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Newport Transporter Bridge – ECI Survey Works Report.

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The remarkable Newport Transporter Bridge is one of only six operational transporter bridges left worldwide from a total of twenty constructed.

The bridge opened in 1906 and has dominated the Newport skyline ever since

A transporter bridge is basically a suspended ferry that can operate more efficiently than a conventional ferry.

A high-level boom that allows ships to pass underneath is suspended from towers at each end.

The boom carries a rail track on which a moving carriage or 'traveller' runs.

A gondola or platform is suspended from the carriage and can be pulled from one side of the river to the other by means of a hauling cable.

The Transporter Bridge is powered by twin 35 horsepower electric motors.

Although an 'aerial ferry' was the idea of English engineer Charles Smith, the first working example was built by Spaniard Alberto Palacio and Frenchman Ferdinand Arnodin in 1893 at Portugalete near Bilbao in Spain

The scope of the ECI Survey works are as follows:

1. **Removal of vegetation to anchor pits to see damp/corrosion.**
2. **Removal of internal bracing pins and cables – say 3 no. Provide feedback on performance and temporary works requirements.**
3. **Removal of hanger rods, assessment of members to be removed in line with currently undertaken analysis to identify the least stressed elements for removal – say 2 no. Feedback as item 2.**
4. **Removal of Eastern Approach span hardstanding, removal of timber sleepers – inspect steelwork beneath.**
5. **Material grade testing – several spare elements available within workshop.**
6. **Component integrity tests – As point 2**
7. **Preliminary local blasting**
8. **Detailed bearing / anchorage inspection (saddles on top of piers)**
9. **Torqueing up of TCB's on old steel.**
10. **Testing weld-ability of material.**

CLARIFICATIONS: -

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curtins

Item 2 - Removal of internal bracing pins and cables – say 3 no. Provide feedback on performance and temporary works requirements.

Please could you clarify if any temporary works are required in order to remove 3 No. Bracing Pins and associated cables. i.e. do we need to manufacture temporary bracing pins and cables to replace the ones removed? Allow for tirfors or steel rods as temp bracing – to suit you

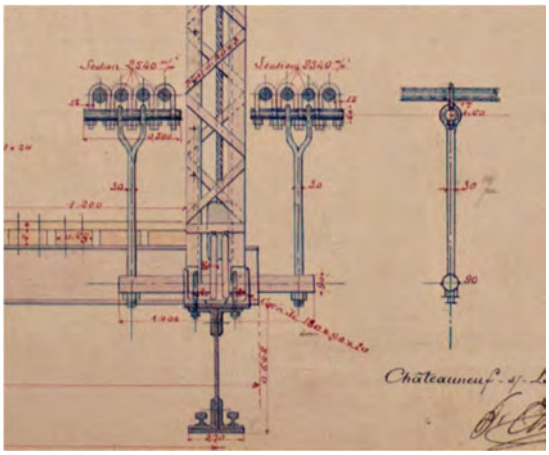
If temporary bracings are required could these be made from solid bars with a turn buckle instead of cables to speed up the acquisition of the temporary bracings? Yes – see above

Do these need to be removed from any specific location? No. For example, if temporary access is required it would be better if these were all in the same location to enable the same access to be used for all 3 bracings. We will agree 3 locations with you if you're successful, convenient for using same access.

It is highly likely that the existing pins and U Bolts and fixings etc, will be damaged during this exercise, is it your intention that we replace these with new modern materials as part of this trial? Modern materials can be used to replace the historic features until such time as the main works progress.

We would propose removal of 2 pins in one location to minimise access costs, i.e One Top Pin and One Lower pin, would this be acceptable? Yes

Item 3 - Removal of hanger rods, assessment of members to be removed in line with currently undertaken analysis to identify the least stressed elements for removal – say 2 no. Feedback as item 2.



Please could you clarify if any temporary works are required in order to remove 2 No. hanger rods. i.e. do we need to manufacture temporary hanger rods to replace the ones removed? Yes – mild steel replacements can be installed (appearance not critical) until such time as the main works progress

Is it acceptable to undertake the 2 Hanger Rod replacements in the same location as the replacement pin requirement (Item 2) again as this will minimise access costs.? Yes – subject to agreement on site with Curtins.

As the hanger pin appears to be shared by two hanger rods, can we limit the removal to two hanger rods and one pin.? Yes. We may instruct additional pin if required. Do not allow for the additional one at this stage.

Looking at the drawing and photos, the hanger rod pin appears to be continuous allowing it to be used by pairs of hangers. Is this your understanding.? Yes

Can these hanger rods be removed from any location? Obviously, the central hanger rods are shorter and will be easier to handle and replace if temporaries are required. Allow within the middle quarter of the bridge span

Item 4- Removal of Eastern Approach span hardstanding, removal of timber sleepers – inspect steelwork beneath.

We would propose a 1*2m excavation to facilitate access and inspection is this acceptable? Yes, if that allows you sufficient space to operate – your decision

To negate security /hoarding costs we would propose to excavate, inspect and re-instate within one day, would this be acceptable. Yes – so long as we arrange acceptable time for inspection with you

Do we assume that a visual inspection only is required with a written report detailing observations along with photos etc. will suffice? Annotated photographs (by Taziker) for any elements not seen during the joint inspection will suffice.

Item 5 - Material grade testing – several spare elements available within workshop.

Test Pieces required for testing need to be 150 mm x 50 mm

The tests will provide enough information to indicate what grade of steel has been used but this is only a guide and not a guarantee. We assume that this is acceptable.? Yes

How many tests are required, or should we quote a rate per test.? Rate per test, assuming a nominal number of 6 TBA.

Item 6 - Component integrity tests – As point 2

Please can you clarify what tests a required. This is to include whatever other physical or chemical tests that you require beyond the tests to determine material grade and weldability referenced elsewhere (e.g. Charpy Impact). Please price within the PS previously set out for £2k.

Item 7 - Preliminary local blasting

We assume this item is redundant as these works have previously been carried out by ourselves and all information is available if required. Is this acceptable? No, please allow for local blasting as discussed with Sam

Item 8 - Detailed bearing / anchorage inspection (saddles on top of piers)

To facilitate safe access to these works the existing damaged ladder will need to be repaired using scaffold as a temporary repair. Do we include this cost within this item.? Please identify separately.

Do we assume that a visual inspection only is required with a written report detailing observations along with photos etc. will suffice? Yes

Item 9 - Torqueing up of TCB's on old steel.

Please could you indicate how many and where these bolts are located. Allow for 6 at mutually agreed locations (we will choose convenient access)

Obviously, if these are TCBs the splined shaft will have been sheared off during their original installation so do we include for replacing these with new on a one out one in basis.? Yes

Do we have details on what size and lengths these bolts are? Approximate sizes will suffice. No – did you see any on the bridge with Sam? If you have no information, then assume M24 60mm long for pricing. Please state your assumptions.

Item 10 - Testing weldability of material.

The material testing carried out in item 5 will indicate if the material tested is weldable. However, are these tests being carried out on different items? No – assume the same

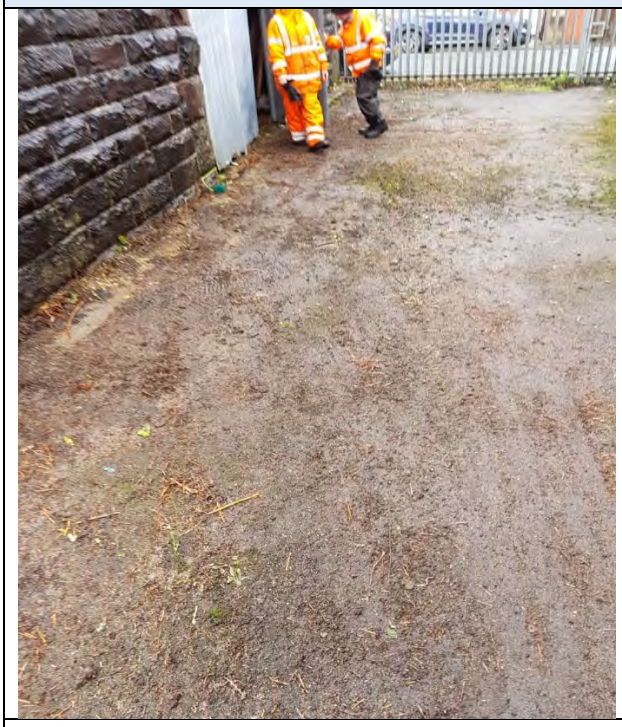
How many tests are required, or should we quote a rate per test? Rate per test, assuming a nominal number of 6 TBA.

Do you want us to carry out a test weld with these materials? Yes

RESULTS

Item 1. Removal of vegetation to anchor pits to see damp/corrosion.

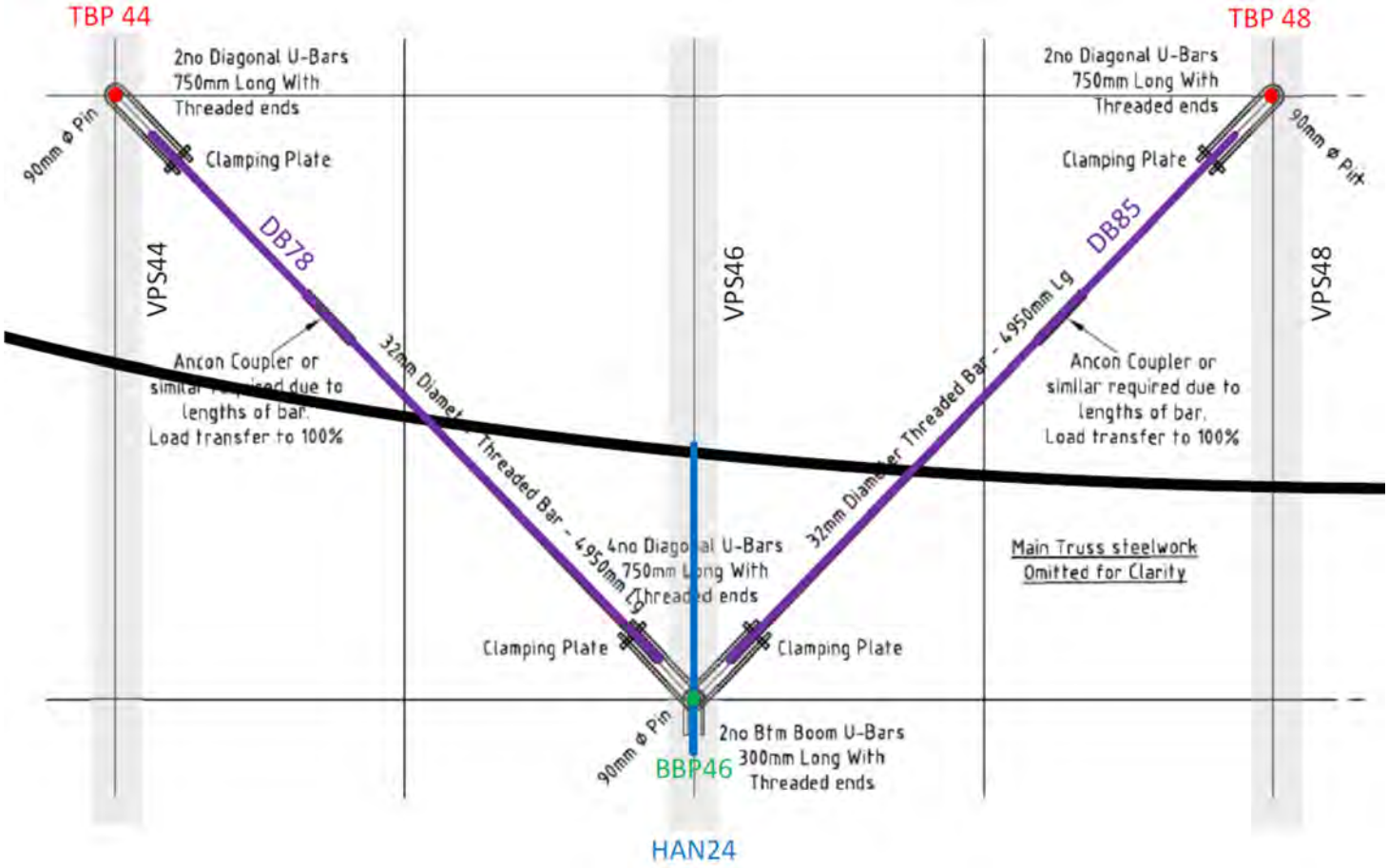
Vegetation around the full perimeter of both Anchor Houses has been undertaken to facilitate a thorough inspection of the pits and associated buildings.

West Anchor House	West Anchor House
	
	

Item 2. Removal of internal bracing pins and cables – say 3 no. Provide feedback on performance and temporary works requirements.

The location for the trial works was chosen around Hanger 24, which includes the following items for replacement: -

HAN24 – Hanger 24, 2 No. M30 Bars, 2 No. Rod Clamping Plates, 4 No. Hanger U-Bars
BBP46 – Bottom Bracing Pin, 2 No Holding down U-Bolts.
TBP44 – Top Bracing Pin, 2 No. Strengthening Plates.
TBP48 - Top Bracing Pin, 2 No. Strengthening Plates.
DB78 – Diagonal Bracing 36mm Threaded Bar, 2 No. Clamping Plates, 8 No. U-Bolts.
DB85 – Diagonal Bracing 36mm Threaded Bar, 2 No. Clamping Plates, 8 No. U-Bolts.



To facilitate these works we also had three other considerable challenges, that will also impact the cost of the core works, therefore we have chosen to comment on these within this report, these are namely:-

- Logistics
- Access Scaffolding
- Temporary Works

Logistics

Road access to either side of the structure is relatively unhindered, however raising plant material and equipment to the main boom is problematic.

It is not safe to utilise the existing Pier leg staircases for nothing other than pedestrian access; therefore, all other means of logistics needs to be accommodated by another means.

The structure is fitted with a 400kg powered winch, however this is currently uncertified and not in use, when this is operational it has working restrictions in respects of speed of operation (it takes 12 mins to either raise or lower each load) and is therefore unsuitable for a project of this size.

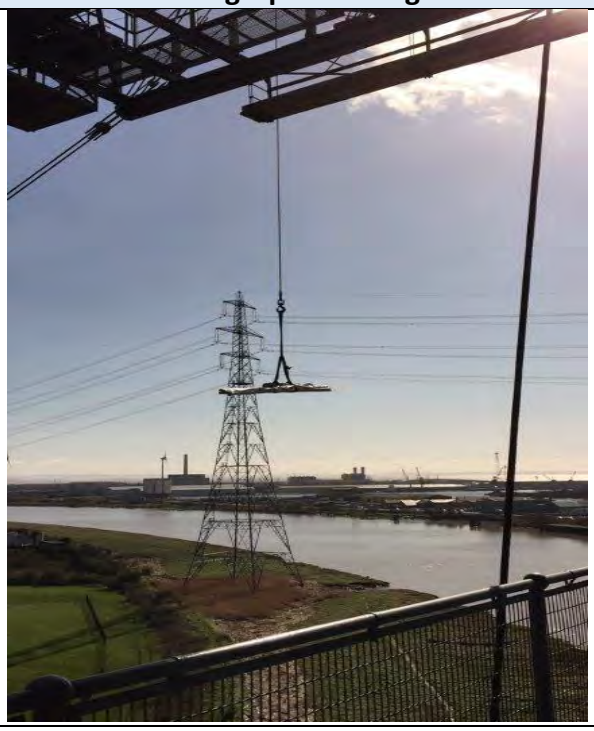
For the trial work we used Gin Wheels to raise and lower materials, which is both laborious and very time consuming.

Consideration needs to be given to a safe and reliable means of material transportation for the core works.

A refurbished winch with greater SWL Capacity, faster speed motor and an extremely high duty cycle would probably be the most pragmatic solution, but other alternatives could be considered, however most of these will have their own restrictions.

Tower Crane – Very Expensive as would need to be manned.

Mast Climber Hoist – Unable to affix to boom or pier leg and the scaffold needed to self-support would be significant.

Winching Up Handtools	Winching Up New Diagonals
	

Scaffolding

In order to facilitate access to the three pin locations we installed 3 specific scaffold access platforms.

Access to the Two Top pin locations was relatively simple as we could erect the inside working lift from the existing walkway and then brace and box tie around the Top Chord to allow us to cantilever to the outer face and erect a small external access platform.

Access to the Lower pin, was much more complex. Initially we hade to create a support frame from the existing walkway and cross members, prior to lifting the grating on the existing walkway and using T-Bar droppers. Once on the underside of the walkway scaffold tubes could be thread onto the top of the Bottom Chord allowing several box ties to be installed to support the required hangers to support the working platform. Once the scaffold frame was installed, a few sway braces were also installed along with butt tubes to the runway beams to give additional stability.

Access Ladders where then installed to facilitate access to the new working platforms.

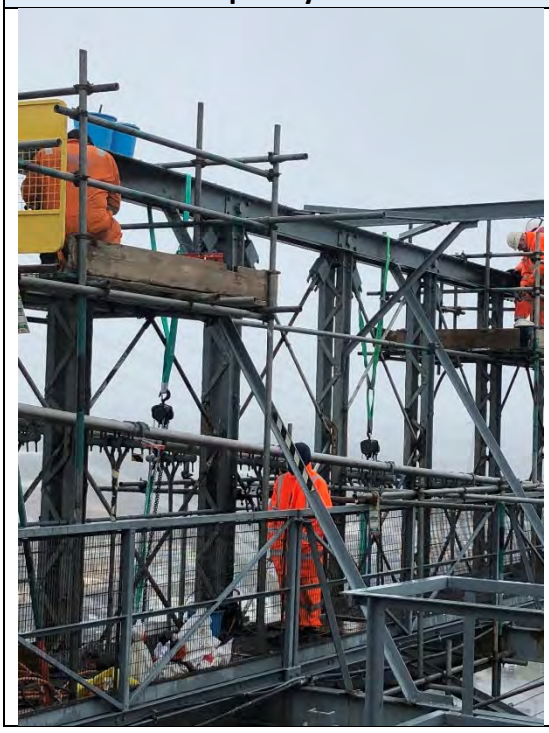
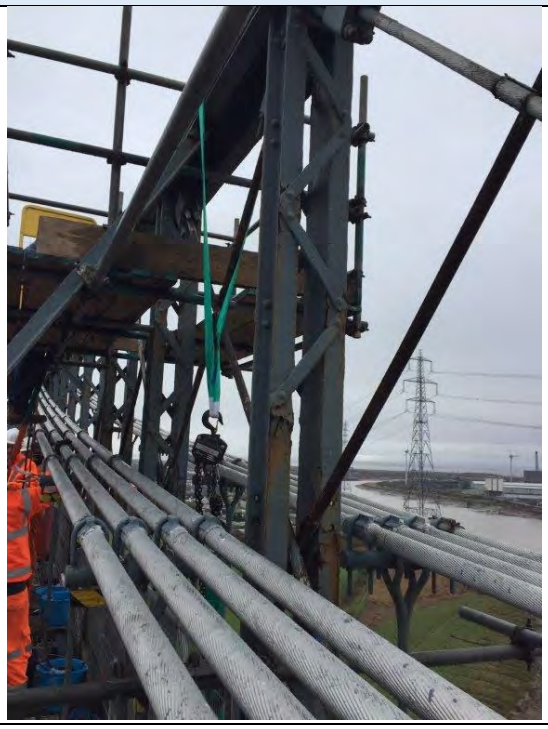
Scaffolding General - Internal	Scaffolding General - External
	
Top Pin Scaffold - Internal	**Top Pin Scaffold - External**
	

Lower Pin Scaffold - Internal	Lower Pin Scaffold - External
	

Temporary Works

The removal of the existing Diagonal Bracing Cables and associated pins could cause localised effects as the Top and Bottom Chord will naturally want to separate as items are removed.

In order to negate as much of this movement as possible, we installed 4 No. temporary restraints, these where formed from 3t Web Slings slung around the Top and Bottom Chords and tensioned using 2t Chainblocks.

Temporary Restraints	Chainblock in Place
	

Top Bracing Pin 44 (TBP44)

Existing Pin - External	Existing Pin – Internal
	

Prior to removal of the existing pin, the 4 U-Bars holding the Diagonal Bracings (DB78 & DB77) were released using hot works techniques.

Prior to releasing the U-Bars, the Diagonal Braces were temporarily held in place using 1t web slings, supported from the Top Chord to ensure these did not move in an uncontrolled manner.

No significant inertia movement was observed when releasing the existing U-Bars.

The remnants of the U-Bars around the pin were removed using hand tools to free them, albeit the numerous coats of paint around these bars did need to be removed to facilitate movement.

The remnants of the U-Bars passing through the Cable Sockets are a lot more difficult to extract, as they appear to have been additionally fixed in place using either lead putty or a resin through the holes. Each Bar was forced out by hammering drifts through the apertures taking care not to damage the cast iron socket.

Released U-Bars	Diagonal Cable Sockets
	

The existing pin was cleared of all paint on the internal face, to ensure that this did not impede passage of the pin through the Top Chord.

The Pin was firmly locked in position and wouldn't move despite various means being introduced to release it from its housing.

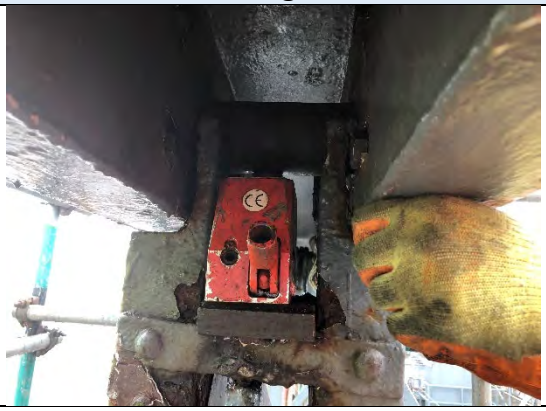
The existing strengthening cover plates affixed to the internal and external faces of the Top Chord Flanges were removed to free up the pin. However, this proved futile as the Pin remained firmly locked in place. *Please Note: The existing bolted connections in each corner of the strengthening plates were all hand loose after removal of the paint, prior to us undertaking any structural works, it is not known how these have all worked loose?*

It became apparent through observation that the Vertical Primary Steelwork (VPS44) was transferring all the weight from the Bottom Chord directly onto the Pin Connection and therefore removal of the pin was unattainable without releasing the applied force.

Pin Internal – Locked in Place	Strengthening Cover Plate Removal
	

In order to release the weight from the pin, we used a small 10t hydraulic bottle jack to drive the VPS down slightly.

Once we could confirm a nominal movement, we introduced steel wedges between the VPS and the Top Chord to maintain the gap prior to releasing the jack. This removed the applied load from the pin and allowed us to extract this by hammering it through the aperture.

Jacking Pin	Separation Wedges
	

Removed Pin Elongated Aperture	Removed Pin
	

On removal of the pin it became more apparent that the inside face of the VPS (at the connection to the pin) was heavily corroded/ delaminated and in need of repair. A design will need to be produced to allow such repairs to be undertaken during the core works to ensure a robust connection between the Pin and VPS.

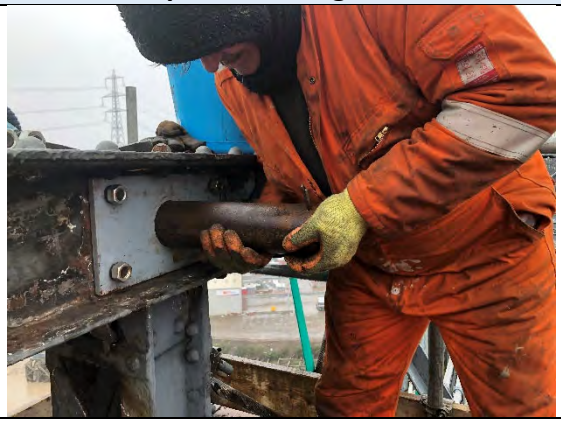
There was also evidence of prior elongation of the aperture on the Top Chord Flanges, adding credence to the historical installation of the cover plates.

Severe Corrosion to VPS Connection	VPS Corrosion from Pin Aperture
	

Aperture Elongation	Aperture Elongation
	

After removal the new Strengthening plates were installed to the external faces and bolted into position.

The periphery of the existing aperture was dressed using an acorn grinder to remove any stress fractures, prior to insertion of the new pin, which was easily slid in by hand.

Aperture Elongation	Aperture Elongation
	

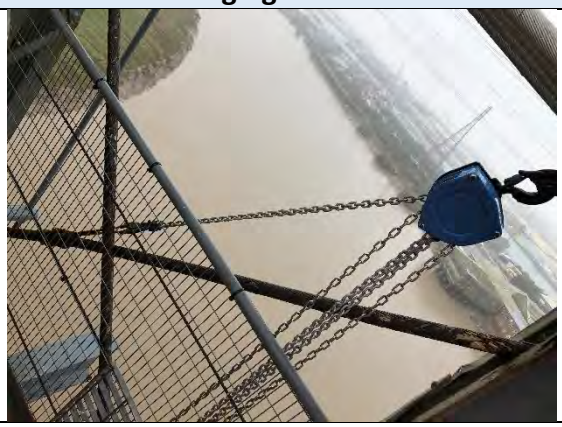
In order to load the pin, we inserted the jack again and pushed down the VPS to allow the removal of the wedges, prior to releasing the jack to load the pin. Once the jack was removed the Pin was secure and unable to be moved (even under force). The Split pins where then inserted and secured in place.

New Pin U-Bars could then be inserted to facilitate reconnection of DB77 and for the replacement of DB78.

Loading of New Pin	Installation of New U-Bars
	

In order to re-connect the existing Diagonal Bracing Cable DB77, we had to install a sling and chain block arrangement, to pull the cable back into position as it had dropped on the lower Cable Socket.

Once retained back in position the new U-Bars could be thread through the Cable Socket and torqued back up.

Slinging of DB77	Reconnection of Cable Socket
	

The new U-Bars required for DB78 received a new clamping plate, ready to receive the new 36mm Diagonal Bar.

New Clamping Plate	Complete TBP 44 Arrangement
	

Top Bracing Pin 48 (TBP48)

The same process was used for the extraction and replacement of TBP44, however this was somewhat easier having learnt the easiest method of removal.

The main difference with this location, was the significant corrosion discovered to the inside face of the Top Chord.

Internal Face of TBP48	Elongation of External Face of TBP48
	
Less corrosion to VPS	**Prior to Pin Removal**
	
Plug of DB86	**New Diagonal U-Bolts over New Pin**
	

Bottom Bracing Pin 46 (BBP46)

Existing Pin - External	Existing Pin – Internal
	

Prior to removal of the existing pin, the 4 U-Bars holding the Diagonal Bracings (DB78 & DB85) were released using hot works techniques.

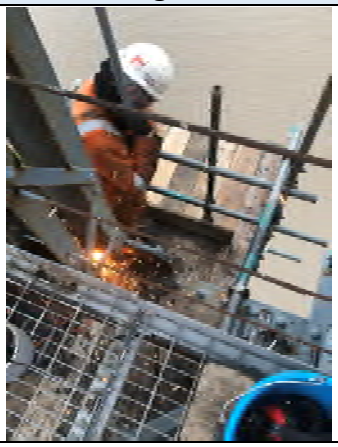
No significant inertia movement was observed when releasing the existing U-Bars.

The remnants of the U-Bars around the pin were removed using hand tools to free them, albeit the numerous coats of paint around these bars did need to be removed to facilitate movement.

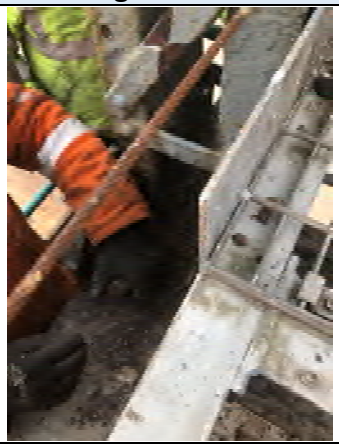
Released U-Bars	Removed U-Bars
	

Due to the load imposed by the VPS it was apparent there was no means of releasing the Pin without using destructive techniques.

Therefore, the Bottom pin was burned into small sections to allow the small remnants to be forced out of the apertures.

Releasing Hangars	Burning Out Pin
	

Once the Pin was removed, the area was cleared to allow the Holding Down U-Bars to be accessed and removed using Hot Works.

Clearing Pin Remnants	Removal of Holding Down Bolts
	

On examination of the Bottom Chord and VPS, they both appeared in good condition with limited corrosion and no visible elongation of the apertures.

Removed Pin	Aperture
	

After cleaning the apertures, it became apparent the VPS had dropped slightly and therefore the insertion of the new Pin would not be possible.

Therefore, we used a small 10t hydraulic bottle jack to lift the VPS up slightly to re-align the apertures.

Jacking up of VPS	Aligned Aperture on Inside Face
	

Once aligned, we inserted the Pin by hand from the inside face, to support one side of the VPS, this then allowed us to lower the jack and then drive the pin through the outer face.

New Pin Insertion	Pin Inserted
	

Once completed the Holding Down U-Bars and Diagonal U-Bars were installed (same method as Top Pins).

Diagonal Bracings (DB78 & DB85)

Once the pins had been installed with the associated U-Bars and Clamping Plates, we commenced installation of the new Diagonal Bracings which took the form of a 36mm Threaded Bar.

The bars came in two 3m lengths, the first length was threaded through the intermediate VPS45 & 47 and fitted with a threaded connector.

It was passed through the central hole on the Top Pin Clamping Plate and bolted into position.

New bar Passing through VPS	New Bar with Connector
	

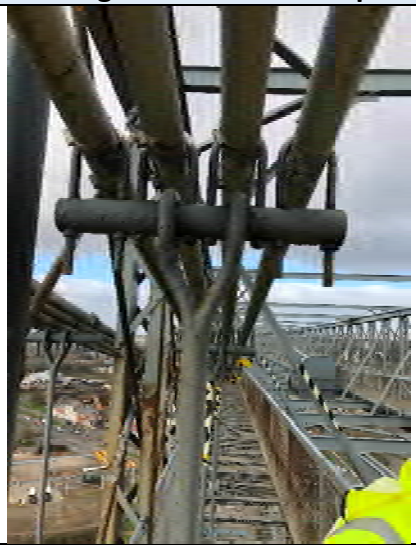
The second bar was cut to length and inserted through the Bottom Pin Clamping Plate and then affixed to the other bar using the threaded connector.

Top Pin Connection	Bottom Pin Connection
	

All U-Bars and the Diagonal Bar connections were then torqued and locking nuts applied to all bolts. The lower sections were also Denso wrapped for additional protection from the elements.

The old Diagonal Cables have been retained for testing (by others).

Item 3. **Removal of hanger rods, assessment of members to be removed in line with currently undertaken analysis to identify the least stressed elements for removal –2 no. (Feedback as item 2.)**

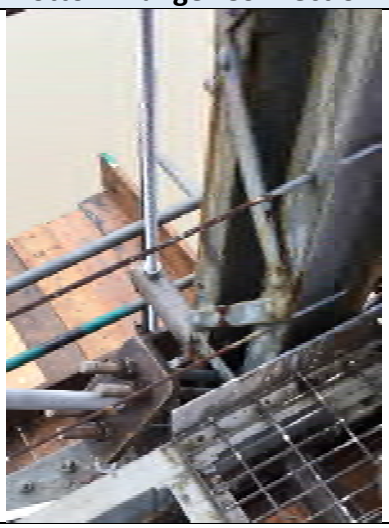
Hangar Connection - Top	Hangar Connection - Bottom
	

The existing Hangers where removed by burning through the existing hangers at the lowest point at the Bottom Bracing Pin and also at the Top connection to the Cable Pin.

Bottom Hanger Connection	Top Hanger Connection
	

Once removed, new U-Bolts were installed over the Cable Pin and a new clamping plate installed.

The new Hangers made from 30mm Threaded Bar were then threaded through the new Bottom Bracing Pin and through the clamping Plate and Torqued into position, prior to locking nuts being installed to all bolts.

Top Hanger Connection	Bottom Hanger Connection
	

Item 4. Removal of Eastern Approach span hard standing, removal of timber sleepers – inspect steelwork beneath.

Eastern Approach	Previous Excavation Area
	

To enable the inspection of the steelwork underneath we removed a section of the existing timber decking, by removing the coachscrew fasteners from on top.

Once the location of the steel girder could be ascertained, we marked out the area for excavation.

The ground was made up of 100mm of Tarmacadam and then 200mm of Cobbled Setts then general fill around the steelwork to the rear of the stone abutment wall.

The excavation needed to be left open for several days to facilitate inspection by the designers, therefore we installed safety barriers around the perimeter.

Steel Bearing on Masonry Abutment	Extent of Steel Bearing
	

Once inspected the timbers were re-affixed and the excavation re-filled, setts reset and a new hot tarmacadam surfacing applied.

Excavation Fenced Off	Completed Re-surfacing
	

Item 5. **Material grade testing – several spare elements available within workshop.**

To be completed on receipt of results.

Item 6. Component integrity tests – As per Item 2

To be completed on receipt of results.

Item 7. Preliminary Local Blasting.

It was mutually agreed that the costs for undertaking this element of work would be disproportionate for the information it would provide.

Taziker Industrial undertake Grit Blasting and Painting on similar structures throughout the UK and therefore can offer further advice on the pertinnent issues and risks that would need to be overcome when Grit Blasting the Main Boom.

The erection and maintenance of temporary works to protect the environment whilst the works are being completed, is the single major factor that will influence the success of the planned works. Success of the works being defined as the actual durability of the new coating in excess of 25 years.

The temporary works will require a significant period for the design phase. Failure to plan for this will result in decisions being made that are driven by time, rather than finding the most effective technical solution. The extent of the temporary works at any one time on the structure and their size, how long it takes to relocate, and the weather resilience will determine the overall duration of the project.

The other main consideration pertinent to this structure is the logistic of getting compressed air to the main boom to feed the blast pots, then the extraction equipment required to remove the used abrasive and lead contaminants back to ground level.

Once the temporrary works and logistics are in place, the practicality of completing the Grit Blasting activities will be no different than to any other structure.

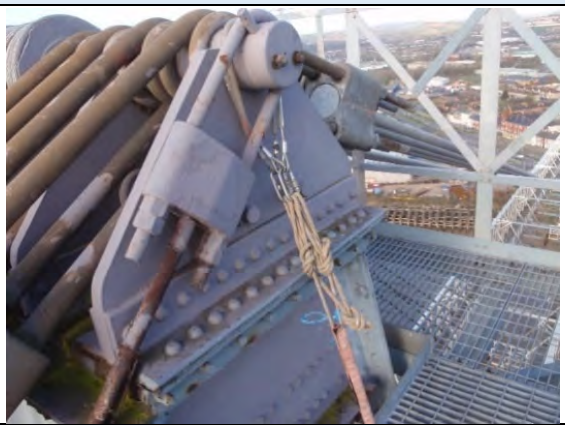
Item 8. Detailed bearing / anchorage inspection (saddles on top of piers)

Ladder Access, landing gates and fall cages have been installed to each anchorage to allow safe additional detailed inspection to be undertaken by others.

On visual Inspection of the Saddle Anchorages, there does not appear to be any deformation or cracking to the Main Cable U-Bars or the Cable Sockets.

It is difficult to assess the actual saddle and roller arrangements, as these are covered by all the U-Bars, however from the small areas visible under the U-Bars, there does not appear to be any fractures or significant corrosion.

South West Saddle	North West Saddle
	

South East Saddle	South West Saddle
	

Item 9. Torqueing up of TCB's on old Steel.

It was agreed that it would be more practical to undertake this testing on sections removed from the structure and bolted together off site.

Taziker Industrial have been using TCB's on a wide range of structures and applications over the last decade and never encountered any issues using these as a conventional rivet or HSFG replacement.

The small sections we removed from the structure were affixed to new steel sections using a standard TCB Shear Wrench.

No deformation of the parent metal was observed and as the correct preload was reached.

Excavation Fenced Off	Completed Re-surfacing
	

Item 10. Testing weld-ability of material.

To be completed on receipt of results.