

# Bristol Beacon



## Appendix 2

## Technical Report

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Project Director

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Version C



# Post DoV Impact of Delays on Construction Programme

## 1. Introduction

This Appendix describes the issues which have impacted the Bristol Beacon construction programme since the execution of the DoV in April 2021 and which have, to date, resulted in the contract Completion date moving from April 2023 to August 2023.

This Appendix summarises the chronology of events and their impact on the programme and also provides technical details and commentary from the Structural designers.

## 2. Project Manager's Summary

Since execution of the DoV in April 2021 numerous problems relating to the existing building structure ("discovery items") have required rectification. As the risk in such items was retained as Employer's Risk at DoV, the associated works have been instructed to the Contractor.

Three significant discovery items in particular have impacted the programme, summarised in the table below:

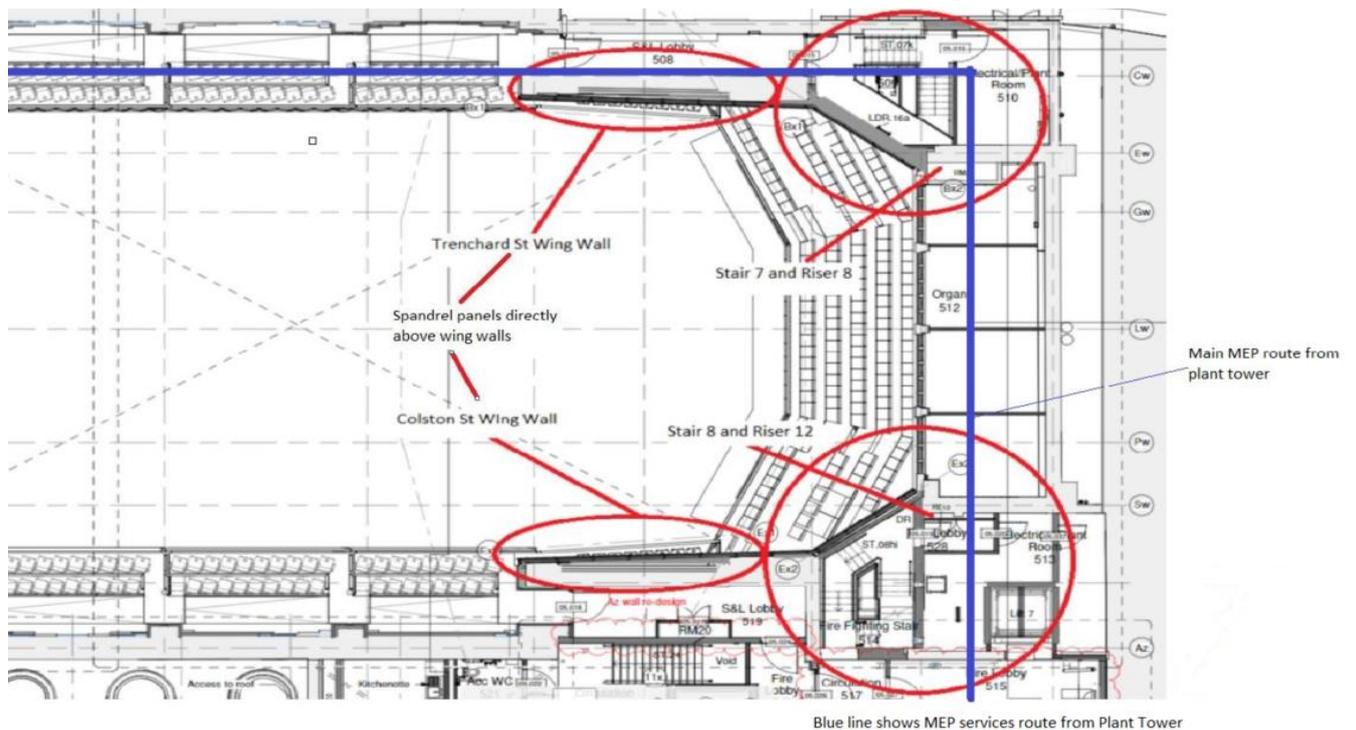
	Element	Event / delay	Known risk at DoV	Impact on critical path
1	Wing walls steel frames	<p>Detailing of bolting connections / fabrication details post-DoV</p> <p>Poor condition of masonry condition at base of south pier became apparent following demolition / cutting operations in preparation for steel frame</p> <p>Void under north wing wall was not apparent from building surveys and was discovered during advanced stages of demolition / preparation for wing wall steels</p>	<p>Wing wall steel 'goal post' frame drawings were issued at DoV, however the Contractor was not prepared to price this new information at that point</p> <p>Existing condition was not apparent from building surveys. Unknown until masonry pier was cut back in preparation for steel beam</p> <p>Refer to Structural Engineers' Wing Wall Steelwork commentary section below</p>	<p>Delay to installation of stage end roof trusses and "practically watertight" milestone</p> <p>Consequential impact on riser construction and electrical (bus bar and cable) installation</p>
2	Spandrel panel high level over wing walls	<p>Spandrel panels located at high level could not be saw cut during removal as required by demolition design. Alternative support, hand demolition and re-build was required</p>	<p>Make-up and condition of spandrel panels was not known to Employer's design team or Contractor. No intrusive surveys on spandrel panels had been</p>	<p>Delay to installation of roof trusses and "practically watertight" milestone</p> <p>Consequential impact on riser construction</p>

			undertaken prior to discovery  Refer to Structural Engineers' Spandrel Panels commentary section below	and electrical (bus bar and cable) installation
3	Stair 7 existing structure condition and padstones	Additional steels required to support construction of demolition and reconstruction of stair 7	Not apparent until the extensive demolition required for remodelling of stair 7. Issues discovered at high level were previously inaccessible  Refer to Structural Engineers' Stair 7 commentary section below	Delay to completion of roof trusses and "practically watertight" milestone  Consequential impact on riser 8 construction and electrical (bus bar) and containment installation  Impact on start of electrical wiring from plant tower through key risers

The discovery items described above had a particularly large impact on the critical path for the programme agreed at DoV due to the following reasons: -

- Steelwork Requirement – All 3 elements required large amounts of additional bespoke steelwork to precise measurements. Due to them being discovery items, the Contractor was not able to book predetermined fabrication spots and was at the mercy of the availability of both material and fabrication of their supply chain, which was under huge pressure at the time
- Location of Discoveries – All 3 elements (particularly on the Trenchard St side) prevented the completion of riser RE08, which is one of the main electrical services 'arteries' from the plant tower through to the rest of the building and vital to completion. Discovery at the foyer end of the building would have had much less of a significant impact
- Point in Programme – At point of discovery the Contractor was nearing the completion of the roof structure and these elements prevented the achievement of the "practically watertight" milestone.

These events resulted in the change from DoV programme Completion in April 2023 to the current forecast Completion in August 2023.



In addition to the main discovery events identified in the table above, the structural engineers' wider building perspective in Section 5 below highlights a number of significant structural issues discovered within the building which also required rectification.

These events resulted in an unusually high number of Project Manager's Instructions being issued to the Contractor and, although not all of them were on the critical path, this sheer volume of additional work impacted on the progress of the construction.

### 3. Chronology Relating to Delay Events 1-3 and Contract Notifications

20/04/2021	Compensation Event instructed to the Contractor with associated drawings: amendments to wing wall strengthening steelwork
05/05/2021	Compensation Events instructed to the Contractor with associated drawings. North wing wall masonry support - As discussed and agreed on site on the 04/05/21, the Contractor was instructed to price and proceed with the works outlined in SK-S-2129 - which details the additional masonry required to support the steel frame
02/06/2021	Discovery of loose material at the base of wing wall masonry piers. Following the Contractor's discovery, site visit by the structural designer
27/06/2021	Compensation Event instructed to the Contractor. Northern wing wall flue remedial solution
14/07/2021	First wing wall re-designed steel section arrives on site

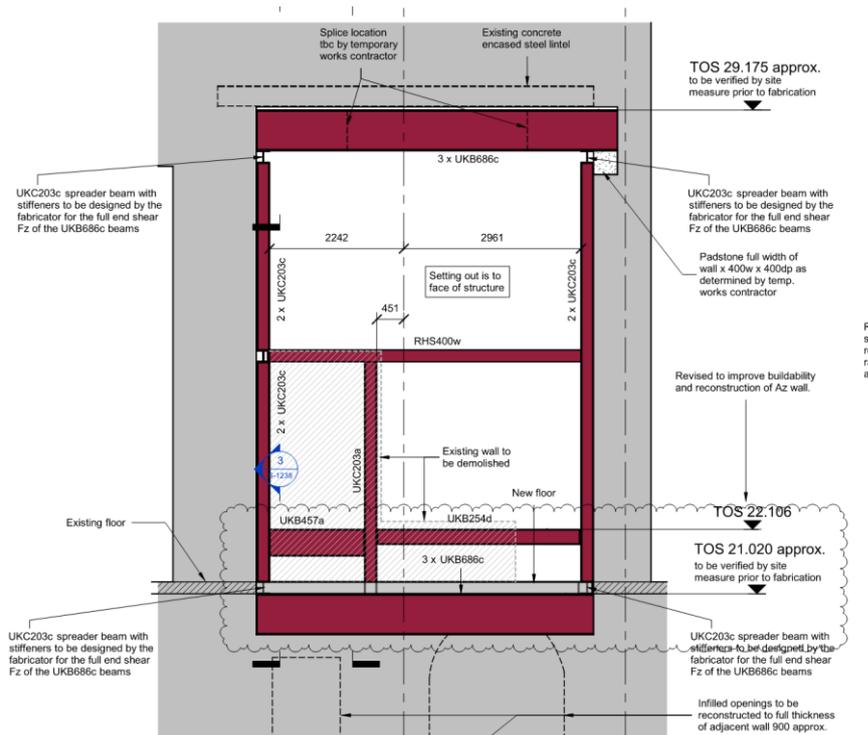
04/08/2021	Early Warning Notice issued by the Contractor relating to spandrel panel discovery. The Contractor noted the presence of two masonry panels and, as a result, the proposed vertical saw cut to the supporting columns could not proceed because it would have lead to an unsafe condition.
08/09/2021	Compensation Event instructed to the Contractor. Southern wing wall spandrel panel bracketry
10/09/2021	Compensation Event instructed to the Contractor. Northern wing wall spandrel panel bracketry
04/03/2022	Early Warning Notice issued by the Contractor relating to stair 7 padstones in which the Contractor noted concerns regarding structural stability of existing masonry directly below the main roof truss on a significant load path. Works could not progress until works to achieve permanent stability in adjacent structure had been completed.
17/03/2022	Compensation Event instructed steelwork to resolve Stair 7 high level pads without existing masonry support
11/05/2022	Compensation Event instructed Stair 7 amendments to interface with existing masonry at junction of GLs 06x and Cw

## 4. Structural Engineers' perspective on delay events

The information noted below provides details of the ongoing discovery items and further increased costs and programme prolongation associated with structural issues discovered since the Deed of Variation in February 2022.

### 4.1 Wing Wall Steelwork

The structural designer's drawing DR-S-1238 which provides elevations of both Trenchard St and Colston St Walls and associated sections 1267. 1238 was last issued as Rev C04 on 21/08/20 and the structural elements shown therein are what has been built.



Extract from DR-S-1238

The new Wing Wall steelwork frames support a significant load of masonry above and also supports the new roof trusses over the stage. The existing openings had to be enlarged, both horizontally and vertically. The main construction issues were related to the complex temporary works (as explained in the next section).

During cutting back of the masonry to install the steelwork, the Contractor identified what it considered was a weaker band of random stone masonry below stage level on the Colston St side. The Contractor had concerns about this rubbly masonry as it was located directly underneath a highly loaded pier. Whilst ultimately remedial works to this rubbly material were not required, checks had to be made.

An additional splice connection in the steelwork was also introduced to facilitate installation of the steelwork.

On the Trenchard St side, the cutting of the masonry arches to form the opening for the stage lift revealed the bottom of a previously unknown flue. In particular, the vertical route of the flue was not known but it was considered likely to pass underneath a highly stressed, masonry pier of the Wing Wall. It was therefore considered important to trace the flue and grout it up to ensure the support to the existing pier was sound and adequate. Tracing the flue proved difficult due the presence of a large cobble blocking the tracing rods at a bend. Attempts to dislodge the cobble were unsuccessful. Horizontal cores to locate the flue/dislodge cobble were drilled but were unsuccessful. A series of vertical small pilot holes were drilled around the base of the masonry pier and water was poured down each one. One pilot hole was found to connect with the flue. This allowed the flue to be pressure grouted so as to ensure all voids under the masonry pier were fully filled.

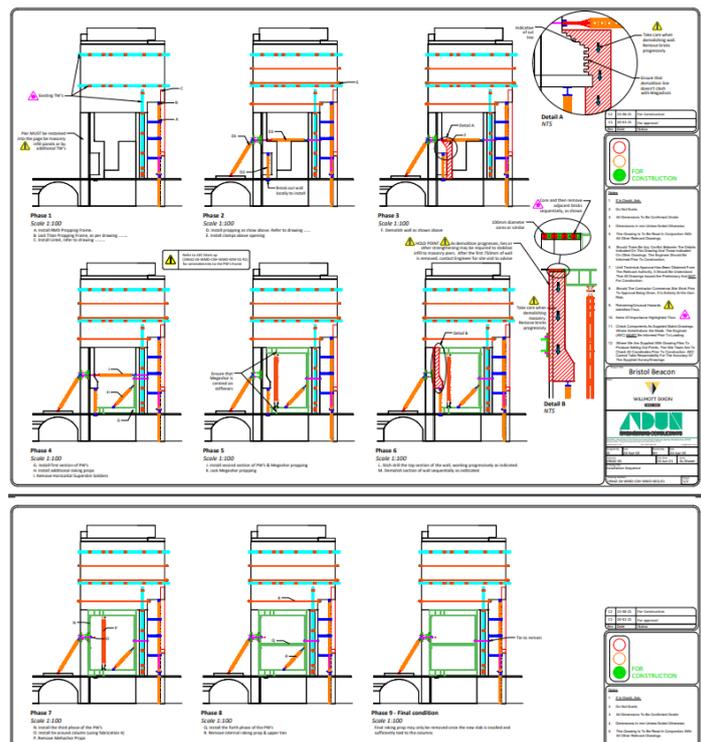
#### 4.1.1 Temporary works perspective

The initial proposal was to incorporate two columns per side within the required aperture, meaning that, when the loads were applied, each column had to withstand a factored axial loading of 1200kN x 2 (240 Tons). This was a significant design challenge and for it to be successful the sequence of works was paramount.

Due to the slender nature of the columns and incoming steelwork the points of connection required significant strengthening and this was achieved with heavy wrap around plated bracketry placed at three levels per side.

In order to avoid collapse whilst carrying out these works a strict methodology had to be followed. However, when the works began on the Trenchard St side, the chimney flue was discovered. Works could not continue until the investigation and subsequent remediation works to the flue were carried out.

The drawing below illustrates the complexity of the Contractor's construction sequence for the revised wing wall steelwork installation (including temporary works).



## 4.2 Wing Wall Spandrel Panels

On the Trenchard St side, access had been difficult due to the extensive temporary works and rebuilding of the masonry around Stair 7. Once access was afforded in July 2021, it was observed that the lintels supporting a spandrel panel of masonry between the wing wall pier and the external walls were corroded. Access also allowed the Contractor to review its methodology and sequence and it was observed that the masonry panel obstructed the cutting of the masonry back to the correct line. The spandrel panel tied the masonry pier to the external wall and its removal required temporary works to replace the restraint which would be lost when the panel was removed.

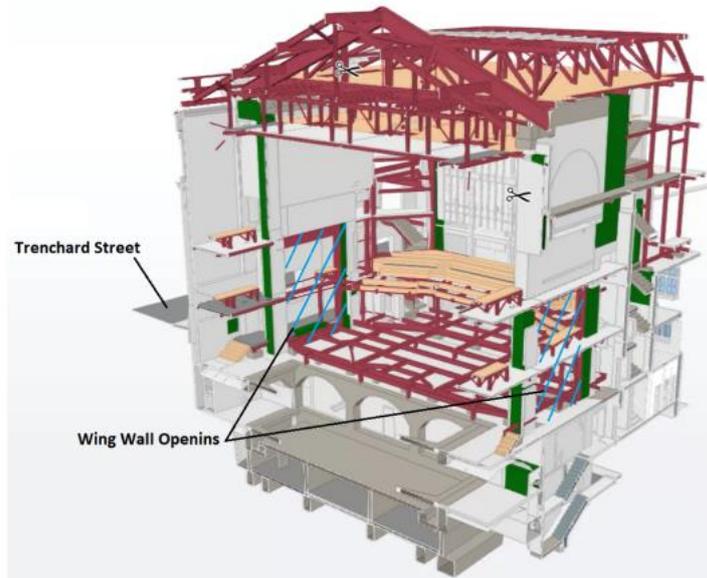
Whilst lintels on the Colston St side were found to be in reasonable condition, the spandrel panel once again clashed with the cut line for the enlarged opening and a similar detail to the Trenchard St side was adopted which resulted in the temporary removal of the spandrel panel and the need for temporary works to maintain restraint.

### 4.2.1 Temporary works perspective

To accord with the Architect's design intent, two openings through the spandrel were required to pass from the side balconies to back of house. The associated demolition cut was required directly to the rear of the Masonry Columns referred to above.

With the intricacy of adjacent Wing Wall works and the safety issues surrounding anything directly attached thereto, a normal demolition could not be considered.

To achieve the end goal, a revised design required steelwork to be wall mounted within an existing aperture below and to provide lateral restraint to the rear of the Wing Wall Column, before the required opening was formed.

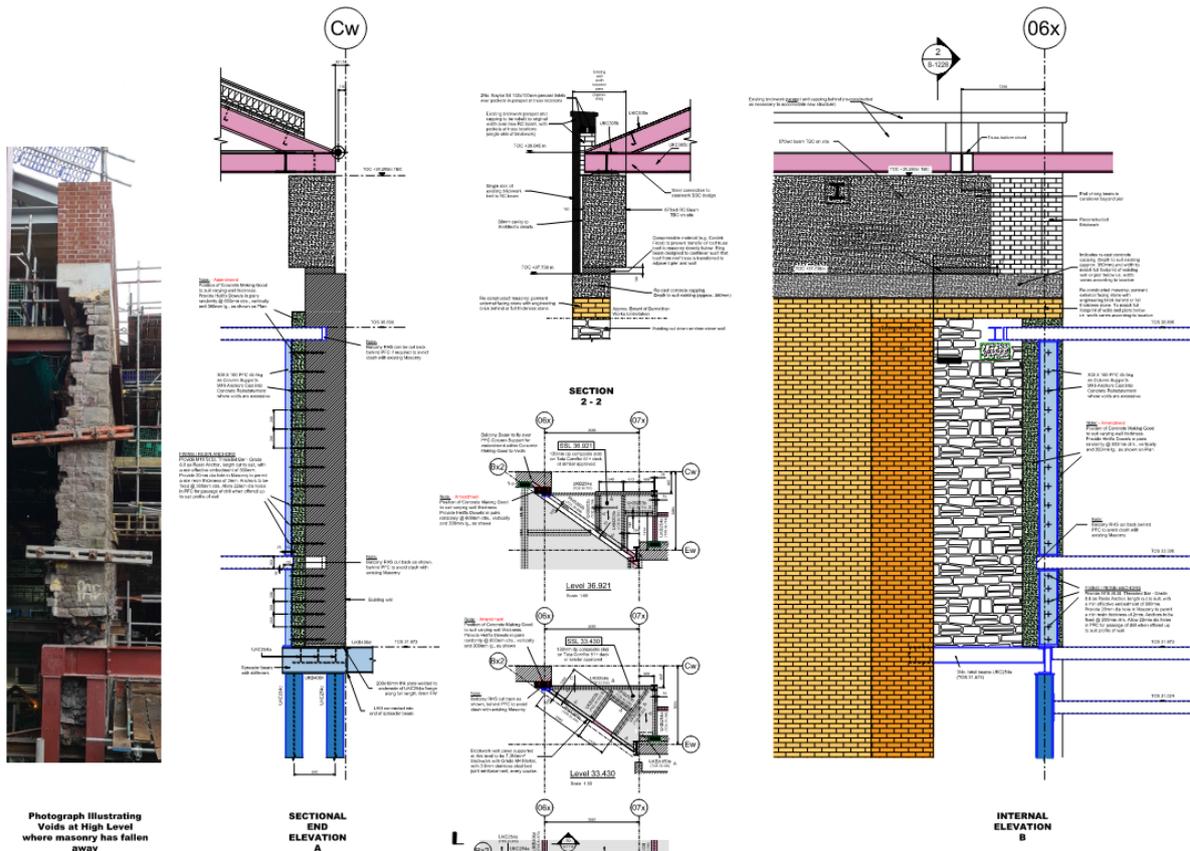


#### 4.3 Stair 7

The main alterations to Stair 7 are associated with an Early Warning Notice, issued on 04/03/22, which stated *“While attempting to form the padstone at GL Aw/06x on level 6, it became apparent that the existing stone, rubble infilled wall, was unstable. To avoid collapse we immediately removed the unstable elements. Following completion of the padstone and concrete of steel this element will require rebuilding by specialist due to the conservation element of this façade”*.

A visit to site concluded that the wall required stabilising by the addition of steelwork, bolted into the face of the masonry. Works to this area were stopped and temporary measures were put in place to ensure the temporary stability of the wall until the permanent steelwork strengthening details were issued, fabricated and installed.

The review of the Contractor’s structural engineer’s structural proposals issued on 15/03/22, was subsequently re-badged and issued to the PMO on 16/03/22 as the structural designer’s drawing S-1641C01. S-1641C02 was issued on 13/05/22 and included minor amendments – including concrete making good to the inside face of the wall.



Photograph Illustrating Voids at High Level where masonry has fallen away

SECTIONAL END ELEVATION A

SECTION 2-2

INTERNAL ELEVATION B

#### 4.3.1 Temporary works perspective

The use of non-percussive machinery was paramount for these works in order to avoid further damage to the existing structure. This particularly applied to Stair Core 7 at high level and where works joined with the opposite side of the Stage-End Wing Wall Masonry Column. A triple beam connection was required from Stair 7 to the masonry above the wing wall steels and this could not be installed until stability had been gained below.

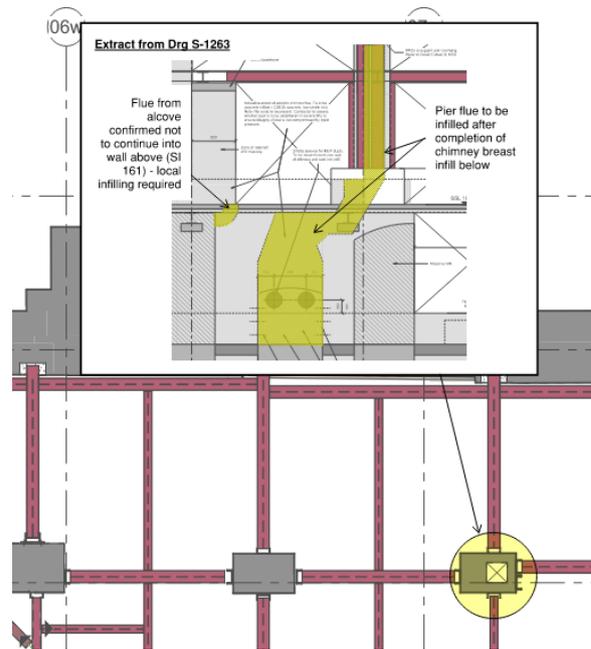
## 5. Structural Engineer's wider building perspective

### 5.1 Discovery Items

The following structural items were unknown at the time of the February 2021 DoV but their discovery required that remedial works be undertaken to the existing structure. The list is not exhaustive but is typical of the type of structural intervention required.

- Defects in the existing structure, hidden behind finishes, continued to be discovered as the finishes were removed and/or as access was provided, including various cracks and defects in existing masonry walls. Also, Hall 2 roof rot was only discovered when a subcontractor started undertaking plaster repairs. The discovery of soft plaster led to investigation/opening up which identified further timber rot even though none had previously been observed.
- Defects in the existing structure only became visible when new works were undertaken, such as when walls were cut back to form new openings or padstones were formed, revealing defects

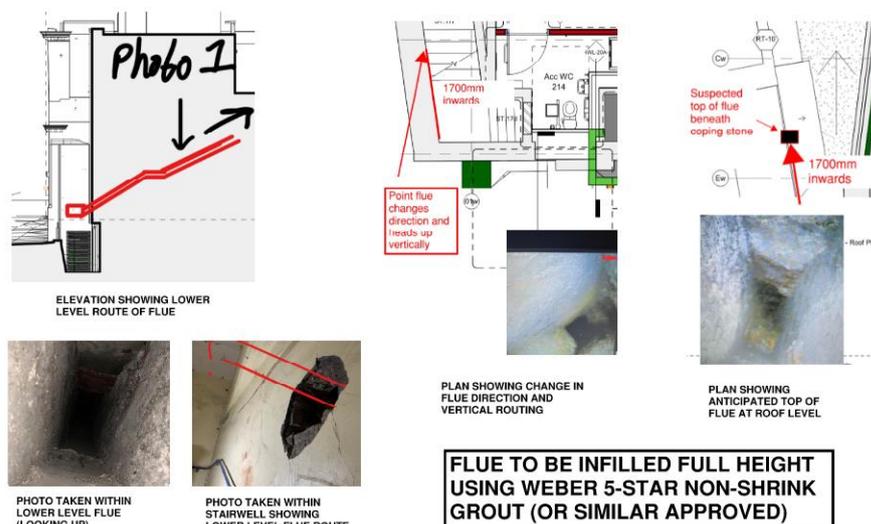
and flues, e.g., Various flue infills: Sk-S-2044 (Hall 2, 16/04/22), Sk-S-2045 (Lantern, 16/04/22), Sk-S-2160 (Restaurant Pier, 02/11/21), SK-S-2176 (toilet block, 18/05/22).



Extract from Sk-S-2044

### 5.1.1 Horizontal Chimney Flue

The existing horizontal chimney flue structure was not as expected and this impacted on the new structure, requiring further checks and/or design changes, e.g., an almost horizontal flue in the toilet block was discovered that required grouting up to stabilise the wall. SK-S-2176, issued 18/05/22.



Extract from Sk-S-2176

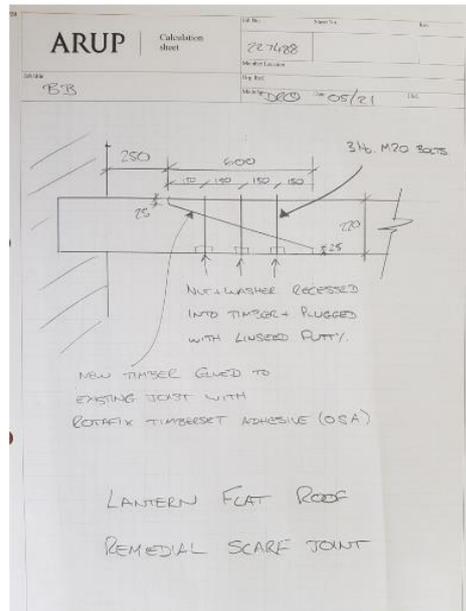
### 5.1.2 Deterioration of Structure

Sudden and/or unexpected deterioration of the structure, e.g., Hall 1 Bath Stone masonry suddenly cracked under a padstone. The Contractor's specialist subcontractor's assessment was that the stone was weakened in the 1947 fire but had only cracked when the new load was applied to it. See SK-S-2158, issued 07/10/21.



#### 5.1.4 Changes to Construction Sequence

In some areas the originally intended construction sequence was very specific. When defects were discovered, like for like replacement was not feasible as other surrounding structures prevented access. This necessitated more complicated remedial works (e.g., replacing flat roof timbers either side of Lantern where both ends were built into walls). SK-S2139 issued 16/06/21



CROSS SECTION OF SCARF DETAIL TO REPLACE ROTTEN JOIST ENDS

PHOTO OF TYPICAL - 120 x 220 JOIST END TO BE REMEDIATED

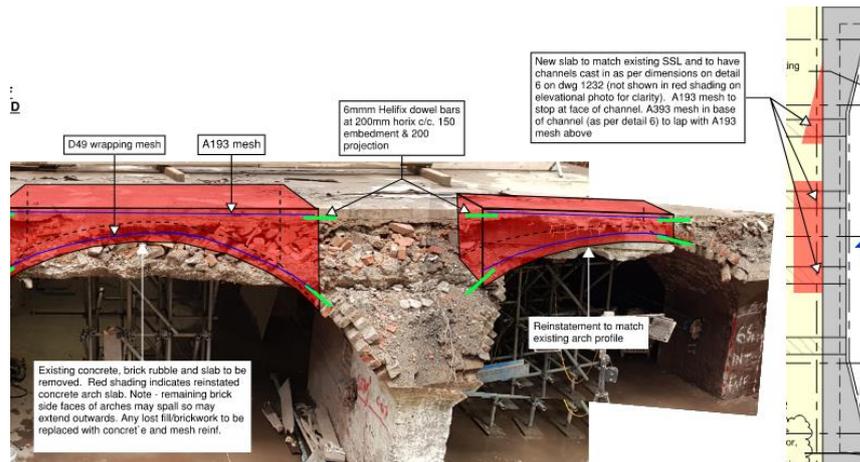
Extract from Sk-S-2139

#### 5.1.5 Original Surveys of Limited Nature

The original LIDAR survey of the existing building, which was used as the basis of all design work, was undertaken while finishes were still in place. Subsequent removal of finishes revealed previously unknown structure which either clashed with the new works or was in poor condition, e.g., existing steel around Stair 7 and almost all of the masonry defects

#### 5.1.6 Poor Historic Repairs

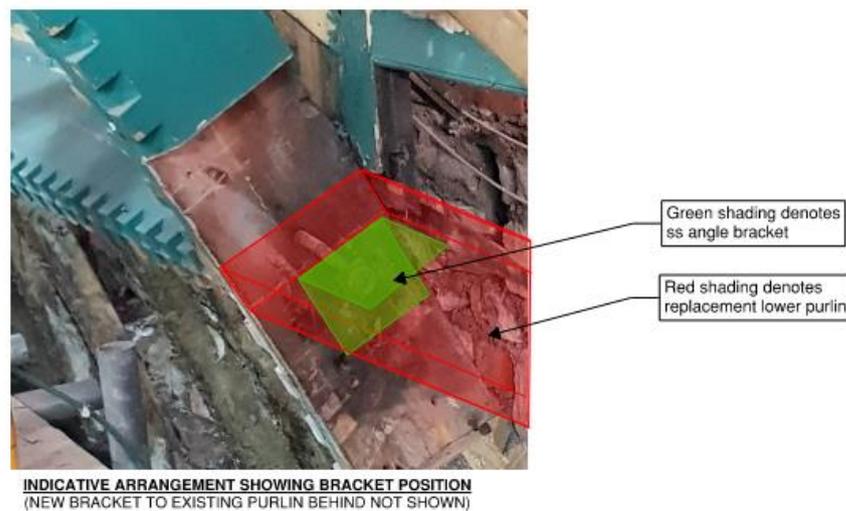
Historic 'covered up and poorly executed' repairs or alterations continued to be found, e.g., Hall 1 Stage level where the cutting of masonry vaults to create a void for the lift revealed poor fill around concrete openings and under existing slabs. SK-S-2131 issued 14/05/21.



Extract from Sk-S-2131

### 5.1.7 Defects to Key Structural Elements

Some defects have been found in highly stressed structural elements with the result that investigations to determine the extent, severity and repairs had to be carried out slowly and carefully to avoid undermining/damaging remaining existing structure. This often required temporary propping and frequent adaptation of existing scaffolding and or access towers e.g., wing walls (See below) and ongoing complexity of Lantern roof repairs SK-S-2128 issued 26/04/21.



Extract from Sk-S-2128

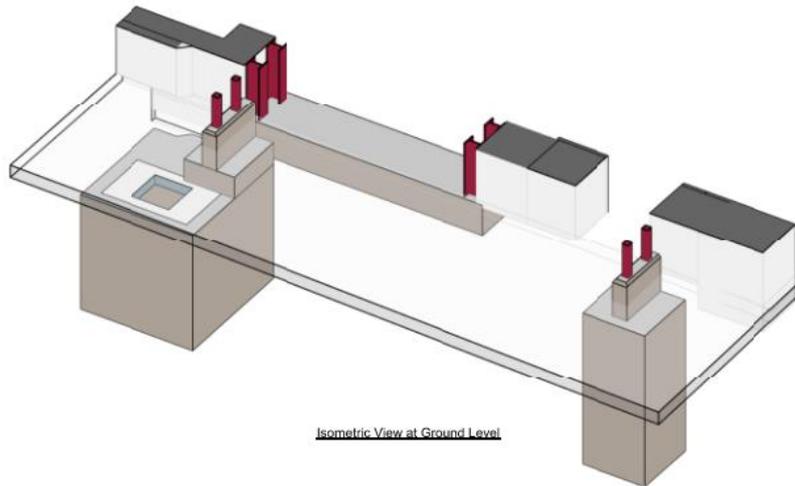
### 5.1.8 Discovery Item Summary

In summary, the Resident Engineer (RE) role finished in late 2021. However, in 2022 the structural designer has been requested to undertake approximately 20 site visits to review newly discovery items (effectively extending the RE role). Also, since the DOV was instructed at the end of Feb 2021, newly discovery items have resulted in the need for the structural designer to issue approximately 75 construction sketches.

## 5.2 Unforeseen Poor Ground Conditions

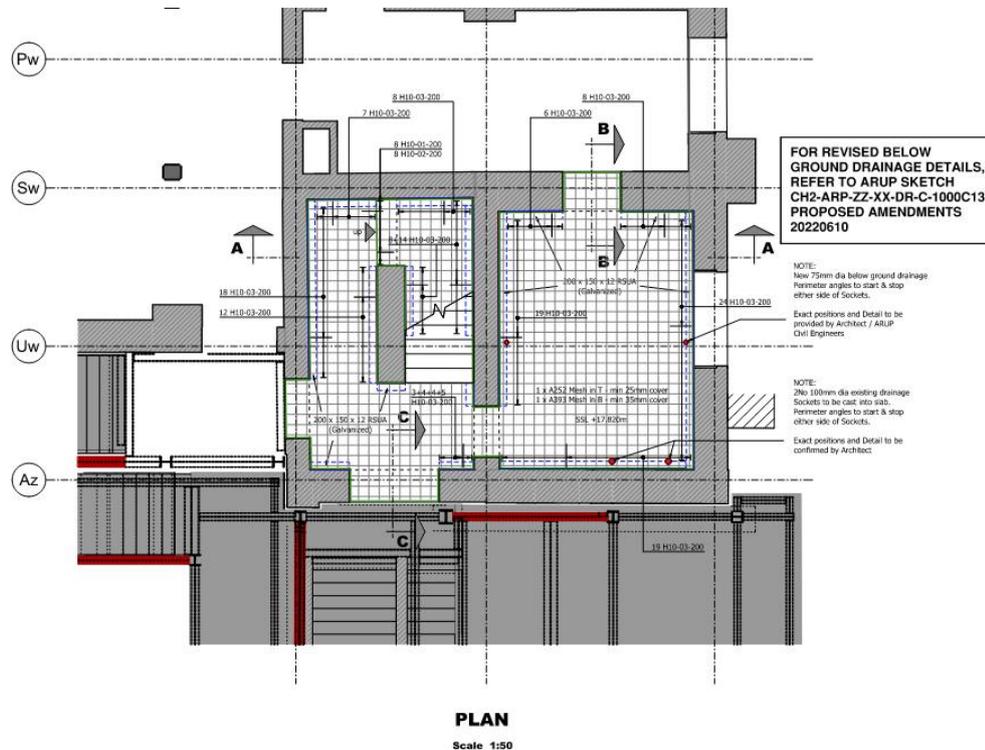
The profile/level of the quartzitic sandstone (a hard and competent rock which the foundations 'sit' on) is very erratic, resulting in areas of competent material at shallow depth which then suddenly and unexpectedly become areas of poor (soft) ground (consisting of silts and clays). This makes ground conditions in any one area extremely difficult to predict. For example:

- Piling required for the restaurant entrance portal foundation to the Colston St side. Quartzitic sandstone was found nearby at shallow depth but excavation directly under the portal column failed to find it approximately 3.5m below ground level. Further excavation risked undermining Hall 2 foundations. See DR-S-1277 and 1278 issued 25/11/21.



Extract from DR-S-1277

- Replacing a ground bearing slab which had significant voids underneath it, involved installing a suspended slab on new shelf angles. See Sk-S-2178 issued 13/06/22



Extract from Sk-S-2178