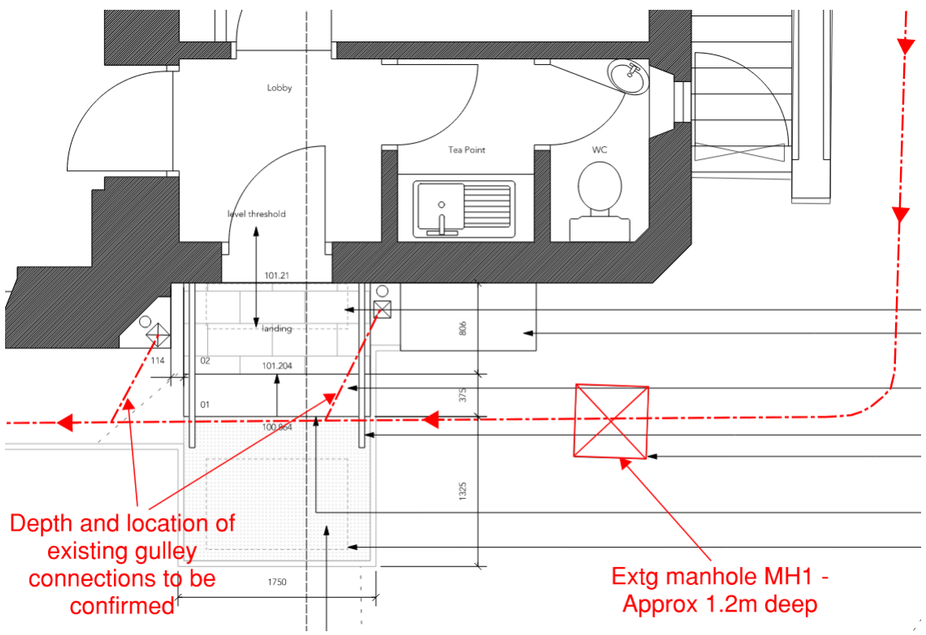
West Entrance Steps Section – marked up comments



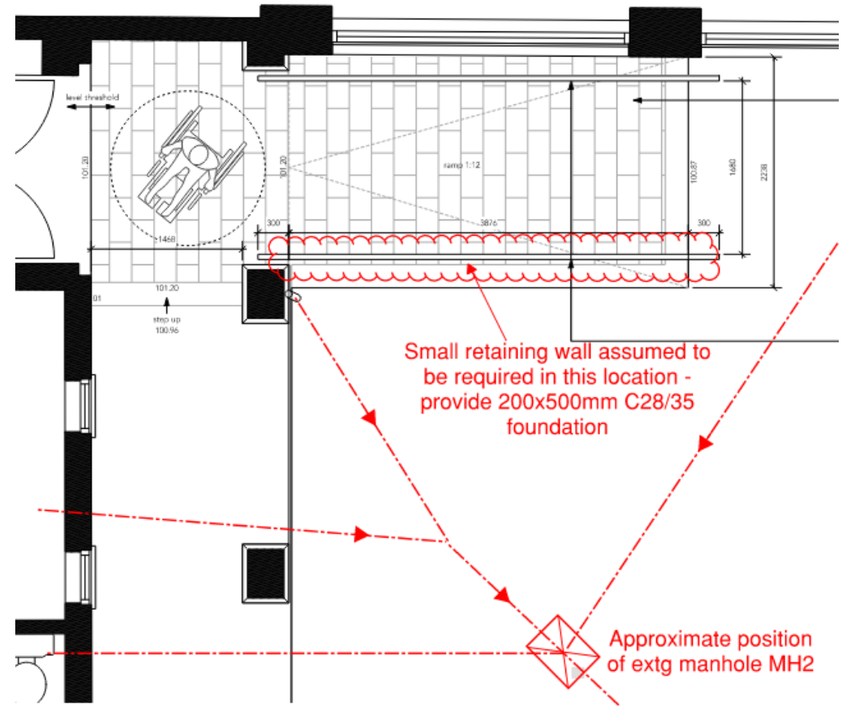
West Entrance Ramp Section – marked up comments



Vestry Entrance Steps Section – marked up comments



Vestry Entrance Steps Plan – marked up comments



Cloisters Ramp Plan – marked up comments

4.2 Raised Floor in the Nave and Aisles

In order to improve accessibility, it is proposed to raise the floor across the footprint of the Nave and the north and south aisles by approximately 150mm. This will enable underfloor heating to be incorporated and also provide routes for services distribution beneath the floor.

Loading

Table NA.4 of the UK National Annex to BS EN 1991-1-1:2002 *Actions on structures — Part 1-1: General actions — Densities, self-weight, imposed loads for buildings* identifies minimum design imposed loads depending upon the proposed use. The client has advised that the Nave floor will not need to accommodate wheel loads from mobile elevated wheeled platforms (MEWPs) or scissor lifts. Therefore, to provide flexibility we would propose that the raised floor shall be designed for category C4 – *Areas with possible physical activities*.

Table NA.5 identifies that for category C4 an imposed load of 5.0 kN/m^2 shall be adopted. There are a number of ways that the raised floor could be constructed.

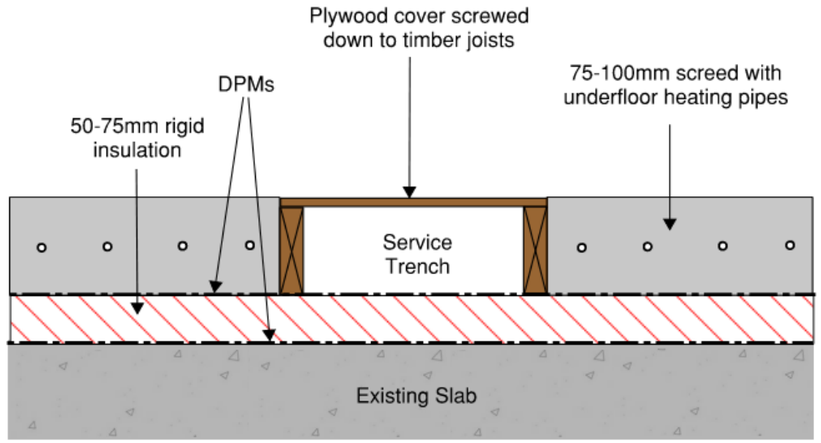
Option 1 – Rigid Insulation and screed

The simplest solution is to provide a rigid insulation with a screed above, incorporating underfloor hearing pipes within the screed. In accordance with BS8204-1 *Screeds, bases and in situ floorings - Part 1: Concrete bases and cementitious levelling screeds to receive floorings — Code of practice* when laid on a compressible layer the thickness of the screed at any point should be not less than 75 mm. Owing to deviation of the base levels, the specified design thicknesses might have to be 100 mm, to maintain minimum thickness.

There is a risk of floating screeds curling exists with unbonded and floating levelling screeds, which can lead to steps at joints due to differential movement. Therefore, we recommend that reinforcement is provided to the screed. In accordance with Section 5.7 of BS8204-1, the reinforcement should be steel fabric of type D49 (flat sheet, not on a coil) or A98 conforming to BS 4483, Table 1. The screed shall be placed and cured strictly in accordance with the manufacturer's instructions.

With regards to the proposed insulation beneath the screed this should be a rigid product such as Kingspan Thermafloor TF70, which provides an adequate compressive strength.

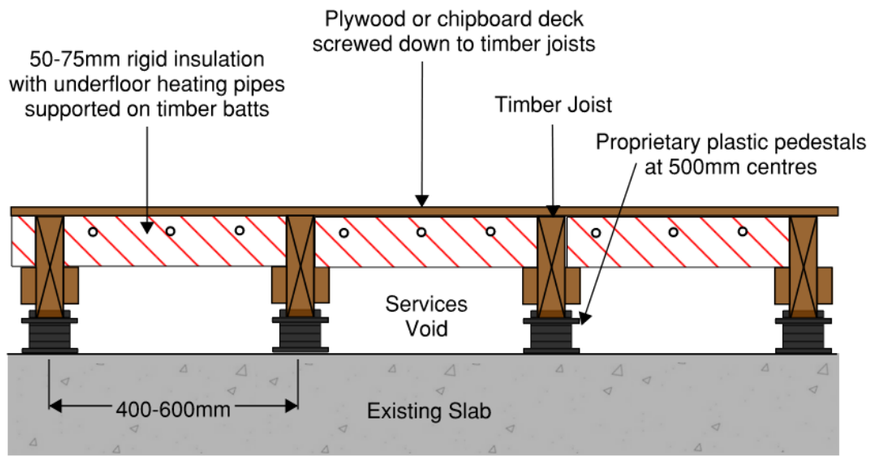
The disadvantage of this solution is that it provides little flexibility for services distribution, therefore service trenches would need to be provided in the depth of the screed in fixed locations, with a plywood cover to provide access. The underfloor heating distribution would need to be co-ordinated with the service trenches. Refer to the following indicative cross section for details.



Indicative floor build up for screed on insulation

Option 2 – Joists on pedestals

To provide a raised floor with a void beneath the new build up, a timber deck could be supported on time joists which in turn span between plastic deck risers such as the Mesa DA-SP-10 product. These will support 50mm wide timber joists and create a clear void beneath the joists of up to 40mm. Refer to the following diagram for an indicative arrangement.

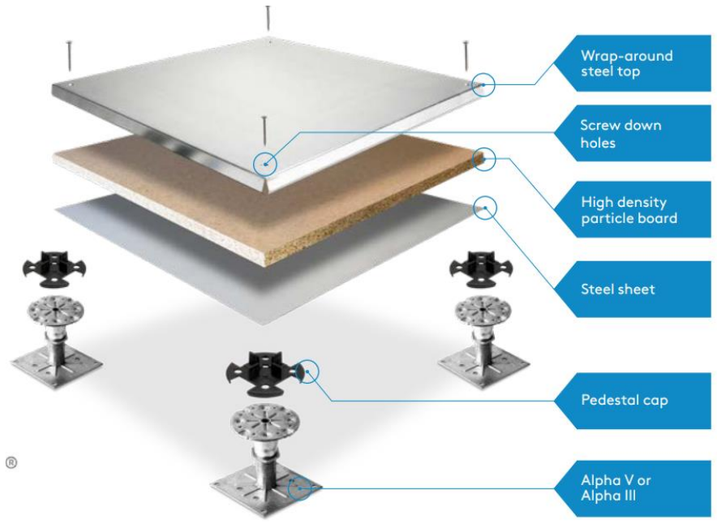


Indicative floor build up for timber joists on pedestals

The advantage of this solution is that a constant gap is provided beneath the joists for cable distribution, and the timber is not in contact with the existing floor slab. The distribution of the under floor hearing would need to be co-ordinated with the joists.

Option 3 – proprietary raised access floor

A proprietary raised access floor system – similar to that often seen in modern offices - has the benefit that it is an 'off the shelf' solution. A medium duty system, such as Kingspan TLM26, has a load capacity in excess of 5kN/m^2, and can provide a high degree of flexibility for services distribution. The following diagram shows the typical construction for this type of raised floor.



Example of Kingspan TLM26 raised access floor build up

The disadvantage of this solution is that there is limited opportunity to incorporate insulation or underfloor heating. If a warm air heating system were to be considered however, the raised floor system can be supplied with neoprene gaskets to minimise air loss and enable the void to act as an underfloor plenum to aid air circulation.

4.3 Improved access from the Narthex into the Nave

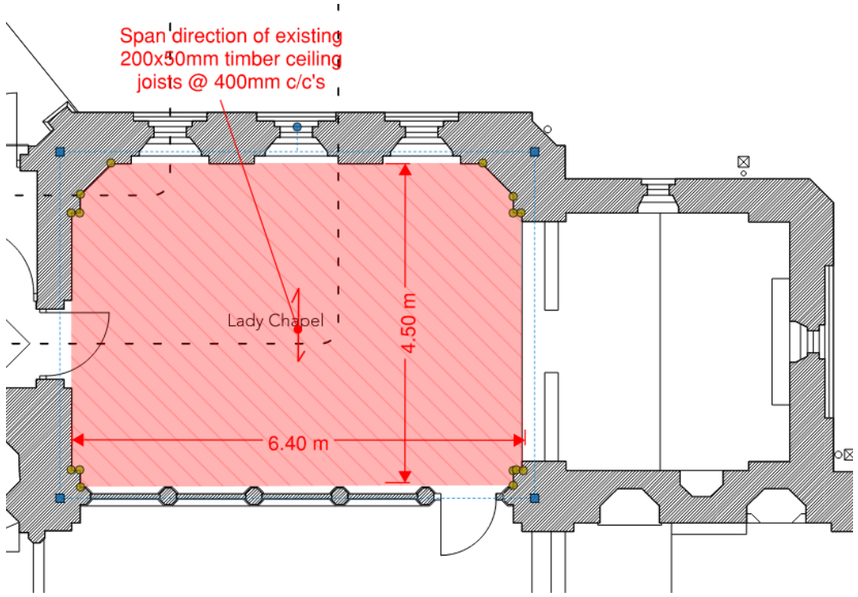
As part of the improving circulation and accessibility, there is a proposal to relocate the font at the west end of the Nave so that the central arch between the Narthex and the Nave can be opened up to create an additional doorway.

The arch is of the same form of construction as the adjacent arches, where the double doors already exist. In addition, there is an existing timber framed arched window at the head of the existing infill. The infill wall beneath the window comprises a single leaf of brickwork. Based on our observations we are satisfied that the brickwork beneath the arch (shaded red in the following photograph) can be removed without the need to provide additional structural support above.

Existing central arch between Narthex and Nave

4.4 Storage Mezzanine above the Lady Chapel

The Lady Chapel ceiling is currently supported on timber joists spanning perpendicular to the external wall. There is a desire to lay a floor deck across this area and use it for light storage. We understand that the existing construction comprises 200x50mm timber joists supported on joist hangers, with 200x50mm timber wall plates. At window locations the timber stretchers span across the opening and are bolted to the wall on either side.



Plan on Lady Chapel showing span direction of ceiling joists above

View on top of Lady Chapel Ceiling

View of Joists and Wall Plate to Lady Chapel Ceiling

Loading

In accordance with table NA.4 of the UK National Annex to BS EN 1991-1-1:2002 the proposed storage mezzanine is considered to fall into category E11 – *Areas susceptible to the accumulation of goods - General areas for static equipment not specified elsewhere (institutional and public buildings).*

Table NA.5 identifies that for category E11 an imposed load of 2.0 kN/m^2 shall be adopted, with a maximum point load acting on the floor of 1.8 kN.

Joist Assessment

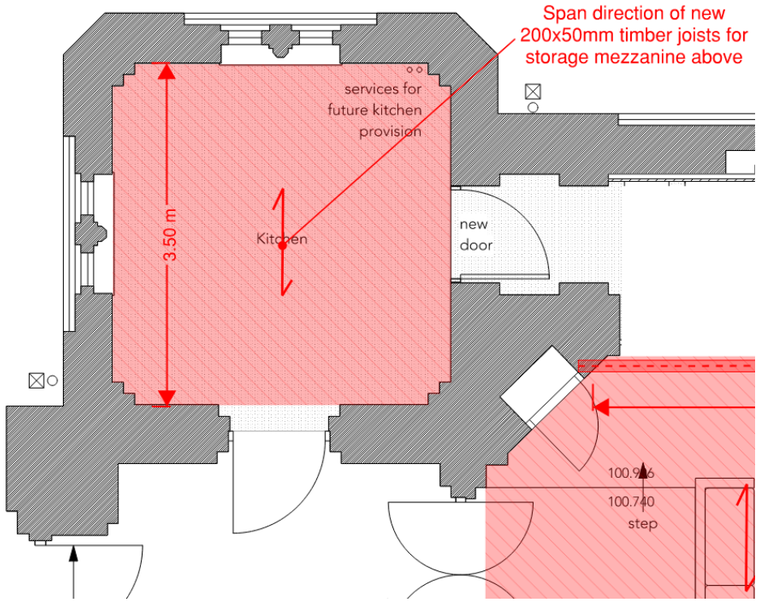
An assessment of the existing 200x50mm timber joists has been carried out. In the absence of any other information, the existing joists are assumed to be grade C16 timber. Analysis of the existing joists shows that for a span of approximately 4.5m, they are not adequate to support the required storage loading – they are overstressed by approximately 40% and exceed deflection limits by approximately 50%.

Therefore, to use the space above the Lady Chapel ceiling for storage purposes, new floor joists will need to be installed. Initial sizing suggests that 225x50mm Grade C24 joists at 400mm centres are acceptable to support the required loading. These could be installed between or above the existing ceiling joists if required to avoid disturbing the existing ceiling below. Noggins should be provided between the joists at third points.

A 225x50mm timber wall plate should be provided to the perimeter walls to support the new joists via proprietary joist hangers. The wall plate should be fixed to the wall using threaded rods and injection mortar suitable for masonry. A detailed specification shall be provided for the fixings at the next stage of design, including rod diameter and minimum embedment depths. The existing wall plate should not be relied upon, as the capacity and embedment of the existing bolts supporting it are not known.

4.5 Storage Mezzanine Floor to the Northwest Tower

The northwest tower is currently a full height open space used for storage. As part of the proposed works, this space is to become a kitchen for the ground floor café area. There is a proposal to create a new storage mezzanine in the tower at first floor level, with access off the existing balcony. The following diagram shows the proposed arrangement.



Plan on Northwest Tower showing span direction of Proposed Mezzanine joists above

Loading

As for the proposed storage mezzanine above the Lady Chapel, it is assumed that the new mezzanine will be used for general storage of materials. Therefore, in accordance with Table NA.5 of the UK National Annex to BS EN 1991-1-1:2002 for category E11 an imposed load of 2.0 kN/m^2 shall be adopted, with a maximum point load acting on the floor of 1.8 kN.

Joist Assessment

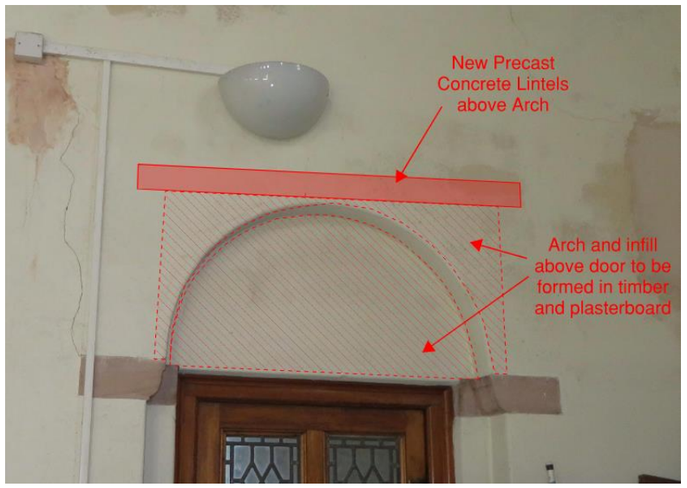
An initial assessment based on the above loading has been carried out. For a span of approximately 3.5m, 200x50mm Grade C24 joists at 400mm centres are acceptable to support the required loading. Noggins should be provided between the joists at midspan.

A 200x50mm timber wall plate should be provided to the perimeter walls to support the new joists via proprietary joist hangers. The wall plate should be fixed to the wall using threaded rods and injection mortar suitable for masonry. A detailed specification shall be provided for the fixings at the next stage of design, including rod diameter and minimum embedment depths.

New Access Door

A new access door is to be formed in the south wall of the tower to connect the new mezzanine floor to the existing balcony. The new door opening will be in the order of 1.0m wide and will take a similar form to the existing door from the southwest tower where an inset arch of approximately 1.25m width is present.

The total width of the existing wall thickness is understood to be approximately 480mm, with the inset section in the order of 225mm thick. To form the new door opening, it is proposed to install multiple precast concrete lintels above the crown of the new arch and form the arch and inset infill above the door in timber stud and plasterboard. Refer to the following marked up photograph. This will avoid the need to construct a new brick arch.

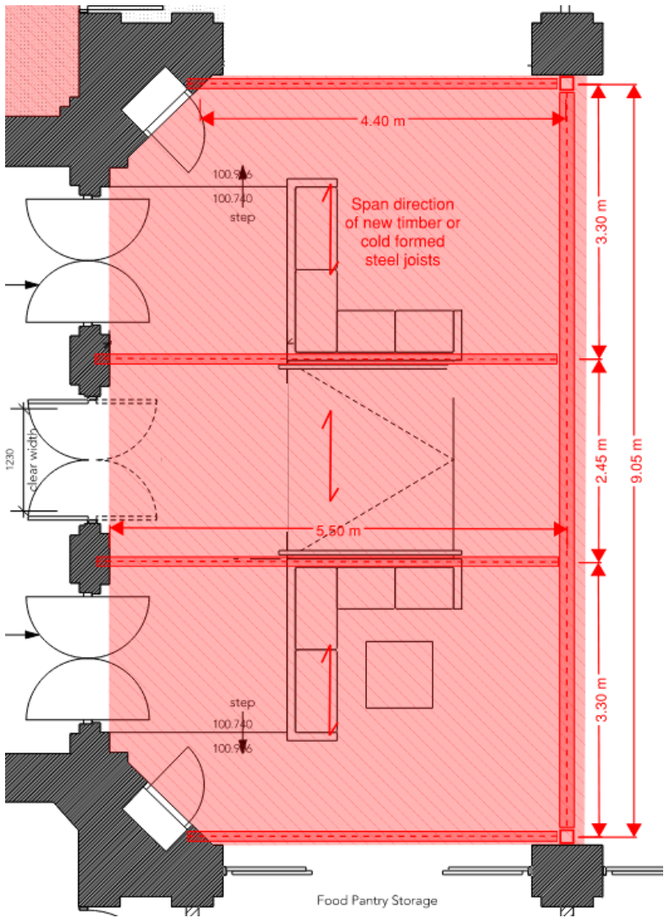


Existing Door Opening to Balcony showing proposed method for construction of new door opening

The new lintels shall be designed in accordance with BS 5977-1:1981 *Lintels - Method for assessment of load*. This approach is based on the fact that brickwork will naturally arch above an opening, therefore the load due to the masonry on the lintel is limited to a 45° triangle having 1.1 times the clear span of the lintel at its base. Any additional point loads within an interaction zone outside the 45° triangle are also considered.

4.6 Balcony Extension Mezzanine

An extension to the existing balcony is proposed at the west end of the Nave. The additional area of floor will be located in the first structural bay, with overall dimensions of approximately 5.5-6.0m by 9.5m. The mezzanine shall be of lightweight timber and steel construction. This will minimise the need for wet trades, such as casting concrete slabs. The space beneath the balcony extension is to be column free to avoid conflicts with circulation, therefore secondary steel beams will span onto a long span beam at the front edge of the mezzanine. Refer to the floor plan below for an indicative layout.



Indicative arrangement of balcony mezzanine extension

The mezzanine is to be supported by the existing wall between the Narthex and the Nave, together with new steel columns placed adjacent to the existing main columns in the Nave.

Loading

In accordance with table NA.3 of the UK National Annex to BS EN 1991-1-1:2002 the new area of balcony is to be designed to resist an Imposed load of 3.0kN/m^2 (Category C22 - *Areas where people may congregate - Places of worship*). In terms of serviceability, a deflection limit of span/360 has been adopted assuming brittle finishes to the soffit of the new floor.

Initial Structural Sizes

We have undertaken an initial assessment of the key structural elements to suit the arrangement shown above and the stated loading. Sizes are as follows:

- Floor Joists: 200x50mm Grade C24 timber joists at 400mm centres, or
  Metsec 150.M.15 cold formed C-Sections at 400mm centres.
- Secondary Steel Beams: 254x146 UB
- Primary Steel beams: 457x152 UB or 305x305 UC (incorporate as upstand if required)
- Columns: 100x100 SHS

The timber deck is to take the form of 38mm thick floor grade chipboard in accordance with FSC heavy duty, Type P6, to EN312:2003. All sizes stated above are subject to detailed design and coordination.

Balustrades

Permanent balustrades shall be designed in accordance with BS 6180:2011 Barriers in and about buildings code of practice and loading as specified in BS EN1991-1, as duplicated below:

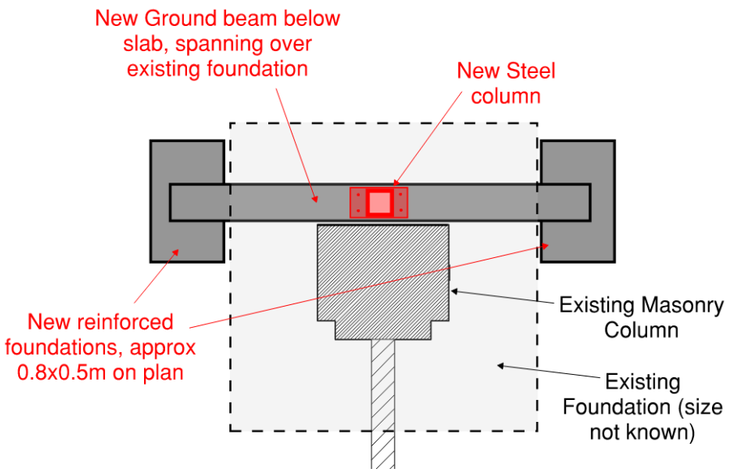
- Horizontal loading: Table NA.8 — Horizontal loads on partition walls and parapets, Category C, Sub-category (vi), horizontal loading q_k = 0.74kN/m. Height of application: 1.2m, as per section 6.4(1) of BS EN 1991-1-1.
- Lateral deflection of top of balustrades shall be limited to 25mm.

The specialist contractor's design for all elements of the balustrade system shall satisfy the above loading, including the design and specification of appropriate fixings into the new steel beams at the perimeter of the balcony mezzanine structure.

Foundations

The new columns supporting the long span front edge beam impose an unfactored point load of approximately 45kN on the foundations. Details of the existing column foundations are not known; therefore investigation is required to establish whether this additional load can be accommodated by the existing foundations.

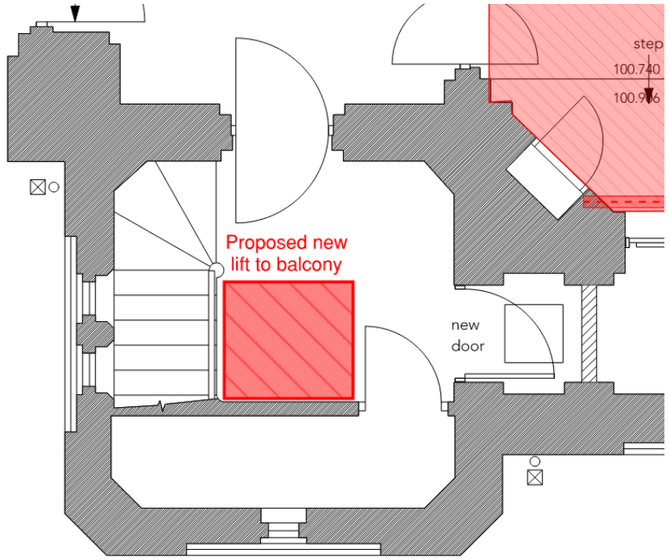
If not, it will be necessary to provide a ground beam to the base of the column, spanning above the existing foundation to new reinforced pad footings to either side. Refer to the following diagram for an indicative arrangement. All details are subject to further investigation and detailed design.



Indicative arrangement of foundations to balcony extension columns

4.7 New Lift in Southwest Tower

Associated with the balcony extension, it is proposed to provide a new lift in the southwest tower to improve access to the upper level. Refer to the plan extract and photograph below for the proposed location. It is not known whether this will be a standard lift with a full pit, or a platform type lift.



Location of proposed new lift in southwest tower

Location of proposed new lift in southwest tower

Standard Lift

If a standard lift is to be installed, it will require a new reinforced concrete lift pit in the order of 1.1-1.5m deep. It is recommended that a location specific ground investigation and subscan survey is carried out in the location of the pit prior to construction to inform the ground conditions and foundation design, and also to identify whether any buried obstructions or below ground services are present in this location.

The pit will be tanked, with waterproofing lapped into any existing slab DPM (if present) to the architect's details and specification. The shaft walls will be constructed from 215mm thick blockwork (100mm blocks laid flat) with a minimum compressive strength of 10.4N/mm^2. The blockwork is assumed to be capped with a timber lid that will stop beneath the existing roof structure, however this is subject to confirmation of the clear shaft heights required by the manufacturer.

Platform Lift

If a platform lift is to be adopted, the extent of structural work required is far less than for a standard lift installation. The base of a platform lift usually only requires a shallow recess and the lifts tend to be self-supporting such that any shaft walls are non-structural.

At ground floor, the recess required to achieve a flush threshold is typically 100mm or less, therefore this can be created by breaking out the existing slab locally and reinstating it at a lower level with a 200mm thick slab on a minimum of 150mm MoT Type 1 sub base, with a DPM to the underside of the slab. For costing purposes, the reinstated slab shall be grade C28/35 concrete with 1 layer of A393 mesh.

4.8 New doorway between Nave and Cloister Toilets

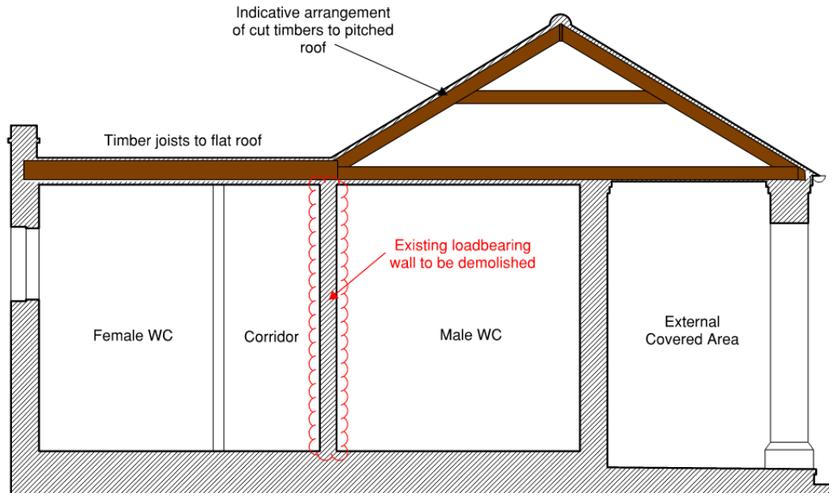
A new doorway from the Nave into the Toilet block is to be created to improve access. The door is to be located directly beneath the existing high level window, in the location indicated below.

The existing wall thickness is understood to be approximately 480mm, with the inset section to the rear of the radiator in the order of 225mm thick. To form the new door opening, it is proposed to install multiple precast concrete lintels above the new door opening, which will be in the order of 1.0m wide. The new lintels shall be designed in accordance with BS 5977-1:1981 *Lintels - Method for assessment of load*.

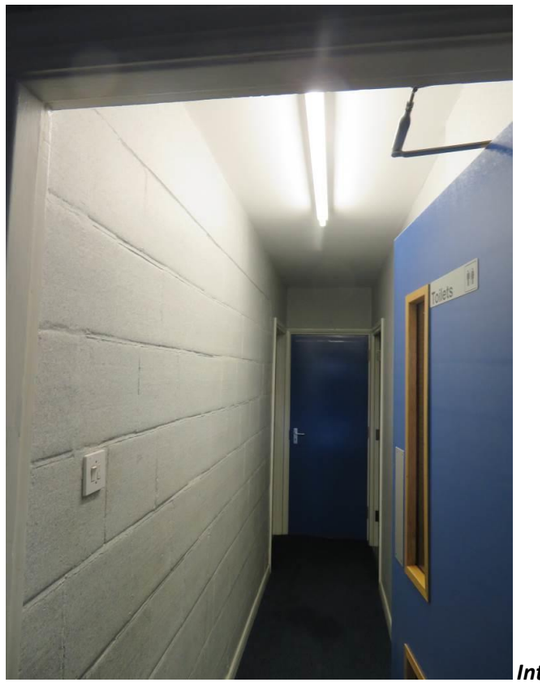
Location of proposed new door opening

4.9 Internal wall removals to the Link Building

In order to improve circulation and access, it is proposed to remodel the internal arrangement of the Link Building. Based on our site observations, it is apparent that the existing internal blockwork wall between the corridor and the male WC / store is providing support to the roof structure, as shown in the following cross section.

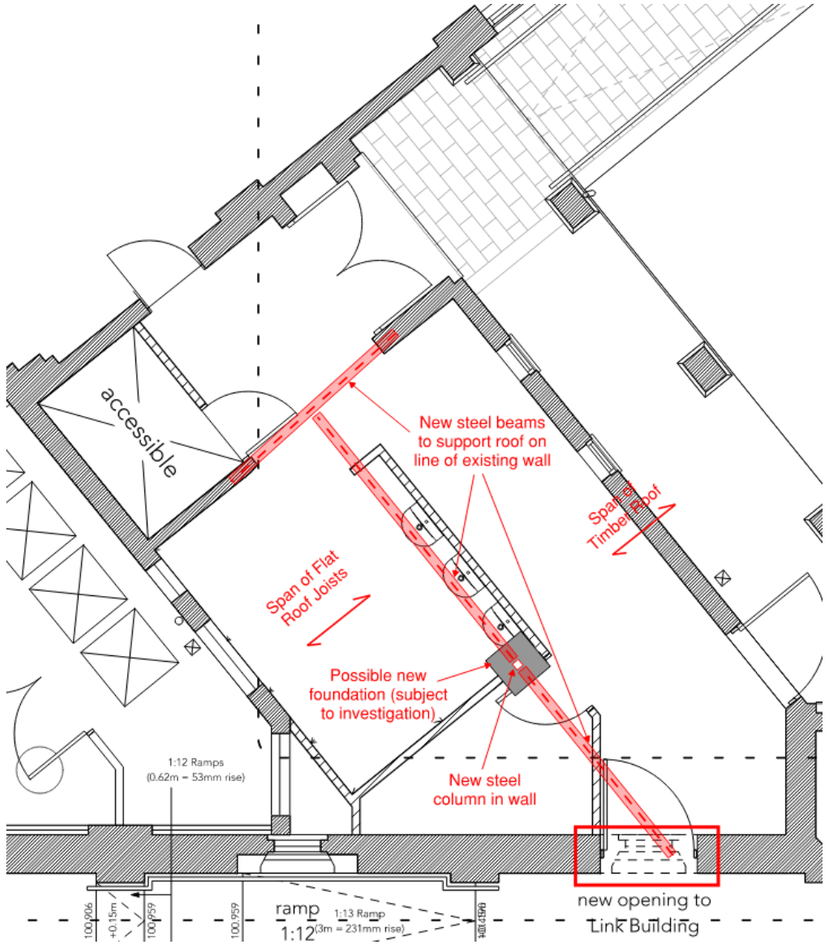


Cross Section through existing toilet block



Internal Loadbearing wall in toilet block

In order to remove the wall, new steel beams will need to be provided on the same line. Initial appraisal suggests that the beam will be approximately 200mm deep, with an 80x80 SHS steel column located within the depth of the new stud partition wall to the toilets to reduce the span (and therefore depth) of the new beam. Subject to investigation of the existing wall foundation, a new pad foundation may be required to the support this new column. Refer to the following diagram for the proposed arrangement of new structural elements in this area.

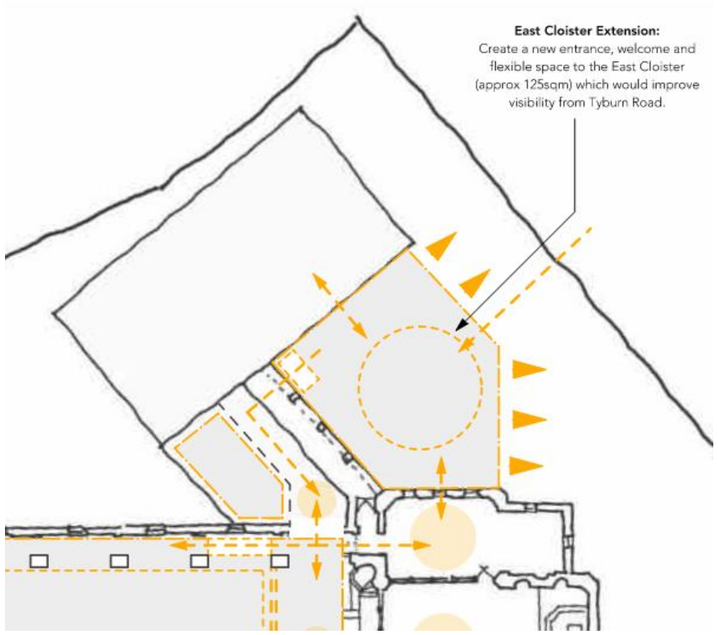


New Beams and Column in Link Building

4.10 East Cloister Extension

Part of future plans (Phase 3) is the potential to construct a single storage extension to the Cloisters to provide a flexible space linking the church to the church hall, whilst enhancing the entrance to this part of the church.

The architectural feasibility study identifies this as the 'East Cloister Extension' that will *Create a new entrance, welcome and flexible space to the East Cloister (approx. 125sqm) which would improve visibility from Tyburn Road*. No details of this space have been defined to date, other than the area indicated on the following plan.



Extract of Architectural Feasibility Study showing proposed location of East Cloister Extension

Proposed location of East Cloister Extension

The structural form is likely to comprise a lightweight braced steel or timber frame with a flat roof supported on columns. The roof height is anticipated to be higher than the existing Cloisters eaves, to suit the levels of the existing windows to both the church and the church hall. Internal columns will be minimised and where possible located within the depth of internal walls (subject to co-ordination with the proposed layout). Foundations will be lightly loaded and therefore are anticipated to take the form of shallow reinforced pad and strip footings, with a ground bearing concrete slab. The extension would be structurally independent from the existing buildings.

The proposed plans shall be developed with the existing below ground drainage in mind. There are a number of foul drains and surface water pipes at a shallow depth, together with an existing manhole in the centre of the proposed extension. Consideration shall be given to whether the manhole is to be relocated or incorporated into the new construction. It is recommended that this is considered in advance of the extension works to avoid undertaking repair works now to existing drainage that may be replaced in the near future.

5 Summary and Next Steps

This report sets out the structural aspects of the proposed phases of works to XXXX Church and the associated link building. The various elements of work detailed in Section 4 of this report are generally not interdependent, so can be undertaken in phase as proposed. Exceptions to this are the following:

- Removal of walls to the link building toilets and the new door from the nave to the link building (it is assumed that these works would be done at the same time)
- Any repairs to the below ground drainage in the Cloisters should take into account potential future diversions to suit the proposed Phase 3 East Cloister Extension.

The proposed structural solutions aim to minimise the impact on the fabric and structure of the existing building. Where possible, options that minimise the use of heavy materials or wet trades have been proposed.

It should be noted that all structural proposals, layouts and sizes shown in this feasibility report are subject to design development and co-ordination with the rest of the design team during the next stages of design.

5.1 Next Steps

We recommend that the following steps are taken to progress the design and plan for repairs to be carried out:

1. Undertake below ground drainage repairs noted in the Lanes for Drains Synopsis
2. Develop a detailed specification for concrete and brickwork repairs as set out in Section 3 of this report. It is recommended that these repairs are completed prior to other proposed works in the northwest and southwest towers
3. Undertake localised investigations to establish the establish foundation sizes to the columns in the nave and to the internal wall in the link building. The slab in the southwest tower is also to be investigated. This may be through small inspection pits or by the use of non-destructive techniques such as ground penetrating radar. Trial pits will provide a greater degree of accuracy and will enable a visual inspection of the existing ground conditional at formation.
4. Develop a preferred solution for the raised floor construction within the nave in conjunction with other members of the design team.
5. Consider options for the proposed lift in the southwest tower and develop the design on the basis of the preferred lift type.
6. Generally, develop the design for all areas of proposed new structure. In particular, co-ordinate details for the proposed balcony extension mezzanine, including balustrade details, clear heights to underside and perimeter interface details.

6 Rights of Originator

Allcott Associates LLP will consider the re-issue of the report in its original form to a third party within 6 months of the original report date for an administrative fee (currently £50.00 excl VAT). Upon the lapse of a 6-month period the report can only be re-issued following a full re-inspection, which will attract a full inspection fee.

We reserve the right to refuse copies of the report to any third party (other than those named above). We also reserve the right to amend our opinions in the event of additional information being made available at some future date. The Contracts (Rights of Third Parties) Act 1999 shall not apply to this agreement.

END OF REPORT

James Bodicoat MEng, CEng, MICE, MIStructE

Partner

For and on behalf of **Allcott Associates LLP**

7 Structural Engineers Conditions

1.0 **Inspections**

A **Specific Structural Inspection** is restricted to visual observations of the matters, concerns, or problems stated in the report. The inspection will be undertaken externally and internally as necessary and you must provide us with access to all necessary parts including any basements and roof spaces if possible. We do not normally move heavy furniture, lift floor coverings or make exploratory holes during and inspection. If our Engineer considers that access to any area would be unsafe, or potentially unsafe, we will be unable to access such areas unless safety measures are arranged, this may incur an additional cost.

1.1 A **General Structural Inspection** of the structural load bearing elements does not include those aspects normally dealt within a Surveyors report, such as services, decorations, roof coverings and the like, the position of the property with respect to local amenities and the condition of the property with regards to dry rot, timber infestation, dampness, vermin and the like.

1.2 The structural load bearing elements normally comprise items such as the roof trusses, rafters, purlins, floor slabs, joists, beams, columns, external walls, internal walls which support other elements, foundations and the like. The inspection is limited to the main building and excludes any detached garages, outbuildings, walls, fences etc unless specifically included in the request. The report is a considered opinion of the structure at the time of the survey only.

1.3 Unless noted in the report we have not considered matters such as contaminated land, asbestos or other potentially hazardous materials, nor high alumina cement or other potentially deleterious materials.

1.4 Our report will include details of the inspection, being the condition of the property at the time of our inspection, our conclusions on the findings and our recommendations for any investigations, monitoring, repair or remedial works, or other action required.

1.5 A General Structural Inspection **is not** 'A Full Building Survey' in accordance with conditions of engagement of the Royal Institute of Chartered Surveyors (see note 1.2)

1.6 Our inspections will be carried out in a safe manner as advised by the HSE and no undue risks will be taken. Roof areas will have a head and shoulder inspection.

1.7 We do not check electrical installations or appliances as this has to be done by members of the IEE institute we will however advise if this is necessary.

1.8 We do not test gas installations or appliances as this has to be a Gas Safe registered gas engineer we will however advise if this is necessary.

1.9 We will advise if we note timber infestation however we will not check for timber infestation, as this has to be carried out by a member of the British Wood Preserving and Damp proofing association (BWPDA). Similarly with damp this also has to be checked and reported on by a member of (BWPDA).

1.10 No opening up of areas or lifting of carpets or moving of furniture is carried out.

1.11 Roof inspections will normally be head and shoulders inspections unless specifically having been requested for a roof survey, where we require the roof to be boarded or safe access arrangements made for the inspection. In any case old roofs will not be entered as potentially unsafe.

1.12 Where we arrange for other Contractors to carry out specialist reports we are not responsible for their content.

1.13 Where costs are quoted for remedial works these are budget costs and not fixed costs and may vary depending on a contractor's availability and location of works.

2.0 **Investigations**

2.1 Our services will be limited to an investigation of the problem(s) specified. Investigations means, and may include, archive research, interviewing persons or organisations, making exploratory holes or excavations, opening up or taking apart, taking samples, undertaking tests and any other activities necessary to determine the extent and cause of the problem.

2.2 Investigation work may cause damage – particularly to finishes and decorations. If you request us to carry out any investigation work this will indicate to us that you have all the necessary permissions from the owners and tenants of the property for us to carry out the work. Reinstatement will be included only if specifically agreed.

2.3 Our report will include details of the investigations, our conclusions on the findings and our recommendations for any monitoring, repair or remedial works, or other action required.

3.0 **Monitoring**

3.1 Our services will be limited to monitoring the problem areas specified and will involve measurements and visual observations at regular intervals for a predefined period.

3.2 Our report will include details of the monitoring, our conclusions on the results and our recommendations for further investigations, repair or remedial works, or other action required.

4.0 **Repair / Remedial Works – Design Stage**

4.1 Our services may include the detailing. Scheduling and specification of repairs and remedial works as agreed, the preparation of tender documents, obtaining of competitive tenders, reporting on the tenders and applying for Building Regulations and / or other necessary approvals. Building Regulations fess and the like will be extra.

5.0 **Repair / Remedial Works – Construction Stage**

5.1 Our service may include inspecting the contractor's work on an occasional site visit basis and administering the contract.

5.2 We normally undertake site inspections at weekly intervals although the frequency may vary according to the needs and the progress of the works.

5.3 We will issue instructions to the contractor and variations to the contract as necessary. Please note that you must not instruct the contractor yourself.

5.4 We will certify progress payments and upon satisfactory completion will certify the work and the final valuation. Completion certificates will only be issued when all our invoices are fully paid.

6.0 **Calculations**

6.1 Calculations will include for a site visit wherever possible although it is possible to work from your architectural drawings however the onus for dimensions will remain with person providing the plans. All steel beams are calculated on clear openings. Bearing length generally 150mm each side should be added to the length used.

6.2 According to your requirements, we will give structural advice on the feasibility of your proposals and will prepared structural calculations and sketch details for incorporation into your architectural drawing, for building regulations submission, and for your builders use and information.

6.3 Architectural, general arrangement or structural drawings are not normally prepared and will only be prepared if agreed in writing. Please be aware that architectural drawings are normally required for building alterations and extensions, in all but the simplest of cases.

7.0 **Miscellaneous Services**

7.1 The scope and any limitations to miscellaneous services will be agreed with you before commencing.

8.0 Limitations

8.1 This report is for the sole use of the person instructing the survey and cannot be passed to a third party without the consent of Allcott Associates LLP as the content will not be guaranteed to be correct as to when the report was transferred.

8.2 This survey is only valid for 6 months from the date of the survey as stated within the report

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