ARUP

Castlefield Viaduct – Phase 2

Truss End Support Boxes – Remedial Options Appraisal

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Document verification

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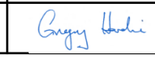
		Signature			

Castlefield Viaduct - Phase 2
Truss End Support Boxes – Remedial Options Appraisal

1.0 - INTRODUCTION

- This report summarises and appraises options for the remediation of the truss end support boxes at Castlefield Viaduct. Defects in the truss end support boxes were identified during surveys as part of a 2025 Principal Inspection + Assessment.
- The truss support box structures are introduced, then the type and extent of the defects are identified. A series of remedial options are introduced and their relative advantages/disadvantages described. This is followed by a relative appraisal of the options to determine a preferred remedial, to be developed further into a construction-status detail.
- The report summarises structural sketches, drawings and other documents prepared since the extent of the defects were identified. The structural descriptions are complemented by focussed commentary on the heritage implications of each remedial, which also feeds into the options appraisal.
- This report is a simple stand-alone document which sets out the known information and the holistic design decisions made in response. It has been prepared for review by the Manchester City Council (MCC) Planning Team as part of an ongoing dialogue concerning the truss end support boxes and their remediation.
- The report is written by Arup as structural engineer, with input from Purcell as Heritage Consultant. Both Arup and Purcell are engaged by National Trust (NT) to advise on a proposed Phase 2 extension to the current high-level urban garden on the Castlefield Viaduct (Phase 1). The viaduct is owned and maintained by the Historic Railways Estate (HRE) with the NT as tenants.

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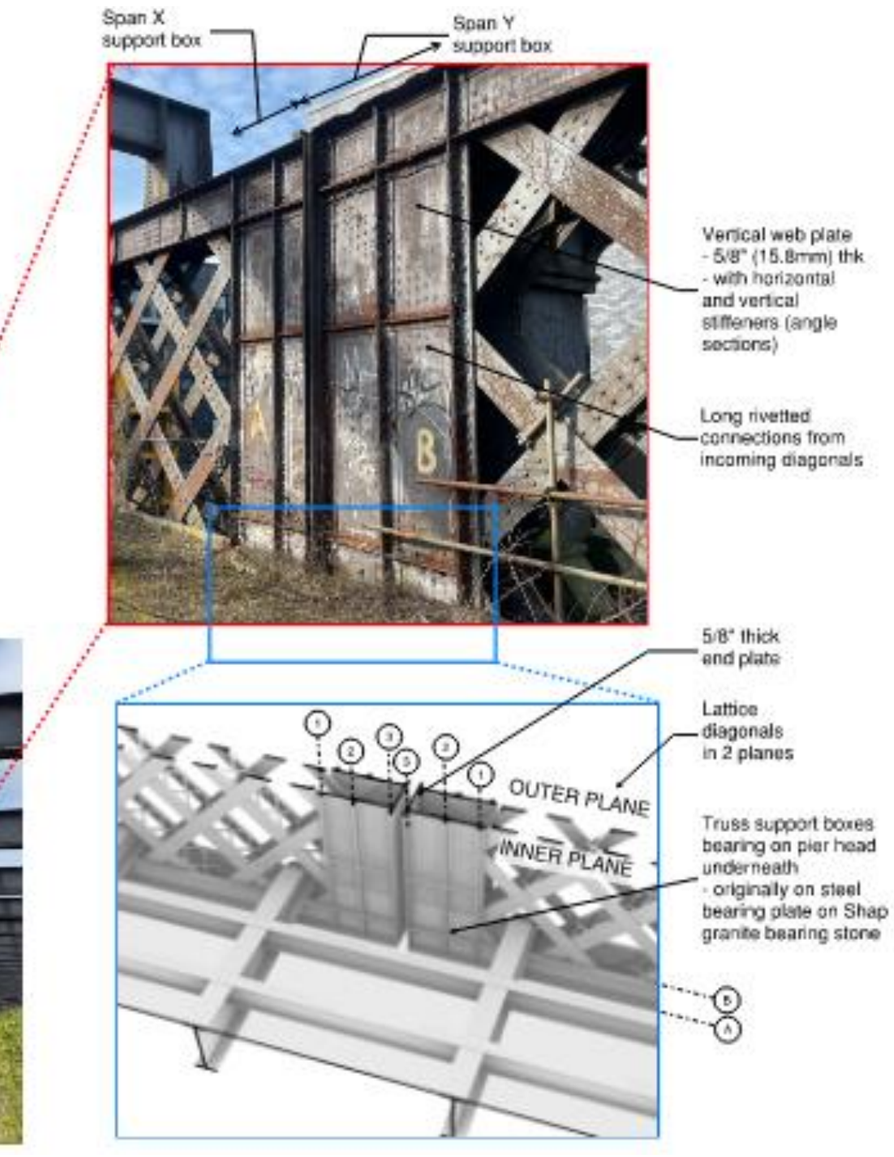
2.0 – VIADUCT TRUSSES

- The deck of the Castlefield Viaduct is supported by a grillage of beams which are in turn supported by steel lattice trusses to each side (notionally north and south elevations). The trusses span a maximum of approximately 50m to transfer loads into the piers/abutments.
- The trusses are 20’ (6.1m) deep double lattice girders with diagonals running at 45° in both directions of two vertical planes. The planes are known as the ‘inner’ and ‘outer’ planes as viewed from the deck. The direction of diagonals working in tension or compression flips along the length of the span.
- The lattice diagonals consist of either flat plates, angles, or compound sections of both. Between the planes of diagonals are cross braces, known as lacings, which connect the diagonals together.

3.0 – TRUSS END SUPPPORT BOXES

- At the truss ends the diagonals connect by rivets into large vertical steel plates in both the inner and outer planes.
- These 5/8” (15.8mm) thick web plates typically extend 5’ (1524mm) along the length of truss, stiffened by horizontal and vertical Tees and Ls into a series of panels.
- Enclosed by the top and bottom chords, and a further 5/8” thick end plate to the rear, this forms an effective ‘**truss support box**’ into which the diagonals run with long rivetted connections.
- Within the support boxes the cross braces (lacings) of the compression diagonals become solid steel plates which prohibits easy access (note the tension diagonals are not laced together within the box). The interior of the support boxes are further compromised by the transverse beams of the deck grillage, which run through the support boxes in the infrequent locations where the transverse beams coincide.
- The support boxes continue below the deck where they bear on large granite stone slabs at the pier heads.



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4.0 – CONDITION SUMMARY

- The truss support boxes were initially surveyed by rope and MEWP access methods between February-April 2025, as part of an Arup Principal Inspection commissioned by the NT. This was followed in July 2025 by a dedicated survey of span 1, which runs over the operational Network Rail (NR) viaduct beneath.
- The surveys found the **bottom panels of the support boxes, below the deck, to be in a very poor condition**. These areas are prone to water attack from driven rain running down the outside of the outer plane. Some will also collect water overflowing from the truss bottom chords, which acts as gutters and are unable to discharge in some locations. Maintenance may also have been neglected through the life of the structure given the challenging access to both support box planes.
- An end-by-end survey was carried out for all trusses, for both the inner and outer planes. Significant corrosion was found at several locations, with complete paint absence and loss of thickness to the 5/8” steel web plate. Some panels were found to be deteriorated such that large holes were evident. At other locations, however, the condition was found to be more acceptable, with paint present and negligible corrosion.
- A qualitative rating was ascribed to each truss end in Appendix B.2 of the Principal Inspection (CVI-ARUP-ZZ-ZZ-RP-S-000001), extracted opposite. The ratings are coloured red, amber, yellow, green (RAYG) in decreasing order of deterioration. This Condition Summary helps to show spatially where the defects occur.

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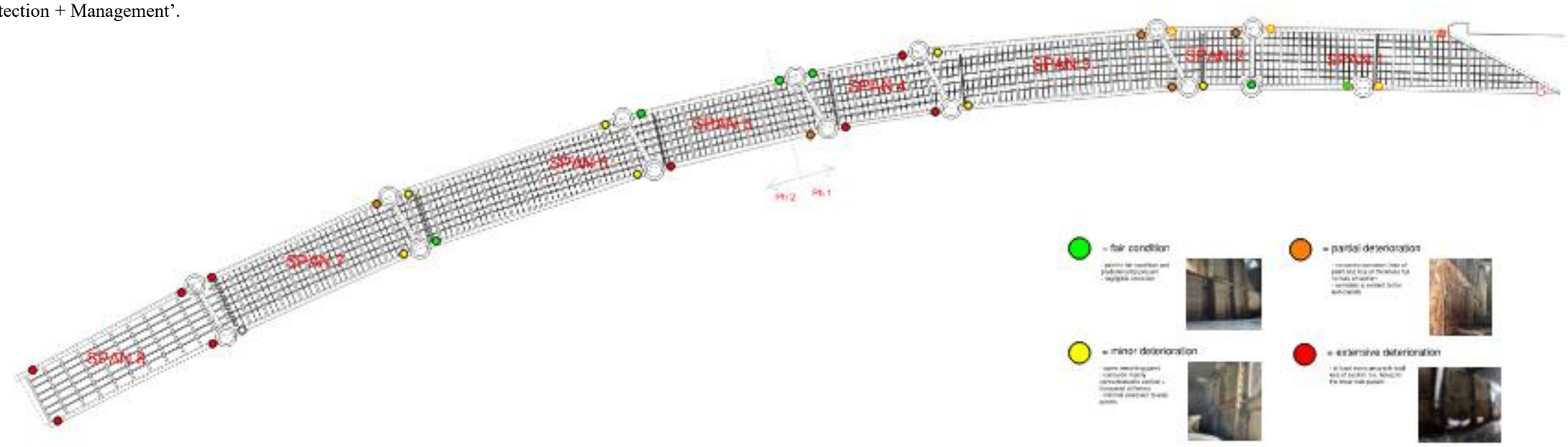
5.0 – REMEDIATION SCHEDULE

- The Arup Principal Inspection + Assessment recommended that the most deteriorated support boxes should be remediated. These are those rated ‘red’ in the Condition Summary: there are 9No. ‘red’ truss ends across the viaduct.
- The Principal Inspection outlines how remediation will enhance the robustness and resilience of this semi-hidden critical element (HCE) into the future, mitigating the risk of further deterioration. This recognises the fact the support box bottom panels carry all the loads from the deck and that there is no secondary load path for load redistribution.
- Useful guidance on the significance of HCEs can be found in CIRIA C764 ‘Hidden Defects in Bridges – Guidance for Detection + Management’.
- The full extent of deterioration will be properly understood once the debris and rust has been cleared. A wider programme of debris clearance, cleaning and painting has been proposed by Arup in sketch CVI-ARUP-ZZ-ZZ-SK-S-3033 on an end-by-end basis (extract opposite). Different actions are recommended depending on the RAYG rating from the Condition Summary.
- More detailed structural surveys will follow as part of this process, aiming to understand the full extent of corrosion at the ‘red’ ends. This is known as a **Special Inspection** (SI) in bridge terminology.

Condition	No.	Clean	Debris	S.I	Paint	Remediate
White	2					
Green	6		✓			
Yellow	10		✓			
Amber	6	✓	✓		✓	
Red	9	✓	✓	✓	✓	✓

Σ = 33



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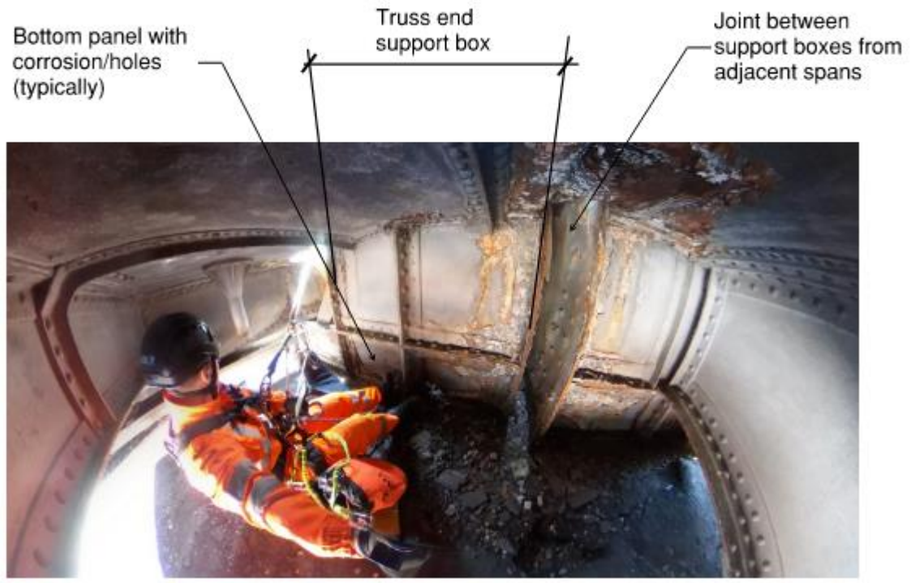
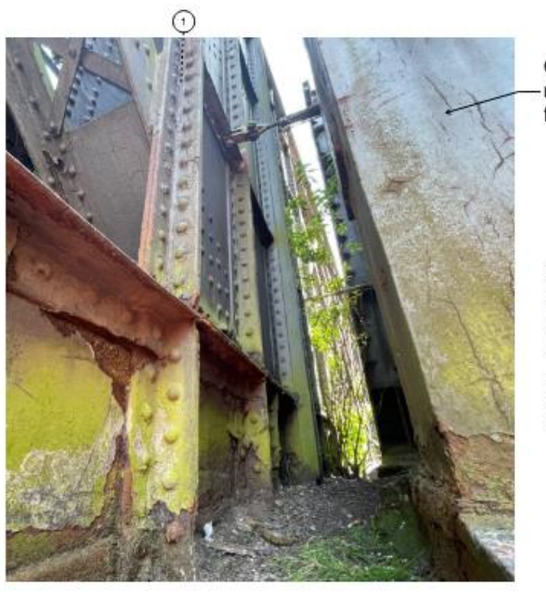
Truss End Support Boxes – Remedial Options Appraisal

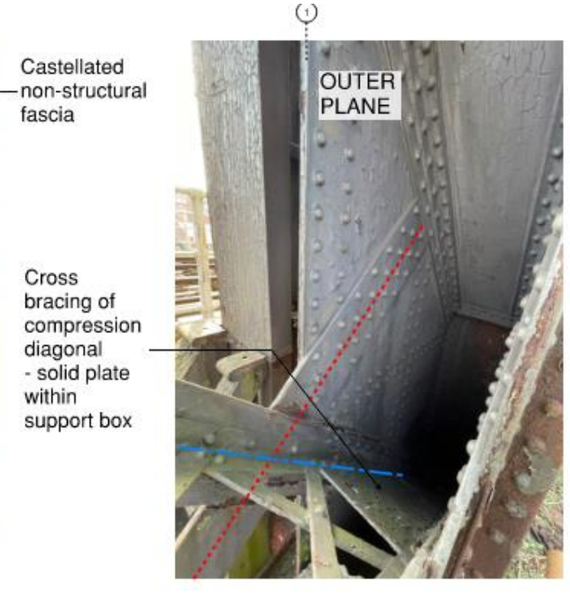
6.0 – REMEDIAL OPTIONS

Overview

- The need and location of remediation has been outlined. **The exact type of remedial is to be determined.**
- The remedial is as much guided by the **challenging access limitations** as it is by structural capacity. Access to the inner plane is restricted by the tight vertical clearance between the deck soffit and the pier head. The outer plane is constrained by the small zone available against the non-structural castellated fascia to the outer elevation. Access within the support box is restricted by the compression diagonals solid plates (typically) and the transverse beam ends (infrequently). See drawing CVI-ARUP-ZZ-ZZ-DR-S-4017 for more background of access constraints.
- Alongside the 'buildability' implications of these access constraints, any remedial design will be guided by best-practice approaches concerning the historic fabric, recognising the **key heritage significance** of the grade II listed structure. The remaining **key design factors** feeding into the remedial are costs, aesthetics and maintainability.
- **Several options for remediation** have been conceived and varyingly developed into sketches for internal and external review. These are listed below and discussed on the following pages against the key design factors, with a dedicated commentary on heritage issues provided per option. The relative merits of each option are appraised comparatively in Section 7.0.
    - **Option 1** – Conventional Over-plating
    - **Option 2** – Internal Steel Frame
    - **Option 3** – External Concrete Block
    - **Option 4** – 'Tea trays'
    - **Option 5** – Concrete Infill
- Note some of the phrasing used may differ from that in previously circulated drawings. This is to simplify the later comparisons. For ease of reference a full list of structural documents, and a chronology, is provided in Appendix A.
- It should be noted that all the options act to **add** new structure and therefore **add** capacity to the current structural arrangement. This is an important distinction to the alternative strategy of replacing the thinned or holed web panels. This approach, say **Option 6**, would require that the deteriorated plates be removed which would in turn temporarily weaken the structure. This would mean significant temporary works to support the viaduct in the short term, which may require some form of propping and/or possibly more invasive impact to the structure. Combined with the access constraints this option is not deemed currently feasible and is not part of the comparison.







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Truss End Support Boxes – Remedial Options Appraisal

6.1 - OPTION 1 – CONVENTIONAL OVER-PLATING

Overview

- This option is shown as a concept on sketch CVI-ARUP-ZZ-ZZ-SK-S-3031.
- It follows the nearest applicable industry-standard guidance for such defects, as described in NR document NR/CIV/SD/TUM/800 ‘Bridge Repair And Strengthening’. As such it is labelled the ‘conventional’ option.
- It involves bolting a new steel web plate to the deteriorated existing plate, then using lapping plates to connect the new plate into the surrounding horizontal and vertical stiffeners.
- The same remedial would apply to both planes, even if only one plane was deteriorated. This reinstates the symmetrical vertical stiffness of the original.

Advantages

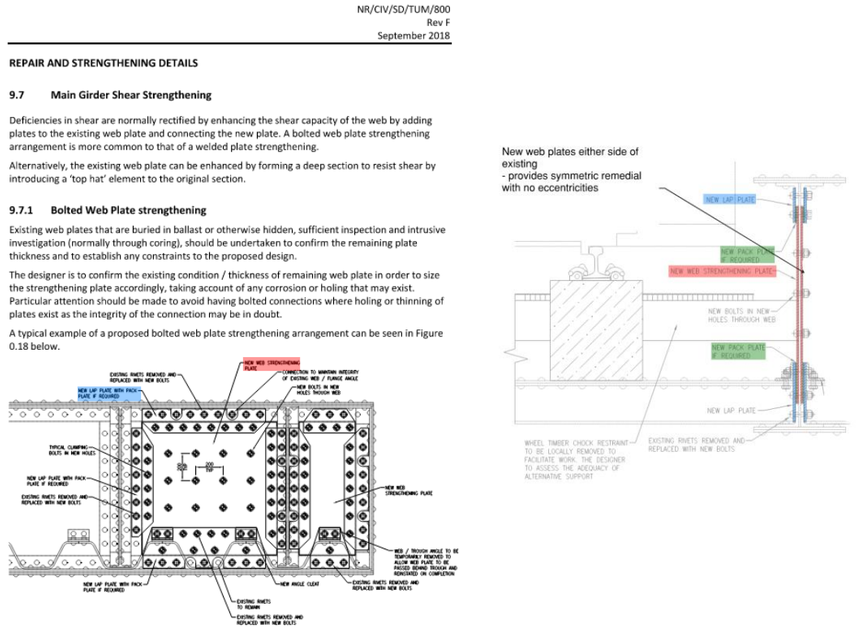
- Follows industry-standard approaches (as far as possible)
- Maintains similar load paths as existing
- Aesthetically can be understood as a legible intervention.

Disadvantages

- Access required within support box (the NR detail assumes the remedial is to an I-beam with easy access both sides).
- Existing web plate rivets prohibit the new plate being pushed flush – potential for water trap behind.
- Limits future access to existing web and surrounding stiffeners.
- Bolting of lapping plates means removal of existing rivets: loss of fabric; potential weakening of capacity during installation (temporary works may be required).
- New support is offset from existing web plate, creating eccentricities in load paths (which would need to be verified).
- Welded alternative not considered given difficulties of pre-heating existing steelwork.

Heritage Commentary

- Option 1 would result in the loss of original historic fabric through the removal of existing rivets and the installation of new ones.
- The new plates and bolts would be a distinctly modern intervention, which may impact upon the viaduct’s architectural interest, but would retain its overall industrial character.



NR/CIV/SD/TUM/800
Rev F
September 2018

REPAIR AND STRENGTHENING DETAILS

9.7 Main Girder Shear Strengthening

Deficiencies in shear are normally rectified by enhancing the shear capacity of the web by adding plates to the existing web plate and connecting the new plate. A bolted web plate strengthening arrangement is more common to that of a welded plate strengthening.

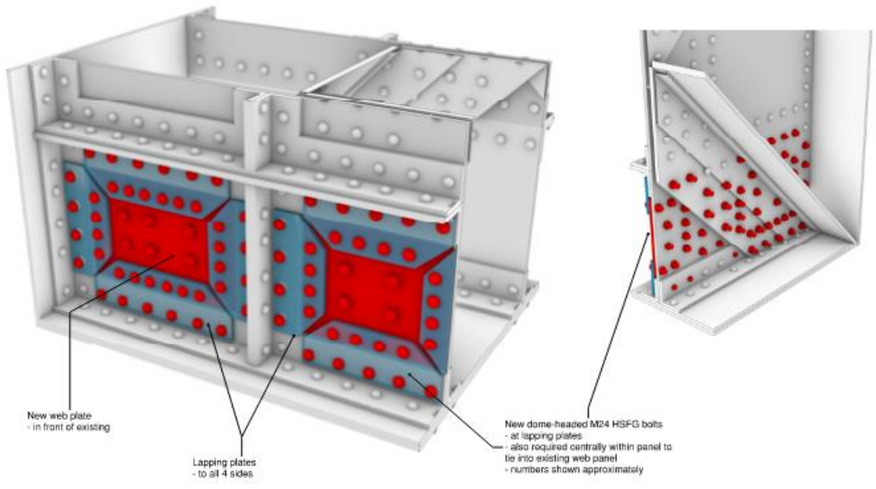
Alternatively, the existing web plate can be enhanced by forming a deep section to resist shear by introducing a ‘top hat’ element to the original section.

9.7.1 Bolted Web Plate strengthening

Existing web plates that are buried in ballast or otherwise hidden, sufficient inspection and intrusive investigation (normally through coring), should be undertaken to confirm the remaining plate thickness and to establish any constraints to the proposed design.

The designer is to confirm the existing condition / thickness of remaining web plate in order to size the strengthening plate accordingly, taking account of any corrosion or holing that may exist. Particular attention should be made to avoid having bolted connections where holing or thinning of plates exist as the integrity of the connection may be in doubt.

A typical example of a proposed bolted web plate strengthening arrangement can be seen in Figure 0.18 below.



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6.2 - OPTION 2 – INTERNAL STEEL FRAME

Overview

- This option is shown as a concept on sketch CVI-ARUP-ZZ-ZZ-SK-S-3032.
- It proposes a new steel frame being installed within the support box, consisting of braced vertical columns with horizontal ‘arms’ cantilevering out to take loads from the support box.

Advantages

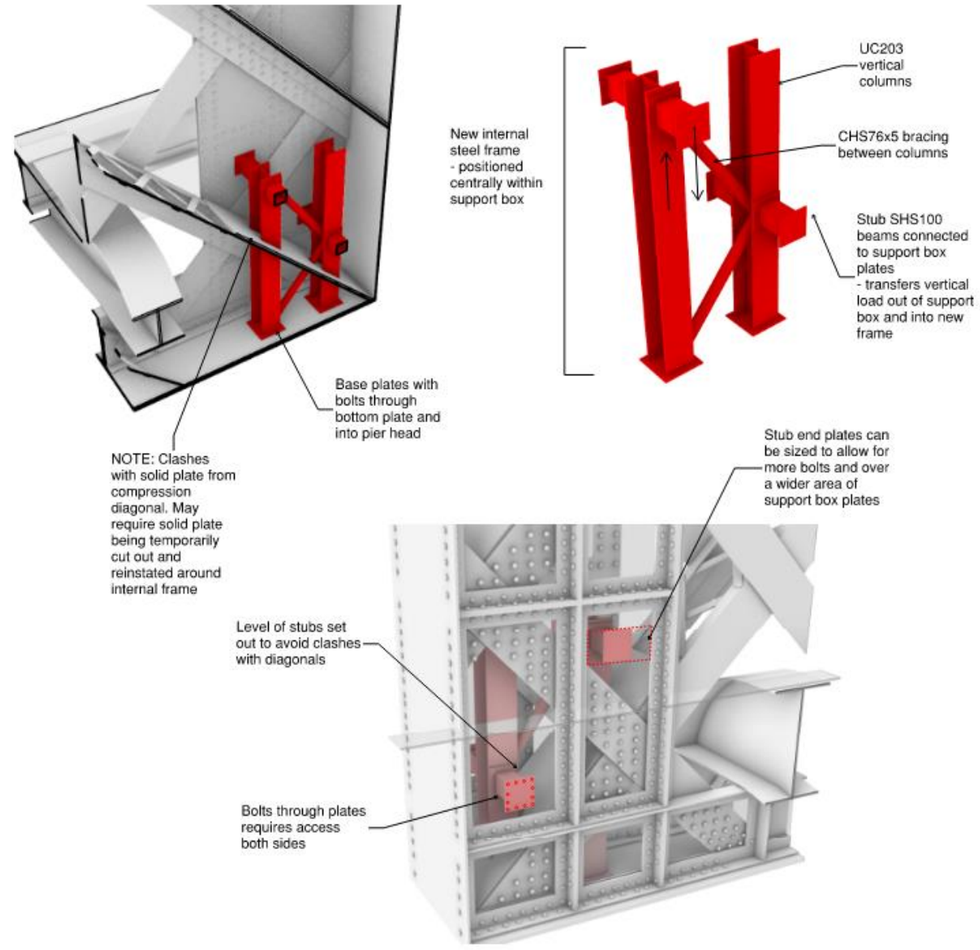
- Discrete: limited visibility externally
- Minimal access required outside support box
- Good for future access to outside faces of existing steelwork
- No need to remove existing rivets.

Disadvantages

- Significant access required within support box: may require compression diagonal solid plates being removed (temporary works may be required). Loss of fabric.
- May also clash with transverse beams and other stiffeners which are present within the box at some locations.
- Conceptually different arrangement of load paths to existing: transfers all loads centrally (possible risks in shifting loads)
- Limits future access within box
- Long-term maintenance obligations (e.g. painting)
- Minimal in-plane shear stiffness

Heritage Commentary

- Option 2 would have a limited impact on the original historic fabric, with only small numbers of bolts required to fix the frame in place.
- This option would not be visible externally and as such would have no impact on the viaduct’s architectural interest.
- The disadvantages presented, however, suggest that Option 2 would not be an ideal engineering solution to secure long-term use and appreciation of the grade II listed structure.



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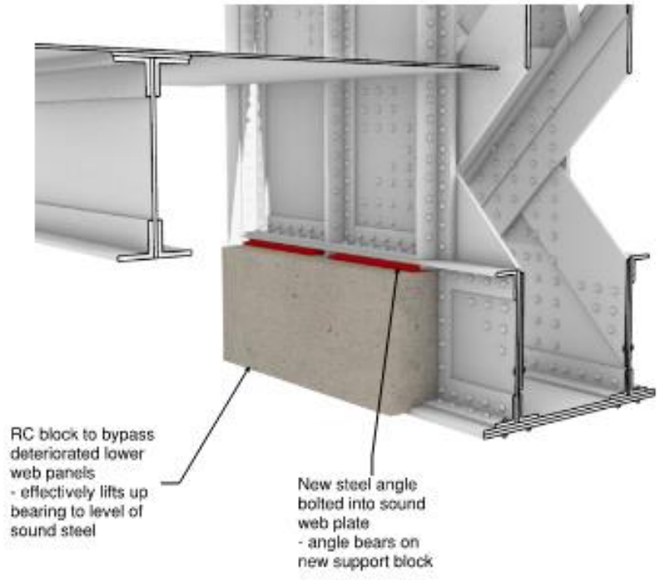
6.3 - OPTION 3 – EXTERNAL CONCRETE BLOCK

Overview

- This option is shown as a concept on sketch CVI-ARUP-ZZ-ZZ-SK-S-3032.
- It proposes a new concrete block to be poured against the defective web panels. The block acts to support a new steel bearing angle bolted into the sound steel above the holed plate, transferring loads down into the pier/abutment.
- It would effectively be lifting the effective bearing level above the defective areas.
- The same remedial would apply to both planes, even if only one plane was deteriorated. This reinstates the symmetrical vertical stiffness of the original.

Disadvantages

- Some access still required within box for installing bolts to existing web plate.
- Prevents maintenance access to outside of steelwork, both to web panels and also surrounding stiffeners.
- Aesthetically unsympathetic: blocks off existing fabric both sides.
- If concrete not fully against steelwork then an inaccessible water route has been created behind (which will encourage further deterioration).
- New support is offset from existing web plate, creating eccentricities in load paths (which would need to be verified).

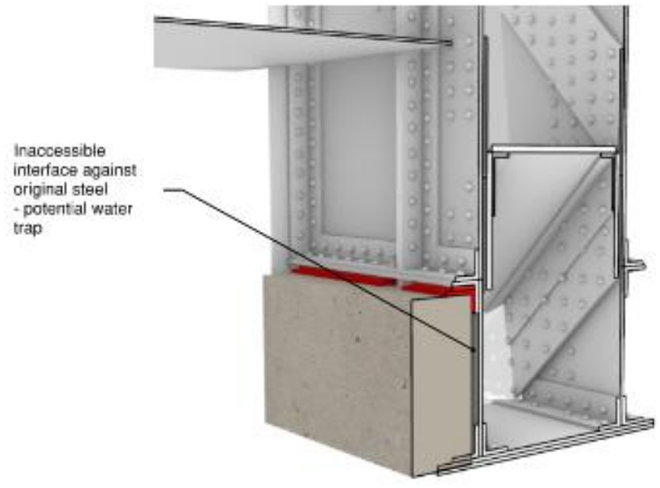


Advantages

- Simple, straightforward
- Minimal access required within support box
- No need to remove existing rivets.

Heritage Commentary

- Option 3 is visually intrusive and would have a negative impact on the architectural interest of the viaduct.
- The original fabric would remain intact, but to achieve the highest chance of preventing water ingress (and thus further corrosion) the concrete would be poured directly against the historic steelwork. The long-term effect of the interaction of these materials is unknown.



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6.4 - OPTION 4 – 'TEA TRAYS'

Overview

- The 1st iteration of this option is shown as a concept on sketch CVI-ARUP-ZZ-ZZ-SK-S-3032. A 2nd iteration is shown on drawing CVI-ARUP-ZZ-ZZ-DR-S-4018 as a developed proposal supported by analysis and calculation.
- It proposes lipped steel plates, like 'tea trays', offered up to both planes (not only the plane with defective web panels). Through-bolts between inner/outer planes then support the support box above and transfer loads into the web panels.
- Bolts around the edges of the tea trays allow for load sharing between trays, and between trays and the remnant vertical stiffeners.

Advantages

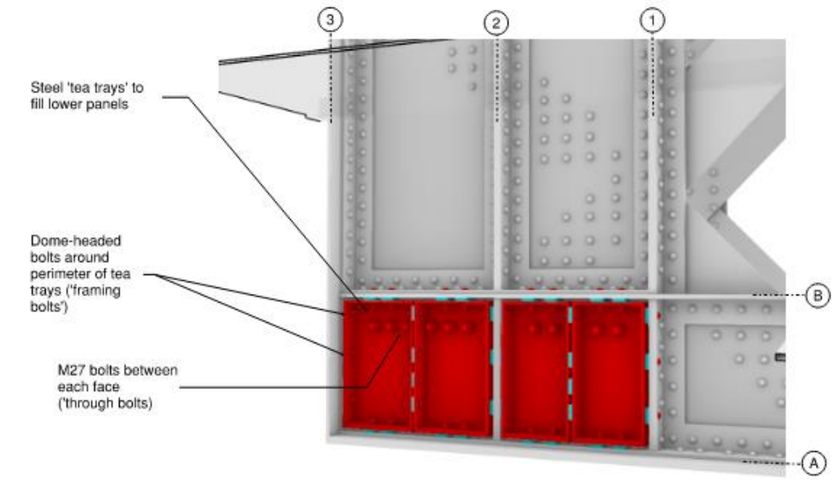
- Multiple trays allows for hit-and-miss removal for future maintenance and access to existing steelwork behind (subject to temporary works justification).
- Aesthetically can be understood as a legible intervention.
- Maintains similar load paths as existing.
- Reinstates in-plane shear stiffness of defective panel.
- Minimal access required within support box.

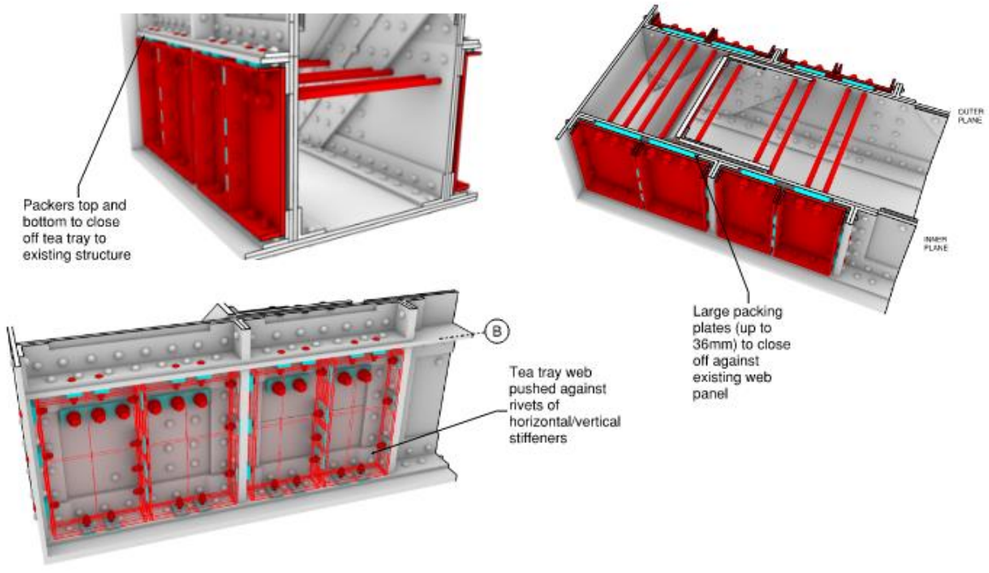
Disadvantages

- Existing web plate rivets prohibit tea tray being pushed flush – potential for water trap behind.
- Limits future access to existing web and surrounding stiffeners.
- New support is offset from existing web plate, creating eccentricities in load paths (which would need to be verified).
- Multiple new holes requires into sound steel.
- Requires close tolerance to existing rivets: likely to require site-specific fabrication per each condition.
- Untested and novel solution.
- Doesn't prevent overflowing gutters causing corrosion from 'inside-out'

Heritage Commentary

- Option 4 would introduce the greatest amount of modern steelwork. This would impact the architectural interest of the viaduct, but would likely retain its industrial character.
- It would result in the loss of a small amount of original historic fabric through the removal of existing rivets and the installation of new ones.
- It has the potential to result in water traps and is a largely untested solution which carries a degree of long-term risk.





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6.5 - OPTION 5 – CONCRETE INFILL

Overview

- This option is shown on drawing CVI-ARUP-ZZ-ZZ-DR-S-4019 as a developed proposal supported by analysis and calculation.
- It adopts a similar approach to that evident in the adjacent 1870s viaduct (refer to Appendix B). It consists of through-bolts between the two planes of the support box, which then bear on a concrete infill poured within.
- The concrete infill would be shuttered to avoid leakage through web panel holes and to form a clean vertical face at the front of the support box.
- Further structural commentary is given in Appendix C in response to previous MCC queries concerning construction sequence, maintenance and de-construction.

Disadvantages

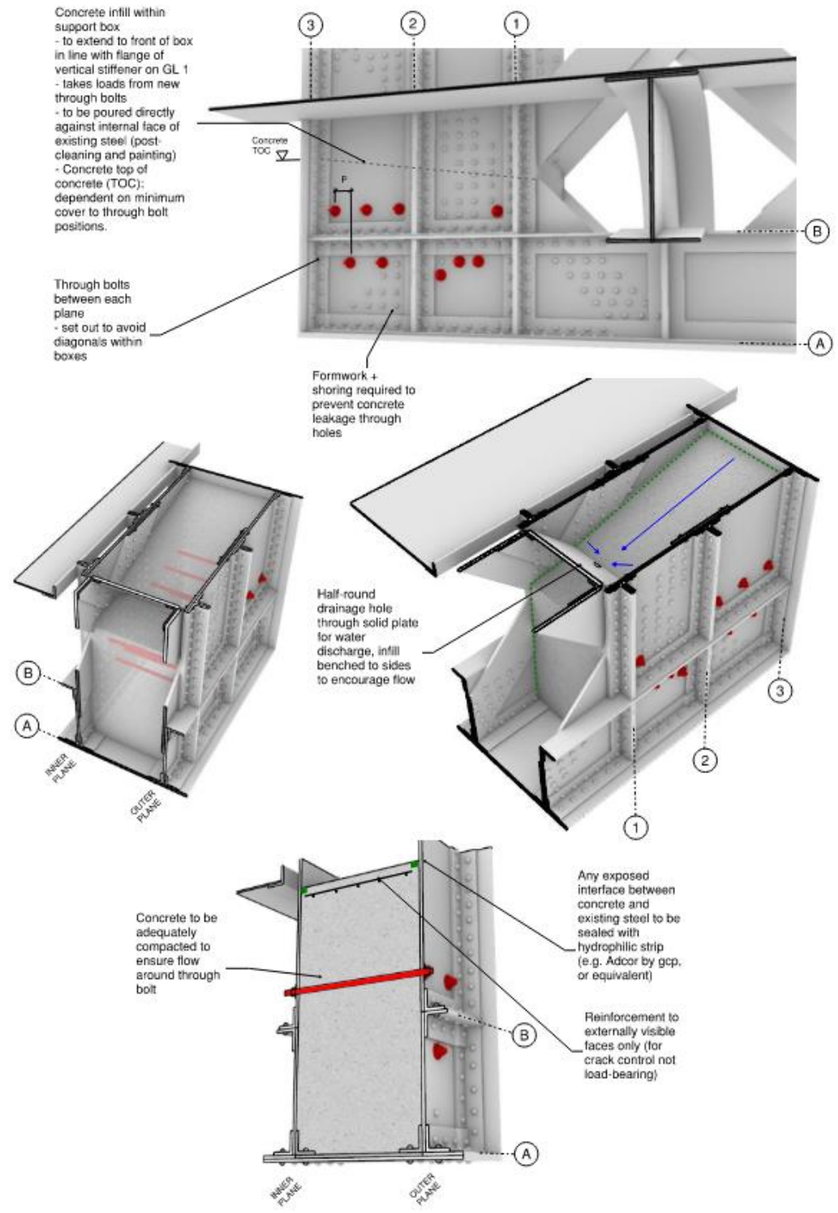
- Access required within support box (for concreting only)
- Limits future access within box
- Potential water trap internally (if concrete not fully in contact with inside steel surfaces)
- Small hole required through compression diagonal solid plate.

Advantages

- Proven solution, evidenced by long-term performance of 1870s remedial
- Relatively simple to construct
- Good for future access to outside faces of existing steelwork
- Minimal new bolting
- Minimal new holes into sound steel
- Not reliant on existing rivet geometry
- Maintains similar load paths as existing
- No need to remove existing rivets.
- Minimal long-term maintenance.
- Prevents overflowing gutters causing corrosion from ‘inside-out’

Heritage Commentary

- Visually, Option 5 would be a minimally intrusive intervention and would result in no discernible impact on the architectural interest of the viaduct.
- There is a historic precedent for this solution on the adjacent viaduct which has proved effective.
- The original fabric would remain largely intact, except for a limited number of new bolts. However, to achieve the highest chance of preventing water ingress (and thus further corrosion) the concrete would be poured directly against the historic steelwork. The long-term effect of the interaction of these materials is unknown.
- Solution would be difficult to reverse in future should issues arise.



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7.0 – OPTIONS APPRAISAL

- Each of the suggested remedial options has advantages and disadvantages when judged against the key design factors.
- The table below summarises their relative merits using a RAYG appraisal, to determine an overall qualitative rating. From this, an overall preferred option can be identified, in principle. There is a degree of subjectivity in the ratings but all are informed by the experience and skills of the design team's combined experience working with and remediating existing structures.
- Not the stated key design factors could be extended to include other criteria, and/or weighted for their relative significance, but the appraisal has been kept purposefully simple at this stage. Similarly other options could be investigated, however, a suite of five options for such a challenging, non-standard, remedial is deemed reasonable.

Poor	Above average
Below average	Good

Design Factor / Option	Structural	Buildability	Cost	Maintainability	Aesthetics	Heritage	Overall
1. Conventional Over-plating							Ranked 4/5
2. Internal steel Frame							Ranked 3/5
3. External Concrete Block							Ranked 5/5
4. Tea tray							Ranked 2/5
5. Concrete infill							Ranked 1/5
NOTES	- Considering simplicity of load paths, risks of working with existing structure, likelihood for successful capacity increase etc	- Considering access limitations, tolerance of existing structure etc	- Estimated costs only	- Considering future visibility + access to elements requiring maintenance (cleaning, painting, replacement etc)	- Considering non-heritage visual aesthetics - Note all options are contained below the viaduct deck	- Considering visual and physical impacts on heritage significance	

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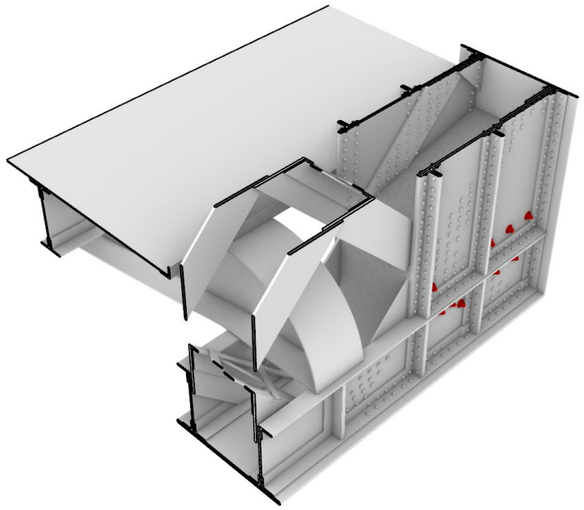
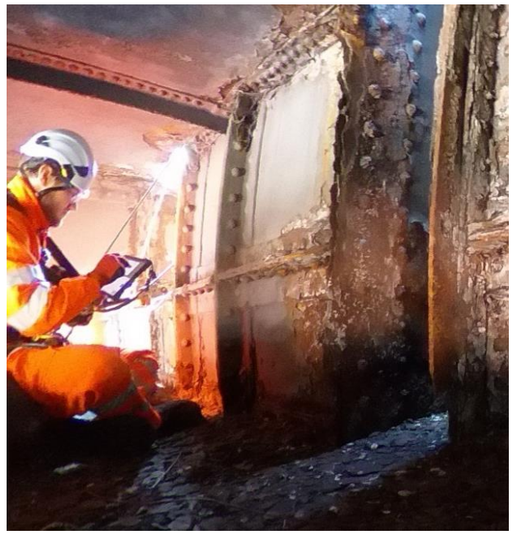
8.0 – SUMMARY RECOMMENDATION

Preferred Option

- This appraisal has considered five different options for the remediation of the ‘red’ truss support boxes. Using a relative qualitative appraisal the **preferred solution is Option 5, the concrete infill**.
- With reference to Section 7.0 this concrete infill is the most buildable, the most straightforward structurally, and likely the most cost effective. It is also the easiest to maintain. The heritage implications of the remedial have been outlined but on balance are countered by the other positive design factors. Additional structural commentary is provided in Appendix C to give more background to construction sequence, maintenance, and theoretical de-construction.
- The **concrete infill is recommended for approval to MCC**, whether this is through the currently approved Listed Building Consent (LBC) application or via a new application.





Next Steps

- Await comments on this report from MCC, including confirmation from MCC regarding LBC approaches.
- Special Inspection to ‘red’ ends
- Review options with Contractor, when appointed, to incorporate any further strategies regarding buildability.
- Confirm acceptance with NT and HRE.
- Contractor to commence cleaning, debris clearance, painting, as per end-by-end requirements of sketch CVI-ARUP-ZZ-ZZ-SK-S-3033.
- Progress remedial detail towards construction-status.

ARUP

Appendix A – Structural Documents

Castlefield Viaduct - Phase 2
Truss End Support Boxes – Remedial Options Appraisal

APPENDIX A - STRUCTURAL DOCUMENTS

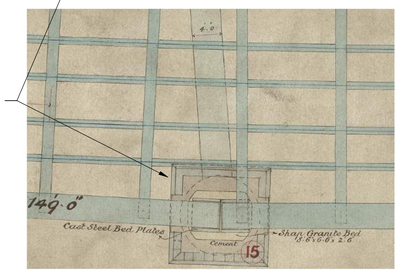
- All relevant structural drawings/documents relating to the truss end support boxes, and their remedials, are listed below and included in this Appendix A.
- For ease of reference, the chronology below details key dates during the development of the proposals.

Document List

- **Truss end support box condition summary**
  - Appendix B.2 of Arup Principal Inspection + Assessment (CVI-ARUP-ZZ-ZZ-RP-S-000001)
  - Initially issued on 02 May 2025
  - Updated to Rev A on 06 Aug 2025 to include Span 1 surveys
- **Remediation Schedule**
  - Sketch CVI-ARUP-ZZ-ZZ-SK-S-3033
- **Access constraints**
  - 1st iteration - sketch CVI-ARUP-ZZ-ZZ-SK-S-3030
  - 2nd iteration - drawing CVI-ARUP-ZZ-ZZ-DR-S-4017
- **Option 1 - Conventional Remedial Option**
  - Sketch CVI-ARUP-ZZ-ZZ-SK-S-3031
- **Option 2 – Internal Steel Frame**
  - Sketch CVI-ARUP-ZZ-ZZ-SK-S-3032
- **Option 3 – External Concrete Block**
  - Sketch CVI-ARUP-ZZ-ZZ-SK-S-3032
- **Option 4 - Tea Trays**
  - 1st iteration - sketch CVI-ARUP-ZZ-ZZ-SK-S-3032
  - 2nd iteration - drawing CVI-ARUP-ZZ-ZZ-DR-S-4018
- **Option 5 – Concrete Infill**
  - Drawing CVI-ARUP-ZZ-ZZ-DR-S-4019

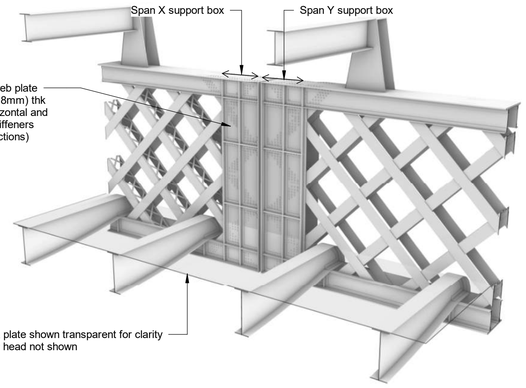
Chronology

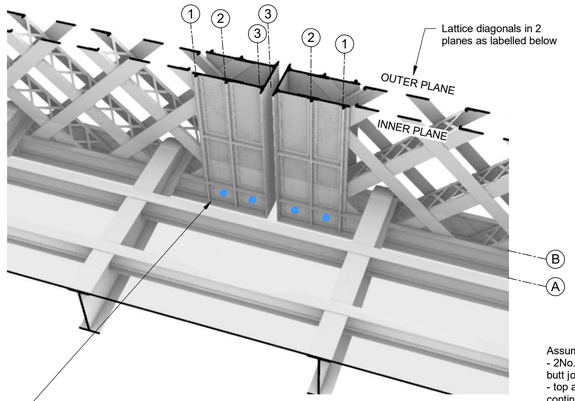
- **Feb-April 2025:** Arup rope surveys across spans 2-8, to form basis of Principal Inspection
- **02 May 2025:** Arup Principal Inspection + Assessment report issued
- **08 May 2025**: Workshop between Arup, NT, MCC to discuss findings of surveys and recommendations from Principal Inspection. Need for truss end support box remedial outlined. Arup circulated sketches 3030 / 3031 / 3032, Appendix B.2
- **21 May 2025**: MCC confirmed preference for tea tray option; no requirement for further LBC to be submitted
- **19 July 2025:** Further overnight Arup rope surveys across span 1, under NR possession
- **06 Aug 2025**: Arup email with developed drawing of tea tray (drawing 4018); also outlined concrete infill option to adopt same approach as 1870s viaduct.
- **04 Sep 2025**: Workshop between Arup, NT, MCC to discuss tea tray option versus concrete infill option. Concrete infill queries raised by MCC by email.
- **01 Oct 2025**: This Options Appraisal circulated externally to MCC



TYPICAL ARRANGEMENT

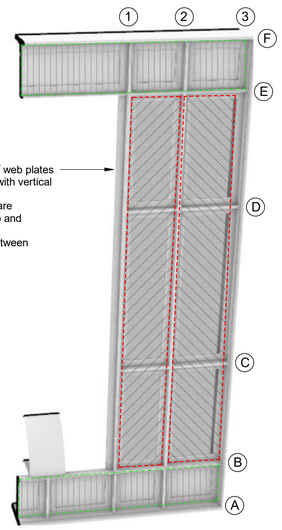
NTS

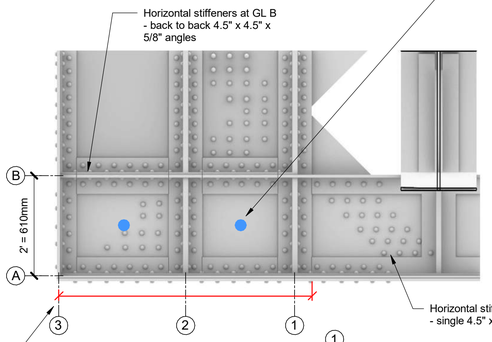


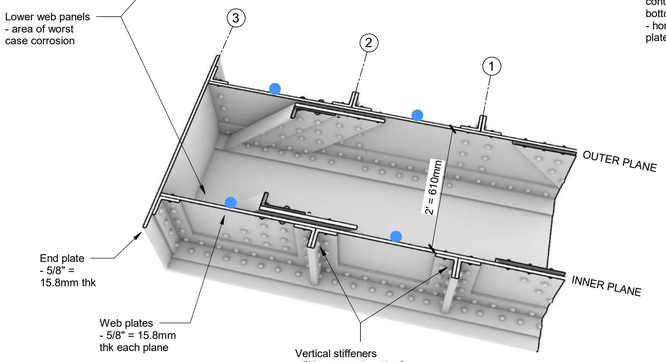


NOTE:
Rivet numbers and sizes shown indicatively. Typically assumed 7/8" (22.2mm) shank with holes (1/16" 1.6mm) greater than shank. Rivet heads assumed to project approx 20mm beyond face of connected plates.

NOTE:
Drawn for notional typical condition along viaduct. Other conditions vary according to configuration of transverse beams and incoming diagonals. Abutment condition follows similar arrangement in principle.







Notes:

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2. Existing condition drawn with dimensions from original archive drawings. All existing dimensions to be verified by the Contractor prior to fabrication or construction.
3. Drawing to be read in colour.
4. Do not scale from this drawing
5. For structural nomenclature refer to drawing CVI-ARUP-ZZ-ZZ-DR-S-1055. For structural notation of spans/beams/piers refer to drawing CVI-ARUP-ZZ-ZZ-DR-S-1056

H&S / CDM Risks:

Specific risks highlighted thus:
- existing paintwork contains lead
- limited structural capacity of viaduct deck plates
- existing ballast contaminated with lead and hydrocarbons
- working at height above water and public areas

Refer to Arup risk register for further details.

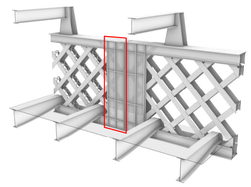
Legend:

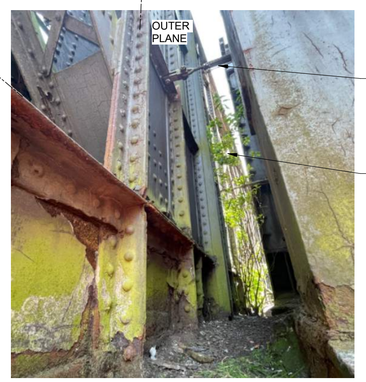
- Existing structure
  - unchanged unless noted otherwise
- Proposed remedial
- Indicative extent of defect
  - typical loss of section or thickness due to corrosion
- Indicative packing plates
  - where required

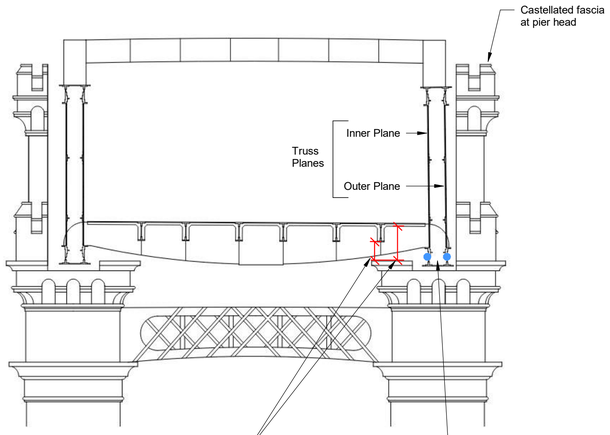
NOTE:
The remedial details shown consider the most likely corrective intervention based on the expected type/extent of defect. Extent of defect to be confirmed pending future brush down, removal of debris, and subsequent tactile surveys. Additional locations may be required following July 2025 Span 1 surveys.

LOCATION / NUMBER OF REMEDIALS REQUIRED:
- Refer to drawing CVI-ARUP-ZZ-XX-DR-S-4018 for remedials required.
- Refer to Arup Principal Inspection & Assessment CVI-ARUP-ZZ-ZZ-RP-S-000001 for further background.

KEY PLAN:

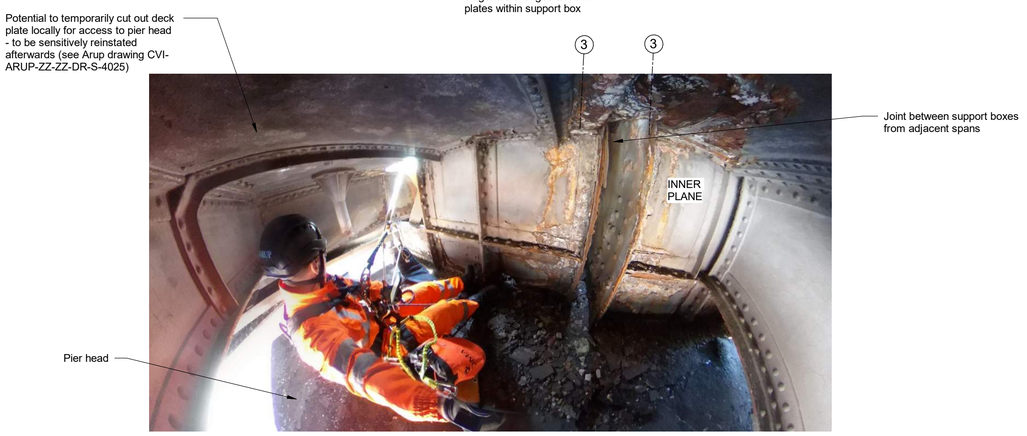






TYPICAL CONSTRAINTS

NTS



Rev	Date	Chkd	Appd	Issue Notes
T1	26/06/25	RR	GH	Issue for Tender

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Client
The National Trust

Project Title
Castlefield Viaduct
Phase 2

Drawing Title
Remedials
Truss End Supports
Constraints

Scale at A1	Drawn By
NTS	EJM

Role: Structural

Status: S2 - For Information

Arup Job No	Rev
282210	T1

ID
CVI-ARUP-ZZ-ZZ-DR-S-4017

Do not scale

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A1

Span 7 North Elevation, Cornbrook End

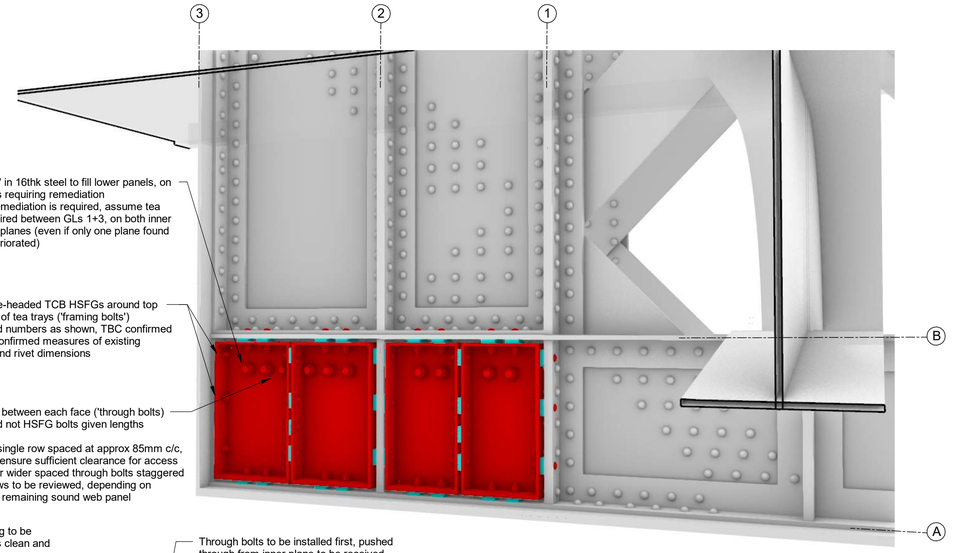
Debris at pier head to be cleared to confirm extents/condition of bottom horizontal stiffener on GL A

Holes on both lower web panels, inner plane

Span 8 North Elevation, Cornbrook End

Note: this is at the Cornbrook abutment; access further constrained by surrounding masonry bearing gallery

Configuration of existing bearing to be reviewed pending further debris clean and tactile survey



'Tea trays' in 16thk steel to fill lower panels, on truss ends requiring remediation
- where remediation is required, assume tea trays required between GLs 1+3, on both inner and outer planes (even if only one plane found to be deteriorated)

M16 dome-headed TCB HSFGs around top and sides of tea trays ('framing bolts')
- assumed numbers as shown, TBC confirmed pending confirmed measures of existing stiffener and rivet dimensions

M27 bolts between each face ('through bolts)
- assumed not HSFG bolts given lengths required
- to be in single row spaced at approx 85mm c/c, set out to ensure sufficient clearance for access
- option for wider spaced through bolts staggered on two rows to be reviewed, depending on extents of remaining sound web panel

Span 4 South Elevation, Cornbrook End

Rivets from incoming compression diagonal within box

Purpose of rivets likely for connection of incoming transverse beam

Note GL 1 vertical stiffener not supported on bearing
- extents of bearing TBC pending further debris clean and tactile survey

Purpose of rivets TBC: potentially for cross stiffener within box

Span 4 South Elevation, Cornbrook End

Note fold in horizontal stiffener flange to run in front of vertical stiffener

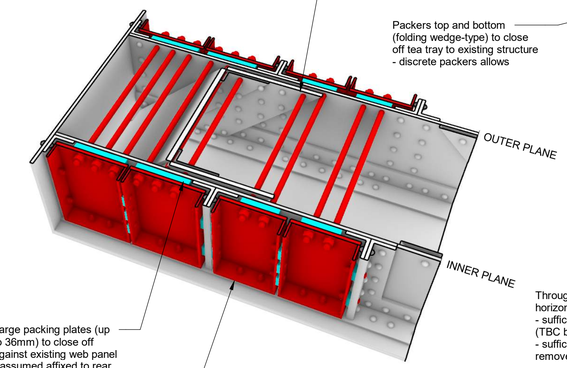
Span 4 South Elevation, Cornbrook End

Horizontal hole to lower web panel, outer plane
- extents of remaining sound steel to be reviewed pending further tactile survey

DEFECT EXAMPLES

NTS

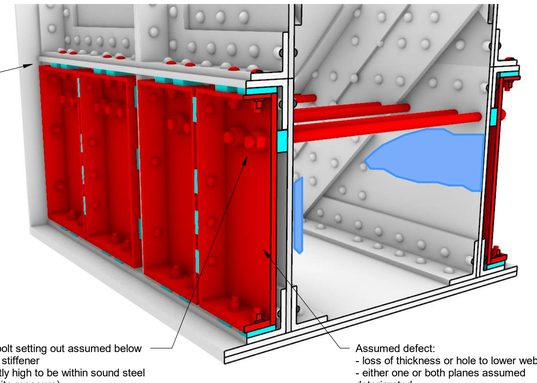
Through bolts to be installed first, pushed through from inner plane to be received on outer (or vice versa). Tea tray to be offered over bolts before bolt tightening.
- minimal access required internally to box
- setting out to avoid clashes with compression diagonal solid plates



Large packing plates (up to 36mm) to close off against existing web panel
- assumed affixed to rear of tea tray

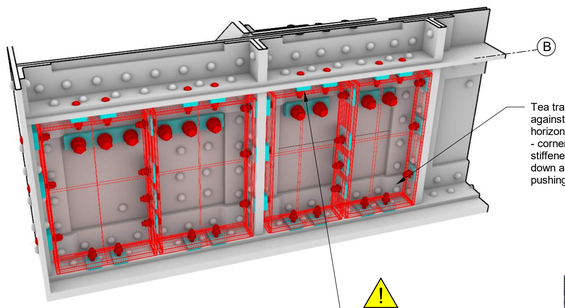
Framing bolts to bottom of tea tray assumed M16 resin anchors into either remnant steel bottom flange or into steel bearing plate
- TBC pending debris clearance and review of bearing plate

Packers top and bottom (folding wedge-type) to close off tea tray to existing structure
- discrete packers allows

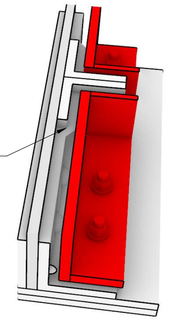


Through bolt setting out assumed below horizontal stiffener
- sufficiently high to be within sound steel (TBC by site measure)
- sufficiently low to avoid needing to removed existing rivets

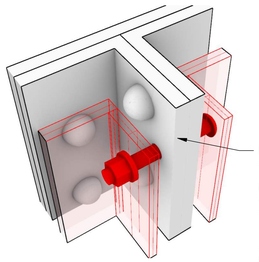
Assumed defect:
- loss of thickness or hole to lower web panels
- either one or both planes assumed deteriorated



Tea tray web pushed against rivets of horizontal/vertical stiffeners
- corner rivets at folded stiffeners to be ground down accordingly to avoid pushing tea tray further out



Note vertical bolts into GL B to be shifted where clashing with incoming transverse beam
- remedial locations to be surveyed to confirm geometry of transverse beam ends



M16 TCBs centred between existing rivets
- setting out to ensure access for torque wrench against tea tray whilst maintaining minimum edge distances to existing plates
- close-fitting holes assumed
- assumes existing stiffeners in sound condition: TBC by further tactile surveys

REMEDIAL DETAIL

NTS

NOTE:
Existing structure assumed blasted, cleaned and re-painted prior to remedial installation.

NOTE:
Rivet numbers and sizes shown indicatively. Typically assumed 7/8" (22.2mm) shank with holes (1/16" 1.6mm) greater than shank. Rivet heads assumed to project approx 20mm beyond face of connected plates.

NOTE:
Drawn for notional typical condition along viaduct. Other conditions vary according to configuration of transverse beams and incoming diagonals. Abutment condition follows similar arrangement in principle.

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H&S / CDM Risks:

Specific risks highlighted thus:
- existing paintwork contains lead
- limited structural capacity of viaduct deck plates
- existing ballast contaminated with lead and hydrocarbons
- working at height above water and public areas

Refer to Arup risk register for further details.

Legend:

Existing structure
- unchanged unless noted otherwise

Proposed remedial

Indicative extent of defect
- typical loss of section or thickness due to corrosion

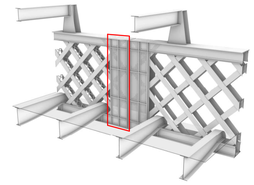
Indicative packing plates
- where required

NOTE:
The remedial details shown consider the most likely corrective intervention based on the expected type/extent of defect. Extent of defect to be confirmed pending future brush down, removal of debris, and subsequent tactile surveys. Additional locations may be required following July 2025 Span 1 surveys.

LOCATION / NUMBER OF REMEDIALS REQUIRED:

- 9No. required as below:
  - Span 4 - North elevation, Deansgate end
  - Span 4 - South elevation, Deansgate end
  - Span 4 - South elevation, Cornbrook end
  - Span 5 - South elevation, Cornbrook end
  - Span 7 - North elevation, Cornbrook end
  - Span 8 - North elevation, Deansgate end
  - Span 8 - North elevation, Cornbrook end
  - Span 8 - South elevation, Deansgate end
  - Span 8 - South elevation, Cornbrook end
- Refer to Arup Principal Inspection & Assessment CVI-ARUP-ZZ-ZZ-RP-S-000001 for further background.

KEY PLAN:



Rev	Date	Chkd	Appd	Issue Notes
T1	26/06/25	RR	GH	Issue for Tender

ARUP

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Client
The National Trust

Project Title
Castlefield Viaduct
Phase 2

Drawing Title
Remedials
Truss End Supports
'Tea Tray' Remedial

Scale at A1	Drawn By
NTS ated	EJM

Role: Structural

Status: S2 - For Information

Arup Job No	Rev
282210	T1

ID
CVI-ARUP-ZZ-ZZ-DR-S-4018

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Do not scale

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Span 7 North Elevation, Cornbrook End

Debris at pier head to be cleared to confirm extents/condition of bottom horizontal stiffener on GL A

Holes on both lower web panels, inner plane

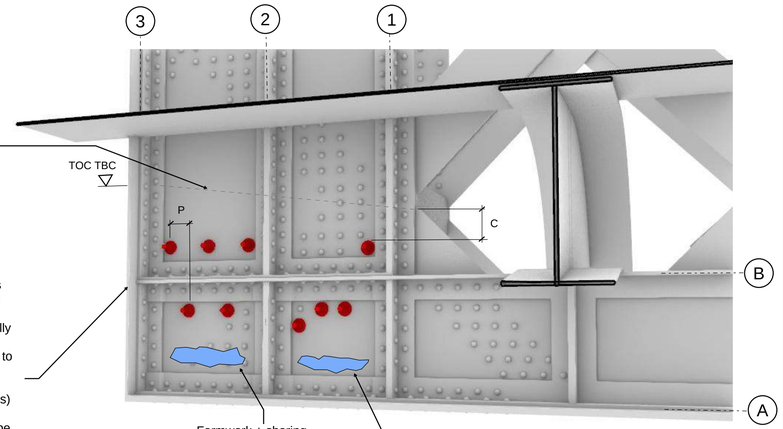
Span 8 North Elevation, Cornbrook End

Note: this is at the Cornbrook abutment; access further constrained by surrounding masonry bearing gallery

Configuration of existing bearing to be reviewed pending further debris clean and tactile survey

Concrete infill within support box
- to extend to front of box in line with flange of vertical stiffener on GL 1
- to be poured directly against internal face of existing steel (post- cleaning and painting)
- infill to fall at 1:40 from GL 3 to GL 1
- TOC TBC - dependent on minimum cover C (100mm) to confirmed through bolt positions. Assume approx 1.5m³ concrete required typically.
- note: two pours may be required if the compression diagonal solid plate bisects the support box volume. Diagonal geometry varies on a location-by-location basis, to be confirmed by further tactile survey.

Through bolts from inner to outer planes
- M27 bolts (or threaded rod) between each face, with 50dia x 4thk washers
- bolts to be at approx 125mm c/c horizontally (pitch P) on a single horizontal row where possible, or staggered vertically (as shown) to avoid:
  - thin sections of existing steel
  - diagonals within boxes (and their rivets)
- bolt positions to be confirmed per location following further tactile survey. Bolts to not be positioned above deck level.
- black bolts assumed, in standard clearance bolt holes each side



Formwork + shoring required to prevent concrete leakage through holes

Extend of defect shown indicatively - to be verified by further tactile survey post-cleaning and debris removal

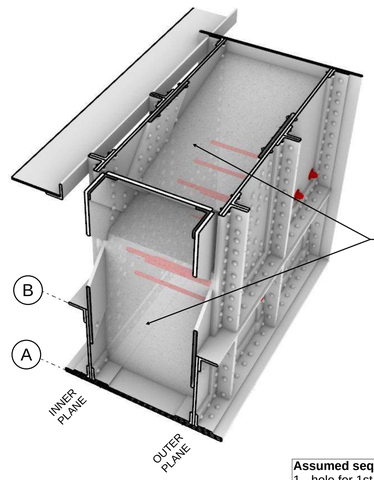
Span 4 South Elevation, Cornbrook End

Rivets from incoming compression diagonal within box

Purpose of rivets likely for connection of incoming transverse beam

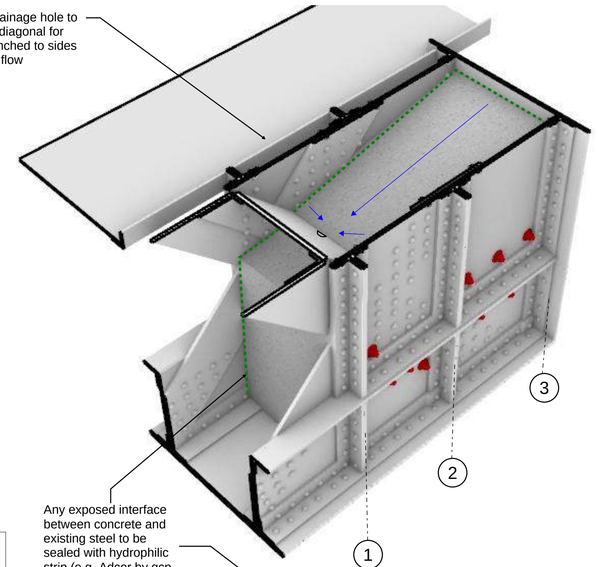
Note GL 1 vertical stiffener not supported on bearing
- extents of bearing TBC pending further debris clean and tactile survey

Purpose of rivets TBC: potentially for cross stiffener within box



Infill to be reinforced with A393 mesh to externally visible faces only
- minimum 50mm nominal cover

At conditions where compression diagonal (solid plate) intersects with concrete infill:
- 30mm dia half-round drainage hole to be drill centrally through diagonal for water discharge, infill benched to sides to encourage transverse flow



Any exposed interface between concrete and existing steel to be sealed with hydrophilic strip (e.g. Adcor by gcp, or equivalent)

Assumed sequence:
1 - hole for 1st bolt drilled into either inner or outer plane (leading hole)
2 - small diameter drill uses leading hole for a pilot hole in opposite plane, ensuring holes are aligned vertically / horizontally
3 - pilot hole enlarged on opposite plane
4 - 1st bolt installed and loosely tightened
5 - repeat for all bolts
6 - infill concrete poured
7 - bolts fully tightened

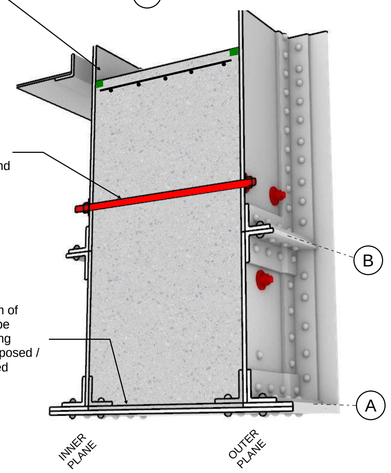
Span 4 South Elevation, Cornbrook End

Note fold in horizontal stiffener flange to run in front of vertical stiffener

Span 4 South Elevation, Cornbrook End

Horizontal hole to lower web panel, outer plane - extents of remaining sound steel to be reviewed pending further tactile survey

Debris in bottom of support box to be removed, existing bottom plate exposed / cleaned / painted



Concrete to be adequately compacted to ensure flow around bolt

DEFECT EXAMPLES

NTS

REMEDIAL DETAIL

NTS

NOTE: Existing structure assumed blasted, cleaned and re-painted prior to remedial installation. Refer to Proposed Remediation Schedule on sketch CVI-ARP-ZZ-ZZ-SK-S-3033.

NOTE: Rivet numbers and sizes shown indicatively. Typically assumed 7/8" (22.2mm) shank with holes (1/16" 1.6mm) greater than shank. Rivet heads assumed to project approx 20mm beyond face of connected plates.

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- Indicative packing plates
  - where required

NOTE:
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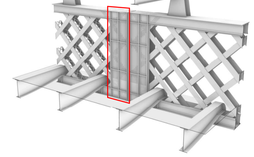
LOCATION / NUMBER OF REMEDIALS REQUIRED:
- 9No. required as below:
  Span 4 - North elevation, Deansgate end
  Span 4 - South elevation, Deansgate end
  Span 4 - South elevation, Cornbrook end
  Span 5 - South elevation, Cornbrook end
  Span 7 - North elevation, Cornbrook end
  Span 8 - North elevation, Deansgate end
  Span 8 - North elevation, Cornbrook end
  Span 8 - South elevation, Deansgate end
  Span 8 - South elevation, Cornbrook end
- Refer to Arup Principal Inspection & Assessment CVI-ARUP-ZZ-ZZ-RP-S-000001 for further background.

KEY PLAN:



Rev	Date	Chkd	Appd	Issue Notes
T1	09/09/25	RR	GH	1st issue

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Client
The National Trust

Project Title
Castlefield Viaduct
Phase 2

Drawing Title
Remedials
Truss End Supports
Concrete Infill Remedial

Scale at A1	Drawn By
NTS ated	EJM

Role: Structural

Status: S2 - For Information

Arup Job No	Rev
282210	T1

ID
CVI-ARUP-ZZ-ZZ-DR-S-4019

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Do not scale

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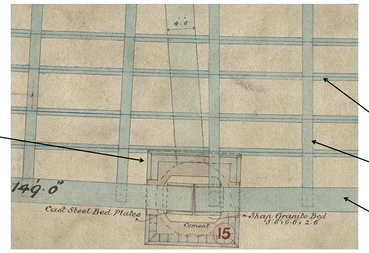
Truss end support boxes
- Access constraints - Sheet 1/2

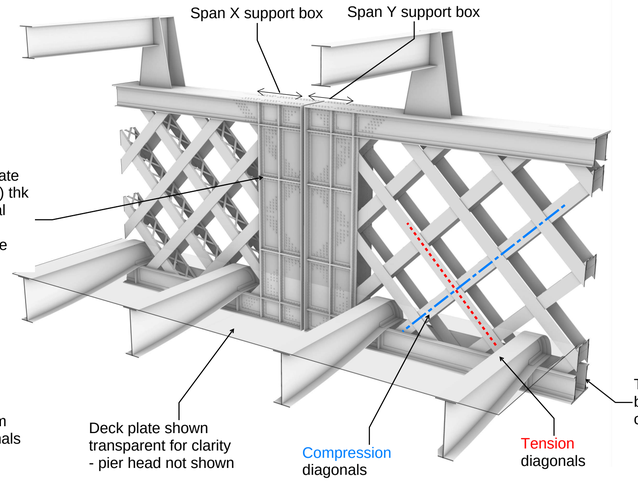
Castlefield Viaduct (282210)

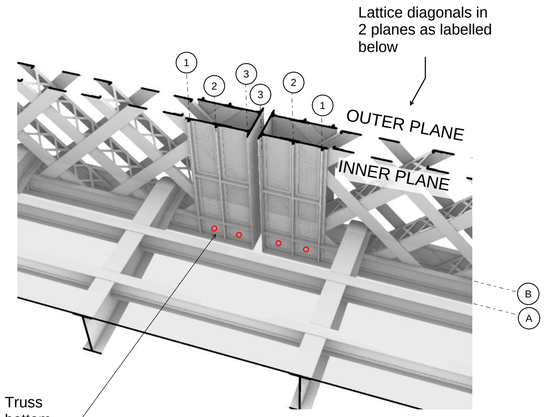
07/05/25 | Issued for Information | RR

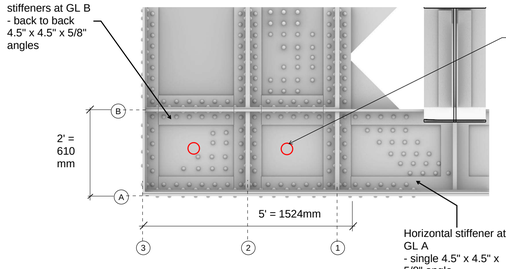
CVI-ARP-ZZ-ZZ-SK-S-3030 ARUP

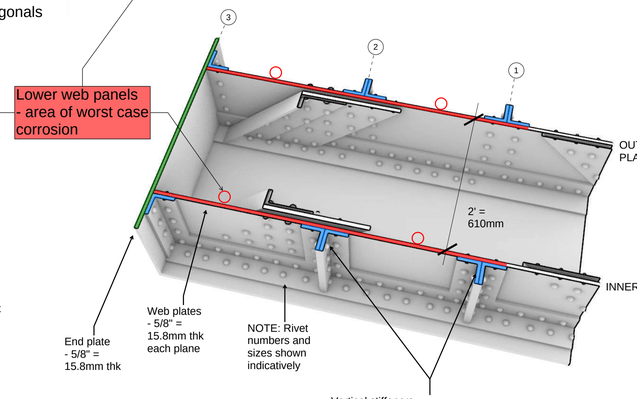
NOTES:
1. Refer to CVI-ARUP-ZZ-ZZ-RP-S-000001 for Principal Inspection + Assessment generally. Refer to Appendix B.2 for condition summary per truss support box
2. Refer to sketches CVI-ARUP-ZZ-ZZ-SK-S-3031 + 3032 for truss support box remedial options









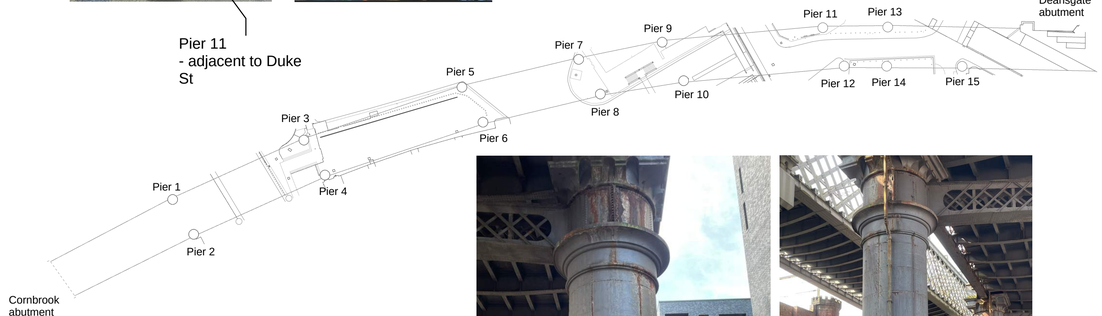


TYPICAL ARRANGEMENT

NTS

PIERS - HEAD CONSTRAINTS

NTS



PIERS - BASE CONSTRAINTS

NTS

Truss end support boxes
- Access constraints - Sheet 2/2

Castlefield Viaduct (282210)

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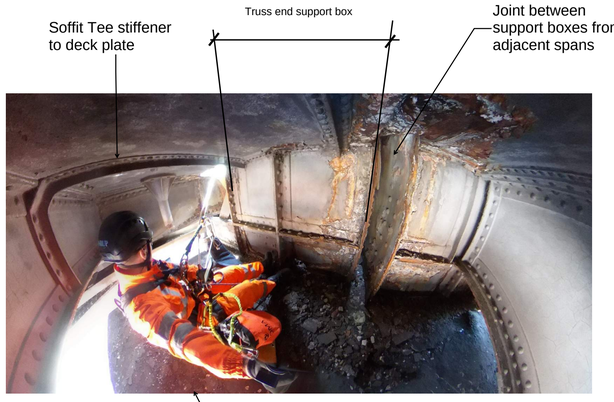
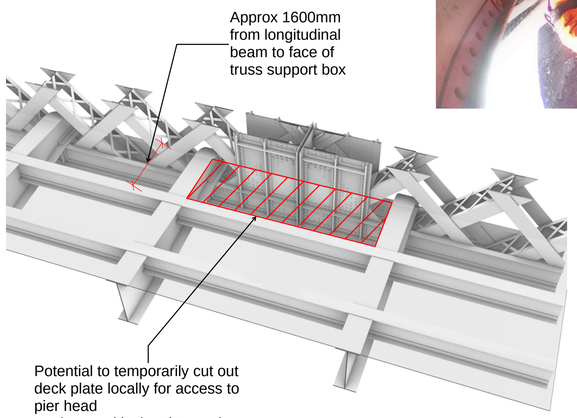
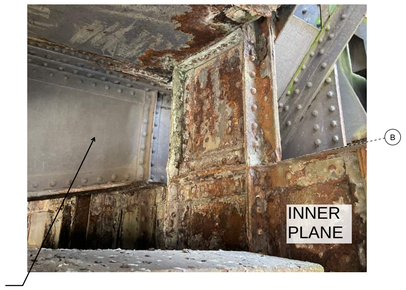
CVI-ARP-ZZ-ZZ-SK-S-3030

ARUP

NOTES:
1. Refer to CVI-ARUP-ZZ-ZZ-RP-S-000001 for Principal Inspection + Assessment generally. Refer to Appendix B.2 for condition summary per truss support box
2. Refer to sketches CVI-ARUP-ZZ-ZZ-SK-S-3031 + 3032 for truss support box remedial options

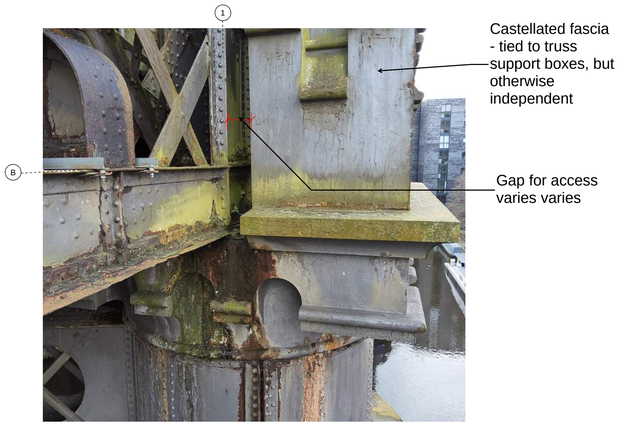


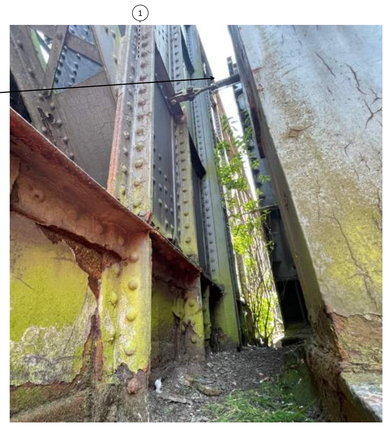


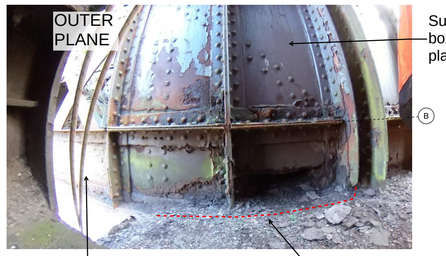


INNER PLANE REMEDIALS - CONSTRAINTS

NTS







OUTER PLANE REMEDIALS - CONSTRAINTS

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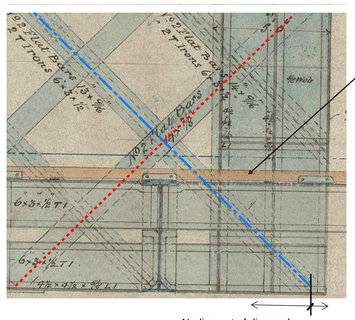
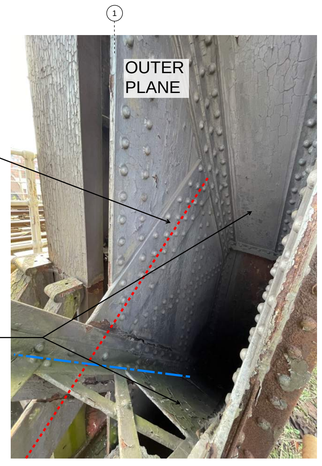
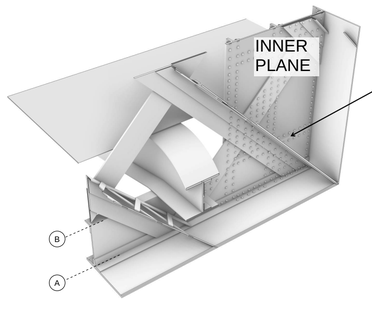
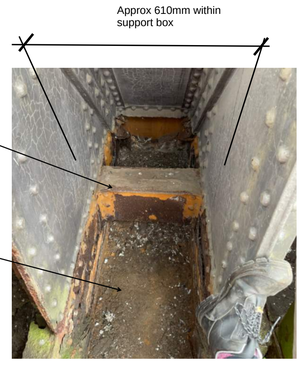


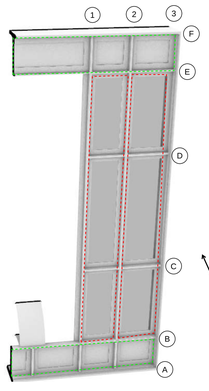


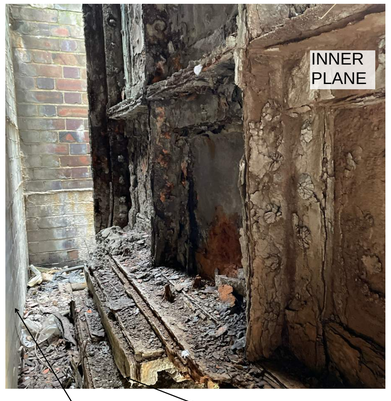


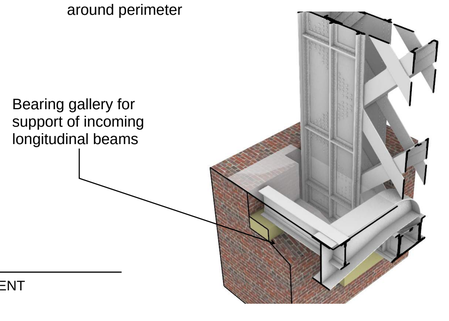


CONSTRAINTS WITHIN SUPPORT BOX

NTS







CONSTRAINTS AT ABUTMENT

NTS; DRAWN FOR CORNBROOK ABUTMENT

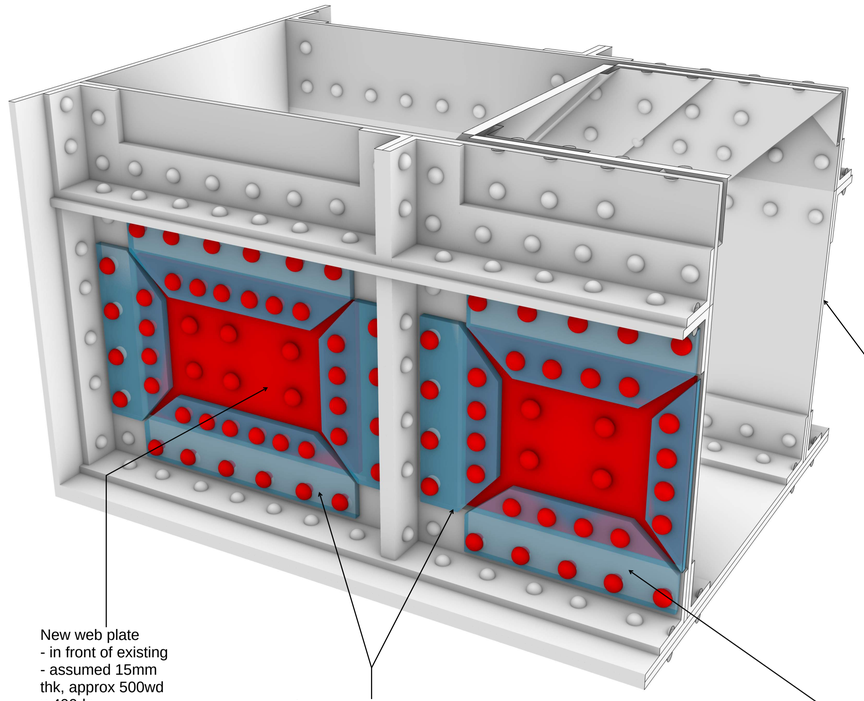
Holes to bottom of lower panels

Hole to bottom of lower panel

Holes to bottom of lower panels

LOWER PANEL CONDITION

NTS; EXTRACT FROM APPENDIX B.2 CVI-ARUP-ZZ-ZZ-RP-S-00001



New web plate
- in front of existing
- assumed 15mm thk, approx 500wd x 400dp

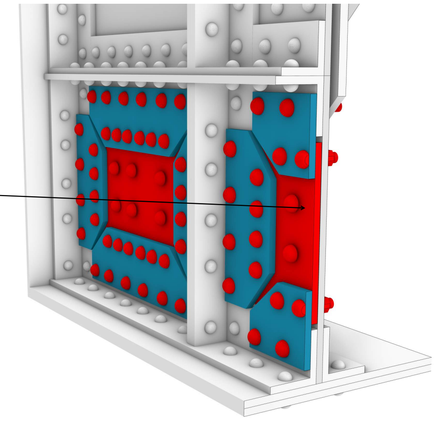
Lapping plates
- to all 4 sides
- assumed 15mm thk, approx 175mm wd

New dome-headed M24 HSFG bolts
- at lapping plates: sequential process envisaged with removal of existing rivets, pinning with temporary rods, fitting over new lap plates then
- also required centrally within panel to tie into existing web panel
- numbers shown approximately

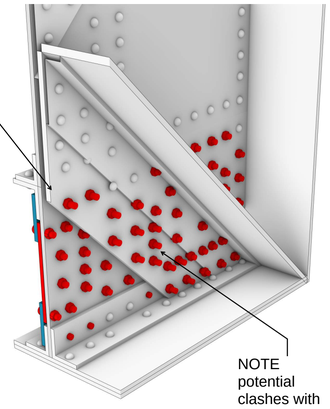
Similar remedial required this side
- not shown for clarity

CONVENTIONAL REMEDIAL OPTION

NTS



New web plate tight against existing



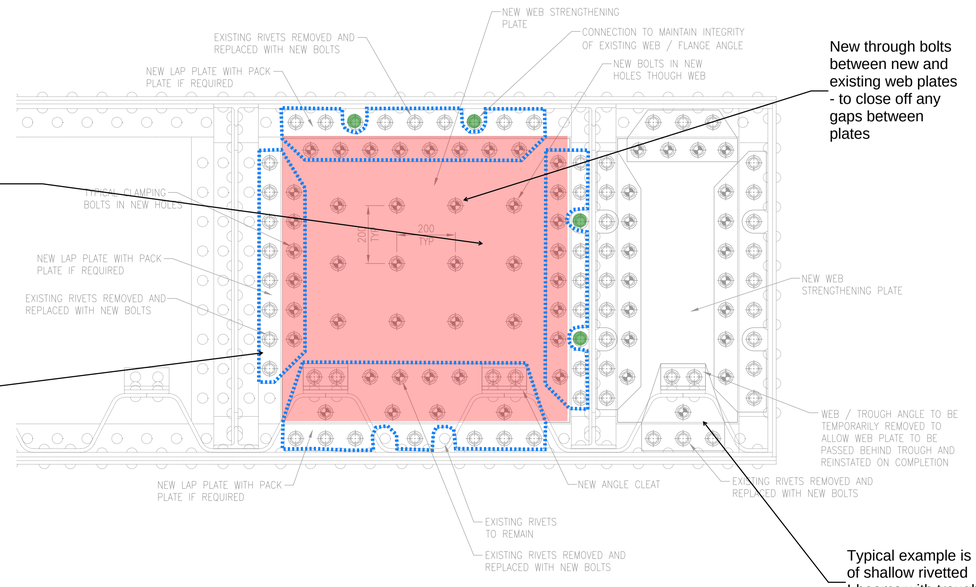
Feasibility of access nuts within box for torquing HSFG bolts? To be reviewed

NOTE potential clashes with diagonals and their rivets
- will vary per truss end
- implications to be reviewed

PROS
- follows industry-standard typical detail in Network Rail guidance documents
- reinstatement closely follows original design intent
- new web plate pushed as close to existing as possible: minimises eccentricities

CONS
- assumes all rivets sequentially removed for new lap plates: potential temporary works required for support during removal + consequent lots of access required within box
- prevents future access to original steelwork behind: potentially creates water trap thus encouraging further corrosion

AREAS FOR DESIGN DEVELOPMENT
- impact of providing single-sided remedial only (typical details provide symmetric new web plates to each side)
- typical detail doesn't envisage arrangements like Castlefield Viaduct truss end support boxes, with large vertical plates positioned above those to be remediated.
- investigate options for new bolts which only require access to one side
- investigate potential number of existing rivets which can be safely removed at any time



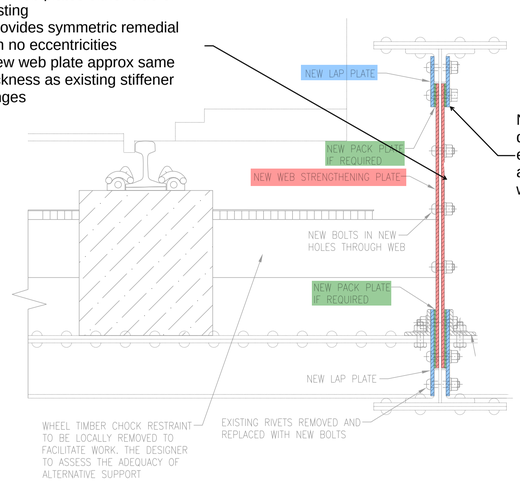
Web strengthening plate
- same each side of existing

New lap plates
- fixed around perimeter on top of existing framing angles
- requires sequential process of rivets being removed and replaced with new bolts

New through bolts between new and existing web plates
- to close off any gaps between plates

Typical example is of shallow rivetted I-beams with trough deck

New web plates either side of existing
- provides symmetric remedial with no eccentricities
- new web plate approx same thickness as existing stiffener flanges



New lap plates run directly from existing stiffener angles onto new web plate

CONVENTIONAL REMEDIAL OPTION - PRECEDENT

NTS; MARKED-UP EXTRACTS FROM NETWORK RAIL NR/CIV/SD/TUM/800 REV F

NOTES:
1. Refer to CVI-ARUP-ZZ-ZZ-RP-S-000001 for Principal Inspection + Assessment generally. Refer to Appendix B.2 for condition summary per truss support box
2. Refer to sketch CVI-ARP-ZZ-ZZ-SK-S-3030 for support box access constraints.
3. Refer to sketch CVI-ARP-ZZ-ZZ-SK-S-3032 for alternative remedial options.

Truss end support boxes
- Conventional remedial option

Castlefield Viaduct (282210)

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CVI-ARP-ZZ-ZZ-SK-S-3031

ARUP

Truss end support boxes
- Alternative remedial options

Castlefield Viaduct (282210)

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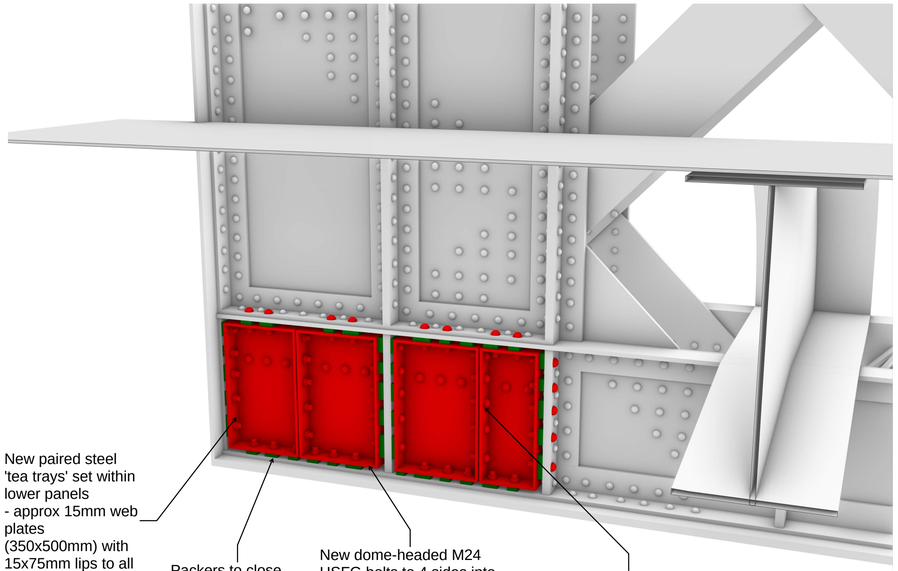
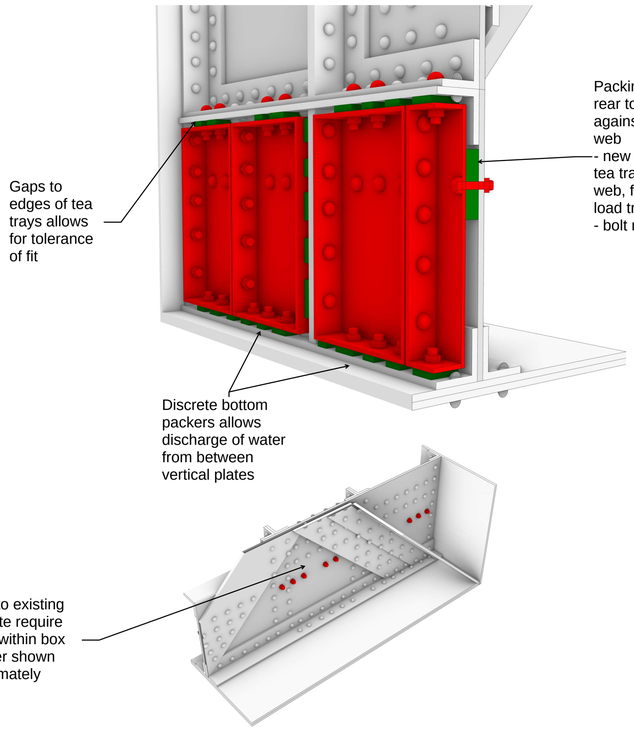
CVI-ARP-ZZ-ZZ-SK-S-3032

ARUP

NOTES:
1. Refer to CVI-ARUP-ZZ-ZZ-RP-S-000001 for Principal Inspection + Assessment generally. Refer to Appendix B.2 for condition summary per truss support box
2. Refer to sketch CVI-ARP-ZZ-ZZ-SK-S-3030 for support box access constraints.
3. Refer to sketch CVI-ARP-ZZ-ZZ-SK-S-3031 for conventional remedial option.



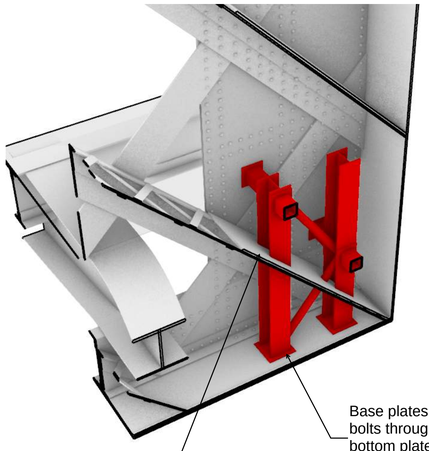


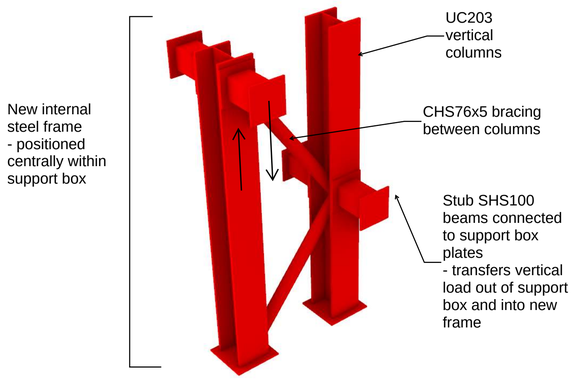
PROS
- minimal access required within box
- avoids sequential removal of rivets as in conventional remedial
- spaced-off existing web plates to allow separation for water management

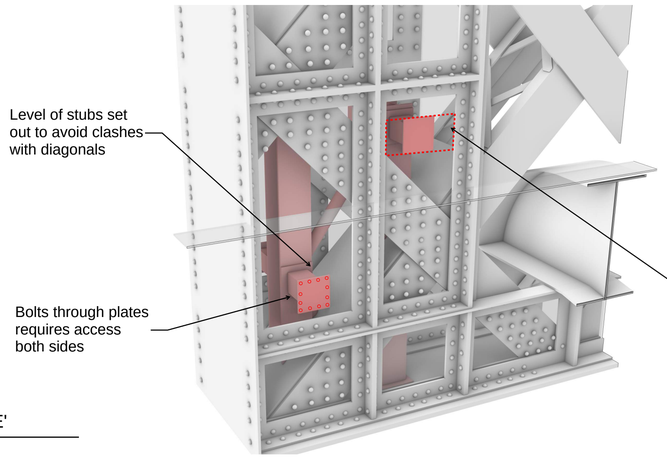
CONS
- prohibits future access to original steelwork behind: proposes paired plates to allow for sequential future removal if required
- tea tray spaced off existing plates, increases resulting eccentricities versus conventional remedial. Means horizontal bolts in bending and shear.
- bolting around perimeter of tea tray requires new holes through existing stiffening angles, potentially weakening existing structure

AREAS FOR DESIGN DEVELOPMENT
- review implications of single-sided support and consequent eccentricities. Possible need for more vertical stiffeners
- review provision of bolts providing load transfer directly into existing web plate.

ALTERNATIVE A - 'TEA TRAYS'
NTS





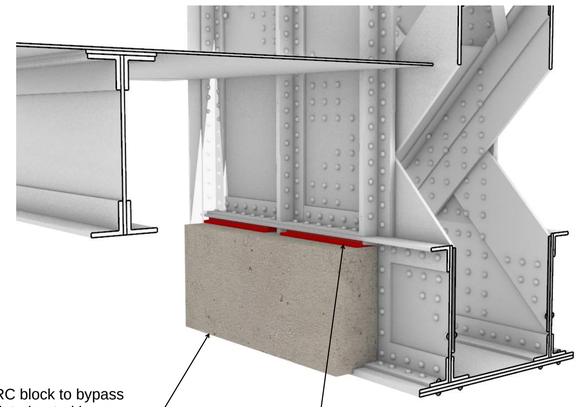


PROS
- minimal access required to outside faces
- good for tolerance
- good for future access to outside faces
- sympathetic aesthetically: discrete + hidden
- no need to remove existing rivets

CONS
- clashes with diagonal solid plate
- requires more access within support box
- no support offered to horizontal + vertical stiffeners; load transfer from web plates only

AREAS FOR DESIGN DEVELOPMENT
- replacement of lost shear stiffness to bottom panels
- impact of shifting loads from outer + inner planes to centreline of truss

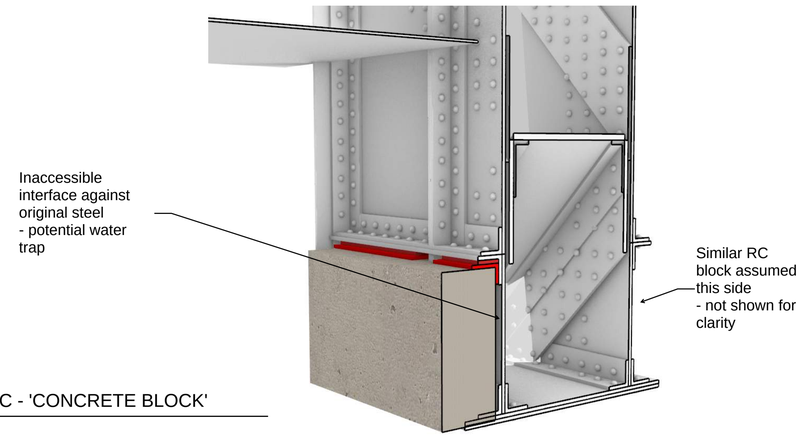
ALTERNATIVE B - 'INTERNAL FRAME'
NTS



PROS
- cost effective
- no need to remove existing rivets

CONS
- prevents future access to original steelwork behind: potentially creates water trap thus encouraging further corrosion
- visible and not heritage sympathetic
- not removable, for instance in case of need for future reinstatement of steelwork as new

AREAS FOR DESIGN DEVELOPMENT
- impact of providing no direct support to web panels



ALTERNATIVE C - 'CONCRETE BLOCK'
NTS

Truss end support boxes
- Proposed Remediation Schedule

Castlefield Viaduct (282210)

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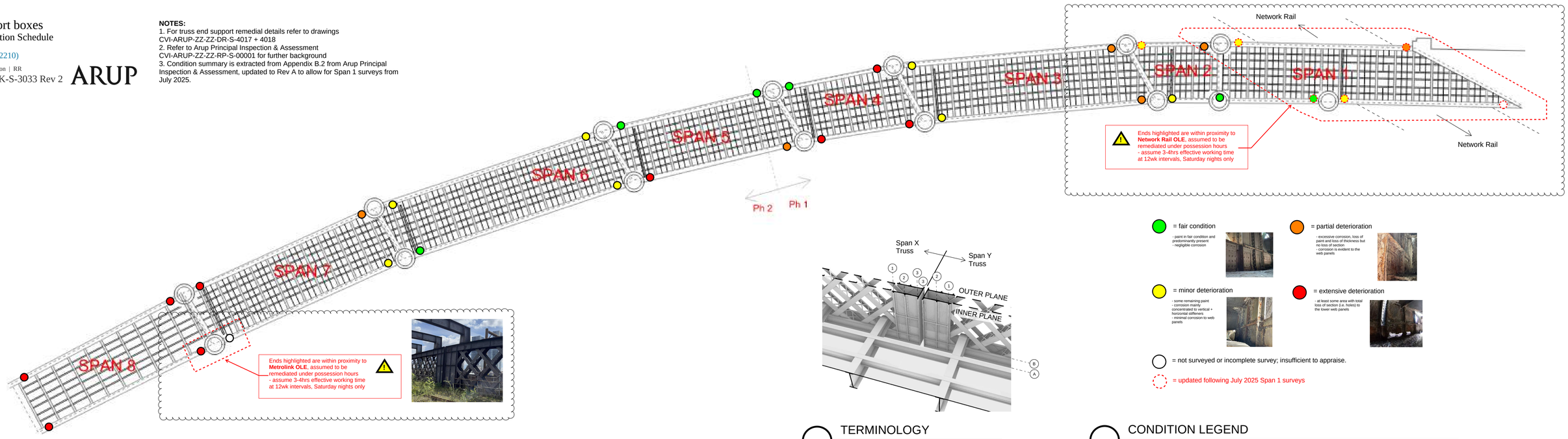
CVI-ARP-ZZ-ZZ-SK-S-3033 Rev 2

ARUP

NOTES:
1. For truss end support remedial details refer to drawings CVI-ARUP-ZZ-ZZ-DR-S-4017 + 4018
2. Refer to Arup Principal Inspection & Assessment CVI-ARUP-ZZ-ZZ-RP-S-00001 for further background
3. Condition summary is extracted from Appendix B.2 from Arup Principal Inspection & Assessment, updated to Rev A to allow for Span 1 surveys from July 2025.



TERMINOLOGY

NTS

- = fair condition
  - paint in fair condition and predominantly present
  - negligible corrosion

- = partial deterioration
  - excessive corrosion, loss of paint and loss of thickness but no loss of section
  - corrosion is evident to the web panels

- = minor deterioration
  - some remaining paint
  - corrosion mainly concentrated to vertical + horizontal stiffeners
  - minimal corrosion to web panels

- = extensive deterioration
  - at least some area with total loss of section (i.e. holes) to the lower web panels

- = not surveyed or incomplete survey; insufficient to appraise.
- = updated following July 2025 Span 1 surveys

CONDITION LEGEND

NTS; CONDITION IS APPRAISED OVERALL PER TRUSS AGAINST REFERENCE EXAMPLES ABOVE; AS A SIMPLIFIED CONSERVATISM THE WORST CASE PLAN DICTATES THE OVERALL CONDITION FOR AN END

TRUSS END SUPPORT BOXES - CONDITION SUMMARY

NTS; SEE NOTE 3

Condition	No.	Clean	Debris	S.I	Paint	Remediate
White	2					
Green	6		✓			
Yellow	10		✓			
Amber	6	✓	✓		✓	
Red	9	✓	✓	✓	✓	✓

Σ = 33

Notes:						
	- Includes July '25 Span 1 surveys	- Clean = surface preparation for retained steel - Mechanical prep to St3 - Before debris removal to avoid re-visits - Cleaning ambers allows for confirmation they're not reds	- Brushing down deposited rust and other debris from pier head, to inner and outer planes	- S.I (Special Inspection by Arup) needs removal of rust - Focusing only on reds, i.e. those to be remediated	- Follows shortly after S.I (to avoid need for re-cleaning)	- As per Arup remedial details 4017 + 4018

NOTE: to BS EN 8501-1

NOTE: number unchanged from Arup Principal Inspection + Assessment

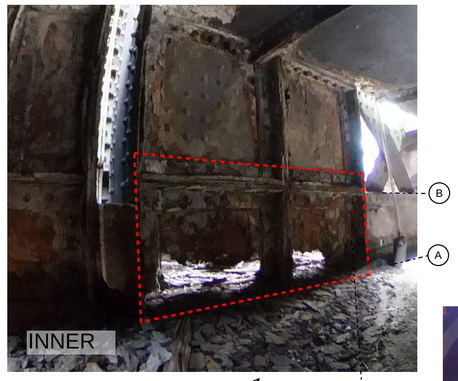
PROPOSED REMEDIATION SCHEDULE

NTS; SEE NOTE 3

Reference examples of debris to be removed
- sufficient for S.I
- to avoid risk of falling debris to public

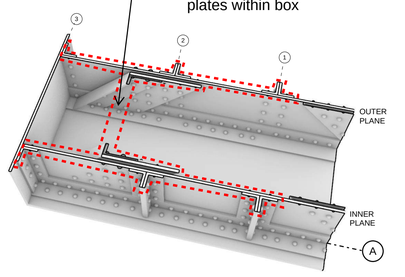
DEFINITIONS - DEBRIS REMOVAL

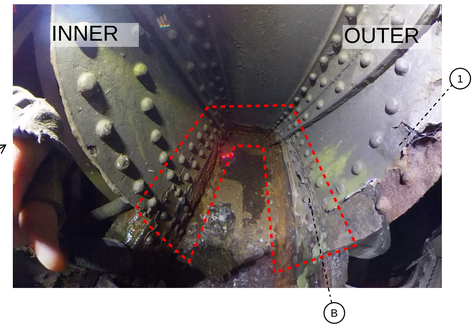
NTS



Clean (surface preparation) to extents shown
- feasibility of access within box to be reviewed
- paint finish E1 as per Arup Steelwork Specification (CVI-ARUP-ZZ-ZZ-SP-S-000007)

Allow for compression diagonals as solid plates within box





DEFINITIONS - PAINTING

NTS

Truss end support boxes
- Condition summary

Castlefield Viaduct (282210)

CVI-ARUP-ZZ-ZZ-RP-S-000001
Appendix B.2 - Rev A

ARUP

NOTES

1. Summary below show best available photographs for each truss support box, as from Arup 2025 Inspection. Incomplete survey alternatively due to poor access or limitations of survey. NOTE: updated Aug 2025 to include Span 1 survey (under possession), with red borders on relevant photographs.
2. Condition rating is based on summary photographs, Arup Fieldwire reports, and Arup surveyor commentary.
3. Condition rating is a subjective qualitative assessment. Ratings may be re-appraised more negatively or positively pending further surveys.

CONDITION LEGEND

- Condition is appraised overall per truss end against the reference examples below
- As a simplified conservatism, the worst case plane dictates the overall condition for an end

= fair condition
- paint in fair condition and predominantly present
- negligible corrosion

= partial deterioration
- excessive corrosion, loss of paint and loss of thickness but no loss of section
- corrosion is evident to the web panels

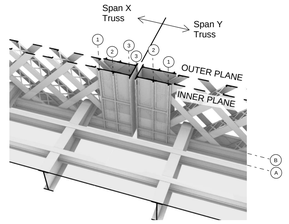
= minor deterioration
- some remaining paint
- corrosion mainly concentrated to vertical + horizontal stiffeners
- minimal corrosion to web panels

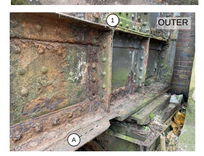
= extensive deterioration
- at least some area with total loss of section (i.e. holes) to the lower web panels

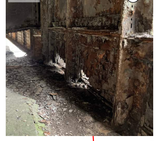
= not surveyed or incomplete survey; insufficient to appraise.

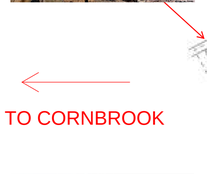
= Rev A update to condition appraisal

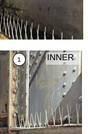
TERMINOLOGY

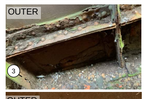












ARUP

Appendix B – 1870s Viaduct

Castlefield Viaduct - Phase 2
Truss End Support Boxes – Remedial Options Appraisal

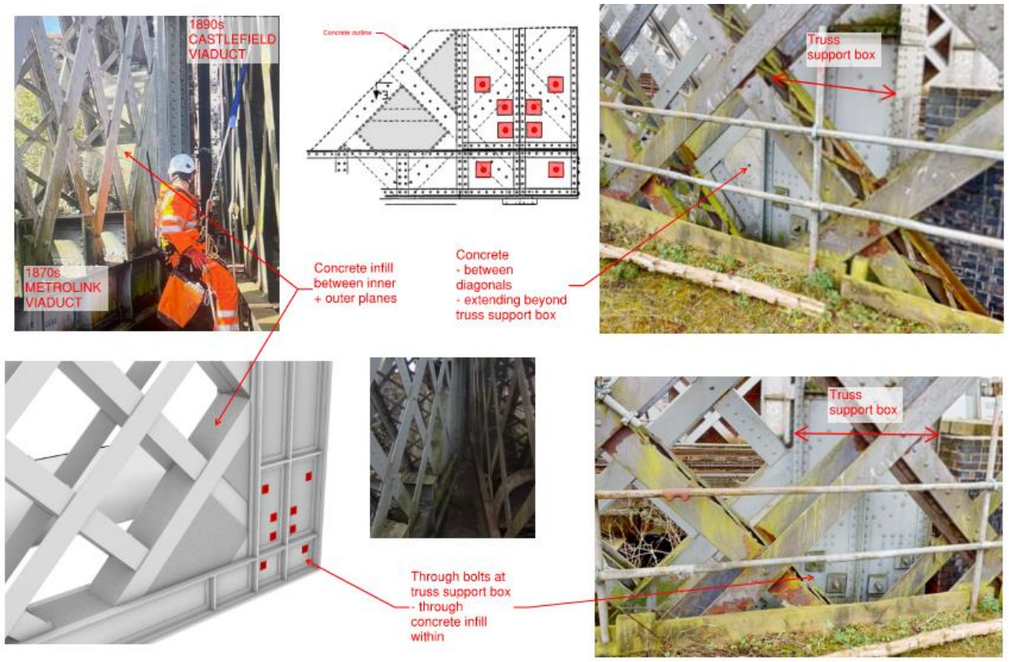
APPENDIX B - 1870s VIADUCT

Overview

- The Castlefield Viaduct dates from the 1890s but is the youngest of the 3 parallel viaducts running above Castlefield in Central Manchester.
- Immediately to the south of the Castlefield Viaduct is the 1873 Cheshire Lines Committee (CLC) Liverpool Railway (‘1870s Metrolink viaduct’). Further south beyond this, and a lower level, is the 1846-1849 Manchester South Junction & Altrincham Railway (‘1840s Rail Viaduct’).
- As can be seen from the top image opposite, in its two spans over the Bridgewater Canal the 1870s viaduct has a similar configuration to the later Castlefield Viaduct: paired lattice trusses, with steel diagonals, and with truss end support boxes at the piers and abutments.
- All 3 viaducts are grade II listed. The 1870s and 1890s viaducts, however, have been confirmed to share the same listing (see MCC Planning Service advice dated May 2021, included as Appendix A to Purcell’s Statement of Historical Significance for Castlefield Viaduct Phase 1). For the shared listing, the structures appear to have been first scheduled in 1988 according to the Historic England Official List Entry, and most recently amended in 1994.

1990s Metrolink Works

- Archive drawings for the 1870s viaduct have been available through Transport for Greater Manchester (TfGM). The 15No. drawings date from the 1990s, are listed on the following page, and are included in this Appendix B.
- The drawings, by consultant WS Atkins, cover a suite of repair and strengthening works for the two lattice diagonal spans of the 1870s viaduct. Working on behalf of Metrolink these works were presumably required prior to the introduction of the two tram lines between Cornbrook and Deansgate, which continue to operate today.
- The 1990s works involved significant works to the 1870s viaduct including repairs to the lattice diagonals and the additional of a new concrete slab over the original steel deck. The bottom chords of the trusses were also infilled with concrete.
- The drawings also show remedials to the truss support boxes. Through-bolts were added between the two planes of the support boxes. The support box was then infilled with concrete. Current survey photos confirm the extent of the concrete, extending out beyond the support box and upwards above the deck, and the large washers on the through-bolts visible to the outside of the support box.
- It is highly likely the 1870s viaduct had the same/similar defects to the bottom panels of the truss support boxes as documented at the Castlefield Viaduct. The through-bolts and concrete infills are a method of bypassing the defective areas and reinstating load capacity.
- Given the continued function of the 1870s viaduct to carry Metrolink trams more than 30 years after remediation, this support box concrete infill seems a useful precedent to guide remedials to the 1890s Castlefield Viaduct.



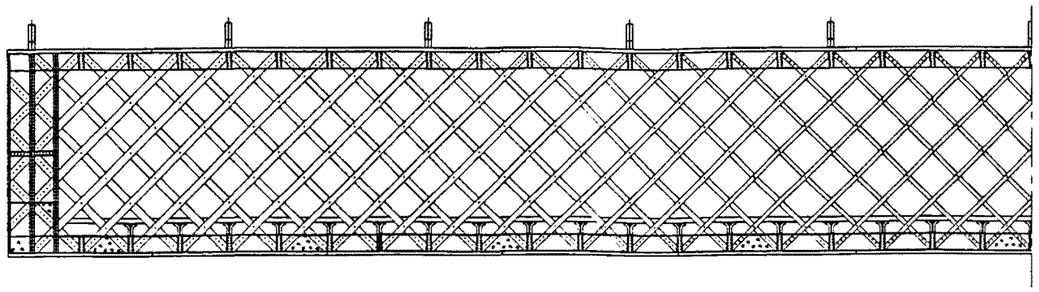
Castlefield Viaduct - Phase 2

Truss End Support Boxes – Remedial Options Appraisal

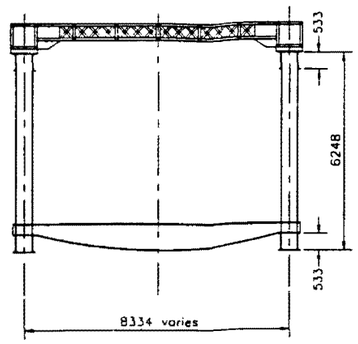
APPENDIX B - 1870s VIADUCT

Document List

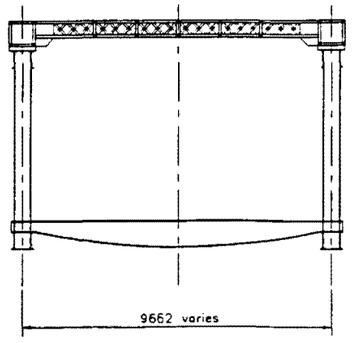
- **R0456 / MWO / 2342**
  - Bridge A47, Span 284A, Deck General Arrangement And Location Of Remedial Works
- **R0456 / MWO / 2343**
  - Bridge A47, Span 284B, Deck General Arrangement And Location Of Remedial Works
- **R0456 / MWO / 2345**
  - Bridge A47, Span 284A, Trackslab And Drainage, GA And RC Details
- **R0456 / MWO / 2346**
  - Bridge A47, Span 284B, Trackslab And Drainage, GA And RC Details
- **R0456 / MWO / 2347**
  - Bridge A47, Central Pier, Remedial Works, Sheet 1
- **R0456 / MWO / 2348**
  - Bridge A47, Central Pier, Remedial Works, Sheet 2
- **R0456 / MWO / 2349**
  - Bridge A47, Spans 284A -284B, Abutments – Remedial Works
- **R0456 / MWO / 2352**
  - Bridge A47, Replacement Bearings At Abutments
- **R0456 / MWO / 2353**
  - Bridge A47, Replacement Bearings
- **R0456 / MWO / 2355**
  - Bridge A47, Span 284A, Tie Beam & Ballast Wall, GA & RC Details
- **R0456 / MWO / 2356**
  - Bridge A47, Span 284B, Tie Beam & Ballast Wall, GA & RC Details
- **R0456 / MWO / 2357**
  - Bridge A47, Spans 284A - 284B, Metal Repair Details, Sheet 1
- **R0456 / MWO / 2358**
  - Bridge A47, Spans 284A - 284B, Metal Repair Details, Sheet 2
- **R0456 / MWO / 2359**
  - Bridge A47, Span 284A, Location Of Remedial Works
- **R0456 / MWO / 2360**
  - Bridge A47, Span 284B, South Girder As Built Repairs



HALF INNER ELEVATION OF NORTH GIRDER

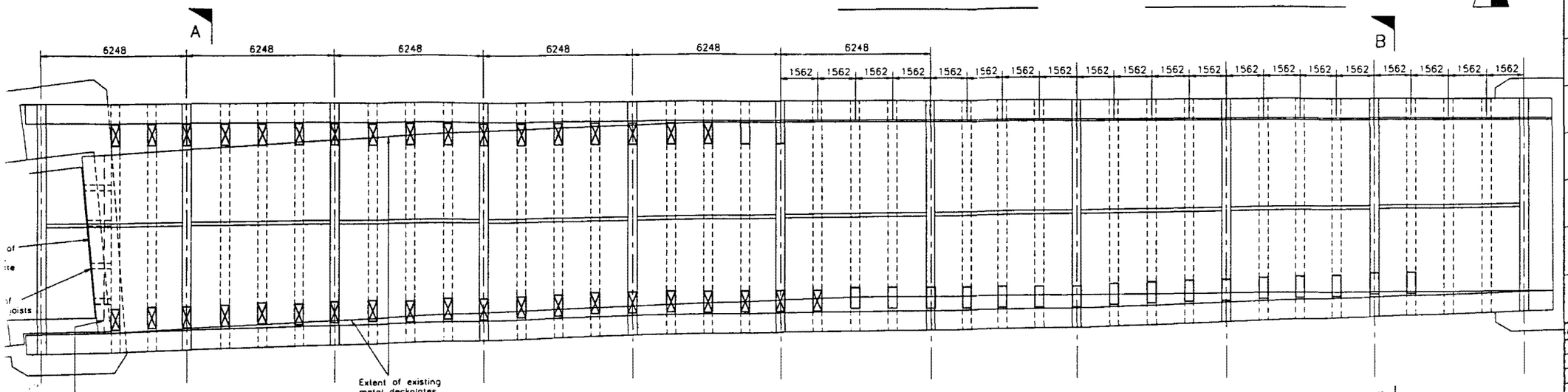


SECTION ON B-B



SECTION ON A-A

SITE NORTH



PLAN

NOTE. Any other element of the structure suffering 20% loss of section is to be reported to W.S. Atkins Consultants Limited.

FOR DETAILS OF REMEDIAL WORKS TO NORTH AND SOUTH GIRDERS REFER TO DRG No R0456/MWO/2359

CB0199A11
CSW WKS 012
TECH. OFFICE

WS/Atkins

NOTES :

1. All dimensions are in millimetres.
2. For details of the remedials to Span 284B see drawing no. 2343 and 2360.
3. For metal repair details see drg nos. 2357, 2358 and 2359.
4. All replacement steelwork to be Grade 43 unless noted otherwise.
5. All rivets must be checked against MR11
6. For protective treatment refer to Bridge A47 Painting Condition Report and Bridge A47 Coating Specification.

KEY

- ☒ Fish belly girder repairs (MR11)
- ☐ Bolt replacement to Fish belly girder top flange

Rev	Description	By	Date	Ch'd	Auth
B	FISH BELLY REPAIRS SHOWN SOUTH GIRDER ELEVATION REMOVED	GK	JAN 92		
A	FIRST ISSUE	LJC	AUG 90	RAM	AGC
	REV B – AS BUILT				
	REV A WSA TO MOWLEM FOR CONSTRUCTION				AGC
	REV A WSA TO MOWLEM FOR PLANNING				AGC
	Issued only for purpose above		By	Date	

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Consulting Engineers,
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Epsom, Surrey, England.
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Tel. (0372) 726140

GREATER MANCHESTER PASSENGER TRANSPORT EXECUTIVE
METROLINK
9 PORTLAND PLACE, PICCADILLY GDNS, MANCHESTER, M60 1HX

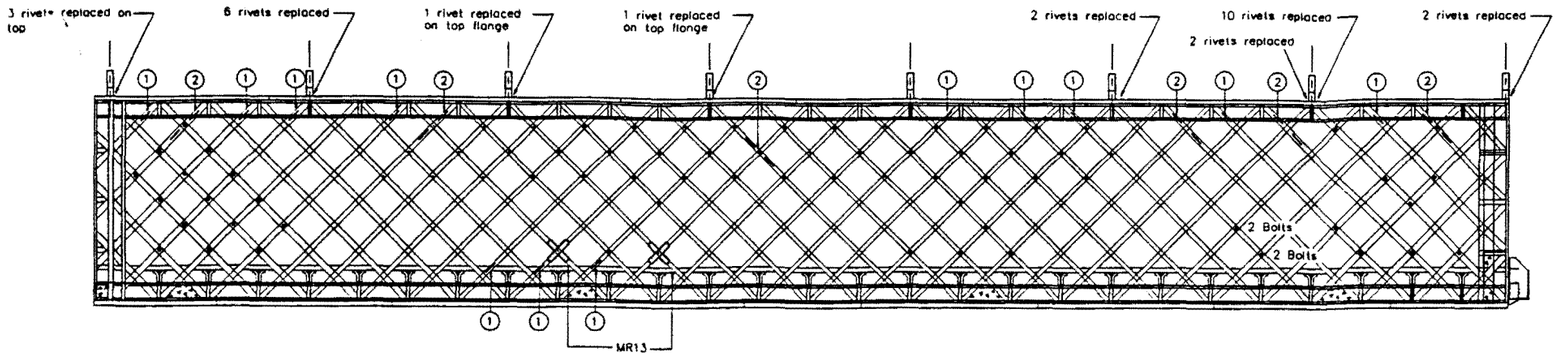
Title
BRIDGE A47
SPAN 284A
DECK GENERAL ARRANGEMENT AND LOCATION OF REMEDIAL WORKS

Original Scale	Drawn	Checked	Authorised
1:100	LJC		
	Date AUG 90	Date 6.7.93	Date 7/7/93

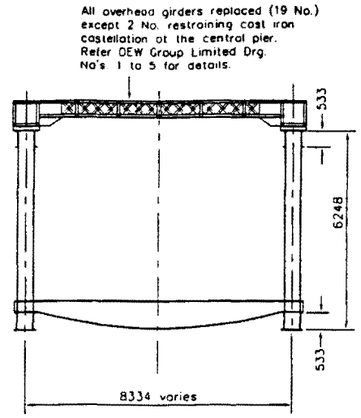
Drawing Number: R0456 / MWO / 2342
Rev: B / Z

Job Dept

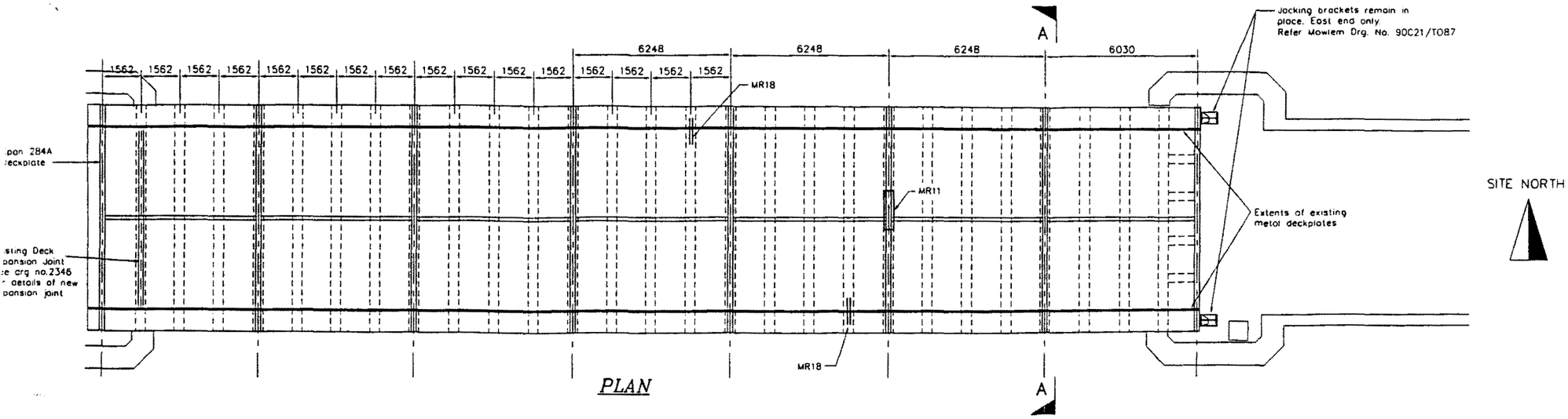
Drawing Number R0456 / MWO / 2342 B



INNER ELEVATION OF NORTH GIRDER

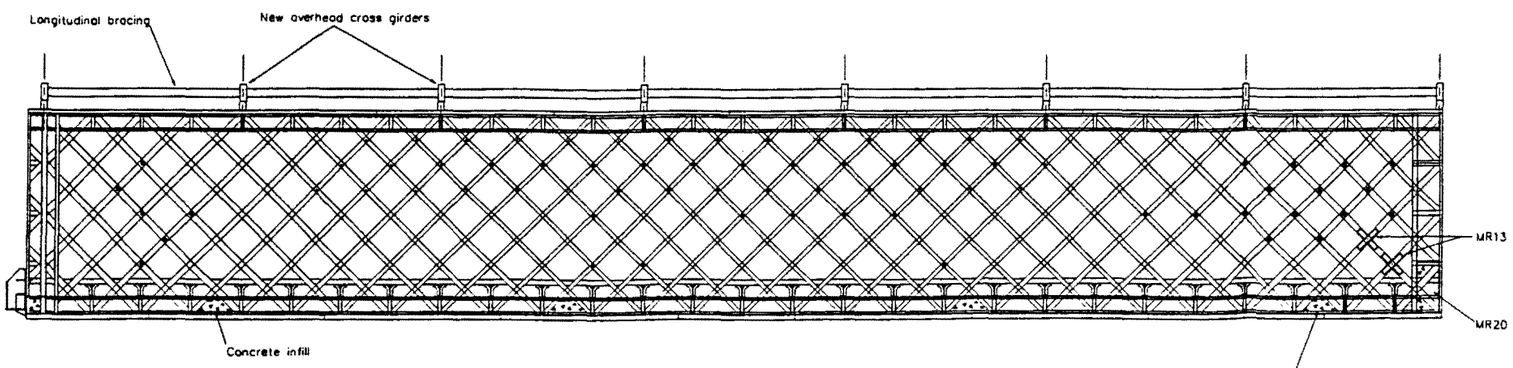


SECTION ON A-A



PLAN

SITE NORTH



OUTER ELEVATION OF NORTH GIRDER

C B 0 2 0 0 A 1 1

CSW WKS 012

TECH. OFFICE

WS/Atkins

NOTES :

1. All dimensions are in millimetres.
2. For details of the remedials to Span 284A see drawing no. 2342.
3. For metal repair details see drg no. 2357 & 2358
4. All replacement steelwork to be Grade 43 unless noted otherwise.
5. All rivets must be checked against MR11
6. For protective treatment refer to Bridge A47 Painting Condition Report and Bridge A47 Cooling Specification
7. For South Girder elevation repairs refer Drg. No. R0456/MWO/2360

KEY

(2) Locing Bars (25 No.) Number replaced on member shown

MR13 Repairs (4 No.)

• Rivet Replacement (99 No.)

Rev.	Description	By	Date	Ch'd	Auth
C	METAL WORK REPAIRS SHOWN	GH	JAN 93		
B	EXTENTS OF LATTICE GIRDER INSPECTION DEFINED	LJC	SEP 90	RAM	AGC
A	FIRST ISSUE	LJC	AUG 90	RAM	AGC

REV C AS BUILT

REV B WSA TO MOWLEM FOR CONSTRUCTION AGC 26/4

REV A WSA TO MOWLEM FOR PLANNING AGC 23/8

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GREATER MANCHESTER PASSENGER TRANSPORT EXECUTIVE

METROLINK

9, PORTLAND PLACE, PICCADILLY GDNS, MANCHESTER, M60 1HX

Title

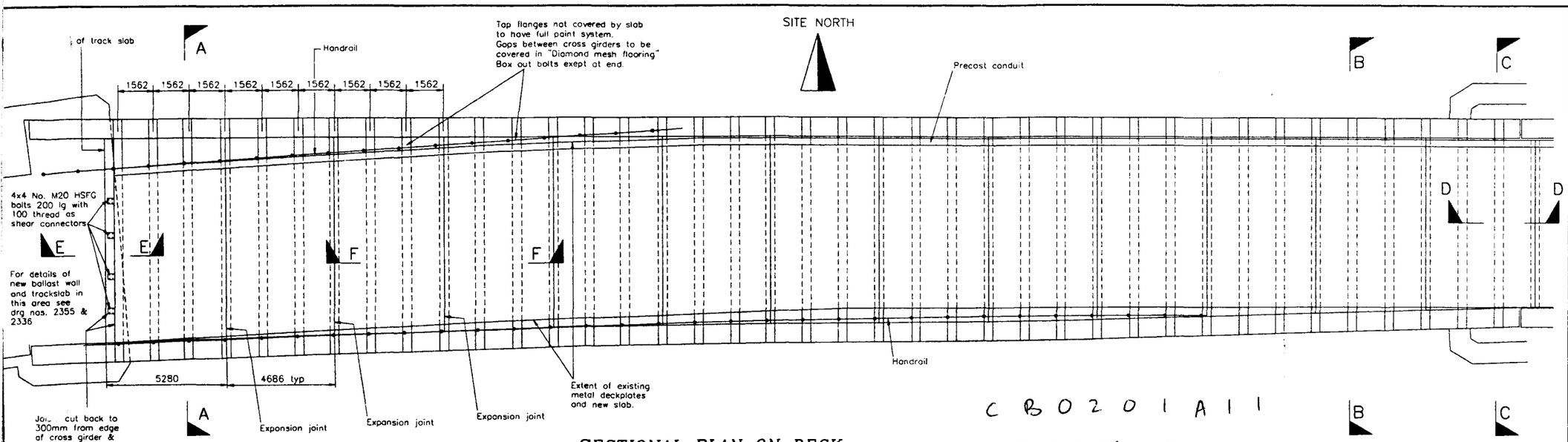
BRIDGE A47
SPAN 284B
DECK GENERAL ARRANGEMENT AND REMEDIAL WORKS

Original Scale	Drawn	Checked	Authorised
1:100	LJC		
	Date AUG 90	Date 6.7.93	Date 19.1.93

Drawing Number: R0456 / MWO / 2343 (Job / Dept.)

Rev C (Issue 2)

R0456 / MWO / 2343 C 2

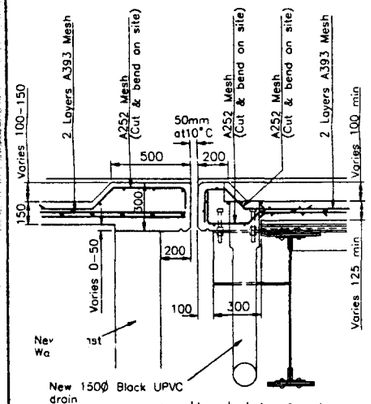


SECTIONAL PLAN ON DECK
(Scale 1:100)

C B 0 2 0 1 A 1 1

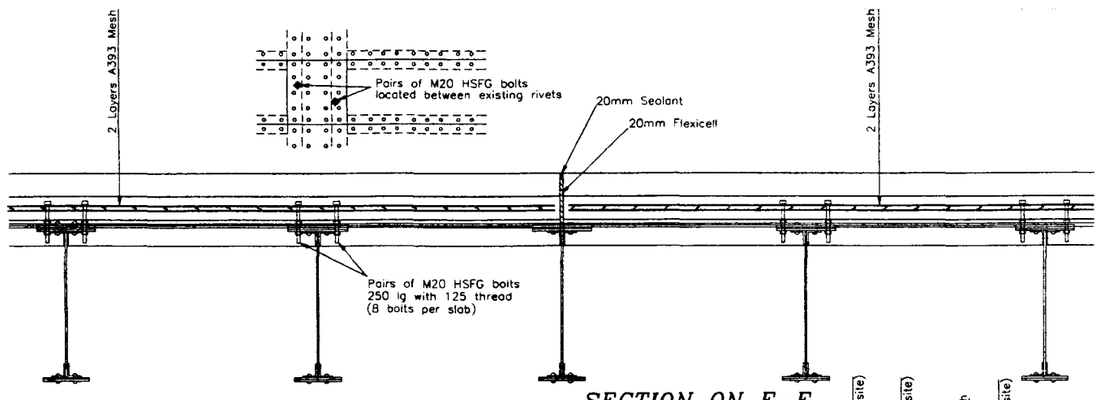
CSW WKS 012

TECH. OFFICE

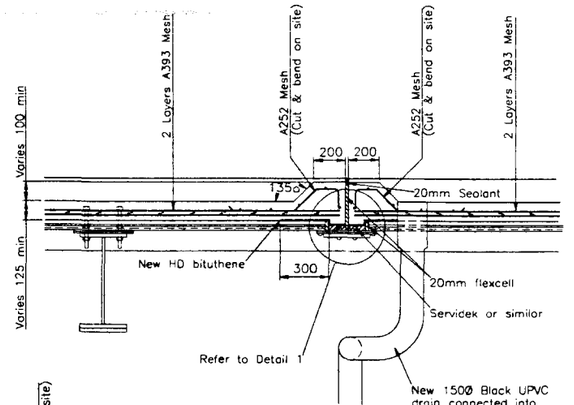


Plan

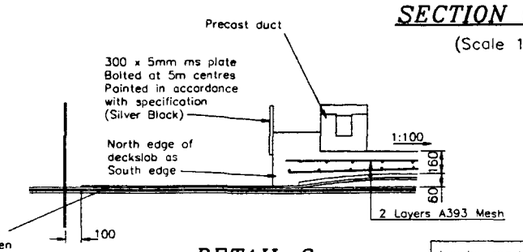
SECTION E–E
(Scale 1:20)



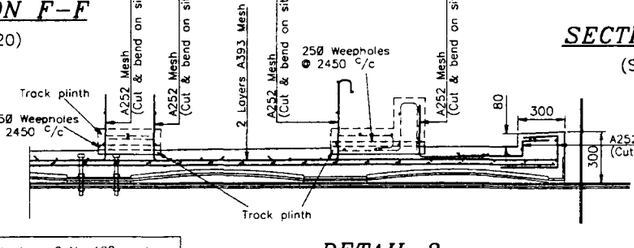
SECTION ON F–F
(Scale 1:20)



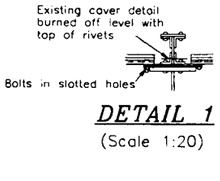
SECTION ON D–D
(Scale 1:20)



DETAIL 2
(Scale 1:20)

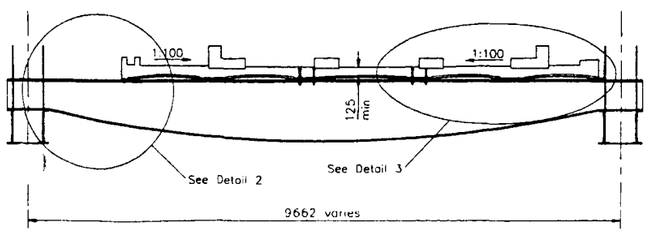


DETAIL 3
(Scale 1:20)

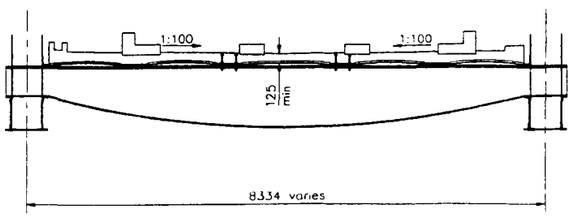


DETAIL 1
(Scale 1:20)

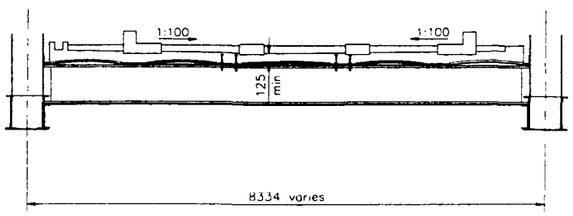
Lapping sheets to have 2 No 100mm long lap welds per 4.8m for soil continuity.



SECTION ON A–A
(Scale 1:50)



SECTION ON B–B
(Scale 1:50)



SECTION ON C–C
(Scale 1:50)

NOTES.

1. All dimensions are in millimetres.
2. All reinforcement to be in accordance with BS 4449 "Hot rolled steel bars for the reinforcement of concrete", or BS 4461 "Cold worked steel bars for the reinforcement of concrete or BS 4483 "Steel Fabric for the reinforcement of concrete.
3. Abbreviations.

   T denotes high yield high bond bars
   R denotes mild steel bars
   T denotes top
   B denotes bottom
   NF denotes near face
   FF denotes far face
   EF denotes each face
4. Reinforcement to be A393 mesh unless noted otherwise. Min laps to be 400mm.
5. Lapping sheets to have 2 No 100mm long lap welds per 4.8m for soil continuity.
6. Concrete cover to reinforcement to be 35mm unless stated otherwise.
7. Concrete to be Class 40/20 in accordance with the Specification.
8. All embedded metal to be free of loose rust paint etc as required for reinforcement under Clause 2621 of the Specification.
9. All exposed arrises to have a 25x25 chamfer.
10. For details of the remedials to span 284B see drg no. 2346.
11. For metal repair details see drg nos. 2357 & 2358.
12. Formed surfaces to be class F2 unless noted otherwise.
13. Unformed surfaces to be class U3 unless nated otherwise.
14. Deck plate bay length may be increased to 4900mm to suit mesh sheet size subject to the provision of 8 No shear studs in each bay.

Rev.	Description	By	Date	Chk'd	Auth	Date
D	AMENDED TO MOWLEM COMMENTS	GK	1.94			
C	AMENDMENTS TO DETAIL 2&3 SECTIONS A–A, B–B, C–C, E–E	LJC	JAN 91			
B	CABLE DUCT ADDED MINOR AMENDMENTS	GK	DEC 90	RAM	AGC	13/12
A	FIRST ISSUE	LJC	SEP 90	RAM	AGC	25/9

REV D AS BUILT — AGC 13/12

REA B WSA TO MOWLEM FOR CONSTRUCTION — AGC 13/12

REV A WSA TO MOWLEM FOR COMMENT — AGC 25/9

Issued only for purpose above — By | Date

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GREATER MANCHESTER PASSENGER TRANSPORT EXECUTIVE

METROLINK

9, PORTLAND PLACE, PICCADILLY GDNS, MANCHESTER, M60 1HX

Title

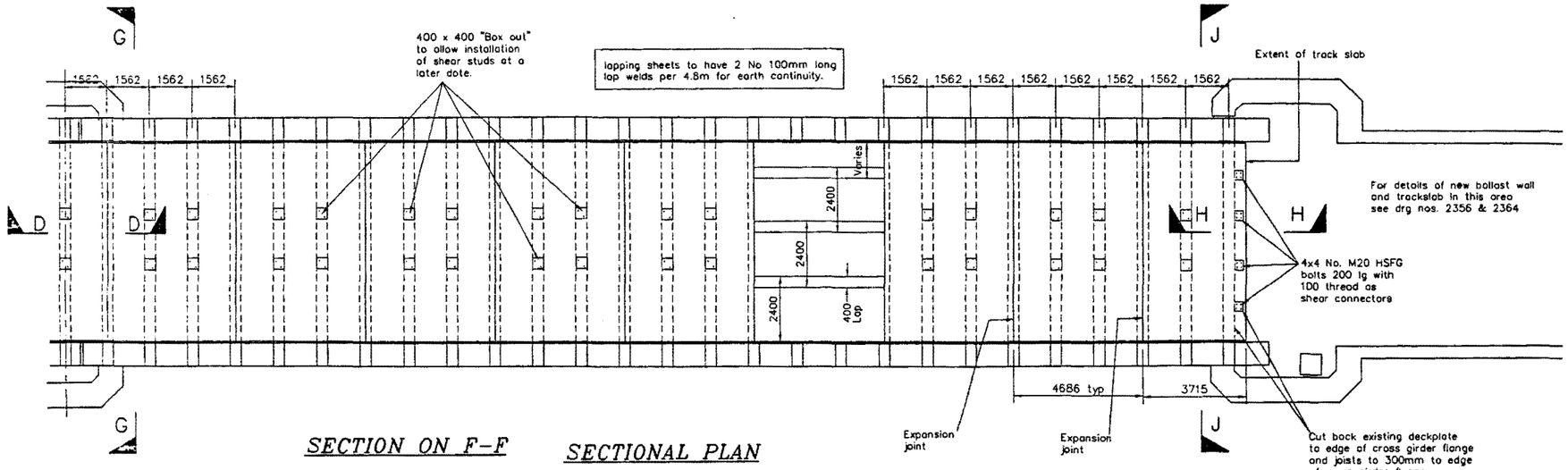
BRIDGE A47
SPAN 284A
TRACKSLAB AND DRAINAGE
GA AND RC DETAILS

Original Scale	Drawn	Checked	Authorised
AS SHOWN	LJC	RAM	AGC
	Date SEP 90	Date JAN 91	Date JAN 91

Drawing Number: **R0456 / MWO / 2345** (Job / Dept.)

Rev: **D** / Z (Issue)

R0456 / MWO / 2345 | D

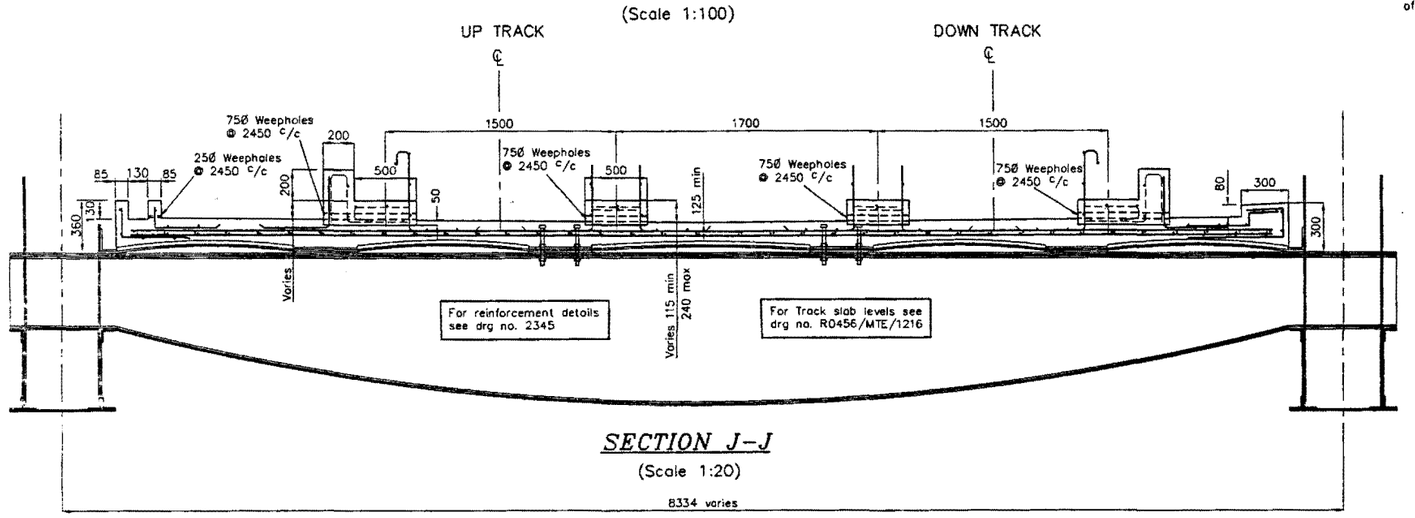


SECTION ON F–F

SECTIONAL PLAN

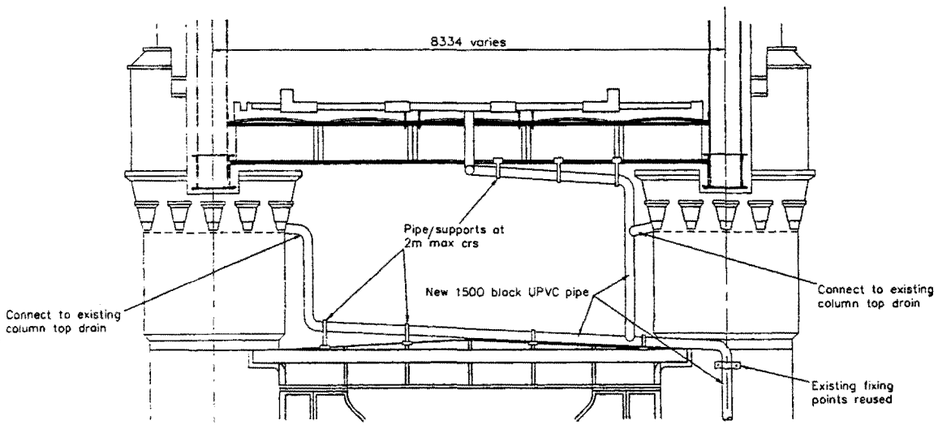
(Scale 1:100)

SITE NORTH



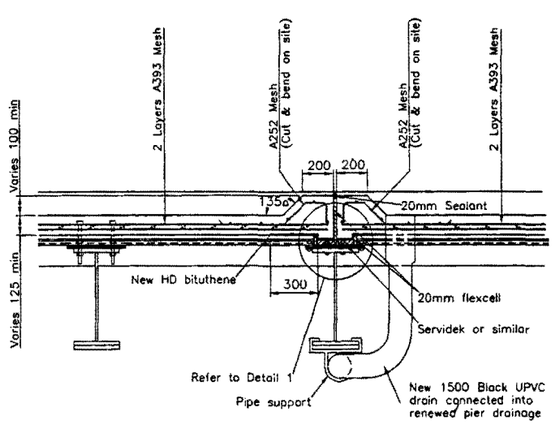
SECTION J–J

(Scale 1:20)



SECTION ON G–G

(Scale 1:50)



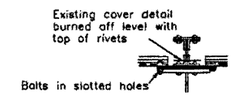
SECTION ON D–D

(Scale 1:20)

C B 0 2 0 2 A 1 1

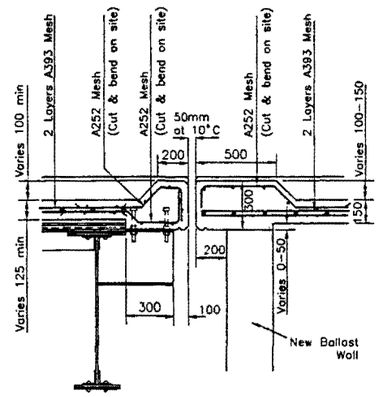
CSW WKS 012

TECH. OFFICE



DETAIL 1

(Scale 1:20)



SECTION ON H–H

(Scale 1:20)

NOTES.

1. All dimensions are in millimetres.
2. All reinforcement to be in accordance with BS 4449 "Hot rolled steel bars for the reinforcement of concrete", or BS 4461 "Cold worked steel bars for the reinforcement of concrete or BS 4483 "Steel Fabric for the reinforcement of concrete.
3. Abbreviations.

   T denotes high yield high bond bars
   R denotes mild steel bars.
   T denotes top
   B denotes bottom
   NF denotes near face
   FF denotes far face
   EF denotes each face
4. Reinforcement to be A393 mesh unless noted otherwise. Min laps to be 400mm.
5. lapping sheets to have 2 No 100mm long lap welds per 4.8m for earth continuity.
6. Concrete cover to reinforcement to be 35mm unless stated otherwise.
7. Concrete to be Class 40/20 in accordance with the Specification.
8. All embedded metal to be free of loose rust paint etc as required for reinforcement under Clause 2621 of the Specification.
9. All exposed arrises to have a 25x25 chamfer.
10. For details of the remedials to span 284B see drg no. 2346.
11. For metal repair details see drg nos. 2357 & 2358.
12. Formed surfaces to be class F2 unless noted otherwise.
13. Unformed surfaces to be class U3 unless noted otherwise.
14. Deck plate bay length may be increased to 4900mm to suit mesh sheet size subject to the provision of 8 No shear studs in each bay.

Rev.	Description	By	Date	Chk'd	Auth	
E	Track plinth width increased to 500mm	TD	1.96	SM	RM	
D	AS BUILT	SC	8.93			
C	AMENDMENTS TO SECTIONS H–H, J–J	LJC	JAN 91			
B	CABLE DUCT ADDED MINOR AMENDMENTS	LJC	SEP 90	RAM	AGC	13/12
A	FIRST ISSUE	LJC	SEP 90	RAM	AGC	20/9
Z	AS BUILT			SM	RM	
REV C	WSA TO MOWLEM FOR CONSTRUCTION					
REV B	WSA TO MOWLEM FOR CONSTRUCTION				AGC	13/12
REV A	WSA TO MOWLEM FOR COMMENT				AGC	20/9

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GREATER MANCHESTER PASSENGER TRANSPORT EXECUTIVE

METROLINK

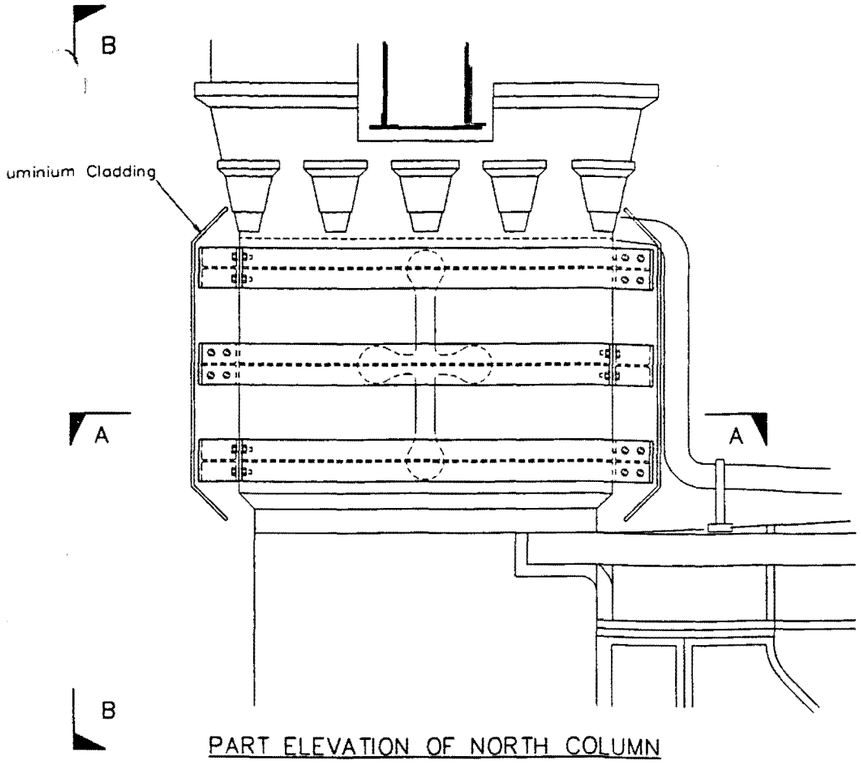
9, PORTLAND PLACE, PICCADILLY GDNS, MANCHESTER, M60 1HX

Title: **BRIDGE A47 SPAN 284B TRACKSLAB AND DRAINAGE G.A. AND R.C. DETAILS**

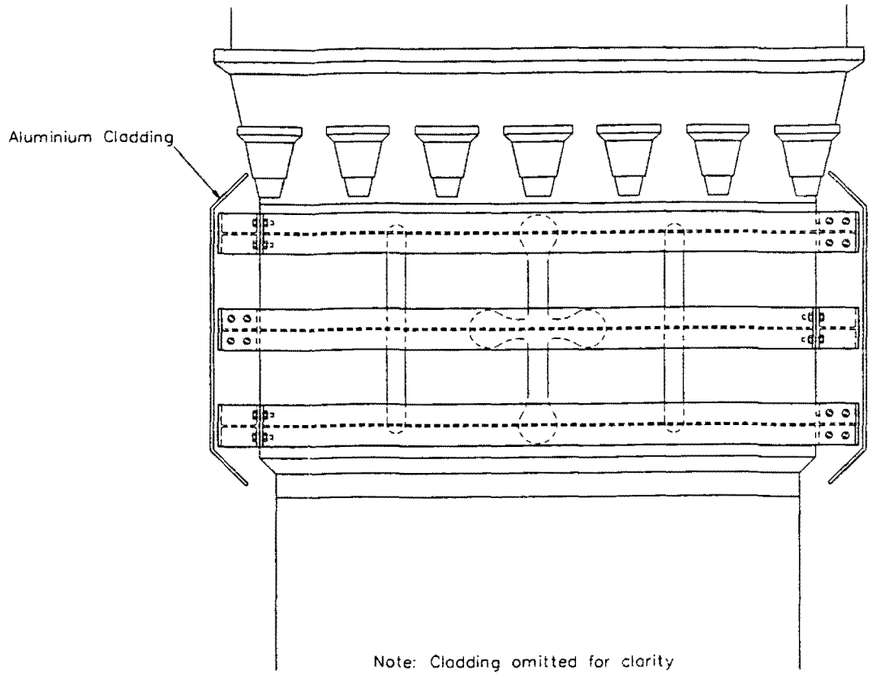
Original Scale	Drawn	Checked	Authorised
AS SHOWN	LJC	LAM	AGC
	Date SEP 90	Date 13.9.90	Date 25.9.90

Drawing Number: **R0456 / MWO / 2346** Rev: **E / Z** Issue

Drawing Number R0456 / MWO / 2346 Rev. EE

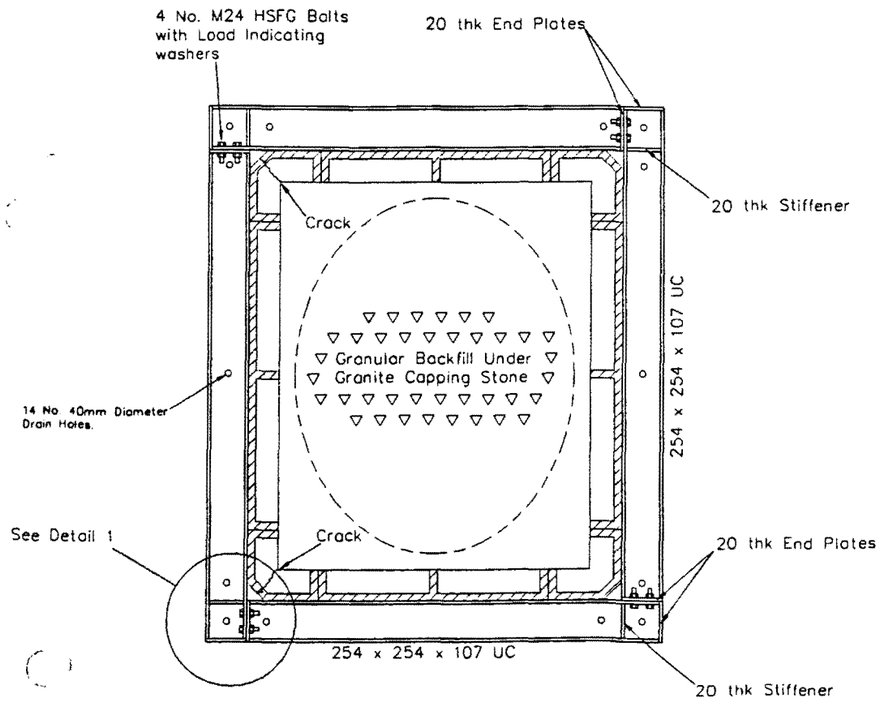


PART ELEVATION OF NORTH COLUMN
SHOWING CLAMPS IN POSITION
(SOUTH COLUMN SIMILAR BUT HANDED)
Scale 1:20

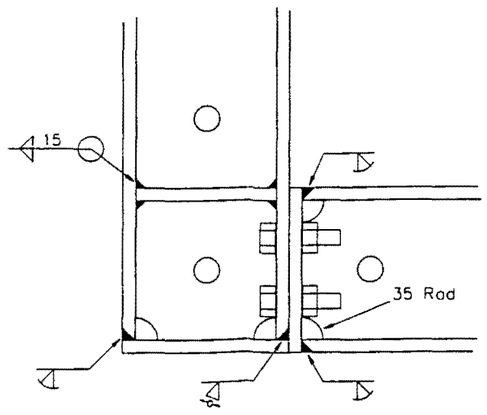


Note: Cladding omitted for clarity

SECTION B–B
Scale 1:20



SECTION ON A–A
Scale 1:20



DETAIL 1
Scale 1:5

NOTES

1. All dimensions are in millimetres unless noted otherwise.
2. All steelwork to be fabricated and erected in accordance with BS 5400: Part 6.
3. All steel to be Grade 50C to BS 4360 unless noted otherwise.
4. Bolts and nuts to be in accordance with the following:
   BS 4395 – High strength friction grip (HSFG)
5. All welds to be as noted.
6. All welding and welding consumables to be in accordance with BS 5135: 1984. Welding shall be carried out by qualified welders in accordance with BS 5135.
7. Surface preparation and painting to be in accordance with 1900 series of the Specification for new steelwork.
8. Clamping bracket inner dimensions as erected to be 2mm less than the outer dimensions of the column prior to tightening of bolts.
9. All 16 No bolts to be tightened simultaneously or by part turn to ensure even closure of gaps between end plates.
10. See drawing number MWO/2348 for details of grouting of granular back fill.

Rev.	Description	By	Date	Chkd	Auth
A	FIRST ISSUE	LJC	SEP 91	IRAM	AGC
	REV A AS BUILT				
	REV A WSA TO MOWLEM FOR COMMENT				AGC
	Issued only for purpose above				By

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GREATER MANCHESTER
PASSENGER TRANSPORT EXECUTIVE
METROLINK
9, PORTLAND PLACE, PICCADILLY GDNS, MANCHESTER, M60 1HX

Title
BRIDGE A47
CENTRAL PIER
REMEDIAL WORKS
Sheet 1

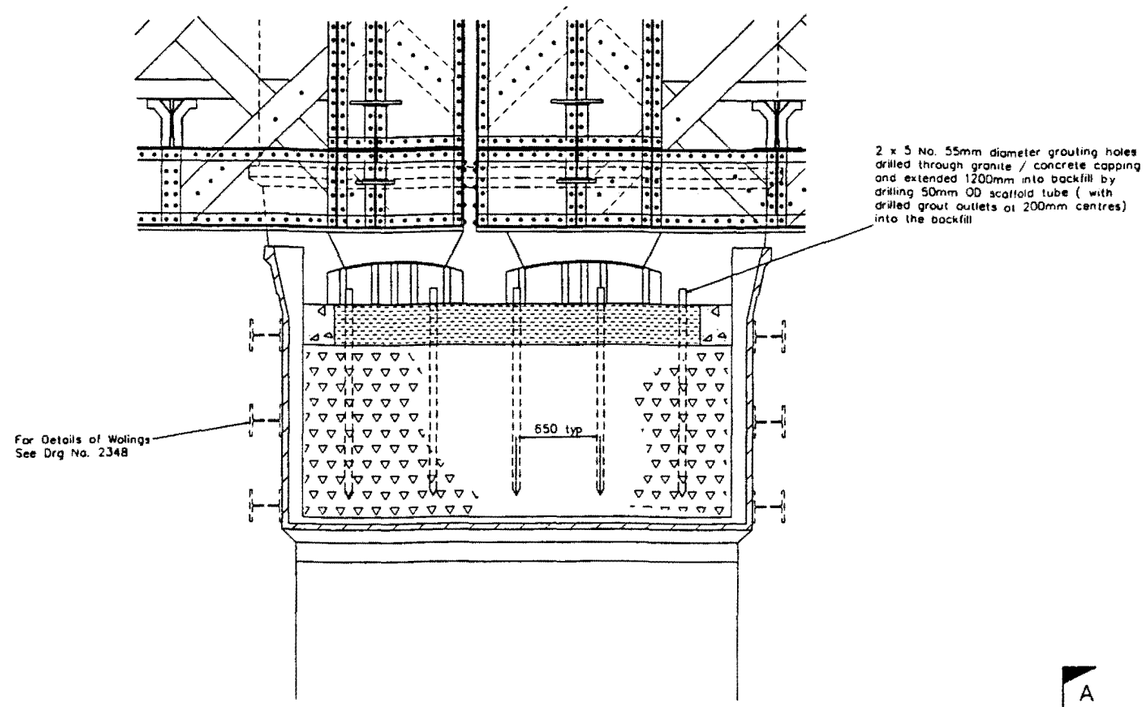
Original Scale	Drawn	Checked	Authorised
1:20	LJC		
	Date SEP 91	Date 6.7.93	Date 7-7-93

Drawing Number
R0456 / MWO / 2347
Rev A
Issue Z

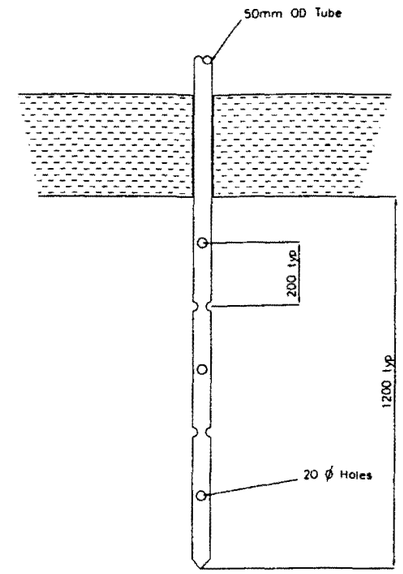
Job Dept.

Drawing Number R0456 / MWO / 2347 A

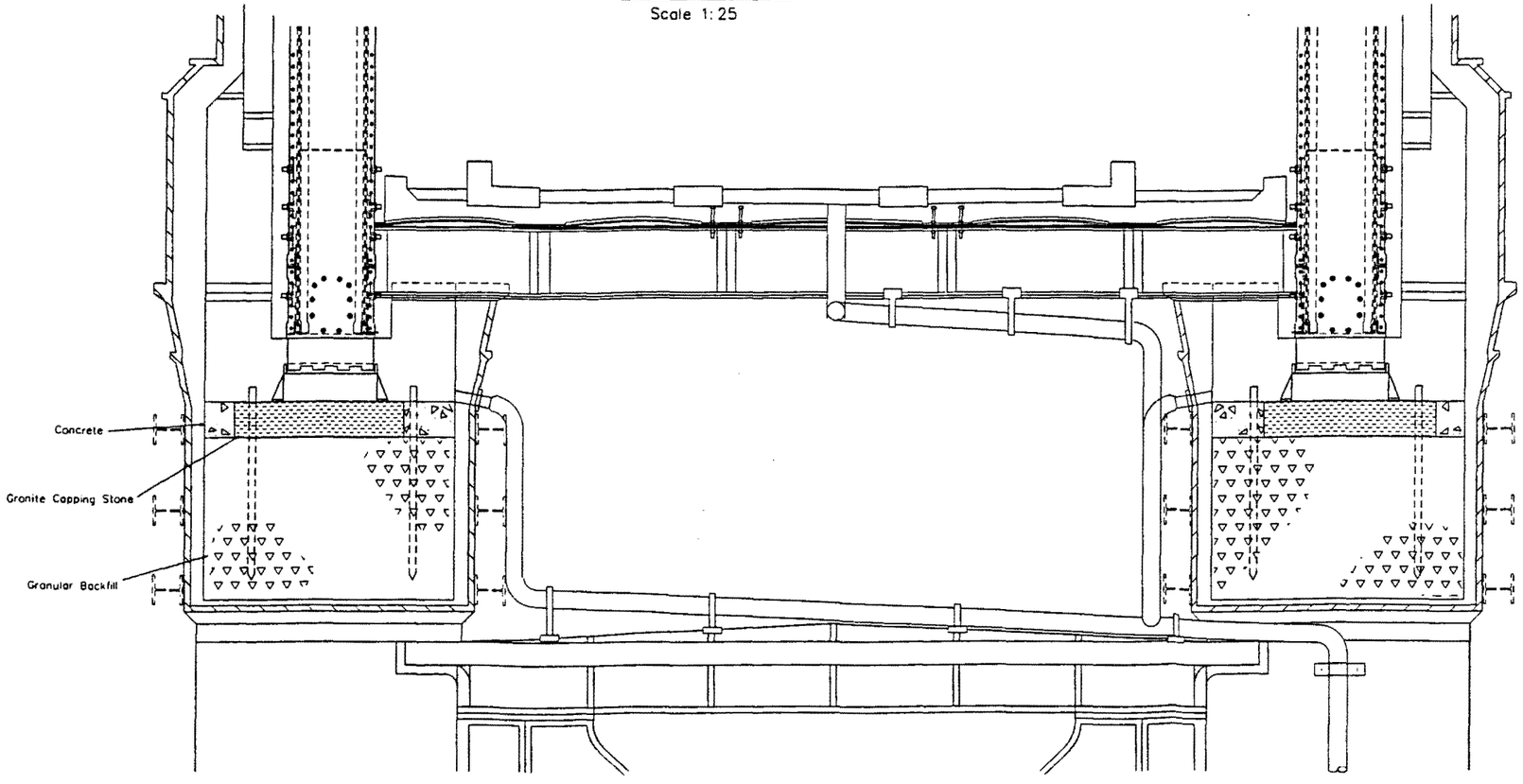
C B 0 2 0 3 A 1 2
CSW WKS 012
TECH. OFFICE



SECTION A–A
Scale 1:25



PROPOSED GROUTING TUBE
Scale 1:10



SECTION THROUGH CENTRAL PIER
Scale 1:25

A

CB0204A22
CSW WKS 012
TECH. OFFICE

NOTES:

1. All dimensions are in millimetres.
2. This drawing is to be read in conjunction with Drg Nos. R0456/MWO/2342 – 2358.
3. Grout to be a free flowing non shrink cementitious grout in accordance with the Specification for Civil Works with a 28 day cube strength of not less than 20 N/mm².
4. No grouting to be carried out until wolings shown on Drg No. 2347 have been installed.

Rev	Description	By	Date	Chk'd	Auth
A	FIRST ISSUE	LJC	SEP 91	RAM	AGC
	REV A AS BUILT				AGC
	REV A WSA TO MOWLEM FOR COMMENT				AGC
	Issued only for purpose above			By	Date

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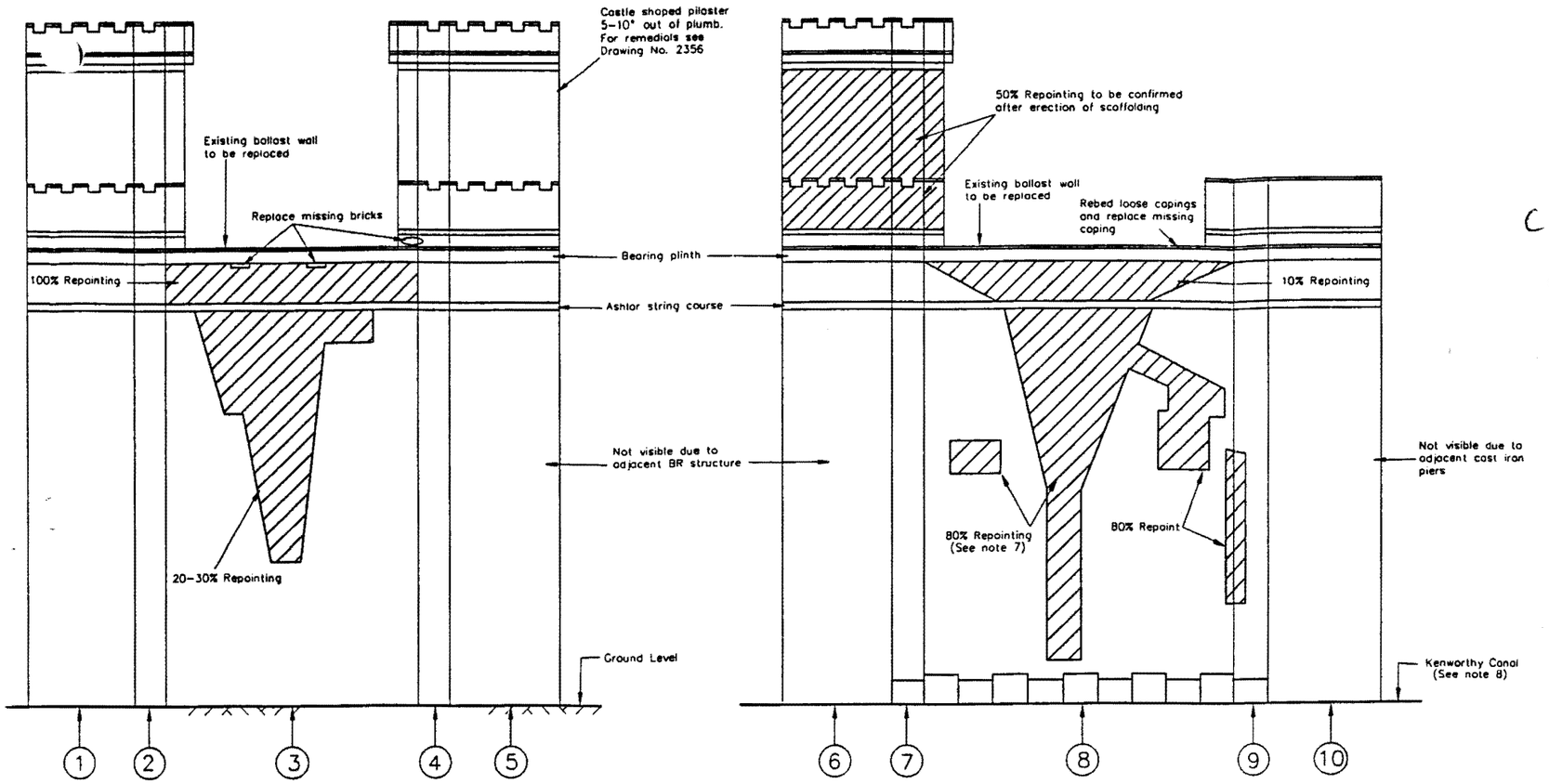
GREATER MANCHESTER PASSENGER TRANSPORT EXECUTIVE
METROLINK
9 PORTLAND PLACE, PICCADILLY GDNS, MANCHESTER, M60 1HX

Title
BRIDGE A47
CENTRAL PIER
REMEDIAL WORKS
Sheet 2

Original Scale	Drawn	Checked	Authorised
AS SHOWN	LJC		
	Date SEP 91	Date 6.7.93	Date 7/7/93

Drawing Number: R0456 / MWO / 2348
Rev: A / Z

Drawing Number: R0456 / MWO / 2348 / A

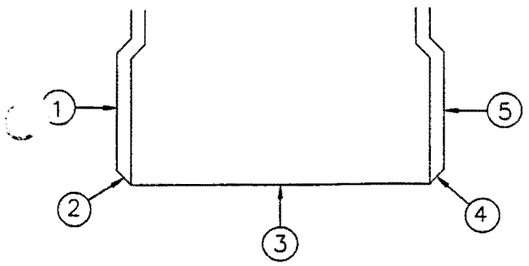


C B 0 2 0 5 A 1 1

CSW WKS 012

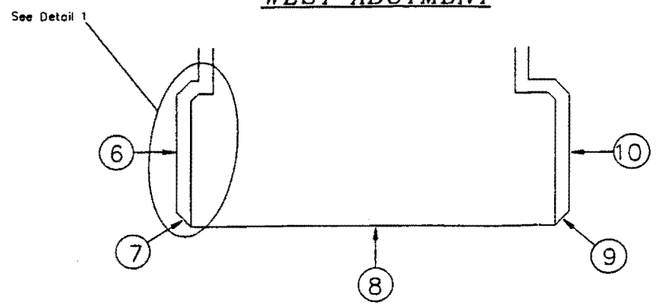
TECH. OFFICE

EAST ABUTMENT

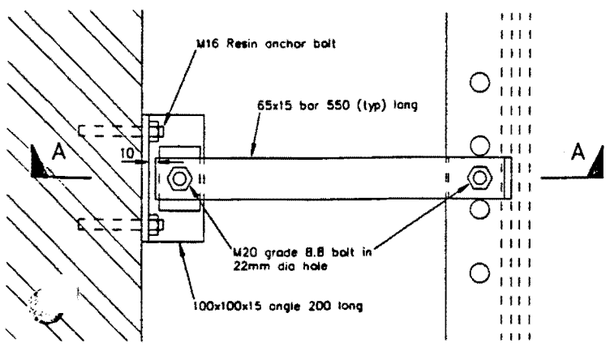


PLAN

WEST ABUTMENT

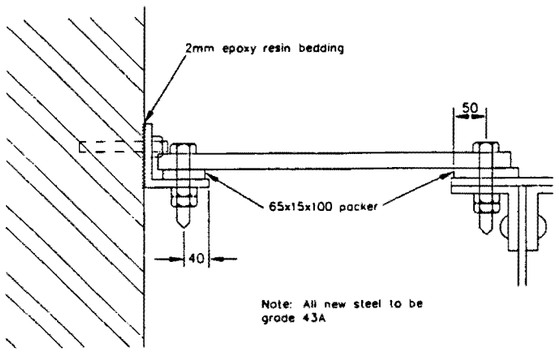


PLAN



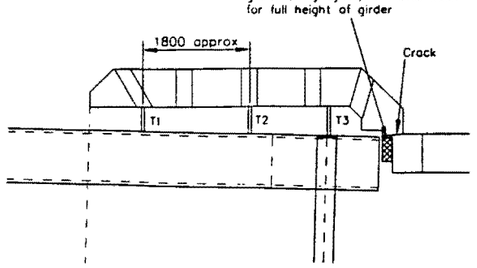
PLAN ON T2 (T1 & T3 Similar)

Scale 1:5



SECTION A–A

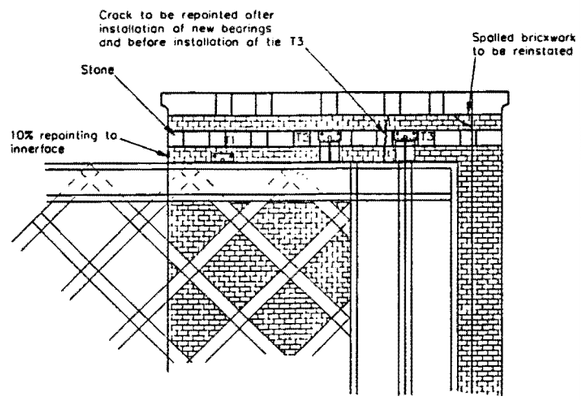
Scale 1:5



DETAIL 1

PLAN ON SOUTH WEST CORNER

Scale 1:50



INTERNAL ELEVATION

Scale 1:50

NOTES:

1. All dimensions are in millimetres unless noted otherwise.
2. All remedial work to be carried out in accordance with the relevant section of the Specification for Civil Works.
3. Repointing and removal of vegetation to be in accordance with Section 3100 of the Specification.
4. All repairs to be Standard II unless noted otherwise.
5. For the details of the new ballast walls see Drawing Nos. 2355 and 2356.
6. For the remedials to the adjacent brickwork structures see Drawing Nos. 2332 and 2362.
7. Touching access not obtained to west abutment below ashlar level. Repairs to be carried out in accordance with the specification after touching access has been provided.
8. Inspection of west abutment foundation, below water level, to be carried out by divers.
9. Ties T1 & T2 should be installed prior to installation of Hilti ties for the external scaffold (S.G.B. Drg T/N 243B / 6^).
10. Tie T3 should be installed after remedial works to castle and installation of new bearings, since the fixing angle bridges a "live" crack in the masonry.

KEY:

Repointing as per note 3 above with mortar colour to match existing.

Rev.	Description	By	Date	Chk'd	Auth
D	AMENDED TO "AS BUILT" IN ACCORDANCE WITH COMMENTS FROM MOWLEM	RS	AUG 93		
C	BRICKWORK TO SOUTH GIRDER TIE DETAILS	LJC	JUN 91	RAM	AGC
B	AMENDMENT TO REPOINTING KEY	LJC	SEP 90	RAM	AGC
A	FIRST ISSUE	LJC	JUL 90	PP	AGC

Z	AS BUILT		
REV C	WSA TO MOWLEM FOR CONSTRUCTION	AGC	31/6
REV B	WSA TO MOWLEM FOR CONSTRUCTION	AGC	27/
REV A	WSA TO MOWLEM FOR PLANNING	AGC	28/6
REV A	WSA TO MOWLEM FOR COMMENT	AGC	25/

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GREATER MANCHESTER PASSENGER TRANSPORT EXECUTIVE

METROLINK

9, PORTLAND PLACE, PICCADILLY GDNS, MANCHESTER, M60 1HX

Title

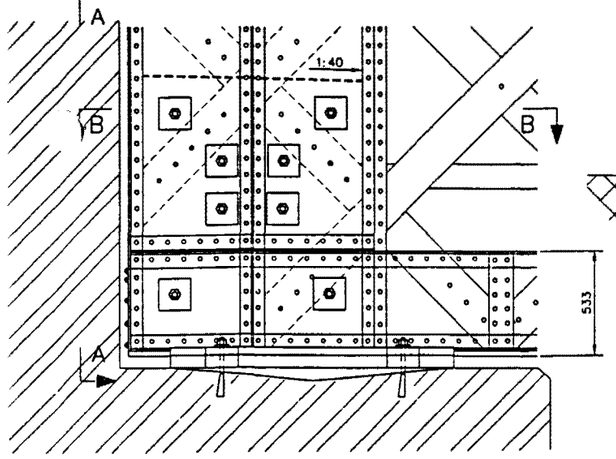
BRIDGE A47
SPANS 284A - 284B
ABUTMENTS - REMEDIAL WORKS

Original Scale	Drawn	Checked	Authorised
1:100	LJC		AGC
	Date JUL 90	Date 15/12/93	Date 17/12/93

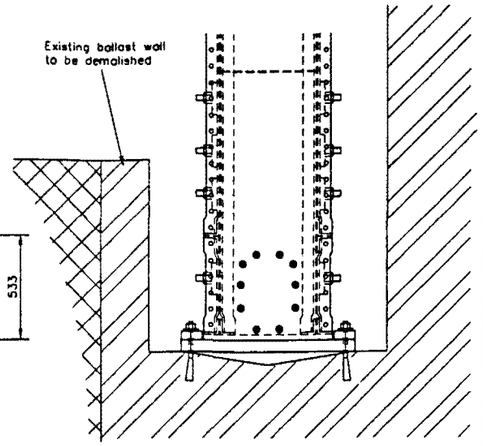
Drawing Number: R0456 / MWO / 2349 — Rev: D / Z

Job — Dept. — Issue

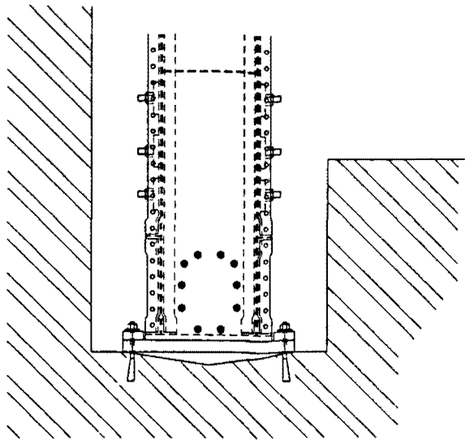
Drawing Number: R0456 / MWO / 2349 | D



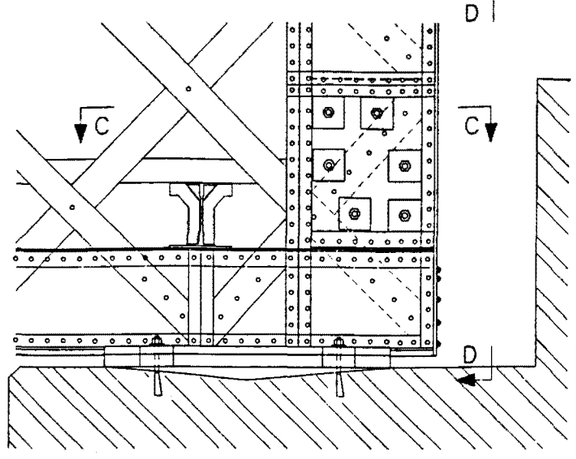
West End of Span 284A
Elevation on Outside Face of South Girder



View on A–A

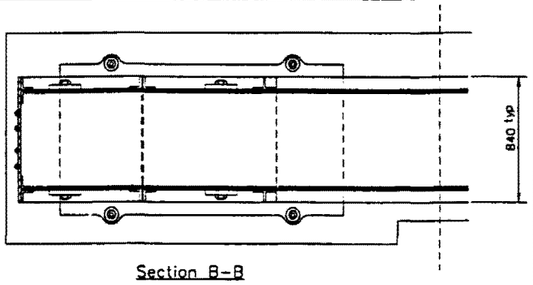


View on D–D

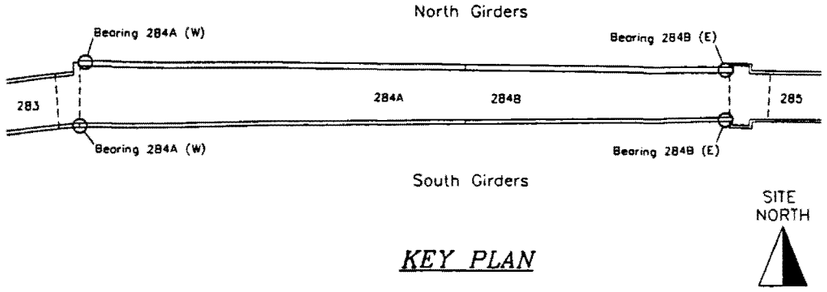


East End of Span 284B
Elevation on Outside Face of South Girder

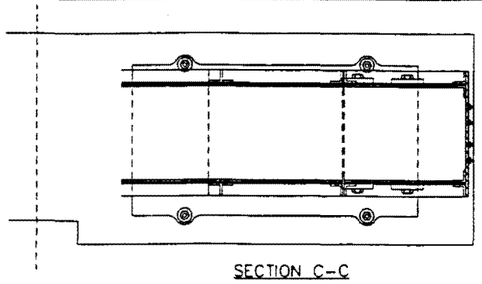
EXISTING BEARING ARRANGEMENT



Section B–B



KEY PLAN

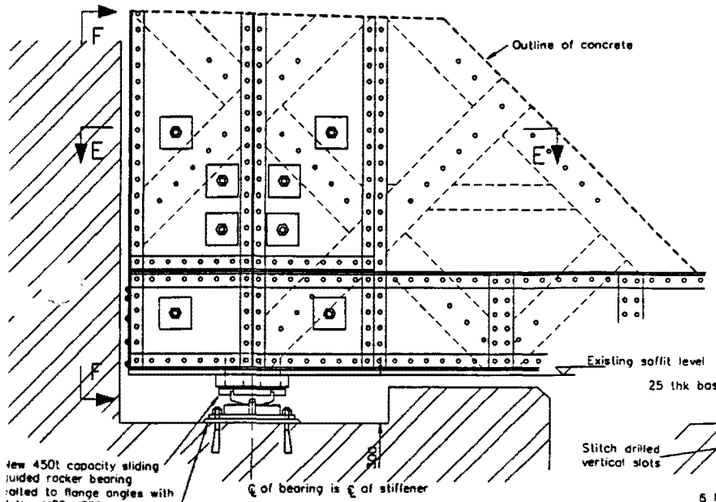


SECTION C–C

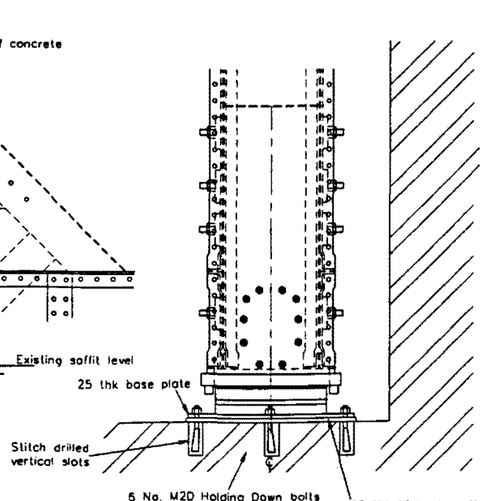
EXISTING BEARING ARRANGEMENT

NOTES :

1. All dimensions are in millimetres.
2. For Remedial details to Superstructure see drg nos. R0456/MWO/2342 – 2358.
3. This drawing to be read in conjunction with drg no. 2353.
4. Jacks and jacking brackets shown are indicative. Temporary works are the responsibility of the jacking contractor but details shall be submitted to W.S. Atkins for checking.
5. All existing dimensions are approximate and shall be verified on site.
6. Refer to drawing no. 2353 for bearing schedule and further notes.
7. No jacking is to be carried out until reinforced concrete infil of end columns has achieved a min cube strength of 30 N/mm² and prestressing complete. Refer to drg no. 2358 for details.
8. Paint system for new bearings is to be the same as that for existing metalwork which is cleaned to bare metal.

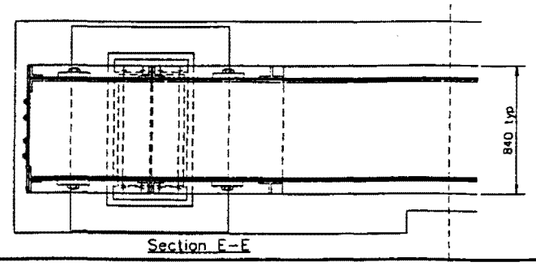


West End of Span 284A
Elevation on Outside Face of South Girder



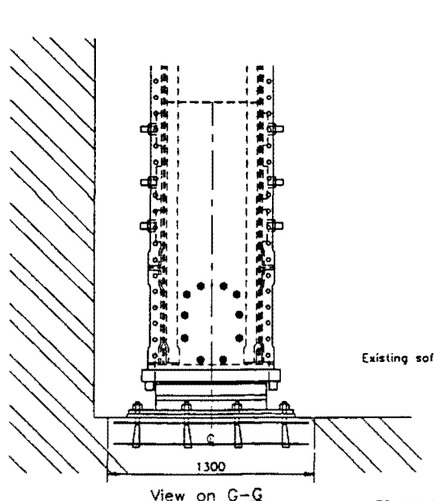
View on F–F

NEW BEARING ARRANGEMENT

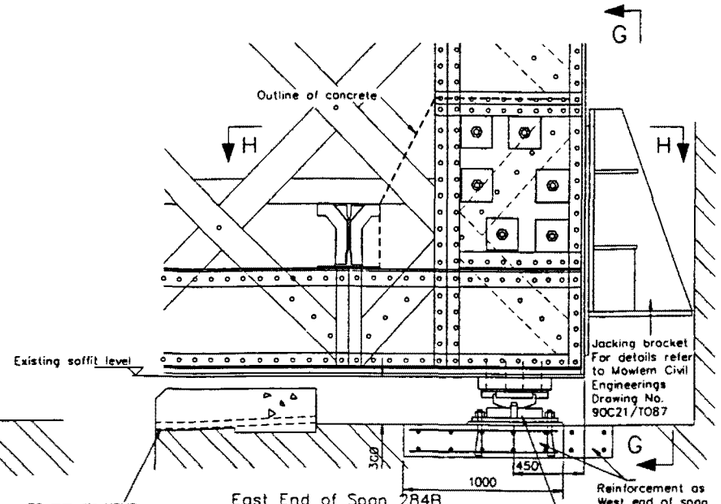


Section E–E

C B 0 2 0 6 A 1 2
CSW WKS 0 12
TECH. OFFICE

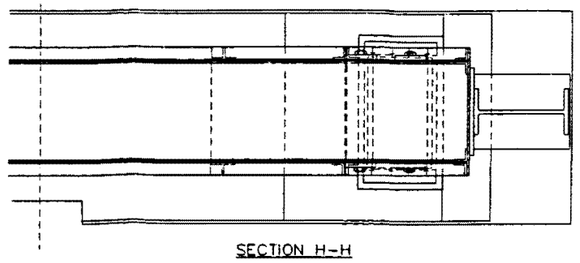


View on G–G
Jack omitted



East End of Span 284B
Elevation on Outside Face of South Girder

NEW BEARING ARRANGEMENT



SECTION H–H

New 450t capacity sliding guided rocker bearing bolted to flange angles with 8 No. M20 HSFG bolts. See drg 2353 for bearing schedule

WS/Atkins

Rev.	Description	By	Date	Chk'd	Auth
C	AMENDED TO "AS BUILT" IN ACCORDANCE WITH COMMENTS FROM MOWLEM	RS	NOV 93		
B	CONCRETE BASES FOR NEW BEARING AND JACKING ADDED NOTE 7 AMENDED	LJC	DEC 90	RAM	AGC
A	FIRST ISSUE	LJC	OCT 90	RAM	AGC

REV C AS BUILT			
REV B WSA TO MOWLEM FOR CONSTRUCTION	AGC	1/12	
REV A WSA TO MOWLEM FOR COMMENT	AGC	1/11	
Issued only for purpose above	By	Date	

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GREATER MANCHESTER PASSENGER TRANSPORT EXECUTIVE

METROLINK

9, PORTLAND PLACE, PICCADILLY GDNS, MANCHESTER, M60 1HX

Title

BRIDGE A47
REPLACEMENT BEARINGS
AT ABUTMENTS

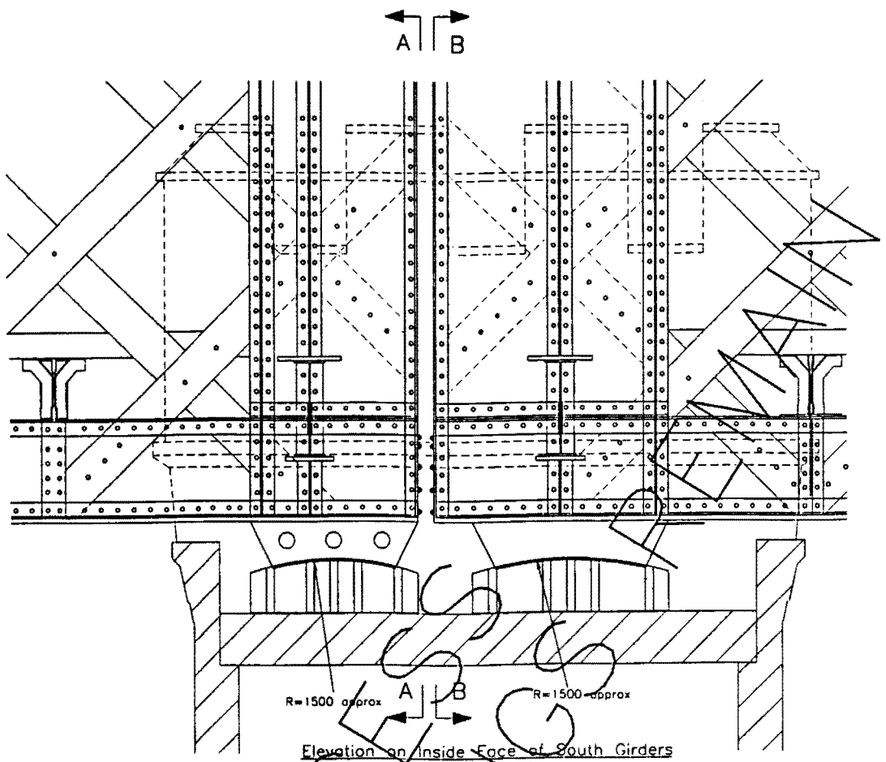
SHEET 1

Original Scale	Drawn	Checked	Authorised
1:20	LJC	RAM	AGC
Date OCT 90	Date 7.11.93	Date 14.9.93	

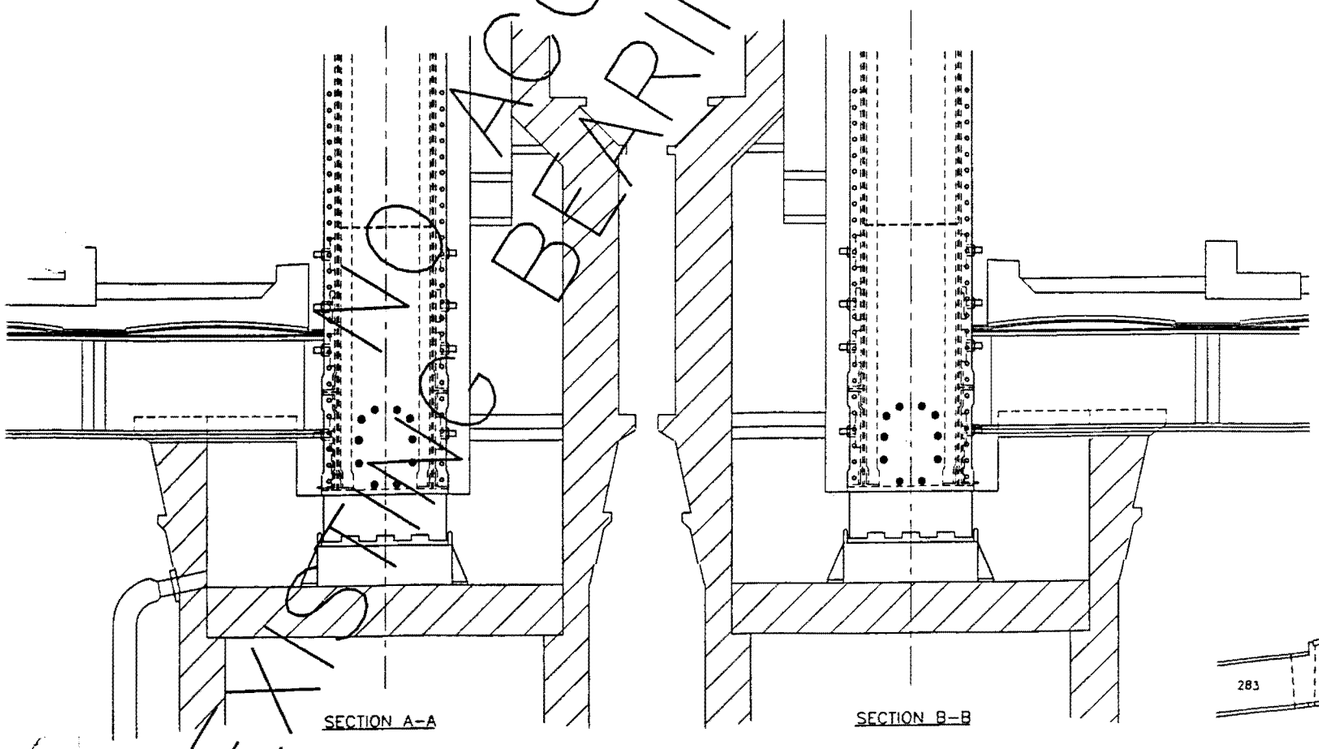
Drawing Number
R0456 / MWO / 2352

Rev C / Issue Z

R0456 / MWO / 2352 C



Elevation on Inside Face of South Girders
Over Central Pier
(North Girders similar)



EXISTING BEARING ARRANGEMENT

EXISTING BEARING ARRANGEMENT
BEARINGS MARK 284A (E) & 284B (W)

(Scale 1:20)

Bridge name or reference	Bridge A47								
Bearing identification mark					284A(W)	284A(E)	284B(W)	284B(E)	
Number off					2 (New)	2 (Existing) †	2 (Existing) †	2 (New)	
Seating material *	Upper surface				Wrought Iron	N/A	N/A	Wrought Iron	
	Lower surface				Granite	N/A	N/A	Granite	
Allowable average contact pressure (N/mm²)	Upper face	Serviceability			20	N/A	N/A	20	
		Ultimate			30	N/A	N/A	30	
	Lower face	Serviceability			20	N/A	N/A	20	
		Ultimate			30	N/A	N/A	30	
Design load effects (kN)	Serviceability limit state	Vertical		max.	4800	4800	3500	3500	
				perm-anent	2560	2560	1800	1800	
				min.	2080	2080	1460	1460	
		Transverse			250	250	250	250	
		Longitudinal			–	500	500	–	
	Ultimate limit state	Vertical			5500	5500	3900	3900	
		Transverse			300	300	300	300	
		Longitudinal			–	600	600	–	
Translation (mm)	Serviceability limit state	Irreversible	Transverse		–	–	–	–	
			Longitudinal		–	–	–	–	
		Reversible	Transverse		–	–	–	–	
			Longitudinal		±35	–	–	±25	
	Ultimate limit state	Irreversible	Transverse		–	–	–	–	
			Longitudinal		–	–	–	–	
		Reversible	Transverse		–	–	–	–	
			Longitudinal		±46	–	–	±32	
Rotation (radians)	Serviceability limit state	Irreversible	Transverse		Nil	Nil	Nil	Nil	
			Longitudinal		0.0004	0.0004	0.0003	0.0003	
		Reversible	Transverse		Nil	Nil	Nil	Nil	
			Longitudinal		± 0.0016	± 0.0016	± 0.0012	±0.0012	
	Maximum rate (radians/100 kN)	Transverse			–	–	–	–	
		Longitudinal			0.0001	0.0001	0.0001	0.0001	
Maximum bearing dimension (mm)	Upper surface	Transverse			850	850	850	850	
		Longitudinal			1800	1200	1000	1200	
	Lower surface	Transverse			Wrought Iron	Cast Iron	Cast Iron	Wrought Iron	
		Longitudinal			Wrought Iron	Cast Iron	Cast Iron	Wrought Iron	
	Overall height				50mm	50mm	50mm	50mm	
Tolerable movement of bearing under transient loads (mm)	Vertical				1	1	1	1	
	Transverse				1.5	1.5	1.5	1.5	
	Longitudinal				NA	1.0	1.0	NA	
Allowable resistance to translation under serviceability limit state (kN)	Transverse				–	–	–	–	
	Longitudinal				–	500	500	–	
Allowable resistance to rotation under serviceability limit state (kNm)	Transverse				N/A	N/A	N/A	N/A	
	Longitudinal				500	1500 †	1000 †	500	
Type of fixing required	Upper face				Bolts	N/A	N/A	Bolts	
	Lower face				Epoxy Mortar & Bolts	N/A	N/A	Epoxy Mortar & Bolts	
Number of complete bearings to be subjected to Acceptance Testing	Bearings other than elastomeric bearings	Combined vertical & horizontal 1000 test at ultimate limit state			–	N/A	N/A	–	
		Combined vertical & horizontal 1000 test at ultimate limit state			–	N/A	N/A	–	
	Laminated elastomeric bearings	Quick production test							
		Compremensive stiffness test							
		Shear stiffness test							

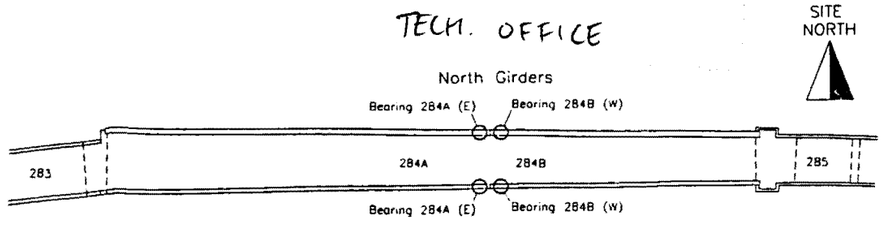
BRIDGE BEARING SCHEDULE

† See Note 7

C B 0 2 0 7 A 2 2

CSW WKS 012

TECH. OFFICE



KEY PLAN

WS Atkins

NOTES :

1. All dimensions are in millimetres.
2. For Remedial details to Superstructure see drg nos. R0456/MWO/ 2342 – 2358.
3. This drawing to be read in conjunction with drg no 2352.
4. Jacks and jacking brackets shown are indicative Temporary works are the responsibility of the contractor but details shall be submitted to W.S Atkins for checking
5. All existing dimensions are approximate and shall be verified on site
6. No jacking until concrete has reached a cube strength of 30 N/mm².
7. Bearings 284A (E) & 284B (W) are to be retained and refurbished by cleaning and greasing the contact surfaces. Maximum permissible friction coefficient after greasing to be 0.2.
8. Refurbishment of bearings mark 284A (E) & 284B (W) is to be completed before jacking for replacement of 284A (W) & 284B (E) respectively.
9. Jacking of north and south girders is to be synchronized so that the maximum differential movement does not exceed 5mm

Rev.	Description	By	Date	Ch'd	Auth
C	AMENDED TO "AS BUILT" IN ACCORDANCE WITH COMMENTS FROM MOWLEM	RS	AUG 93		
B	MINOR AMENDMENT	CK	DEC 90	RAM	AGC
A	FIRST ISSUE	LJC	OCT 90	RAM	AGC
Z	AS BUILT				
REV A	WSA TO MOWLEM FOR COMMENT				AGC
REV A	WSA TO MOWLEM FOR COMMENT				AGC

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Tel. (0372) 726140

GREATER MANCHESTER PASSENGER TRANSPORT EXECUTIVE

METROLINK

9, PORTLAND PLACE, PICCADILLY GDNS, MANCHESTER, M60 1HE

Title: **BRIDGE A47 REPLACEMENT BEARINGS**

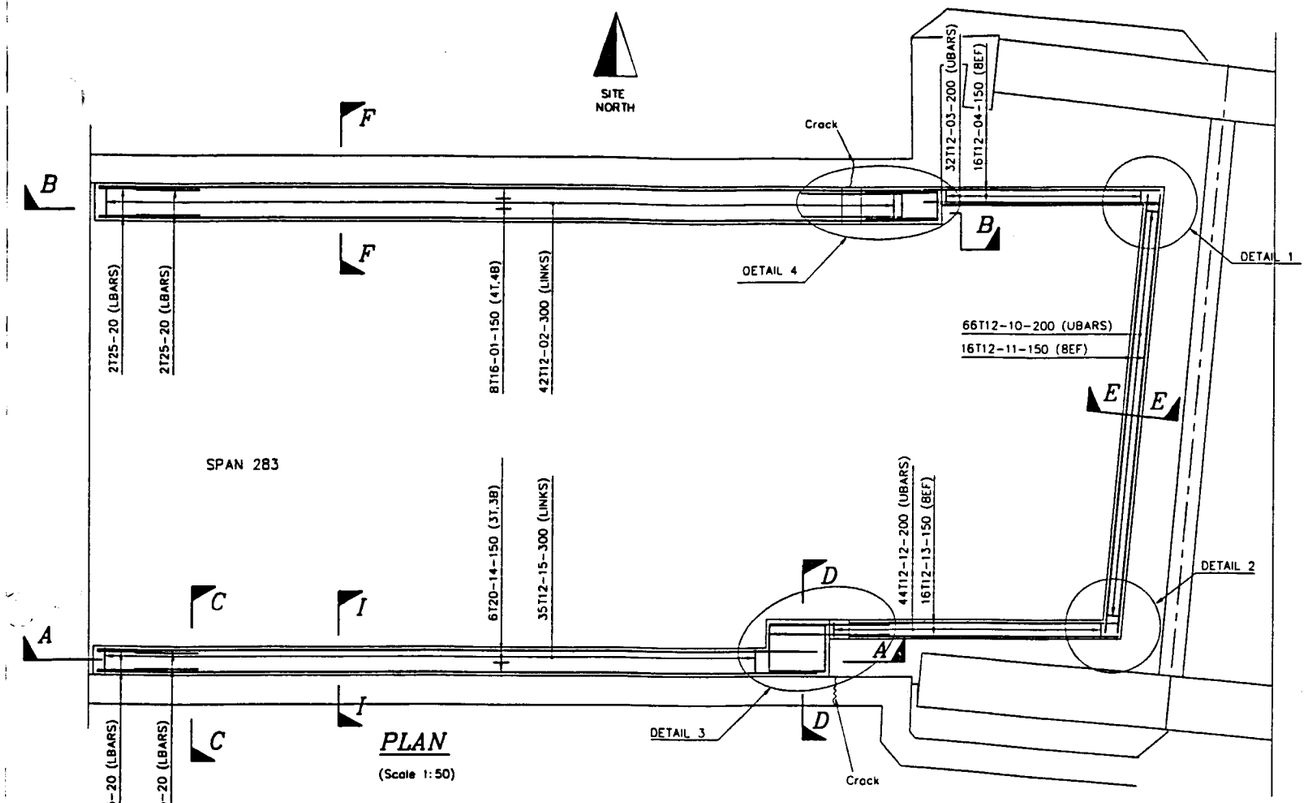
SHEET 2

Original Scale	Drawn	Checked	Authorised
1:20	LJC		AGC
	Date OCT 90	Date	Date 19/1/93

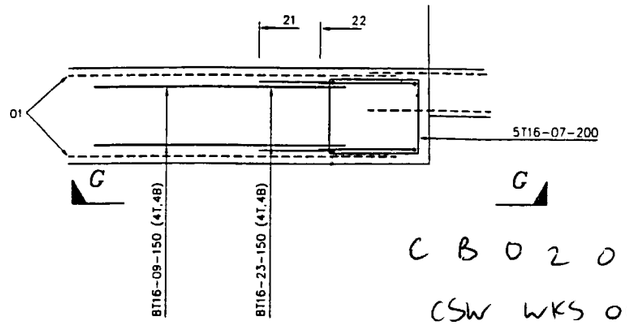
Drawing Number: **R0456 / MWO / 2353** Rev C / Z issue

Job Sect.

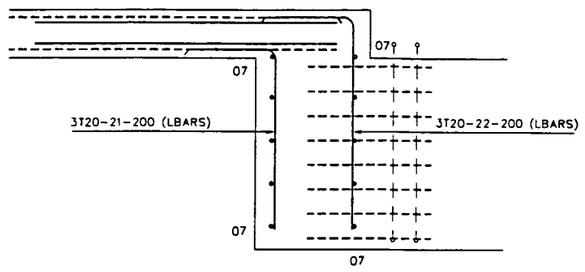
Drawing Number R0456/MWO/2353 C



PLAN
(Scale 1:50)



DETAIL 4
(Scale 1:20)

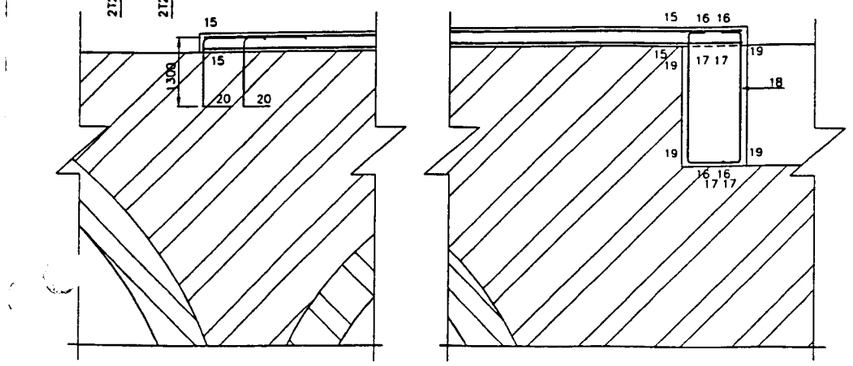


SECTION G-G
(Scale 1:20)

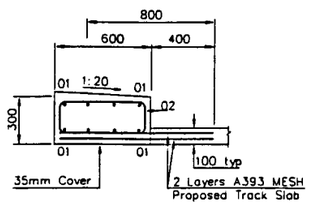
C B 0 2 0 8 A 1 1

CSW WKS 012

TECH OFFICE



SECTION A-A
Section B-B Similar
(Scale 1:50)



SECTION F-F
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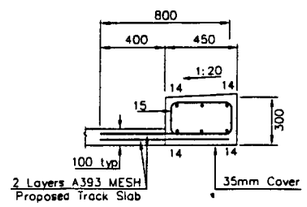
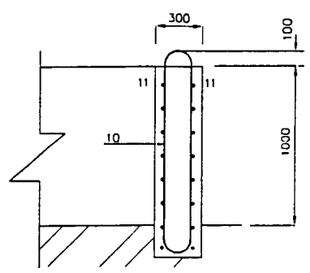


SECTION I-I
(Scale 1:20)



SECTION E-E
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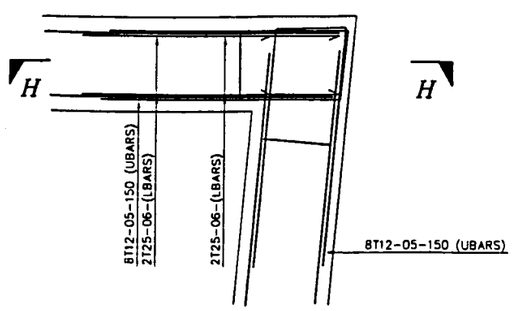
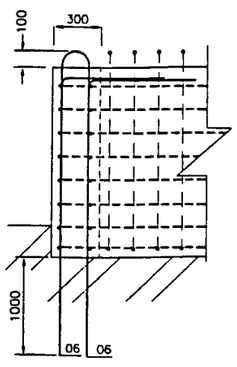
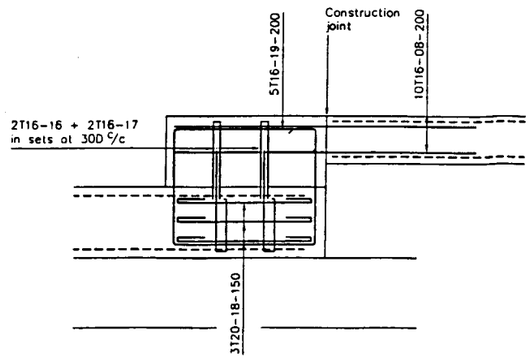


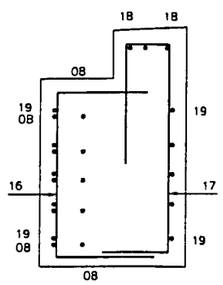
DETAIL 1
Detail 2 Similar
(Scale 1:10)



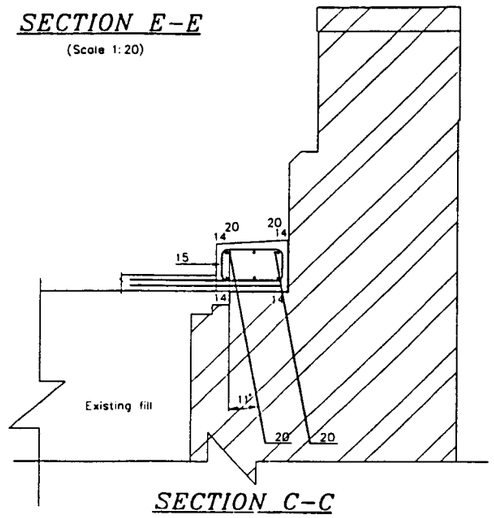
SECTION H-H
(Scale 1:20)



DETAIL 3
(Scale 1:20)



SECTION D-D
(Scale 1:20)



SECTION C-C
Section F-F Opposite hand
(Scale 1:20)

WS Atkins

NOTES.

1. All dimensions are in millimetres.
2. All reinforcement to be in accordance with BS 4449 "Hot rolled steel bars for the reinforcement of concrete", or BS 4461 "Cold worked steel bars for the reinforcement of concrete.
3. Abbreviations.

   T denotes high yield high bond bars
   R denotes mild steel bars
   T denotes top
   B denotes bottom
   NF denotes near face
   FF denotes far face
   EF denotes each face
4. The reinforcement notation used on this drawing is as follows :

Number	Bar Type	Size	Mark	Spacing	Position
10	T	20	01	150	T

5. Min. lap to reinforcement to be 400 where D is the diameter of the larger reinforcing bar unless unless stated otherwise.
6. Concrete cover to reinforcement to be 35mm unless stated otherwise.
7. Concrete to be Class 40/20 in accordance with the Specification.

Rev.	Description	By	Date	Chk'd	Auth
D	AMENDED TO "AS BUILT" IN ACCORDANCE WITH COMMENTS FROM MOWLEM	RS	AUG 93		
C	MINOR AMENDMENTS TO REINFORCEMENT	LJC	NOV 90	RAM	AGC
B	BALLAST WALL REINFORCEMENT AMENDED TO TIE IN WITH TRACK SLAB. TIE BEAM WIDTH REDUCED	LJC	SEP 90	RAM	AGC
A	FIRST ISSUE	GK	JUL 90	RAM	RAM
Z	AS BUILT				
REV C	WSA TO MOWLEM FOR CONSTRUCTION			AGC	9/11
REV B	WSA TO MOWLEM FOR CONSTRUCTION			AGC	18/10
REV A	WSA TO MOWLEM FOR PLANNING			RAM	1/8
REV A	WSA TO MOWLEM FOR COMMENT			RAM	1/8
	Issued only for purpose above			By	Date

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GREATER MANCHESTER
PASSENGER TRANSPORT EXECUTIVE
METROLINK
9, PORTLAND PLACE, PICCADILLY GDNS, MANCHESTER, M60 1HX

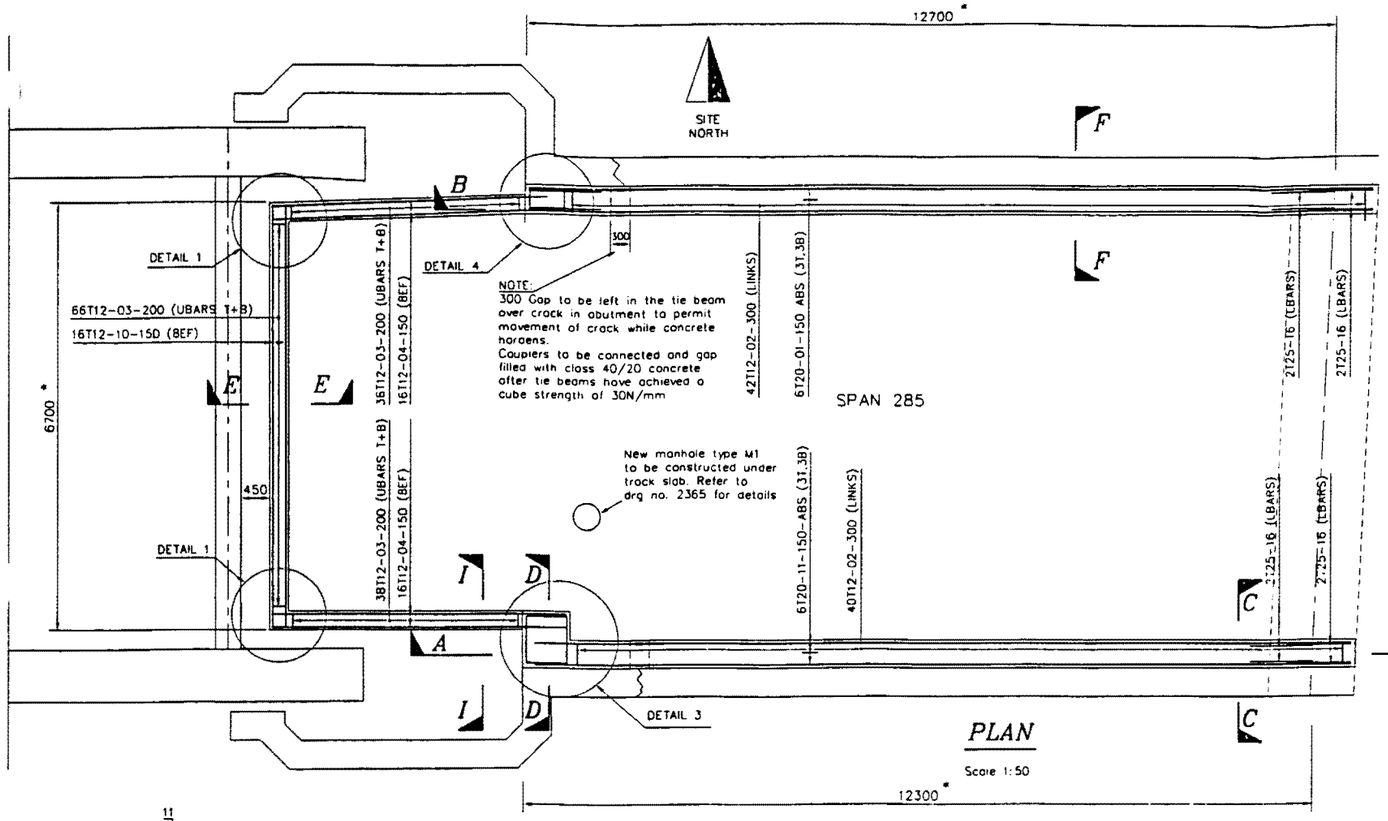
Title
BRIDGE A47
SPAN 284A
TIE BEAM & BALLAST WALL
G.A. & R.C. DETAILS

Original Scale	Drawn	Checked	Authorised
AS SHOWN	G.K.		
	Date JUL 90	Date	Date

Drawing Number
R0456 / MWO / 2355

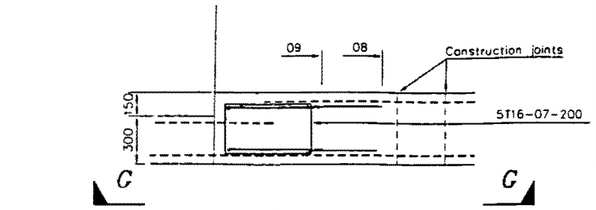
Rev **D / Z**

Job Dept.



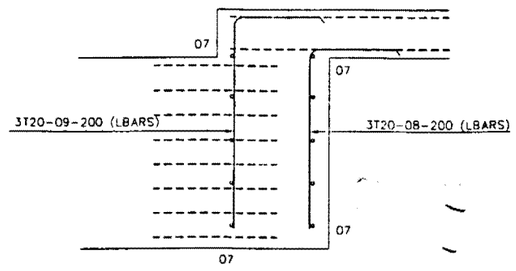
PLAN

Scale 1:50



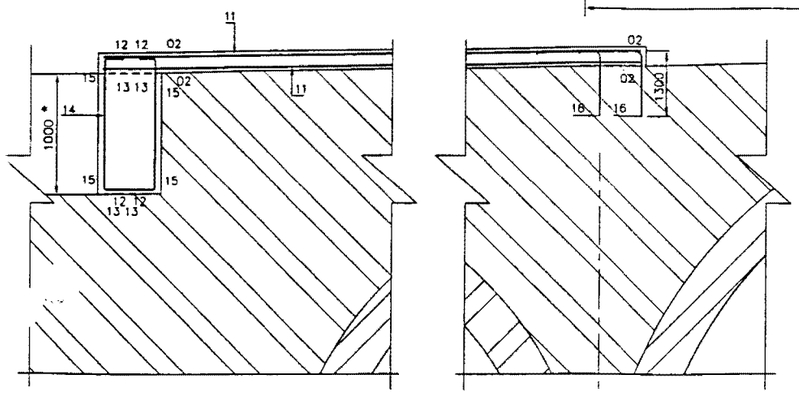
DETAIL 4

(Scale 1:20)



SECTION C-C

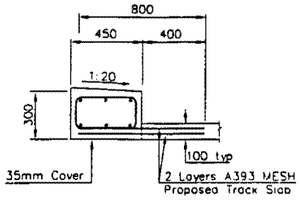
(Scale 1:20)



SECTION A-A

Section B-B Similar

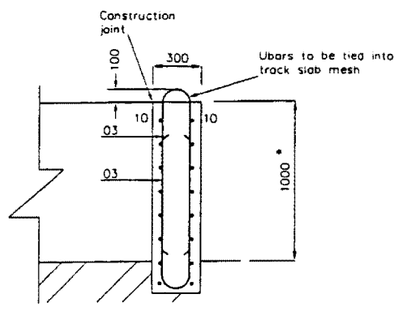
(Scale 1:50)



SECTION F-F

Showing typical beam dimensions

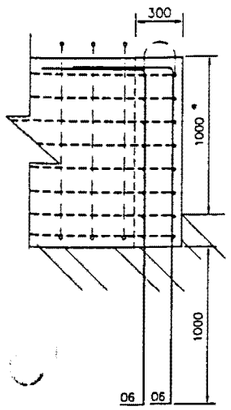
(Scale 1:20)



SECTION E-E

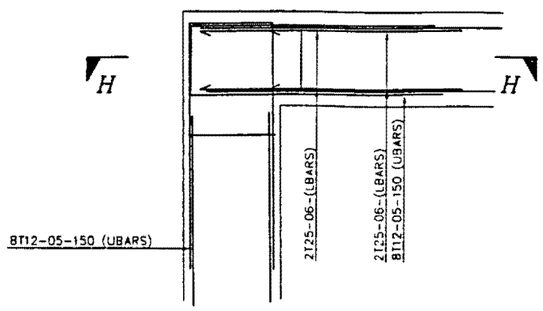
SECTION I-I SIMILAR

(Scale 1:20)



SECTION H-H

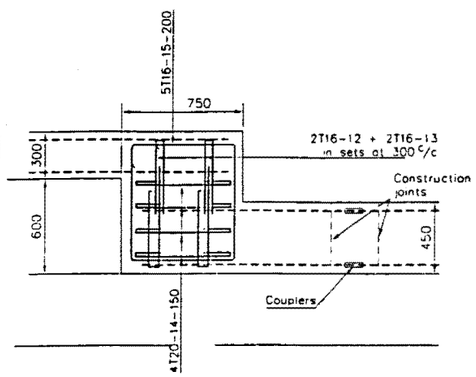
(Scale 1:20)



DETAIL 1

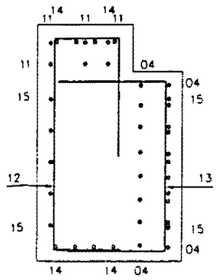
Detail 2 Similar

(Scale 1:10)



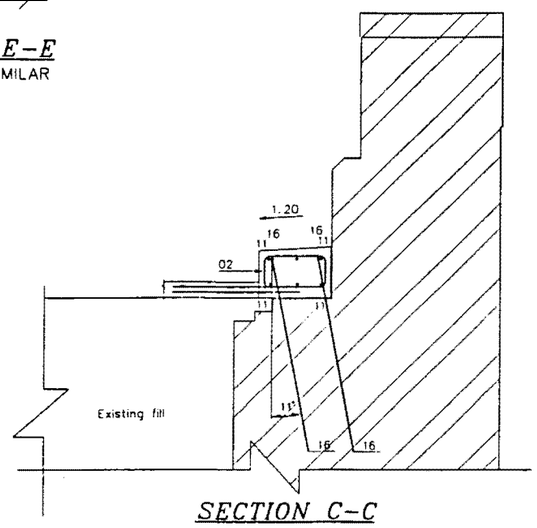
DETAIL 3

(Scale 1:20)



SECTION D-D

(Scale 1:20)



SECTION C-C

Section F-F Opposite hand

(Scale 1:20)

NOTES

1. All dimensions are in millimetres
2. All reinforcement to be in accordance with BS 4449 "Hot rolled steel bars for the reinforcement of concrete", or BS 4461 "Cold worked steel bars for the reinforcement of concrete.
3. Abbreviations.

   T denotes high yield high bond bars
   R denotes mild steel bars
   T denotes top
   B denotes bottom
   NF denotes near face
   FF denotes far face
   EF denotes each face
4. The reinforcement notation used on this drawing is as follows :

Number	Bar Type	Size	Mark	Spacing	Position
10	T	20	01	150	T

5. Min lap to reinforcement to be 40D where D is the diameter of the larger reinforcing bar unless unless stated otherwise
6. Concrete cover to reinforcement to be 35mm unless stated otherwise.
7. Concrete to be Class 40/20 in accordance with the Specification.
8. Dimensions marked thus 1000* to be checked on site

Rev	Description	By	Date	Chk'd	Auth
D	AMENDED TO "AS BUILT" IN ACCORDANCE WITH COMMENTS FROM MOWLEM	RS	AUG 93		
C	MINOR AMENDMENTS TO REINFORCEMENT	LJC	NOV 90	RAM	AGC
B	BALLAST WALL REINFORCEMENT AMENDED TO TIE IN WITH TRACK SLAB TIE BEAM WIDTHS REDUCED	LJC	SEP 90	RAM	AGC
A	FIRST ISSUE	GK	AUG 90	RAM	AGC

Z	AS BUILT			
REV C	WSA TO MOWLEM FOR CONSTRUCTION			AGC
REV B	WSA TO MOWLEM FOR CONSTRUCTION			AGC
REV A	WSA TO MOWLEM FOR PLANNING			AGC
REV A	WSA TO MOWLEM FOR COMMENT			AGC

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Tel (0372) 726140

GREATER MANCHESTER PASSENGER TRANSPORT EXECUTIVE

METROLINK

9 PORTLAND PLACE, PICCADILLY GDNS, MANCHESTER, M60 1HX

Title

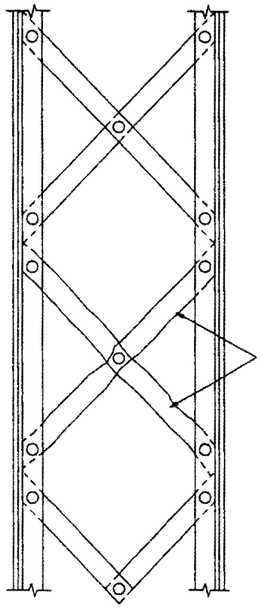
BRIDGE A47
SPAN 284B
TIE BEAM & BALLAST WALL
G.A. & R.C. DETAILS

Original Scale	Drawn	Checked	Authorised
AS SHOWN	GK		AGC
	Date AUG'90	Issued	Date 4/10/93

Drawing Number: R0456/MWO/2356 — Rev D/Z

Drawing Number R0456/MWO/2356 D

C 8 0 2 0 CSW WKS 012 TECH OFFICE 0 9 4 1 1



Existing bent or corroded lacing bars to be removed and replaced one at a time with new 50x10 Flat and fixed with M20 HSFG bolts

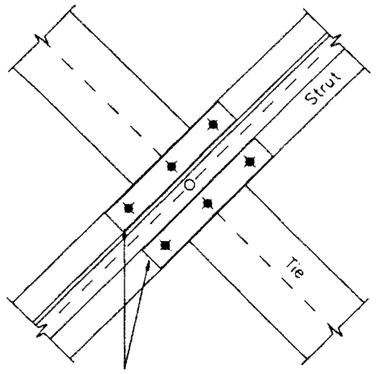
Temporary struts to be provided to maintain the relative positions of the lattice webs while lacing bars are absent

Note : This repair is not required where the damaged lacing bars lie entirely within the bottom chord (See detail MR14)

Section on Lattice Parallel to the Plane of the Lacing Bars

MR17 : Lacing Bar Repair

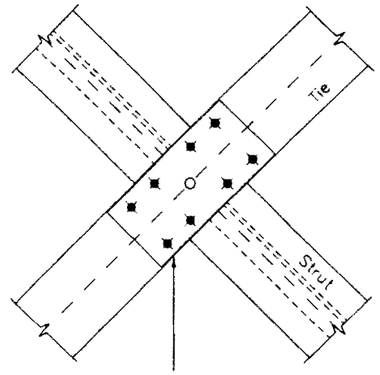
MR19 (Similar)



2No. 500x90x12thk plt.
6No. M20 HSFG bolts

Internal Elevation

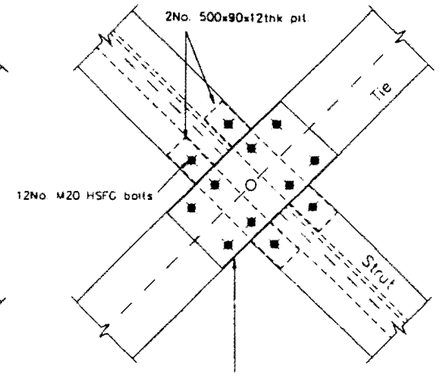
Plating repair if corrosion to laced compressive member only



1No. 500x250x12thk plt.
8No. M20 HSFG bolts

External Elevation

Plating repair if corrosion to laced tension member only



1No. 500x250x12thk plt.

External Elevation

Plating repair if corrosion to both tension and compression members

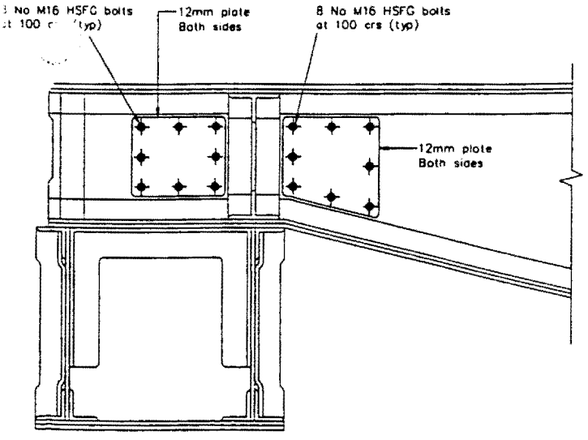
MR12 & MR13 : Plating repair of Lattice Intersections

Plating repairs, 12mm plate + M20 bolts required if loss of lattice section exceeds 40% i.e. 1/2" (13mm) plate reduced to less than 8mm 5/8" (16mm) plate reduced to less than 10mm

C B 0 2 1 0 A 1 1

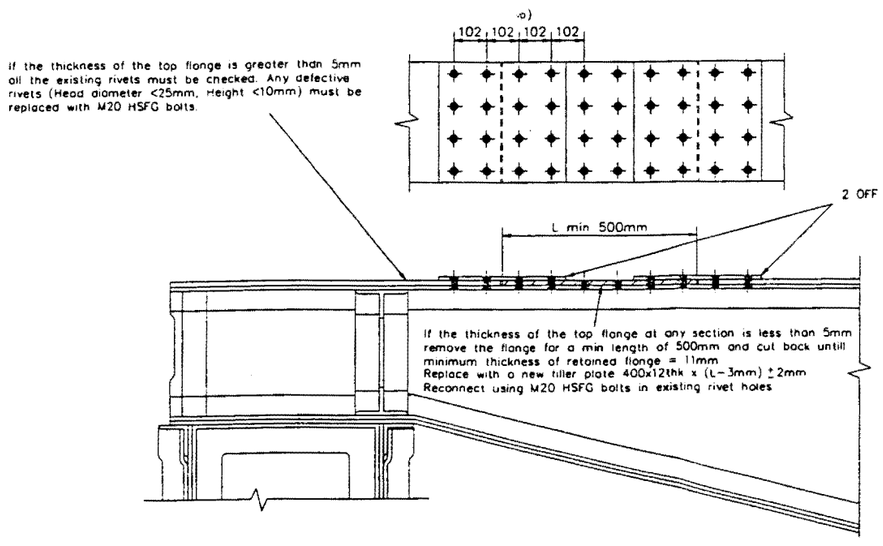
CSW WKS 012

TECH. OFFICE



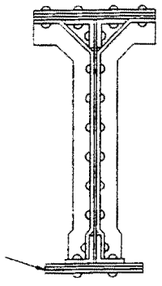
Elevation of Cross Girder MR18 : Repairs to web of Fish Belly Girders

Plating repairs required if web plate of cross girder is corroded >40% LOM.



Elevation of Cross Girder MR11 : Repairs to top flange of Fish Belly Girders

Additional plating repairs required if cross girder stiffeners are corroded >40% loss of stalk



MR20 : Repair to bottom flange of Fish Belly Girders

NOTES:

1. All dimensions are in millimetres
2. To be read with drg nos 2342 & 2343
3. See drg nos. 2344 to 2356 for other remedial details
4. All replacement steelwork to be Grade 43 unless noted otherwise.

Rev	Description	By	Date	Chkd	Auth
B	MR17, MR19 & MR18 REPAIR DETAILS REVISED	LJC	SEP 90	PP	RAM
A	FIRST ISSUE	LJC	AUG 90	PP	RAM

REV B - AS BUILT

REV B WSA TO MOWLEM FOR CONSTRUCTION RAM 8/10

REV A WSA TO MOWLEM FOR PLANNING RAM 24/8

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GREATER MANCHESTER PASSENGER TRANSPORT EXECUTIVE

METROLINK

9, PORTLAND PLACE, PICCADILLY GDNS MANCHESTER M60 1HX

Title

BRIDGE A47
SPANS 284A - 284B
METAL REPAIR DETAILS

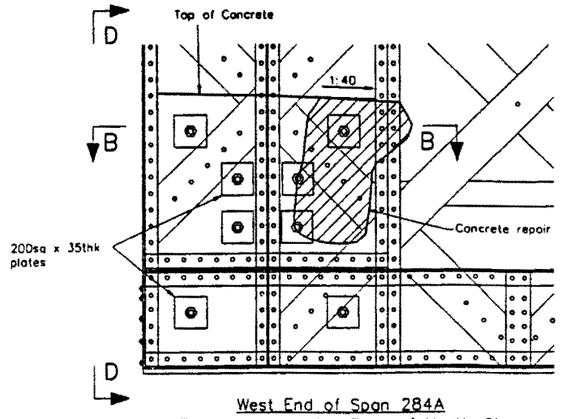
SHEET 1

Original Scale	Drawn	Checked	Authorised
1:10	LJC		
	Date AUG 90	Date 6.7.93	Date 7/7/93

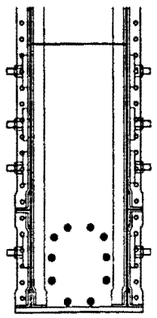
Drawing Number: R0456 / MWO / 2357 Rev B Issue 2

Job Dept.

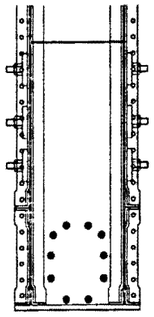
R0456 / MWO / 2357 | B



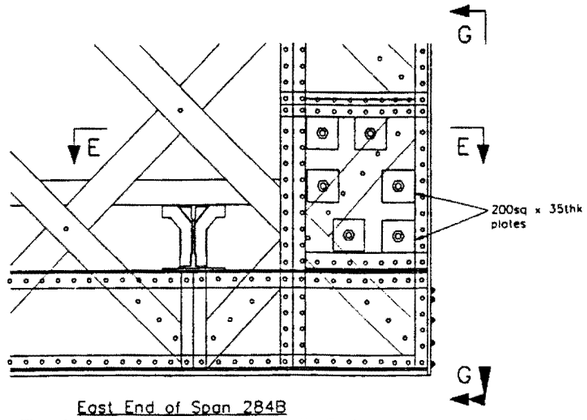
West End of Span 284A
Elevation on Inside Face of North Girder



View on D–D



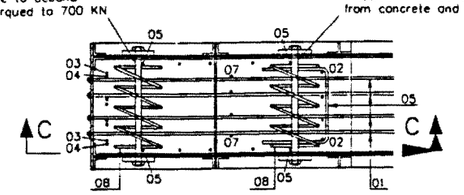
View on G–G



East End of Span 284B
Elevation on Inside Face of North Girder

4No 36 mmø Mcalls prestress bars threaded along their full length wrapped in Densa tape to debond from concrete and torqued to 700 KN

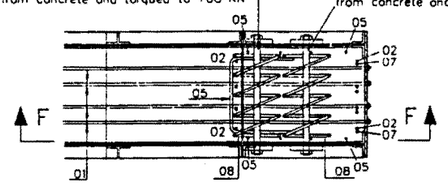
4No 36 mmø Mcalls prestress bars threaded along their full length wrapped in Densa tape to debond from concrete and torqued to 700 KN



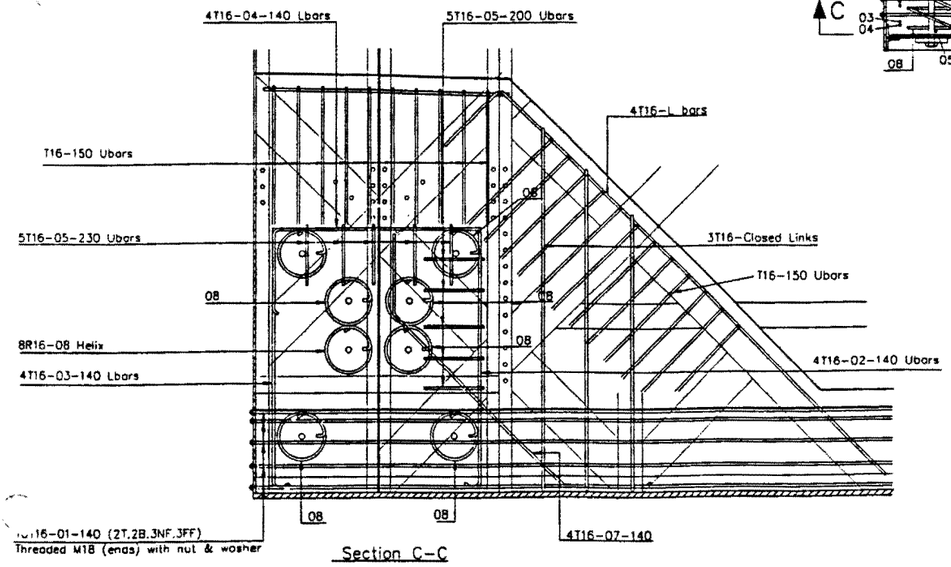
Section B–B

3No 36 mmø Mcalls prestress bars threaded along their full length wrapped in Densa tape to debond from concrete and torqued to 700 KN

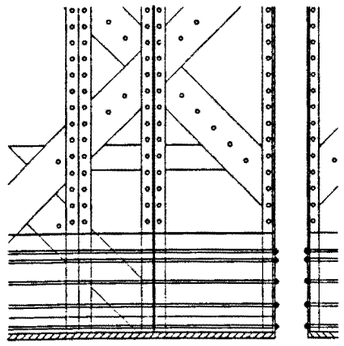
3No 36 mmø Mcalls prestress bars threaded along their full length wrapped in Densa tape to debond from concrete and torqued to 700 KN



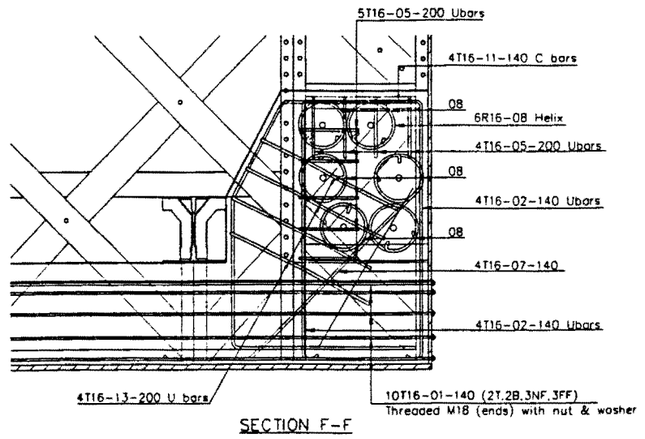
SECTION E–E



Section C–C



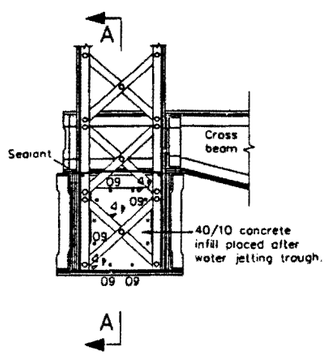
East End of Span 284A
Section Through North Girder
West End of Span 284B Similar



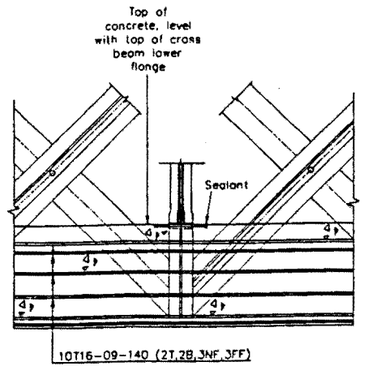
SECTION F–F

MR15 : Reinforced Concrete Strengthening to West End of Span 284A Girders

MR20 : Reinforced Concrete Strengthening to East End of Span 284B Girders



Typical Section Through Bottom Chord of Girder



Section A–A

MR14 : Reinforced Concrete Infill to Bottom Chord of Main Girders

NOTES:

1. All dimensions are in millimetres.
2. To be read with drg nos. 2342 & 2343.
3. See drg nos. 2344 to 2356 for other remedial details.
4. All replacement steelwork to be Grade 43A to BS 4360 unless noted otherwise.
5. Force in Mcalls bars to be established by a combination of indicating washers and torque measurement.
   Bars may not be tensioned until concrete has achieved a cube strength of 30 N/mm²

Rev.	Description	By	Date	Chkd	Auth
D	AMENDED TO "AS BUILT" IN ACCORDANCE WITH COMMENTS FROM MOWLEM	RS	NOV 93		
C	AMENDED TO "AS BUILT" IN ACCORDANCE WITH COMMENTS FROM MOWLEM	RS	AUG 93	JPH	AGC
B	NOTE 5 ADDED NOTE TO MCALLS BARS AMMENDED	LJC	DEC 90	RAM	AGC
A	FIRST ISSUE	LJC	AUG 90	PP	RAM
REV D AS BUILT					AGC 25/11
REV C AS BUILT					AGC 25/10
REV B WSA TO MOWLEM FOR CONSTRUCTION					AGC 5/12
REV A WSA TO MOWLEM FOR PLANNING					RAM 24/8
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GREATER MANCHESTER PASSENGER TRANSPORT EXECUTIVE
METROLINK
9, PORTLAND PLACE, PICCADILLY GDNS, MANCHESTER, M60 1HX

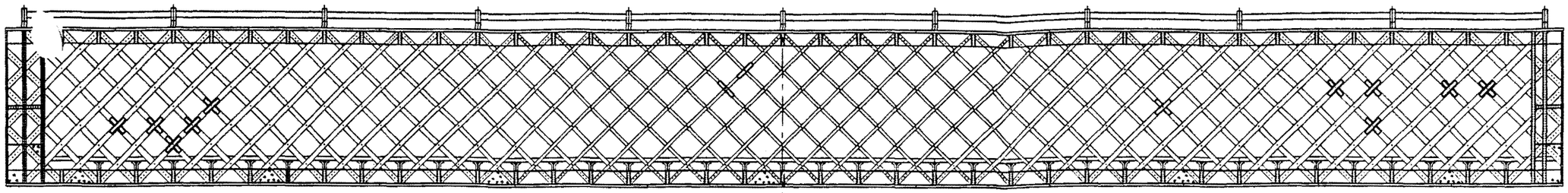
Title
BRIDGE A47
SPANS 284A - 284B
METAL REPAIR DETAILS
SHEET 2

Original Scale	Drawn	Checked	Authorised
1:20	LJC		
	Date AUG 90	Date 7/11/93	Date 9/11/93

Drawing Number
R0456 / MWO / 2358
Rev D / Z
Job Dept. Issue

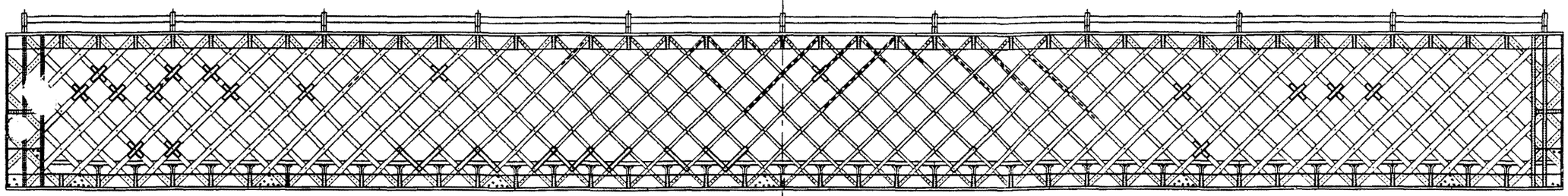
R0456 / MWO / 2358 D

CB0211A11
CSW WKS 012
TECH. OFFICE



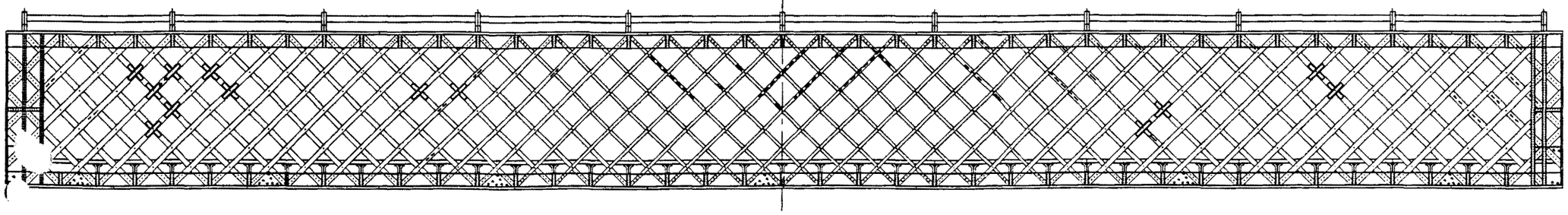
OUTER ELEVATION OF NORTH GIRDER

47% (127 No.) Rivet replacement on Lattice Intersections



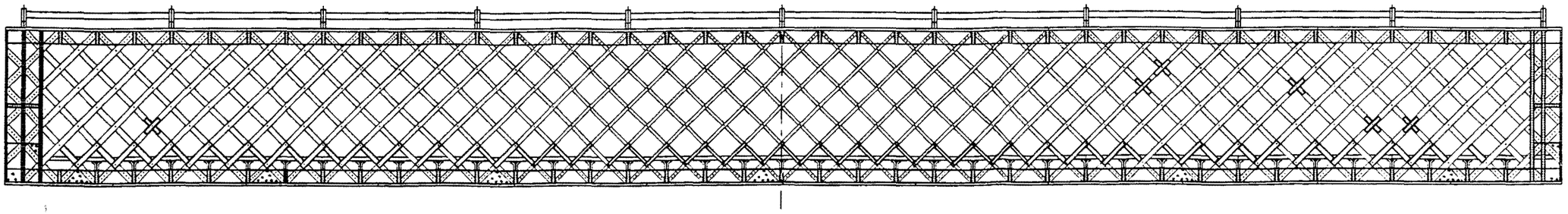
INNER ELEVATION OF NORTH GIRDER

49% (134 No.) Rivet replacement on Lattice Intersections



OUTER ELEVATION OF SOUTH GIRDER

60% (163 No.) Rivet replacement on Lattice Intersections



INNER ELEVATION OF SOUTH GIRDER

31% (85 No.) Rivet replacement on Lattice Intersections

WS/Atkins

Notes

1. This Drawing is to be read in conjunction with Drg. No.s R0456/MWO/ 2342, 2343, 2357 and 2358.

KEY

- MR13 Repairs
- Lacing Bar Repairs
- Plate Repairs

C B 0 2 1 2 A 1 1
CSW WKS 012
TECH OFFICE.

Rev.	Description	By	Date	Chk'd	Auth
A	FIRST ISSUE	GK	JAN 92		
	REV A – AS BUILT				

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GREATER MANCHESTER PASSENGER TRANSPORT EXECUTIVE

METROLINK

9, PORTLAND PLACE, PICCADILLY GDNS, MANCHESTER, M60 1HX

Title

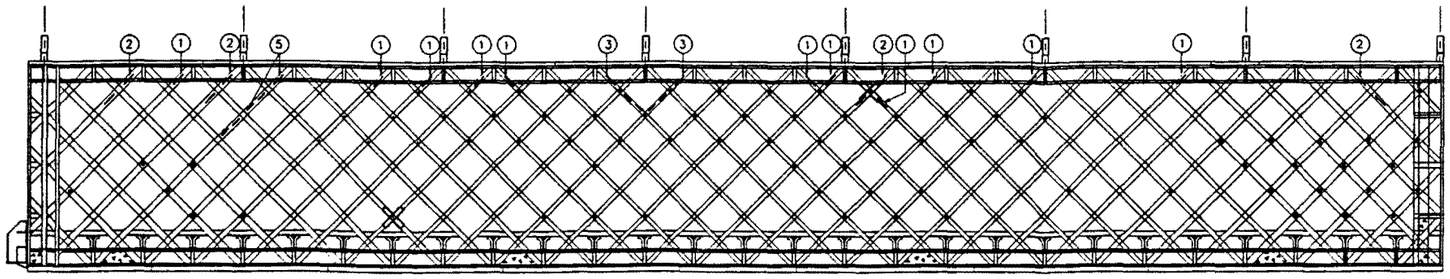
BRIDGE A47
SPAN 284A
LOCATION OF REMEDIAL WORKS

Original Scale	Drawn	Checked	Authorised
1:100	GK Date JAN '92	Date 6/7/92	Date 7/7/92

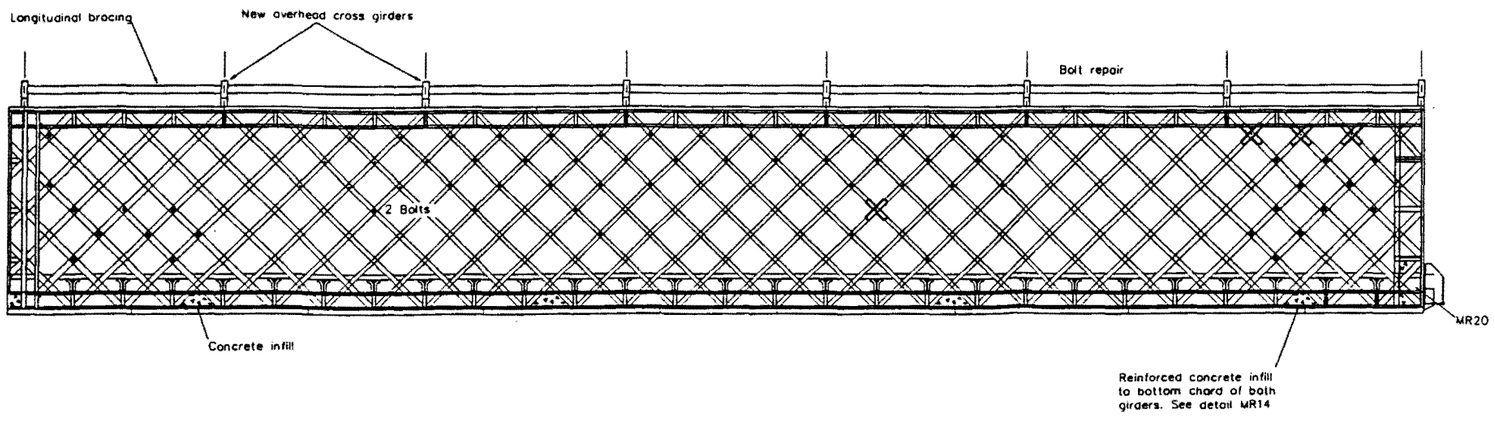
Drawing Number: R0458 / MWO / 2359 — Rev: A / Z

Job — Dept.

Drawing Number R0458/MWO/2359 — Rev A



INNER ELEVATION OF SOUTH GIRDER



OUTER ELEVATION OF SOUTH GIRDER

C B 0 2 1 3 A 1 1
CSW WKS 012
TECH. OFFICE

WS/Atkins

NOTES :

1. All dimensions are in millimetres.
2. For details of the remedials to Span 284A see drawing no. 2342.
3. For metal repair details see drg no. 2357 & 2358
4. All replacement steelwork to be Grade 43 unless noted otherwise.
5. All rivets must be checked against MR11
6. For protective treatment refer to Bridge A47 Painting Condition Report and Bridge A47 Coating Specification.
7. For North Girder metal repairs refer Drg No. R0456/MWO/2343.

KEY

(2) Lacing Bars (26 No.) Number replaced on member shown

MR13 Repairs (6 No.)

Rivet Replacement (75 No.)

Rev	Description	By	Date	Chk'd	Auth
A	FIRST ISSUE	GH	JAN '93		
	REV A AS BUILT				

Issued only for purpose above — By — Date

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GREATER MANCHESTER
PASSENGER TRANSPORT EXECUTIVE
METROLINK
9 PORTLAND PLACE PICCADILLY GDNS. MANCHESTER M60 1HX

Title
BRIDGE A47
SPAN 284B
SOUTH GIRDER AS BUILT REPAIRS

Original Scale	Drawn	Checked	Authorised
1:100	GDH		
	Date 5/1/93	Date 6.2.93	Date

Drawing Number: R0456 / MWO / 2360 — Rev: A / Z Issue

Job — Dept.

Drawing Number R0456 / MWO / 2360 — A

ARUP

Appendix C – Concrete Infill – Further Structural Commentary

Castlefield Viaduct - Phase 2

Truss End Support Boxes – Remedial Options Appraisal

APPENDIX C - CONCRETE INFILL – FURTHER COMMENTARY

Overview

- These further notes are provided in response to MCC queries on the concrete infill, raised by email 4th September 2025.

Construction Sequence

- An indicative proposed construction sequence is included on drawing CVI-ARUP-ZZ-ZZ-DR-S-4019, repeated below with further notes:
- **Step 1** - hole for 1st bolt drilled into either inner or outer plane (‘leading hole’), depending on Contractor’s preference and guided by best access available
- **Step 2** - small diameter drill uses leading hole for a pilot hole in opposite plane, ensuring holes are aligned vertically / horizontally
- **Step 3** - pilot hole enlarged on opposite plane
- **Step 4** - 1st bolt installed and loosely tightened
- **Step 5** - repeat for all bolts
- **Step 6** - infill concrete poured, with hydrophilic strips pre-fixed to rear of shutters (vertical face) and pushed into wet concrete (top surface).
- **Step 7** - bolts fully tightened
- The sequence assumes the cleaning, painting and SI has been completed as outlined in sketch CVI-ARUP-ZZ-ZZ-SK-S-3033.
- The SI will have focussed on the specific geometry of each ‘red’ truss end: rivets, stiffeners, transverse beam ends etc. This will be used to inform the preferred position of the through-bolts and to establish the top of concrete (TOC) for the infill.

Maintenance

- One of the benefits of the concrete infill is the low maintenance requirements and the consequent durability. The notes below expand on how long-term durability can be achieved, points which are in evidence by reference to the successful 1990s application of the remedial to the 1870s viaduct.
- The concrete is working in compression as a simple bearing element, taking loads from the steel through-bolts it will be cast around. The only reinforcement required is that shown (on drawing CVI-ARUP-ZZ-ZZ-DR-S-4019) to the exposed top + vertical surfaces. This is provided for crack control only and isn’t contributing structurally to the concrete. In this sense **the infill should be thought of as a mass concrete** rather than a reinforced concrete (RC) element. Whereas the design life of RC is dictated the durability of the steel reinforcement and limited to a notional 50 years (typically), mass concrete effectively has an indefinite design life, controlled by the durability of its constituent stone aggregates and cement. The concrete infill will have a longer design life than either the existing viaduct or any new steelwork.
- Access to the existing viaduct steelwork will be maintained on the **outside faces of the support box**. One cause of the current corrosion is thought to be water attack from the outside-in, meaning it is important this ‘wet face’ remains visible to allow ongoing monitoring of paint deterioration (once re-painted). Re-painting might be required within 15 years based on the assumed cleaning/preparation methods, meaning this is a real factor to consider with the remedials.
- The concrete infill does prohibit access to the **inside faces of the support box**. Although this is not ideal from a visibility and water management perspective, it is done with knowledge the inside of the boxes are shielded from rain to three sides. Where the inside faces of the boxes are wet and consequently corroding ‘inside-out’, this is likely due to water which has been unable to drain out of the truss bottom chords and which has overflowed into the support boxes. The concrete infill will act to block this water route and keep water within the truss bottom chords, where improved water management (cleaning) will allow it to discharge through down-pipes as intended.
- The risk of infilling can be mitigated by ensuring a robust interface with the new concrete. Key to this is steel **surface preparation**: ensuring the inside faces are clean and textured to increase bond with the concrete and avoid any gaps for water to percolate. The hydrostatic pressure of the wet concrete will allow it to flow and force itself against the steel, which can be further enhanced by sensitive concrete specification to ensure flowability and avoid shrinkage. With the concrete properly adhered to the steel there would be no future need to repaint the interface: the concrete would be providing protection to the steel.
- Other measures to de-risk water ingress to the steel-concrete interface is the proposed use of **sloped concrete surfaces** to the infill top surface, encouraging water flow away from the interface and down into the truss bottom chords (for discharge through down pipes). This would be combined with **hydrophilic strips** around the exposed perimeter of the interface, which would act to swell under water contact and block off any significant flow. These details are suggested more as hypothetical ‘belt and braces’ measures rather than being driven by realistic scenarios of water flow.

Castlefield Viaduct - Phase 2
Truss End Support Boxes – Remedial Options Appraisal

APPENDIX C - CONCRETE INFILL – FURTHER COMMENTARY

De-construction

- For the reasons outlined in the maintenance section, the need for removing the concrete infill is thought unlikely during the notional design life of the viaduct itself. Durability is a key benefit of the proposal.
- There is however the **low likelihood scenario** that there might be a future desire to properly replace the holed web panels of the truss support boxes, in which case the concrete infill would need to be removed. The temporary works implications of this would be challenging, as explained previously in Section 6.0.
- In this eventuality there are **several methods which could be adopted**, some of which are explained in more detail opposite. A mixture of methods would likely be used, depending on the portion of concrete being removed and all methods would be challenged by the tight access constraints. There would likely be some future temporary works in place to prepare the structure for removal of the remedial.
- Concrete removal can be as aggressive or sensitive as the project requires. For the truss end support boxes the vulnerability of the existing viaduct steel would be the key driver in dictating speed and method of demolition. It may require the use of hand tools in lieu of machines, potentially slowly working into the concrete from the top and vertical faces.
- To make concrete removal easier one option could be to use a de-bonding layer (e.g. plastic sheet) between concrete and steel inside faces, avoiding adhesion between the two. This however would bring the risk that air gaps are created if the sheeting isn't fully against the steel, which is not unlikely given the intricate geometry of the support box inside (rivets, diagonal plates, transverse beam ends). It is therefore recommended that no de-bonding is used: the concrete is to be used to its potential to flow into all the gaps, providing a 'known' more durable solution in preference to the 'unknown' scenario that the concrete would need to be readily removable.
- **Hydrodemolition** – using high-pressured water jets to force open the pores within the concrete, avoiding any damage to surround steel (even reinforcing bars). Difficult to adopt at Castlefield Viaduct given the volume of water required.
- **Concrete splitting** – hydraulic tools inserted into drilled holes, which use opposing tapered wedges to split concrete for removal.
- **Concrete saws** – cutting from exposed concrete faces
- **Pneumatic breakers** – for removing small fragments of concrete at a time. Different sized tools can be used for different accessibilities.
- **Stitch drilling** – interlocking drilled holes around the perimeter of a concrete portion to be removed

Hydrodemolition

Concrete splitting

Concrete saws

Pneumatic breakers

Stitch drilling