BURO HAPPOLD

Design Note

Project	SIM - Gantry Conservation
Subject	Conservation Philosophy
Project no	054704
Date	28 June 2023

Revision	Description	Issued by	Date	Approved (signature)
00	Initial Revision – RIBA Stage 3	D. Conboy	28/06/23	D. Conboy

1 Introduction

1.1 Overview of Works

The ongoing Science + Industry Museum (SIM) Sitewide Capital Works project includes a proposal to conserve the historic crane Gantry which sits adjacent to the Power Hall. The Gantry itself is not believed to be listed, but it is assumed that the Gantry falls within the curtilage of the Grade II listed Power Hall, and as such needs to be conserved in line with appropriate approvals and guidance.

The client intents to preserve the Gantry as a static historic exhibition. Lifting and moving features are not intended to be restored. Similarly, several features of the original Gantry construction such as timber cabins and secondary access gantries are not intended to be reinstated as these elements were removed and disposed of at some point in the past.

The current protective coatings to the Gantry have failed in many locations, leading to widespread corrosion of the existing structures. Based on recent inspections the Gantry needs conservation works to stop the progressive deterioration and corrosion of the superstructure and safeguard its future.

Figure 1-1 SIM Gantry viewed from west

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1.2 Description

The Gantry is located at the eastern end of the SIM plot, directly adjacent to the north of the Power Hall. It is understood to have been built in the 1880s to facilitate unloading the goods from train wagons.

The Gantry superstructure is approximately 15m wide x 72m long. It consists of two rows of nine columns with longitudinal beams running between the column heads in the east to west direction. These beams support two paired crane beams which previously were able to track along the length of the Gantry. Secondary structures are also present which house lifting gear, and form balustrading and access gantries.

Archive photographs show timber cabins being present as part of the crane beam lifting gear, but these are understood to have been removed in the 1980s and not reinstated. Reference should be made to Appendix A of this document for further details of the Gantry structure and condition survey.

2 Current Condition

2.1 Survey Summary

A detailed MEWP-assisted survey was of the Gantry structure was undertaken by Buro Happold (BH) in May 2023, with full findings included in Appendix A. The summarised conclusions of the survey were as follows:

- The Gantry superstructure is widely corroded due to failed paint coatings. The severity of corrosion varies. In some places the level of corrosion is judged to have led to a reduction in structural capacity. In other areas corrosion may be less significant, but unless addressed will lead to future problems. See Figure 2-1 for examples.
- A high-build paint finish, thought to be micaceous iron oxide containing, has been applied to visual surfaces, but this has now failed in several locations. Inaccessible areas such as the rear face of the southern columns and beams do not appear to have been coated.
- Gantry columns and plinth bases appear to be in good condition throughout, although there is some evidence of localised failure of paint finishes and associated minor corrosion.
- There is evidence of previous repair work in several locations across the Gantry. These are visually obvious and would not necessarily be considered best practice by modern conservation standards due to the use of face-welded plates.
- Longitudinal Gantry beams show widespread evidence of corrosion, ranging from minor surface corrosion to localised severe corrosion and loss of structural capacity. Corrosion can generally be grouped into 3 types:
  - Southern face of south beams. Severe corrosion of the top and bottom flanges has reduced the section width by up to 50mm.
  - Lower part of beam web, at stiffener/column head locations – south and north. These areas appear to have trapped water leading to moderate/severe corrosion in most instances along the length of the beams.
  - Top face of the beams – south and north. Moderate/severe corrosion is present across the Gantry in these locations, particularly affecting the rail section which allows movement of the crane beams.
- The 4 no. crane beams also show widespread corrosion, ranging from minor to localised severe cases, which can be categorised into 3 types:
  - Moderate/severe corrosion to the lower section of the beams along their full length. Similar to the Gantry beams this typically affects the angle which connects the web to the bottom flange, but also includes corrosion of the web and flange themselves.
  - Minor/moderate corrosion to the beam webs – particularly affecting the outside faces of beams 2 and 3.
  - Moderate severe corrosion to the top face of beams, with details as per the Gantry beams.

- The crane beams host several secondary structures including balustrades and lifting gear. Balustrades are typically in poor condition due to deformation and corrosion. The lifting gear appears to be sound, but with widespread minor corrosion. As the gear supports cabled hooks etc, it is suggested that this apparatus is inspected by a cranage specialist subcontractor who can advise on how best to preserve and make safe the gear.
- It is apparent that changes have been made to the Gantry over time. These include alterations to the bracing to the north row of columns, the addition of secondary structures and the removal/addition of transverse beams.

Figure 2-1 Typical examples of corrosion from structural survey

3 Conservation Approach

3.1 General Considerations

The proposed conservation approach outlined in this document is based on the following principles and comments:

- The Gantry superstructure is to be retained as a static historic exhibition, which no longer functions as a working piece of equipment. Note that this has been the case since the 1980s when the Gantry is understood to have last been in use.
- This assumption means that the structural requirements for the Gantry can be reduced considerably – the only relevant design loads being its own selfweight and wind/snow loading. In use, the Gantry would have been subject to much larger loads from cranage and dynamic actions from moving loads.
- The intent is for the Gantry to be conserved in its current state, rather than be restored to a previous configuration or have historic changes or repairs reversed. This affects several items including reinstatement of timber cabins, changes to bracing layouts and 'sanitising' previous repair works. This approach is judged to be in keeping with best practice approach to conservation.

3.2 Painting

A properly installed, appropriately specified paint finish is the Gantry structure's most important line of defence against corrosion and future decay. Failure of the current paint finish is the primary reason for the widespread corrosion present on the Gantry. It is understood that the last re-painting took place in the 1980's, and as such it is not surprising that the existing paint covering has failed. Properly applied paint finishes typically have a design life of 20-25years, meaning that the finish applied in the 1980's is c. 20 years beyond its anticipated design life. Paint sampling carried out for the Gantry shows that the 1980's finish was also applied directly over the top of the previous paint layers which was likely detrimental to its longevity (see Figure 3-1).

To safeguard the Gantry superstructure against future deterioration a new paint coating is required. To achieve the maximum design life and reduce the risk of failures it is proposed that this should be applied onto the prepared bare metal of the Gantry, rather than over existing coatings. Failure to properly prepare the surface is likely to have a detrimental effect on the life of any applied coating, and it is unlikely that an adequate warranty could be provided for coatings applied over existing paint finishes.

It is also important to note that due to the widespread corrosion heavy cleaning is unavoidable in multiple areas across the Gantry. At a minimum any existing corrosion needs to be fully removed before any painting takes place, either by grinding or by blast cleaning. If existing paint finishes were to be left in place away from areas of corrosion, this would create a mix of backgrounds for the new paint finish, which may present issues with consistency of finish and the issues noted previously regarding warranties and reduced design life.

Any proposed blast cleaning would be carried out with a blasting medium chosen to minimise damage to the underlying structural fabric – except for where corroded material is to be removed.

Based on BS EN ISO 12944-2 the gantry is considered to be in exposure class C3 (medium corrosivity - exterior, urban). A recommended coating specification for this environment would be as per Figure 3-2. This requires blast cleaning prior to a 3-coat finish being applied. This specification is proposed for the works, to achieve a coating design life of 25 years.

All of the Crane Gantry samples showed the same surviving history or traces of, that tie in with the representative sample shown here.

DESCRIPTION OF LAYERS:

Modern grey lead undercoat with a dark grey top coat

A thin red lead primer, with a thick coat of aluminium in a dark varnish base as an additional primer.

There is then a dark grey lead oil paint top coat

This scheme repeats the previous decoration.

A move away from the earliest phase is this scheme of red lead primer with a mid grey undercoat and finish coat.
The surface of the scheme has extensive soot deposits.

The earliest and highly significant paint schemes identified on the crane gantry all consist of this phase of at least 4 decorations. Each is virtually identical, in dark red/brown ochre and iron oxide pigmented lead oil paints.

Substrate iron, some mill scale

Figure 3-1 Paint sampling for Gantry beam

System number	IV-C3-A	IV-C3-B
Structure life	50+	45
Coating life	40+	25
Nearest equivalent BS EN ISO 12944-5[3]	-	C3.07
Surface preparation to BS EN ISO 8501-1[4]	-	Blast clean to Sa 2½
Factory applied coatings	Hot-dip galvanize to BS EN ISO 1461[5] (note 3)	i) Zinc phosphate epoxy primer 80µm (note 1) ii) High build epoxy MIO 100µm
Site applied coatings	(note 4)	Recoatable polyurethane finish 60µm

Figure 3-2 Recommended paint spec

3.3 Previous Repairs

It is proposed that previous repairs are retained as part of the visual history of the Gantry structure. As there is no sign that these repairs are failing, there is no structural reason for their alteration. See Figure 3-3.

Figure 3-3 Typical example of previous repair

3.4 New Repairs

Where repair works are judged to be required to safeguard the structural capacity and safety of the structure, these will be carried out to be to be visually unobtrusive and achieve a seamless repair which is not visible in the finished, painted structure.

The workflow is anticipated to be as follows:

1. Remove heavily corroded metalwork back to competent material.
2. Fabricate infill section of metalwork, with material to match existing as closely as possible.
3. Weld replacement metal section to existing to achieve full structural continuity.
4. Grind/polish weld flush.

An alternative conservation approach might call for repairs which are more 'readable' and are also reversible. This type of repair has been considered but ultimately judged to be less appropriate for the repairs required to the Gantry, with the following comments noted:

- More 'readable' repairs would typically include additional or replacement steel plates, bolted to the superstructure. Bolt heads would be rounded to match the appearance of the existing rivets.
- Bolted repair options may be reversible, but they still require the existing fabric to be drilled to accommodate new bolts. The drilled holes are not reversible, so there is still permanent change to the existing fabric.
- Most alternative methods of repair are better suited to tying linear cracks through metalwork, whereas the primary corrosion issues present on the Gantry include patches of corrosion. Strapping or tying is less appropriate in these locations.
- Carbon fibre strengthening was discounted due to the technique being at odds with the character and construction of the existing structure.
- The addition of secondary structures to support areas of decay was considered but discounted as the visual impact of additional elements would detract significantly from the original structure, and are likely to be excessive for the level of repair required. Adding these elements would also require the same intrusive works as any other repairs – i.e. new bolt boles.

3.5 Additional Interventions

Much of the current corrosion has been exacerbated by details within the design of the Gantry which cause water to pool at certain locations. Two specific interventions are proposed to address this:

- New canopy to be installed to cover the southern Gantry beam to divert rainwater away from the superstructure. As the southern beam directly abuts the Power Hall's northern elevation applying coatings to the rear face is extremely challenging. This has led to widespread serious corrosion of the rear of the southern beam. Whilst it is judged that adequate structural capacity remains, stopping further deterioration is a priority and diverting water away from this area is the most robust way of achieving this. It is unlikely that this face will be able to be properly protected by painting and so diverting water away appears to be the most robust means to safeguard. Details of the proposed canopy are included in the architectural information, with an extract show in Figure 3-4 below.

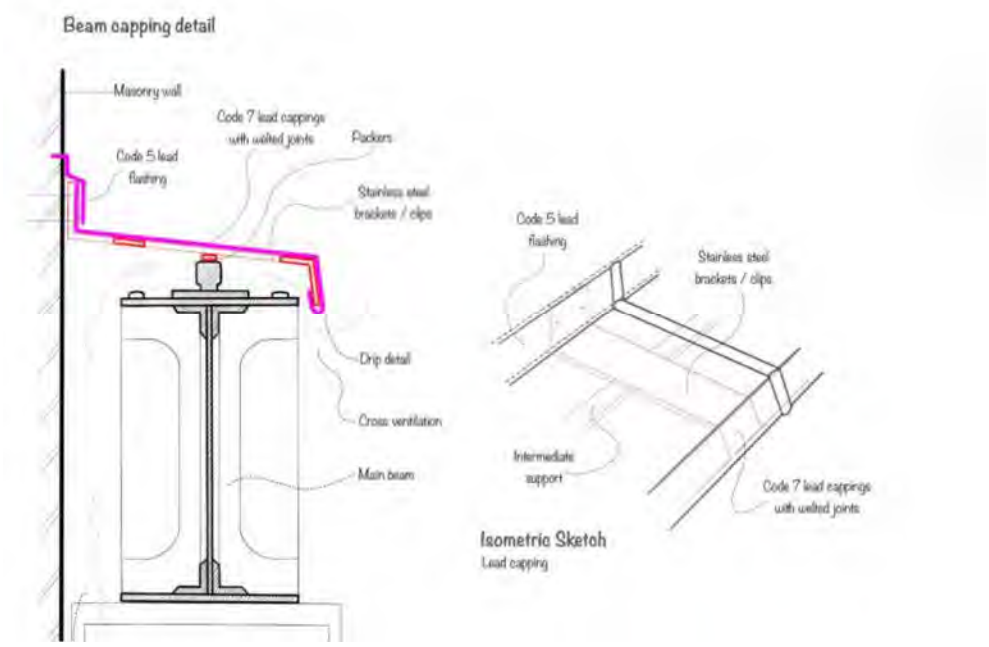

Figure 3-4 Proposal for canopy to southern Gantry beam

- Crane beams are understood to be hollow and the lack of drain holes means that they are likely to trap water, leading to internal corrosion. This is likely exacerbated by internal stiffeners which will trap water at various locations along the length of the beam. It is suggested that the conservation works address this by adding drainage points to the bottom of the beams at the positions of all vertical stiffeners to allow any trapped water to drain out – reducing the risk of further serious internal corrosion which may ultimately compromise the structure.

3.6 Approach for Secondary Items

It is proposed that balustrades and cranage associated with the crane beams are retained in their current state. Where structurally required, balustrades will be repaired in line with the intent discussed in section 3.4.

Cranage will require inspection by a specialist subcontractor, to ensure that it is retained in a safe state. The intention is for the crane hook to remain suspended as it currently is. It is possible that retaining the hook in a suspended position will require the supporting cable to be replaced with a modern galvanised or non-metallic cable to guarantee safety for visitors.

Figure 3-5 Cranage assembly (L) and balustrade support (R)

Appendix A – Stage 3 Structural Report extract for Gantry

BURO HAPPOLD

SIM - Sitewide Capital Works

Stage 3 Structural Report – Gantry Planning Submission

SIM-BHE-XX-XX-RP-S-0102

0054704

5 September 2023

Revision P02

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Revision	Description	Issued by	Date	Checked
P01	Stage 3 Planning submission	Darren Conboy	08.08.23	
P02	Stage 3 Planning submission	Darren Conboy	05.09.23	

https://burohappold.sharepoint.com/sites/054704/02_Documents/04_Reports/10 Planning Docs at Stage 3-4/SIM-BHE-XX-XX-RP-S-0102 - Gantry planning report.docx

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1 Introduction

1.1 Overview

Buro Happold (BH) have been appointed to provide structural engineering services for a suite of projects at the Science + Industry Museum (SIM) site in Manchester. These projects are to be delivered collectively as the Sitewide Capital Works 2025 project.

This report summarises all information related to the proposed structural projects. This includes descriptions of the existing structures based on archive information and investigation work, as well as structural details and assessments for the proposed works.

The projects are noted as follows, and reference should be made to Figure 1-1 for the relevant locations:

i. New Warehouse
ii. SEG
iii. Station Viaduct
iv. Gantry Restoration
v. Upper Yard & Entrance

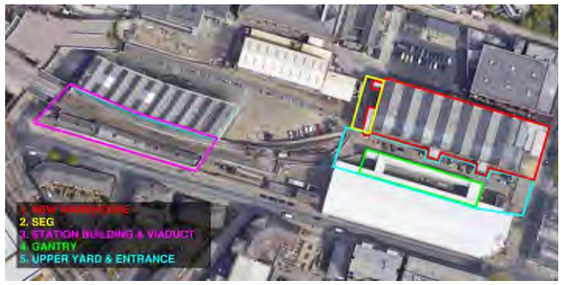

Figure 1-1 Site location plan

1.2 Executive Summary

Reference should be made to the BH Stage 3 drawings package for proposed works.

1.2.1 Gantry

Condition & Structural Assessment

- The Gantry superstructure is widely corroded due to failing paint coatings. The severity of corrosion varies. In some places the level of corrosion is judged to have led to a significant reduction in structural capacity. In other areas corrosion may be less significant, but unless addressed will lead to future problems.
- BH carried out a MEWP-assisted survey during Stage 3, the results of which are covered in this report.
- Several queries are still outstanding regarding the structural behaviour of the Gantry and the most appropriate methodology for any repair works. These will be resolved as the project progresses.

Recommended Works

- Possible dismantling parts of the gantry and move to an off-site facility for cleaning / repair.
- Blast clean whole Gantry structure (paint and corrosion removal) either in-situ or off-site.
- Detailed visual inspection following cleaning to properly ascertain current level of corrosion.
- Carry out repair works to areas of significant corrosion.
- Recoat and paint steelwork, suitable for external exposure.
- Install lead capping cantilevering from the Power Hall and covering South beams.

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2 Gantry

2.1 Introduction

The Gantry is located at the eastern end of the Science and Industry Museum plot, directly adjacent to the north of the Power Hall. It was built in the 1880s to facilitate unloading the goods from train wagons.

The Gantry superstructure is approximately 15m wide x 72m long. It consists of two rows of nine columns with longitudinal beams running between the column heads in the east to west direction. These beams support two paired crane beams which previously were able to track along the length of the Gantry. Secondary structures are also present which house lifting gear, and form balustrading and access gantries.

Archive photographs show timber cabins being present as part of the crane beam lifting gear, but these are understood to have been removed in the 1980s and not reinstated.

Figure 2-1 - Site Location - Gantry (Google Maps, 2023)

Figure 2-2 Gantry overview

2.1.1 Overview of Works

The Client intents to preserve the Gantry as a static historic exhibition. Lifting and moving features or cabins and access gantries do not need to be restored.

The current protective coatings to the Gantry have failed in many locations, leading to widespread corrosion of the existing structures. Based on inspections it is clear that the Gantry needs restoration works to stop the progressive deterioration and corrosion of the superstructure.

2.2 Existing Structures

BH carried out a MEWP-assisted visual inspection of the Gantry superstructure on 25/05/23, with the results informing the description and condition report below. Reference should be made to sketch SIM-BHE-GA-XX-S-0002 for full details from the survey.

2.2.1 Description

- Gantry columns are c. 7m tall and measure c. 610 x 315mm with intermediate web stiffeners and penetrations through the web (Figure 2-43). Columns appear to be single-piece cast elements.
- Gantry beams vary in depth due to the plated construction, but measure c. 410mm wide x 700mm deep. The Gantry beams are compound sections – formed from separate plates held together with angle sections and rivets (Figure 2-44). Where beams meet at the column heads, they appear to be bolted to each other via end plates as well as being bolted into column heads.
- Crane beams are constructed as per the Gantry beams, but appear to be hollow with two separate webs. It is assumed that internal vertical stiffeners are present due to vertical lines of rivets being visible on the beam faces. Crane beams are c. 320mm wide with a fish belly profile meaning that the depth increases towards the midspan (Figure 2-45).
- At their base columns are bolted into a cast iron plinth which is assumed to be hollow and either internally stiffened or infilled. The plinths are in turn bolted to stone pads onto masonry pier foundations. These are assumed to sit onto the underlying rock but this has not been confirmed.
- Based on metal testing carried out by RSK, columns are understood to be formed from cast iron, whilst the longitudinal and transverse crane beams are early carbon steel. The fact that beams are steel rather than iron is relevant as it should improve weldability and therefore facilitate repair work. The RSK report identified that the steel is likely to have good weldability based on metallurgic testing.
- Lateral stability of the Gantry is assumed to work as follows:
  - Braced bays in the East-West direction.
  - For the southern column row this is formed by two bays of tension-only cross bracing.
  - For the northern column row the system includes a single bay of compression cross bracing, which appears to be modern. Archive photos suggest that the original bracing matched the southern row.
  - In the north-south direction it is assumed that the columns cantilevering from their fixed bases resists lateral load.
- Along the southern row of columns the masonry façade of the Power Hall has been chased vertically to accommodate the Gantry columns. This is assumed to be an original detail due to difficulty accessing and suggests a lack of proper coordination between the two structures at the time of construction. The gap between the rear face of the Gantry columns and the Power Hall façade decreases from bottom to top and in some locations it appears that they are touching.
- Verticality of the south columns and Power Hall facade were assessed by Greenhatch in a survey which suggests that both structures are leaning to the North, with the masonry façade leaning further and so leaning onto the Gantry, See section 2.3 for further discussion.
- South plinths are not located symmetrically against the columns above due to the adjacent Power Hall. At the base, the columns are up to 70mm apart from the brickwork with the upper part of the column being in contact with the wall or chased into the brickwork.
- North side columns have broader top endplates. Based on the historic photographs it is vary likely that those supported catwalks providing access to crane beam cabins. Secondary steelwork present at the North-West end of the Gantry was serving a similar function,
- Original Lifting capacity of the crane beams appears to be 10tons, based on a plaque noted at the visit.

2.2.2 Condition

This section is based primarily on the inspection undertaken by BH, but does draw on the Conisbee report where useful. Reference should be made to sketch SIM-BHE-GA-XX-S-0002 for full details.

General

- A high-build paint finish, thought to be micaceous iron oxide containing, has been applied to visual surfaces, but this has now failed in several locations. Inaccessible areas such as the rear face of the southern columns and beams do not appear to have been coated.
- Importantly – the existing paint finish likely obscures additional corrosion and prevents a full understanding of current levels of corrosion. Determining the full extent of corrosion will require blast cleaning and then additional assessment, currently intended to be carried out by the specialist metalwork contractor as part of the works.

Foundations, plinths, and columns

- Plinths are in good visual condition,
- Columns appear to be in generally good condition, with no sign of significant corrosion. However it is possible to crevice corrosion is occurring at the interface between the cast iron and steel elements. There is some evidence of minor surface corrosion.
- Column paint finish is generally in better condition than for the beams, but has failed in several locations,
- Column head impact damage to 1 no. column head.
- Thanks to refurbishment works carried out at the Power Hall some of the Gantry foundations were exposed, allowing for a visual inspection. The pad stones are in good condition, not cracks or deterioration was observed. The blockwork below the pads is un-mortared, however It is assumed that this is the original condition rather than being a sign of mortar wash out.

Longitudinal Gantry Beams

- Gantry beams show widespread evidence of corrosion, ranging from minor surface corrosion to localised severe corrosion and loss of structural capacity. Figure 2-35 to Figure 2-40.
- There are 3 main areas of corrosion to the Gantry beams:
  - Southern face of south beams. Severe corrosion of the top and bottom flanges has reduced the section

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width by up to 50mm. This is more prevalent at the western end of the Gantry, but is present across the whole length. Figure 2-31 to Figure 2-33.

  - Lower part of beam web, at stiffener/column head locations – south and north. These areas appear to have trapped water leading to moderate/severe corrosion in most instances along the length of the beams. This typically affects the angle which connects the web to the bottom flange, but also includes corrosion of the web and flange themselves.
  - Top face of the beams – south and north. Moderate/severe corrosion is present across the Gantry in these locations, particularly affecting the rail section which allows movement of the crane beams.

- Much of the corrosion is likely due to failure of protective coatings and construction details which are prone to the collection of water in crevices and on flat surfaces,
- Corrosion has likely been ongoing for some time as there is evidence of previous repairs in several locations. There typically include bolted plates to replace lost sections of metalwork.

Crane beams

- As with the Gantry beams, the crane beams show widespread corrosion, ranging from minor to localised severe cases. Figure 2-22 to Figure 2-27
- 3 main types of corrosion are present on the crane beams:
  - Moderate/severe corrosion to the lower section of the beams along their full length. Similar to the Gantry beams this typically affects the angle which connects the web to the bottom flange, but also includes corrosion of the web and flange themselves.
  - Minor/moderate corrosion to the beam webs – particularly affecting the outside faces of beams 2 and 3.
  - Moderate severe corrosion to the top face of beams, with details as per the Gantry beams.
- Crane beams are understood to be hollow and the lack of drain holes means that they are likely to trap water, leading to internal corrosion. This is likely exacerbated by internal stiffeners which will trap water at various locations along the length of the beam. It is suggested that the conservation works address this by adding drainage points, and the works should include allowance for these areas to be inspected via borescope of similar.
- Many of the crane beams show evidence of previous repairs. There typically include welded plates to replace lost sections of metalwork. It is worth noting that most of these repairs would not be considered to be appropriate for conservation work due to their appearance.
- The crane beams include several secondary structures including balustrades and lifting gear. Figure 2-29 & Figure 2-30.
  - Balustrades are typically in poor condition due to deformation and corrosion and can no longer considered to be functional. However, it is assumed that they no longer need to fulfil this function. Assuming they are retained as part of the exhibit they will require remedial measures to address corrosion.
  - The lifting gear appears to be sound, but with widespread minor corrosion. As the gear supports cabled hooks etc, it is suggested that this apparatus is inspected by a cranage specialist subcontractor who can advise on how best to preserve and make safe the gear.

Bracing

- Bracing to the southern columns shows signs of historic surface pitting but appears to be generally free from current corrosion. Braces are distorted along their length suggesting that they are no longer functional in resisting lateral loads, without first allowing significant movement. Figure 2-18.
- Bracing to the northern columns appears to be in good condition, with little sign of corrosion.

2.3 Structural Discussion

Loading Considerations

The conversion of the Gantry into a static historic exhibition reduces or removes most types of loadings originally acting on the superstructure. This is relevant as it allows more flexibility in options for repairs as the Gantry does not necessarily need to be repaired to restore full capacity. Load changes include:

- Reduces vertical dead and live load due to removal of access catwalks, cabins and potentially all secondary steelwork elements and installations which served the original functions e.g.: balustrades, cables, mechanical equipment, engines or platforms substructure,
- Removes crane beam lifting loads,
- Removes dynamic loads both vertical and horizontal due to crane beams operation,
- Reduces snow and wind loading acting due to removal of catwalks, platforms and cabins.

Interface with Power Hall

As addressed previously it appears that lack of coordination when constructing the Gantry (1880s) and Power Hall (1850s) means that the two structures are in extremely close proximity. Subsequent (presumed) movement in the Power Hall has meant that it now leans onto the Gantry in some locations.

The primary structural concern with this interface is that lateral load from the Power Hall may be placed onto the Gantry, and the Power Hall may become reliant to some extent on the Gantry for lateral capacity. Whilst this is a valid concern, there are mitigating factors:

- The works currently ongoing to the Power Hall are understood to have addressed lateral spread of the roof and therefore any further outwards movement of the walls. This needs to be verified by future verticality surveys, but is positive.
- The extent of lateral load attracted to the Gantry from the Power Hall is based on its stiffness relative to the stiffness of the Power Hall itself. This will be investigated further at Stage 4 once survey results are returned, but for the current stage it is judged that the Gantry is likely to be significantly less stiff that the Power Hall and so only has limited ability to act as a prop and therefore attract load.

A verticality survey has been commissioned at stage 3, with results expected shortly. This should help confirm any additional movements since the 2018 survey and determine whether the movement has been progressive.

Depending on the results of surveys, the following options may be valid:

- Option A – Assuming that movement is not progressive, the interface between Gantry and Power Hall wall remain as current, with some amount of contact between them. The reasoning would be that this causes no detrimental structural effect in either.
- Option B – chase the brickwork further to separate two structures. This would require an assessment of whether movements are progressive and/or whether disconnecting the two elements may lead to negative effects in either. Early discussions with the Architect indicate that further chasing the brickwork is unlikely to obtain a planning consent.

Previous Alterations

It is apparent that changes have been made to the Gantry over time. These include alterations to the bracing to the north row of columns, the addition of secondary structures and the removal/addition of transverse beams. It is proposed that the Gantry to be preserved in its current state, rather than for previous iterations to be re-instated.

Repair & Conservation Strategy

The repair and conservation strategy needs to address the following aspects:

- In several locations the extent of corrosion will require structural repairs to be carried out. Our aim is to be pragmatic with where this is required, based on the now reduced Gantry loading. However, some areas will still require full repair and replacement of section.
- It is suggested that the whole structure be re-painted with an appropriate system to achieve a minimum of 25 years design life. This is likely to require blast-cleaning of the whole structure followed by a systematic approach to re-painting. A robust paint system should provide significant protection against further corrosion.
- There is clear evidence that corrosion has affected specific areas due to lack of proper access for maintenance and detailing which leads to water accumulation. Details which will prevent water accumulation and facilitate maintenance in future should be considered, although a properly-applied paint system may reduce the importance of this.
- Determination of appropriate methodology to allow for cleaning and protection of the structure, especially for spaces between compound elements.
- Rainwater protection and bird access/ nesting protections to be considered for the South beam.
- Whilst removing elements of the Gantry to carry out repairs may be beneficial in some ways, there are

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significant limitations to doing so. The interface with the Power Hall is likely to cause difficulties, and ar limitations might apply to columns at the North ends due to anchor fixing unknowns. It might be a feasible and efficient solution to dismantle the crane beams and beam and repair those off site,

- Crane beams have been subject to previous repair works which are not deemed to be of conservation standard. Whether or not these are replaced with more appropriate repairs should be considered.

Specialist Input

As the repair works are likely to be specialist items, BH led discussions with the possible specialist subcontractors to get input and help develop proposals. A summary of the input is as below:

- Repair and blast cleaning are feasible both in-situ and with elements removed. Removing is likely to make the works easier to carry out, but will clearly have significant knock-ons in terms of transportation, and safe disassembly and reassembly.
- If the gantry is to be blasted in-place, significant temporary shielding will be required to control lead-containing dust.
- If elements are to be removed, chemical stripping of paint/corrosion is possible. However, still would be subject to size of removed elements and may not be suitable depending on size / material composition.
- All contractors approached would intent to carry out their own detailed survey once blast cleaning was complete, and would then develop location-specific repair details.
- Blast cleaning and re-painting may need to be procured separately to the repair works, dependent on appointed subcontractor.
- Repair details would likely include welding of plates to make-up corroded sections of metalwork. An alternative option would include bolting new metalwork in place mirroring the current construction, i.e. bolted angles to replace the current riveted ones.

2.4 Recommended Works

Reference should be made to the BH Stage 3 drawings package for proposed works.

Works in summary:

- Possible dismantling parts of the gantry and move to an off-site facility for cleaning / repair.
- Blast clean whole Gantry structure (paint and corrosion removal) either in-situ or off-site.
- Detailed visual inspection following cleaning to properly ascertain current level of corrosion.
- Carry out repair works to areas of significant corrosion.
- Recoat and paint steelwork, suitable for external exposure.
- Install lead capping cantilevering from the Power Hall and covering South beams.

Figure 2-3 Archive

Figure 2-4 Archive 1980s

Figure 2-5 Archive 1980s

Figure 2-6 Archive 1980s

Figure 2-7 Archive 1980s

Figure 2-8 High level view 2018

Figure 2-9 Plinth / foundation detail

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Figure 2-10 Plinth detail

Figure 2-11 Column base

Figure 2-12 Power Hall interface

Figure 2-13 Power Hall interface

Figure 2-14 General view from west

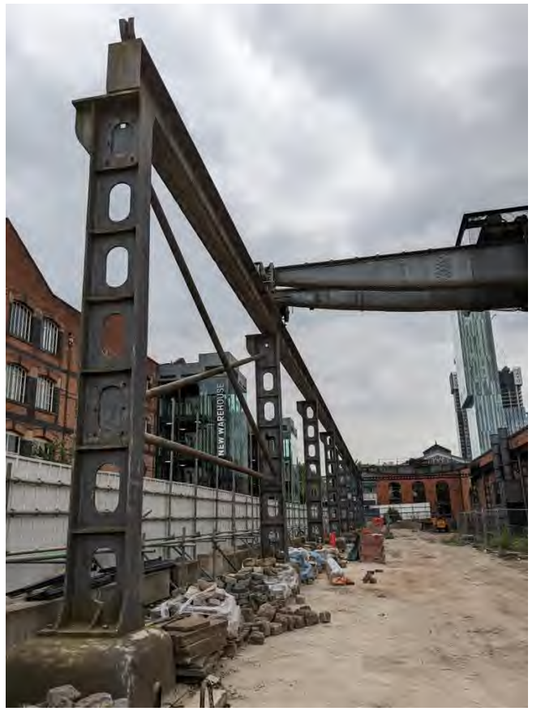

Figure 2-15 North bracing

Figure 2-16 Crane beams

Figure 2-17 South cross bracing

Figure 2-18 South cross bracing showing pitting & deformation

Figure 2-19 – Power Hall chimneys

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Figure 2-20 – North bracing connection detail

Figure 2-21 – Crane beam support

Figure 2-22 Corrosion to top face crane beam

Figure 2-23 Corrosion top face crane beam

Figure 2-24 Corrosion to side face crane beam (western)

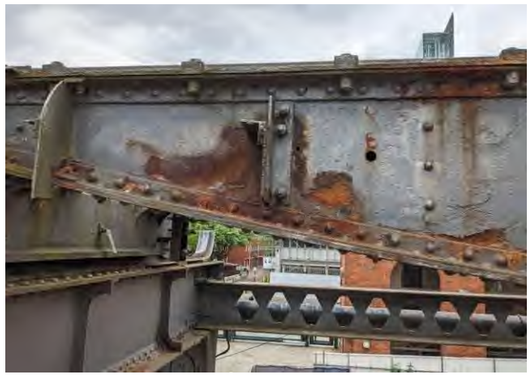

Figure 2-25 Corrosion to side face crane beam (eastern)

Figure 2-26 Corrosion to bottom of crane beam

Figure 2-27 Crane beam end corrosion

Figure 2-28 – Previous repair to crane beam

Figure 2-29 Crane beam balustrade – corrosion & deformation

Figure 2-30 Lifting gear to western crane beam

Figure 2-31 Severe corrosion & loss of section width – southern face of south Gantry beam, bottom flange

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Figure 2-32 Severe corrosion & loss of section width – southern face of south Gantry beam, bottom flange

Figure 2-33 Severe corrosion & loss of section width – southern face of south Gantry beam, top flange

Figure 2-34 Corrosion and lack of protection to southern face of south Gantry beam

Figure 2-35 Typical corrosion to Gantry beam at column head

Figure 2-36 Typical corrosion to Gantry beam at stiffener

Figure 2-37 Severe corrosion to Gantry beam at stiffener

Figure 2-38 Typical corrosion to Gantry beam

Figure 2-39 Typical corrosion to top face Gantry beam

Figure 2-40 Moderate corrosion to top face Gantry beam

Figure 2-41 – Historic lifting capacity

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Figure 2-42 North beams – north face

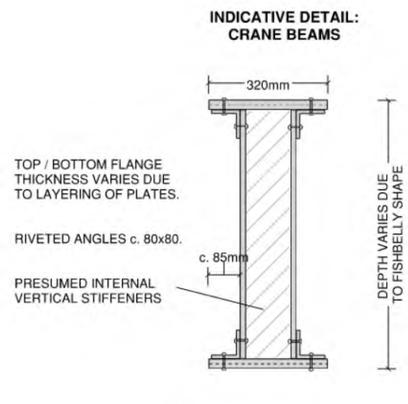

Figure 2-45 Crane beam details

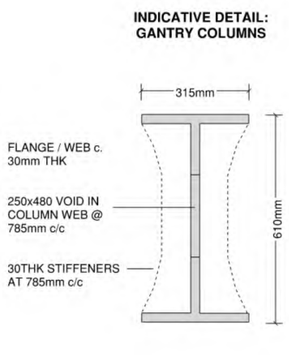

Figure 2-43 Gantry column details

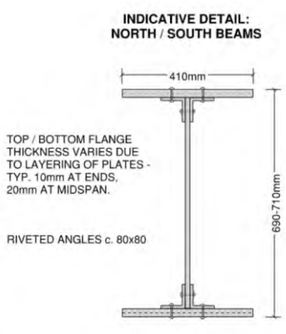

Figure 2-44 Gantry beam details

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Appendix B – Stage 3 Structural Works for Gantry

STAGE 3 COSTING NOTES:

1. ALLOWANCE IS TO BE MADE FOR THE FULL GANTRY STRUCTURE TO BE BLAST CLEANED BACK TO BARE METAL PRIOR TO PAINTING. AS EXISTING PAINT IS LIKELY TO INCLUDE LEAD THIS WILL REQUIRE SIGNIFICANT TEMPORARY WORKS IN THE FORM OF TENTING.

2. CARRYING OUT BLASTING & REPAIR WORKS WILL REQUIRE FULL ACCESS TO THE GANTRY. ALLOWANCE SHOULD BE MADE FOR FULL SCAFFOLDING OF GANTRY.

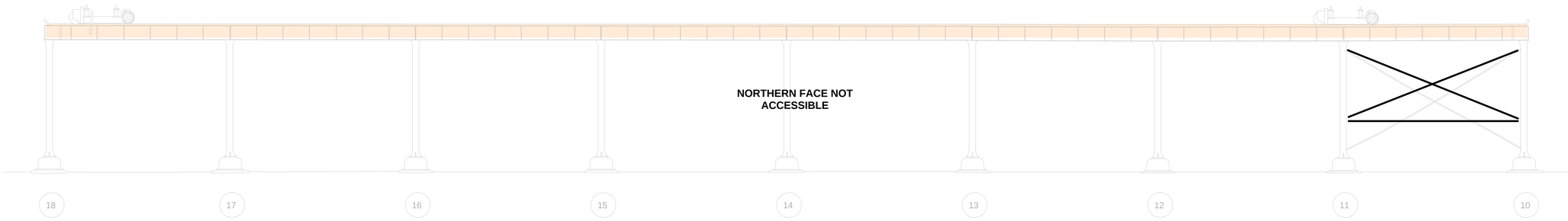
3. ALLOWANCE TO BE MADE FOR FULL INSPECTION BY METALWORK SUBCONTRACTOR TO ASSIST WITH DEVELOPMENT OF REPAIR DETAILS.

4. WHERE METALWORK REPAIRS ARE NOTED THESE ARE ANTICIPATED TO INCLUDE THE FOLLOWING STEPS WHICH SHOULD BE ALLOWED FOR IN COSTING. SPECIALIST SUBCONTRACTOR INPUT ON COST ALLOWANCES MAY ALSO BE VALUABLE:

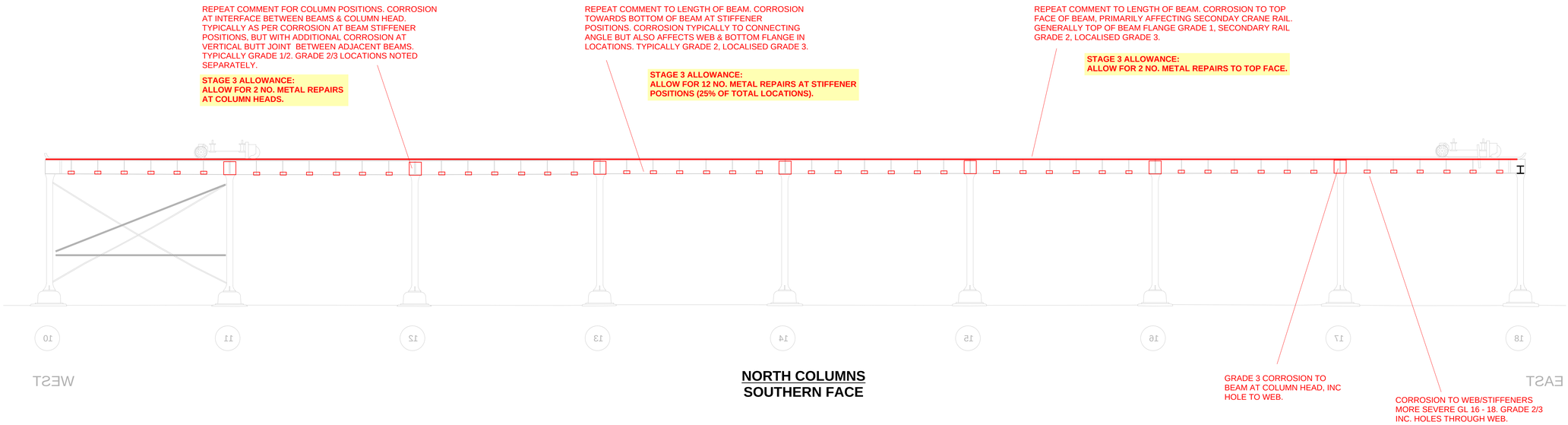
- GRINDING/CUTTING OUT OF CORRODED SECTIONS OF METALWORK,
- REPLACEMENT OF REMOVED METAL SECTION WITH LIKE-FOR-LIKE MATERIAL,
- WELDING OF NEW INFILL METALWORK TO ADJACENT EXISTING STRUCTURE WITH FULL PENETRATION BUTT WELD.
- GRINDING / POLISHING OF WELDS TO ACHIEVE SEAMLESS FINISH

5. THERE IS A RISK THAT REMOVAL OF THE EXISTING PAINT FINISHES & SURFACE CORROSION WILL REVEAL ADDITIONAL CORROSION WHICH REQUIRES REMEDIATION. IT IS SUGGESTED THAN A MIN. CONTINGENCY ALLOWANCE OF 25% OF THE COST OF WORKS SHOULD BE INCLUDED AT STAGE 3 TO ACCOUNT FOR THIS.

INDICATES ALLOWANCE TO BE INCLUDED IN STAGE 3 COSTING.



NORTH COLUMNS
NORTHERN FACE



NORTH COLUMNS
SOUTHERN FACE

BURO HAPPOLD	*Project:* SIM SITEWIDE CAPITAL WORKS	*Project Number:* 054704	*Status:* For Information		
	Sketch Title: PROPOSED GANTRY WORKS - STAGE 3 SHEET 1	*Sketch Number:* SIM-BHE-GA-XX-S-0003-1	*Date:* 16/06/23	*Initials:* DJC	*Revision:* P00

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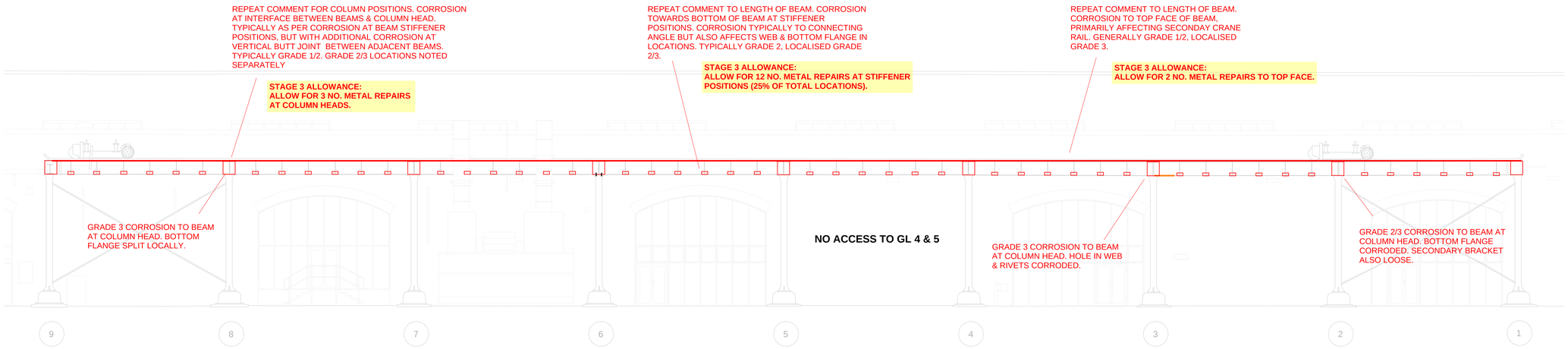
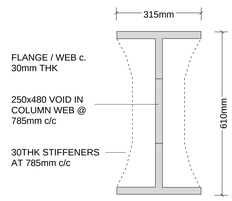
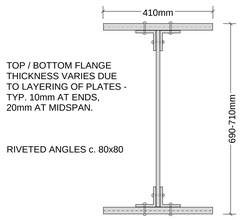


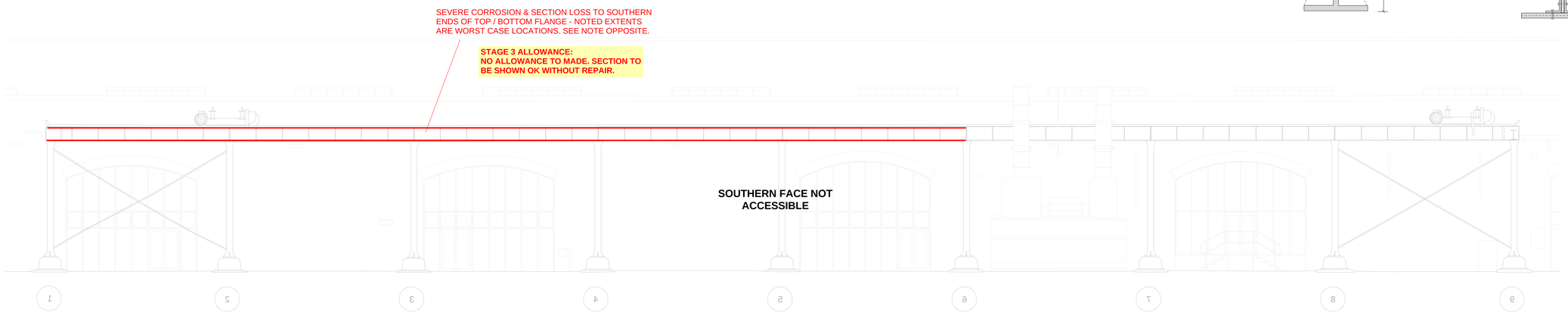
SOUTH COLUMNS
NORTHERN FACE

INDICATIVE DETAIL: GANTRY COLUMNS



INDICATIVE DETAIL: NORTH / SOUTH BEAMS





SOUTH COLUMNS
SOUTHERN FACE

BURO HAPPOLD	Project: SIM SITEWIDE CAPITAL WORKS	Project Number: 054704	Status: For Information		
	Sketch Title: PROPOSED GANTRY WORKS - STAGE 3 SHEET 2	Sketch Number: SIM-BHE-GA-XX-S-0003-2	Date: 16/06/23	Initials: DJC	Revision: P00

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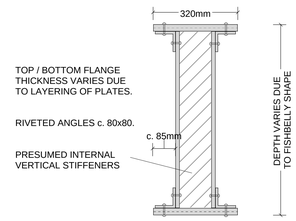
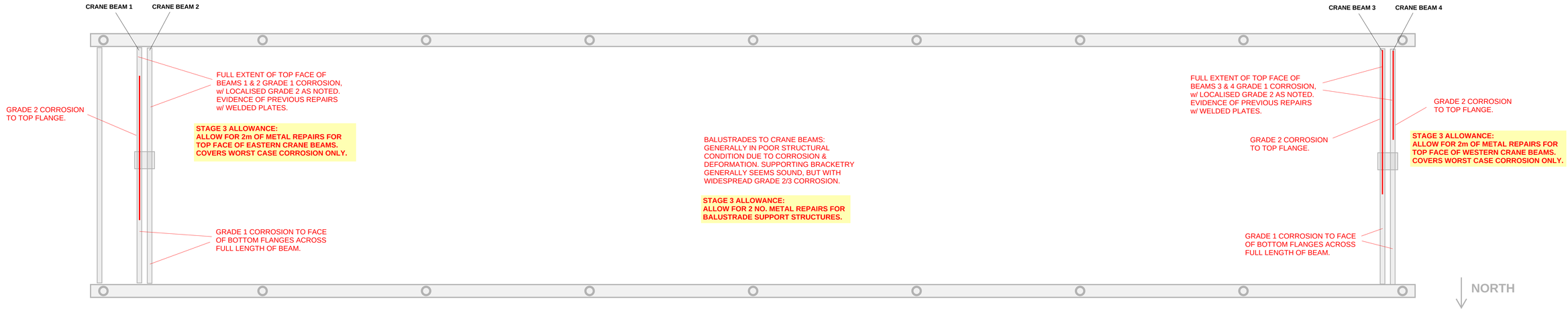
STAGE 3 COSTING NOTES CONT:

6. ALLOWANCE TO BE MADE FOR INSPECTION & MAKING SAFE OF LIFTING GEAR TO CRANE BEAMS BY SPECIALIST SUBCONTRACTOR, AS PART OF WORKS.

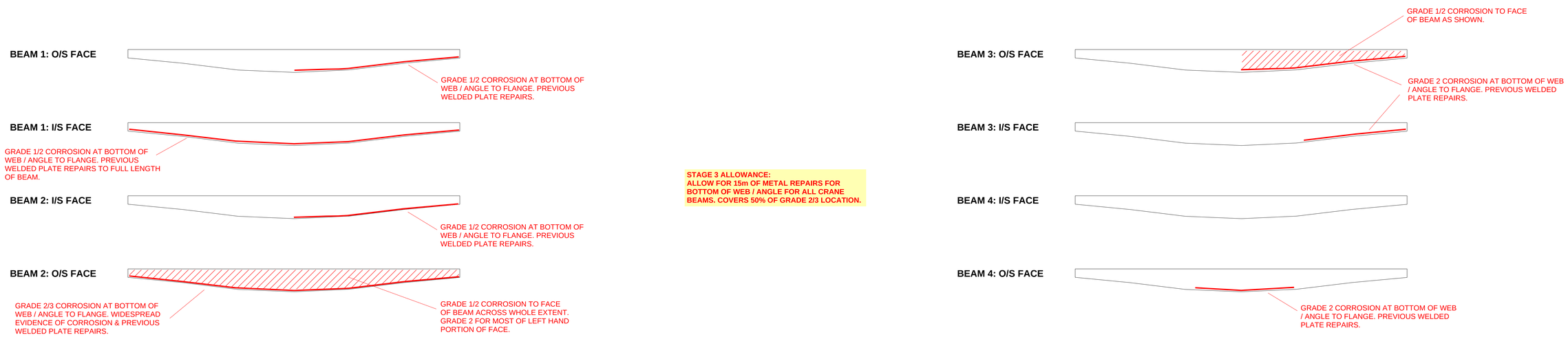
7. ALLOWANCE TO BE MADE FOR BOTTOM FLANGE OF HOLLOW BOX SECTION CRANE BEAMS TO BE DRILLED TO PROVIDE OUTLET FOR WATER INGRESS.

INDICATIVE DETAIL: CRANE BEAMS





CRANE BEAMS



BURO HAPPOLD	*Project:* SIM SITEWIDE CAPITAL WORKS	*Project Number:* 054704	*Status:* For Information		
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