UK Highways
Bridge Management

Principal Inspection Report
Menai Bridge
(Structure Ref. A5 Menai Bridge)

December 2019

Notice

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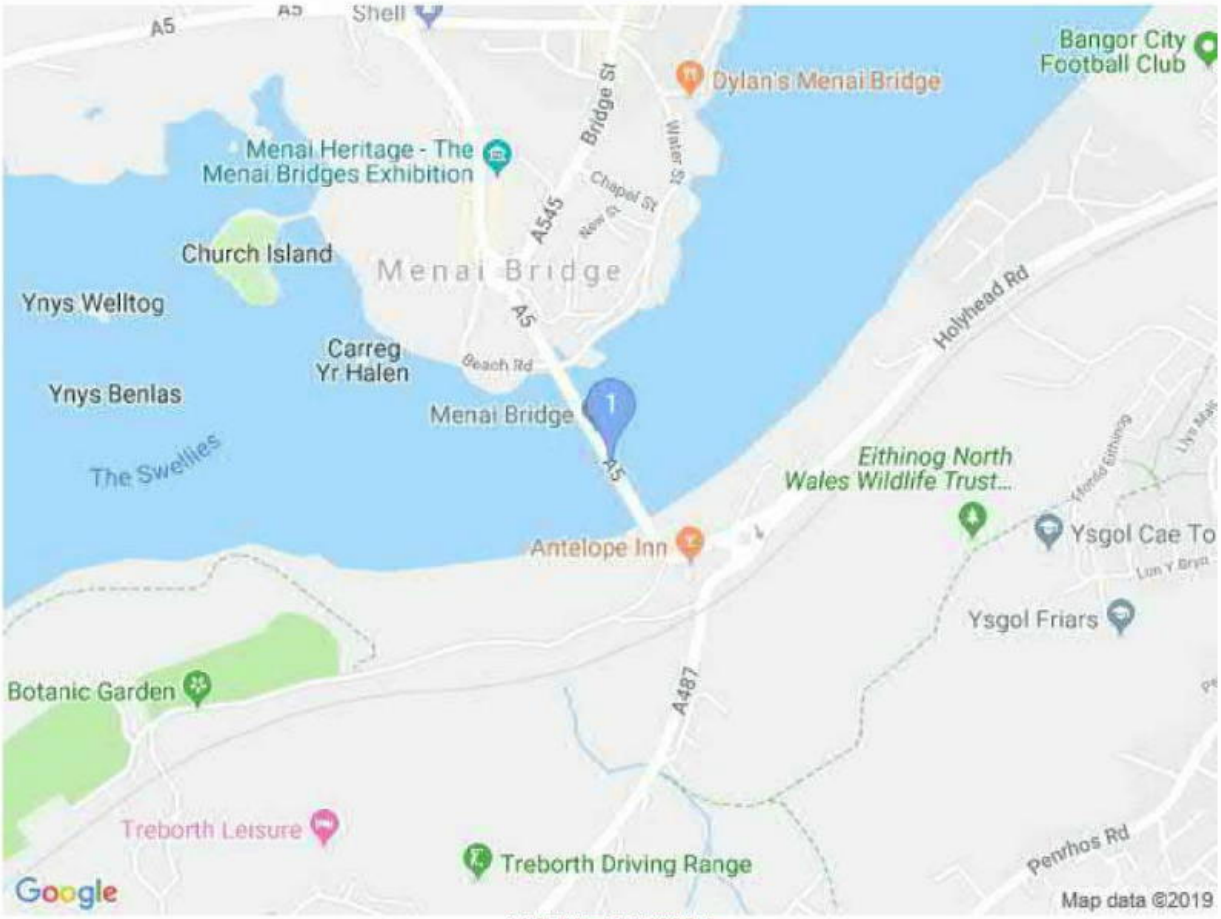
1. Introduction and Location Map

1.1 UK Highways Ltd manage a number of assets, which it has a duty to inspect and maintain on a periodic basis. Atkins is working on behalf of UK Highways Ltd to carry out these inspections and report on the condition of each asset.

1.2 This report covers the Principal Inspection of UK Highways Ltd structure reference A5 Menai Bridge, named Menai Bridge, at grid reference 255677, 371404. A location map is included below.



LOCATION MAP

2. General Description

2.1 Introduction

The Menai Suspension Bridge (MSB) was originally constructed in 1826 with iron suspension chains carrying a wooden deck. Between 1938 and 1940 the entire wrought iron suspension chains were replaced and reduced from four sets to two constructed from high tensile steel. The original masonry works to the towers and approaches remain unchanged. The deck was also replaced at that time and the road deck above the arches were increased in width at the centre of the bridge, by reducing the central reservation approaches, to better accommodate traffic.

The bridge, which is a Grade I listed structure (the curtilage includes the gardens, Bridge masters house and the rear wall at the Antelope pub), crosses the Menai Strait at its narrowest point near the village of Porthaethwy (Menai Bridge). It carries the A5 carriageway linking mainland Wales to the island of Anglesey. The Menai Bridge is used as an alternative route should the Britannia Bridge be closed. The bridge also carries a bus

route on the A5 carriageway and two 2.6m wide cantilevered footways either side of the single carriageway.

2.2 Structural form of the Menai Suspension Bridge

The bridge consists of a centrally suspended span with masonry arch approach viaducts at each end. The main support towers rise 52m above the low water mark, 17m above the road deck and are positioned 176.75m apart. The main bridge deck is suspended with two suspension chains, which are located symmetrically about the centre line of the bridge. Each suspension chain comprises an upper and lower chain. Each individual chain is composed of six flat elements/laminations which are interleaved at the connection to the hanger/node positions. At each node a 254mm dia. connecting pin passes through the twelve laminations forming the chain.

The chains pass over saddle bearings located on top of the support towers and terminate beyond the approach viaducts at connections to the ground anchorages. The anchorages at the mainland side extend to beneath the Holyhead – London railway line and are encased in concrete. The dip of the chain catenary over the central span is 13.1m and the bridge width is 11.38m wide.

The hangers are attached to the upper chain nodes with 12.7mm thick drop plates and to the lower chain nodes by single 25.4mm thick drop plates. At upper chain/hanger locations a secondary drop plate is fitted, which passes between the third and fourth links of the lower chain and is connected to the wire cable hanger, below the underside of the lower chain. At the approach spans, wire rope hangers connect the suspension chains to anchors built into the masonry arches and are tensioned to provide the required catenary form.

Between the back-stay chains, above the approach spans, lateral sway restraints have been fitted above the road level. Along the main span, two vertical restraints were fitted above the road level between the suspension chains and truss. These vertical restraints are positioned so that they effectively split the truss into thirds. The main deck is suspended form the chain nodes by wire rope cables which are replaced at the mid span section between the chain sway restraints by shorter mild-steel hangers of square cross-section.

A number of the wire rope hangers have a modified connection detail between the wire rope hanger and the node drop plates. This detail incorporates a set of screw secured end plates instead of the typical washer and split pin. The road deck consists of a steel plate supported on a steel beam grillage. Two riveted longitudinal stiffening trusses 2.59m deep running the length of the deck stand on each side of the road way.

The truss has been constructed in sections and joined using the splice plates on the flanges of the booms. The longitudinal truss ends rest on pre cast corbels on the support towers and are also suspended off suspension chains. Steel wire hangers, terminating in these stiffening longitudinal trusses, are suspended from the suspension chain by means of drop plates and hanger plates. The vertical hangers are at 2.44m centres attached alternately to the lower and upper chains. The footway on the suspended span is carried on tapered steel cantilever members riveted to the bottom beam of the longitudinal truss.

The approaches are constructed as 16.002m span masonry arch viaducts; three spans on the mainland side and four spans on the Anglesey side. The approach viaducts terminate at masonry retaining walls which curve outwards and decrease in height to match adjacent ground levels. The masonry piers on both sides of the suspended deck are founded on solid rock. On the Anglesey approach all but two of the middle pier bases remain submerged almost permanently, except during Spring Low Tide when all the pier bases are exposed. On the mainland approach the pier bases are submerged at high tide only.

2.3 Recent maintenance works

Recent maintenance works are summarised in the Menai Suspension Bridge - The first 200 years book. This book states that a major repainting of all the structural steel work was

carried out in 2004/2005 consisting of a 3-coat, 2 pack polyurethane protection system which typically lasts 12-15 years depending on specification. The repainting of the bridge required the complete removal of the existing paint system which contained high traces of lead. However, the visual appearance under the main suspended span suggest that re-painting works were only carried out to the first few metres of the east and west edges. The bridge has had some other minor maintenance work including replacement highways signs, maintenance to the lighting systems with some repairs and repainting to the steelwork.

3. Inspection Procedure

3.1 The inspection was carried out in phases which included drone survey, dive survey, confined spaces survey, roped access survey, MEWP and on-foot surveys. The drone survey was carried out between 10th-12th September, the dive survey was carried out during Spring Low Tide between 28th and 29th September and the roped access survey was carried out between 30th September and 5th October 2019. Rectrix Drones undertook the drone survey, Titanium UK Divers undertook the dive survey, Up n Under Roped access teams undertook the roped inspection beneath all spans which also used a safety boat on stand-by during all work over water. The elements of the superstructure above the roadway were carried out via MEWP inspections using Facelift Access by Atkins engineers [redacted]

3.2 Following a review of the initial surveys, the MEWP survey was carried out on the main bridge deck superstructure between 5th and 7th November 2019. The south end of the bridge, above the 3-way junction leading from the A5 to Treborth Botanical Gardens, was carried out during a night-time MEWP inspection on 9th and 10th December 2019. The confined spaces inspection to the north back-stay anchor block and on-foot inspections from the footways were carried out at several opportune periods throughout all these dates by Atkins engineers [redacted]. The general weather at the time of all these inspections was largely dry and a temperature range of between 4-16 degrees Celsius with wind speeds of between 0 and 20mph.

3.3 Buried and below ground parts of the structure were not inspected but the pier bases were inspected and surveyed for scour during Spring Low Tide when they were all visible. No testing was carried out as part of this inspection.

3.4 The position, extent and severity of all significant defects are recorded in Section 4 and summarised on the bridge inspection pro forma in Appendix A. These follow the Bridge Condition Indicators system developed by the County Surveyors Society. The Principal Inspection was to comply with the DMRB Volume 3, Section 1, Part 4 – BD 63/94. Photographs of the bridge and any defects are contained in Appendix B.

3.5 Although the bridge spans between Anglesey and mainland Wales from north north west (NNW) to south south east (SSE) for clarity, this report has adopted the convention of the bridge spanning from north to south. Therefore, the cardinal points within this report use such terms as north tower, south tower, west parapet and east parapet.

3.6 The spans are numbered from 1 to 8 from north to south with the main suspended span being span 5. There are 4 approach masonry arch spans to the north, Anglesey side and 3 approach masonry arch spans to the south, mainland side. Span 1 observations will encompass the northernmost arch, north abutment and corresponding pier 1. Span 2 will include the next arch and pier 2 and so on until span 8 and the south abutment on the mainland side of the bridge is reached. Note that this report has many cross-references so large parts are more straightforward to read when the report is opened twice electronically; one at the descriptions section and one at the corresponding photos.

4. Inspection Findings

1. Primary Deck Element

This element includes the masonry approach arch intradoses, the main span steel truss and high tensile steel catenary chains and anchor blocks. The hanger cables, hanger plates and mild steel square section drop links to the middle third of the main span are included within element 5 – Tie beam/rod. The defects to the primary deck elements are as follows:

- Several small areas of paint loss and surface corrosion were noted throughout the east and west longitudinal trusses located between the footways and carriageway. Most of the paint loss/corrosion areas were to truss element nodes and discrete pockets where water collects due to the intricate detail around rivet heads and in areas where several plates meet and intersect (Figure 35). Typical paint loss and corrosion was noted to the lower west face of the main truss and walkway cantilever, 80.5m from south (Figure 117).

- Several small areas of deep mortar loss were noted to joints throughout both towers particularly to the lower third of the upper towers above the road deck. A typical example of this was to the lower east face of the south tower above the road deck level (Figure 27).

The visible parts of the back-stay anchor block arrangement, located to the east and west footways beneath the north end of the bridge, were structurally sound and generally in fair condition except for the following durability type defects:

- Several small areas of minor to moderate paint loss and minor corrosion were noted to bolt heads on the north back-stay anchor bolt group arrangement. This defect was more so to the west back-stay anchor bolt group arrangement than the east, possibly due to the prevailing south-westerly wind direction making this side slightly more exposed to the elements. Conversely, the relatively sheltered south back-stay anchors, being housed in the bridge-masters building, were in good condition. Also, there was vegetation growing from silting/ponding areas to the base of the north west back-stay anchor arrangement (typically shown on Figure 93, Figure 94).

- The west face of the west back-stay anchor arrangement was generally in good condition with minor algae staining (Figure 92) but general light surface corrosion was noted to the inside, east face bolt group of the west back-stay anchor arrangement. Several small areas of minor to moderate paint loss and corrosion was found to bolt heads. Also, vegetation was growing from silting/ponding to the base (Figure 93).

- Corrosion was noted along the inside, east face of the west back-stay anchor arrangement bolt group where it meets the buried concrete anchor block. There were also several small areas of minor to moderate paint loss and corrosion to bolt heads (Figure 94).

- The north face of the east back-stay anchor arrangement was generally in good condition but with minor cracking to the short retaining wall supporting the east footpath (Figure 95). There was also very minor cracking and algae to the south face of the east anchor block (Figure 96) and minor rust staining and debris surrounding last chain links near the east anchor block (Figure 97).

- The north anchor block showed corrosion and rust staining beneath the south end of the east anchor block strands (Figure 98). There were also algae to, and debris beneath the west face of the east anchor block strands (Figure 99) and algae to the concrete plinth near the east anchor block (Figure 100).

The defects recorded during the roped access inspection of the underside of the deck were typical throughout the bridge with isolated areas of corrosion to elements, small areas of delamination and paint loss throughout with corrosion depths taken every 30m intervals as a reference. The rope inspection site notes start from ch0m at the south end to ch176.75m at the north end. The defects are as follows:

- The walkway deck surfacing was generally in good condition throughout.

- The walkway edge girders exhibited signs of light corrosion throughout.
- Several small areas of paint loss and corrosion were noted throughout lower truss typically to the main span lower west elevation, 27m from south (Figure 110).
- The upper part of the main longitudinal truss, separating the carriageway and the footways, showed several small areas of light corrosion up to 1mm deep throughout, to less than 1% surface area. Typical at 149m from the south (Figure 124). The typical condition of the outer lower truss and cantilevers looking south from the east side at 12.5m and 17.5m from the south end (Figure 130, Figure 131 respectively).
- The lower part of the main longitudinal truss showed several small areas of light corrosion up to 1mm deep throughout to less than 1% surface area with areas of heavy paint loss and up to 3mm deep corrosion typically at 90m north of the south end, at 139m from the south (Figure 141) and at 149m from the south (Figure 142). A general view of some of these defects are within Figure 143.

The defects recorded during the roped access inspection of the limestone masonry approach arch intradoses were also typical throughout the bridge. The defects to note were as follows:

- Areas of minor damp staining and efflorescence were noted throughout the south end of arch span 7 (Typically to Figure 148).
- Several small areas of deep mortar loss were noted to mortar joints throughout the arches. A typical area around the east side, above south springer of arch 7 is within Figure 150, and Figure 151 where vegetation is starting to grow.

2. Secondary Deck Element – Transverse beams

This element includes the steel I beams that were suspended transversely from the main longitudinal trusses using a combination of bolts and rivets. The defects to note were as follows:

- Generally, 1-2mm depth of corrosion was noted to several areas throughout the transverse beams which are suspended from the deck longitudinal truss. Bolt and rivet heads were generally less corroded but bolt/rivet heads at 150m north of the south end were 80% corroded to 2mm deep with some isolated areas measured up to 3mm deep. Areas around where services cut through at the south and north ends and along lower flange plates were typically more corroded, up to 2mm deep in places along the east and west edges of the main span, (Figure 102, Figure 103, Figure 104, Figure 106).
- Paint loss and corrosion was noted to the soffit of the west footpath cantilever to the south tower. Note flaking paint where the concrete soffit had been incorrectly painted (Figure 105).
- Several areas of minor to moderate paint loss and corrosion was noted to the south end of the main span (typical examples of this, along with areas of previous painting visible to beam ends, defects are shown within Figure 103).
- Paint loss and corrosion was prevalent throughout the main span soffit and lower face of truss, typical to 37m from the south (Figure 111, Figure 112). Further paint loss and corrosion was noted to the main deck soffit, typical at 46.5m from the south (Figure 113).
- Deep pitting corrosion and full depth section loss was noted to the lower edge beam flange, 52m from the south (Figure 114).
- Paint loss and corrosion was noted to transverse beam edges, longitudinal stiffeners and bolts, 85.5m and 90.5m from the south end (around mid-span) (Typically within Figure 118, Figure 119 respectively).
- Paint loss and corrosion was noted to the west face of the lower truss, upper flanges of the walkway cantilever and rust-staining was found to the bearing shelf, north end (Figure 125, Figure 126, Figure 127).

- Paint loss, flaking paint, paint loss and corrosion was noted to a small steelwork repair panel to the lower east face of the parapet, 8m from the south end (Figure 128).

- Paint loss and minor corrosion was noted to the transverse beam east end, 12.5m from south end (Figure 129). Further paint loss and corrosion was noted throughout the transverse beams and longitudinal stiffeners, 71m from the south (Figure 135).

3. Secondary Deck Element

This element includes the steel deck plates topped with concrete, spanning the transverse I beams. These elements could not be fully inspected as they were covered with the asphalt carriageway surfacing. The deck plate soffit was inspected at the same time as the underside of the longitudinal truss and the suspended transverse beams, so inter-related defects are covered within elements 1 and 2 – Primary and Secondary Deck Elements respectively. However, a summary of the specific defects to these elements are outlined below:

- The deck plate soffit showed paint loss and corrosion of up to 2mm deep typically throughout but 3mm deep at around ch170m (the north end of the deck) but at 10% area throughout.

- The angle plates showed several small areas of light corrosion up to 1mm deep throughout to less than 1% surface area.

- Several areas of paint loss and corrosion were widespread throughout the deck soffit, typical at 66m and 71 from the south end of the main span (Figure 116 and Figure 135 respectively). Similar defects were typically found at 85.5m from the south (Figure 136).

4. Half Joints

There were no half joints on this bridge.

5. Tie beam/rod

This section will cover the hanger cables, their respective hanger plates and upper pin connections along with the turnbuckle connections which are located just above deck level. It should be noted that the substructure of the back-stay tie bars, buried beneath the approach surfacing, was not inspected. This section will also cover the square section mild steel drop links which were present to the central third of the main span, located around mid-span.

The hanger cables along with the upper and lower connections were generally in good condition throughout the superstructure. However, the mild steel drop links were in poor to fair condition owing to the notable section loss where the links pass through the upper truss members, just above the threaded section where the nut and washer assembly is situated. Large and relatively thick (6-7mm) flakes of paint and corrosion could be easily removed from these areas at will. It appears that this corrosion was due to salty water continuously running along the catenary chains, down the drop links and ponding between the truss plates and local plate stiffeners. This defect effect may have been exacerbated resulting from the use of mild steel for this structural component. The defects to these elements are outlined below:

- Possible vehicle impact damage was located to the east 4th hanger south of the south tower. This was evidenced by a visibly bent lower section and paint loss to cable. Despite this, the turnbuckle and lower circular hanger section appeared to be in fair condition but with non-visible fatigue stress that would be latent and hard to visibly detect (Figure 26).

- Localised paint loss, corrosion and moderate section loss was noted to the 34no (17no each side) square drop link mild steel bar lower portions located throughout the middle third of the east and west sides of the main span (Figure 28, Figure 29, Figure 30, Figure 31).

- A few small areas of paint loss and surface corrosion was noted to the lower hanger cables throughout but particularly to the east side back stay hanger cables at 21m north of the north tower (Figure 35, Figure 36).

The upper hanger connection to the south hanger at the lower south west back-stay chains were structurally in good condition with minor water-staining (Figure 155, Figure 159).

- Small areas of paint loss and minor corrosion was noted to the articulating areas of the upper hanger connection to the 19th hanger on the south west back-stay chains. It should be noted that this element was structurally, in good condition (Figure 160).
- Small areas of paint loss and minor corrosion was noted with rust-staining to the upper hanger connection to mid-southern hangers on the central west catenary chains (Figure 161, Figure 162).
- Small area of paint loss and minor corrosion was noted with rust-staining to upper hanger connection to a southern hanger on the central west catenary chains (Figure 163, Figure 164).
- Paint loss and minor corrosion was noted to the upper hanger connection and split pin to a hanger on the east side north back-stay chains (Figure 180).
- Flaking paint loss and minor corrosion with rust-staining was noted to the upper tie cable on the east side north back-stay chains (Figure 181).

6. Parapet beam or cantilever

This element includes the cantilevered walkways either side of the carriageway which also support the east and west pedestrian guardrails. For the main suspended span, the walkway surfacing sat on possible thin reinforced concrete slabs and steel soffit plate which in turn sit on cantilevered steel beams which connect to the side of the longitudinal truss. For the masonry arch approach spans, the extreme east and west edges of the footway cantilever off stone corbels projecting from the top of the arches. The defects to this element are as follows:

- Wide areas of spalling and exposed rebar was noted to the soffit of the cantilevered footway to the west of spans 1-4 and, to a lesser extent, throughout all the walkway slab soffits (Figure 37, Figure 38). Due to some repairs cracking and ongoing spalling, there was a risk of falling masonry to boaters below.
- Moderate paint loss and minor corrosion was noted to the walkway soffit particularly to the south end of the main span west walkway soffit, 8m from south (Figure 108), south end of main span west walkway soffit, 17.5m from south (Figure 109).
- Moderate paint loss and corrosion was noted to the west walkway cantilever, gusset plate and rivet heads, typical at 117.5m from the south end of the main deck (Figure 120).
- Moderate paint loss and corrosion was noted to the west walkway cantilever flange end and rivet heads, 121.5m from the south end of the deck (Figure 121) and at 149m (Figure 123). Paint loss and moderate corrosion was noted to the base of the east parapet infill bars, 27m from the south end (Figure 132) with corrosion and rust staining to the base of the east parapet post, 41m from the south end (Figure 133), at 56.5m from the south end (Figure 134) and 139.5m from the south (Figure 139, Figure 140).
- Several small areas of moderate paint loss and corrosion were noted to bolt heads to the inside face of the east edge beam, 112.5m from the south (Figure 137) and at 153.5m from the south (Figure 144).
- A short length of expanding foam and compressible fibre board was located to the lower outer east face of the east edge beam, 126m from south (Figure 138).
- Several small areas of spalling and exposed rebar were noted to the west walkway soffit above arch 7 (Figure 152).
- Approximately 800mm diameter x 40mm deep spalling with exposed rebar was noted to the west walkway soffit above the cantilever off span 7 (Figure 154).

- Several areas of typically 100mm x 50mm x 20mm deep delamination and spalling were noted with exposed rebar to the east walkway soffit of span 8 (south span). Previously repaired areas were also visible (Figure 155).

7. Deck bracing

The steel deck plates topped with concrete, spanning the transverse I beams. These elements could not be fully inspected as they were covered with the asphalt carriageway surfacing. However, the deck plate soffit was inspected at the same time as the underside of the longitudinal truss and the suspended transverse beams, so the condition and defects are covered within elements 1 and 2 – Primary and Secondary Deck Elements respectively.

This element includes the transverse chain braces to the north and south back-stay chains. The defects to this element are as follows:

- Minor paint loss and corrosion was noted to the north transverse chain brace mainly to bolt heads (Figure 33,Figure 34).

When looking north along the north back-stay chains and transverse brace connection, there were small areas of corrosion along the top edge, west connection and east corner stiffeners. This brace was generally, in good condition with some minor surface corrosion (Figure 177). A close-up of these defects is shown within Figure 178 and Figure 179 respectively. The outer face of the south east back-stay chains and transverse brace connection were generally in good condition with small areas of minor corrosion (Figure 199).

The south west back-stay chains and transverse brace connection were generally, in good condition (Figure 155, Figure 156, Figure 157, Figure 158).

8. Foundations

The two abutments and seven piers, all constructed from limestone, are largely founded directly onto bedrock and their condition is best described as generally good. The dive survey of the seven pier bases revealed no significant scour and the superstructure above showed no visible sign of settlement or other structural distress resulting from poor foundations. (See Dive Report within Appendix C).

9. Abutments

The north and south abutments were generally in good condition, but the following relatively minor defects were recorded:

- Several small areas of deep mortar loss were noted to the north abutment particularly to the lower west face (Figure 39, Figure 40, Figure 88). The abutment faces had some light-coloured efflorescence and dark-coloured minor damp-staining evident, but these were generally aesthetical defects owing to the age of the structure.

10. Spandrel wall/head wall

The spandrels to the approach arches were largely in good condition but with the following defect:

- Several areas of up to 350mm x 350mm of delamination and spalling with exposed rebar were noted particularly to the west spandrel panels above arch 7 (Figure 153).

11. Pier/column

The seven limestone masonry piers, supporting the eight-span bridge were largely in good condition but with the following defects:

- Areas of minor damp staining and efflorescence were noted throughout all pier north and south faces, typically to the south face of pier 7 (Typically shown on Figure 149) and the south face of pier 5 (Figure 145). Very minor damp staining and efflorescence was also noted throughout the south face of pier 7 (Figure 149).

- Several areas of water-staining and efflorescence were noted to the north face of the north pier (Figure 182).

- Monitor several small areas of efflorescence, small stalactites and minor damp staining was noted to the north and south towers' transverse arches (Figure 32).

12. Cross head/capping beam

The tops of the two stone towers, supporting the suspension chain saddles, were generally in good condition with no obvious defects. This element was accessed by a separate team, mainly inspecting the saddle roller bearings on top of the towers, and its condition will be covered within a separate report.

The cross heads supporting the main suspended truss appeared to be in good condition with no obvious defect. Minor rust-staining from the surface corrosion to the exposed bearings was noted to the top of the piers.

13. Bearings

The bearings, located at each end of the main suspended truss, were largely obscured by the small gap between the corbelled bearing shelf and end transverse deck beams. Therefore, only the visible areas of these bearings, to the inner and side faces, could be inspected. The following defects were recorded:

- Visible areas were suffering from widespread paint loss and minor corrosion to the pin joint. This was probably due to road salt penetrating the open joint from above and the overall salty environment surrounding the bridge in general. These areas were also difficult to access which means it may not have been painted during the 2005 refurbishment works (Figure 107). Extensive surface corrosion was also noted to the north main span bearings on pier 5 (Figure 146).

The suspension chain saddle roller bearings, contained within oil filled trays on top of the towers, were inspected by others whilst this inspection took place. The condition and photos of these elements are therefore contained within a separate report.

14. Bearing plinth/shelf

The top surface of the bearing shelves, located at each end of the main suspended truss, were obscured by the small gap between the corbelled bearing shelf and end transverse deck beams. Therefore, these bearing shelves could not be fully inspected. However, the side faces of these bearing shelves were visible and appeared to be in good condition.

15. Superstructure drainage

The superstructure drainage on the bridge deck consisted of rudimentary 25mm diameter drill holes located at regular intervals along the carriageway edges along the kerblines. These holes were unblocked and appeared to drain carriageway water directly through the deck and into the Menai Strait below. Other carriageway drainage was located off the bridge deck, in the vicinity of the bridge, and the condition of these was generally good but with the following defects:

- A rectangular highway edge gully was blocked to the south west access road where it adjoins the A5 immediately beyond the south end of the bridge (Figure 41).

16. Substructure drainage

There were no weepholes, or other obvious form of substructure drainage, visible throughout the bridge.

17. Waterproofing

The waterproofing system was not visible for this inspection but there were defects which would indicate a minor defect associated with the waterproofing system on the masonry arch approach structures. The defects to this element are as follows:

- General areas of efflorescence and damp-staining were noted through the arch intradoses particularly the slight dripping noted through the west side of the north arch (Figure 42).

- Minor damp staining and efflorescence was noted throughout but typically to the south abutment (Figure 147) and arch 7 (Figure 148).

10. Movement/expansion joints

The continuous arch approaches had no expansion joints to their specific construction form but there were steel comb joints to the north and south ends of the main suspended truss. These comb joints were located just below carriageway level and their top surfaces sat flush with the carriageway surfacing, appearing in good condition.

11. Finishes: Deck Elements

Deck element finishes within this section include all paintwork above the road deck, to the main span truss, hangers and suspension chains. The finishes to the lower truss, transverse beams, deck soffit plates, longitudinal deck stiffeners and walkway cantilevers beneath the top of the deck – because they co-exist with generally deeper corrosion and were also inspected by the roped access teams - are covered within element 1 Primary deck, 2 Secondary deck – transverse beams, 3 Secondary deck – deck soffit plates, 6 Cantilever, 7 Deck bracing and 23 Parapet handrails respectively. The defects to the above road deck elements are as follows:

- Small areas of paint loss, minor corrosion and rust staining were noted extensively throughout the centre span truss members, particularly the bolts, rivets and plate ends (Figure 43, Figure 44).
- Several discrete areas of failed paint, minor corrosion and resulting rust staining to the lower hanger lugs (Figure 45, Figure 46).
- Several areas of full depth paint loss, minor corrosion and rust staining were noted to the truss rivets throughout the entire main span (Figure 47, Figure 48, Figure 49).
- Small areas of failed paint, corrosion and resulting rust staining was noted to the upper hanger lugs (Figure 50, Figure 51).
- Moderate areas of paint loss and minor corrosion were noted to the inside faces of the upper truss members. typically to the east side at 15m south of the north tower (Figure 52, Figure 53).
- Small areas of chipped paint and rust staining were noted throughout the west truss (Figure 54, Figure 55, Figure 56).
- Full depth paint loss and moderate corrosion were noted to the electrical box, just off the carriageway within the truss, to the west side at mid-span (Figure 47, Figure 58).
- Several small areas of paint loss were noted to the hangers, typically to the 2nd north west hanger (Figure 59, and typical to first north west in Figure 60).
- Several small areas of paint loss were located to the north chain brace (Figure 61).

- Paint loss and minor corrosion with rust-staining was noted to the lower hanger connection area to a hanger on the central west catenary chains (Figure 165).

- Paint loss and minor corrosion with rust-staining was noted to the mid-span drop link on the central west catenary chains (Figure 166).

- Minor paint loss and minor corrosion was noted to the lower chain near mid-span on the central west catenary chains (Figure 167).

- A band of minor paint loss and minor corrosion was seen to the upper chain near mid-span on the central west catenary chains (Figure 168) and surface corrosion to the west chain saddle on the south tower (Figure 169). A close-up of this defect is in Figure 170.

- Small areas of surface corrosion were noted throughout the ends of the chain bracing on the south tower saddles, north face (Figure 171). A close-up of this defect is in Figure 172.

- Small areas of surface corrosion were noted to the east chain saddle and to the roller bearing bath on the south tower (Figure 173).

• Paint loss and minor corrosion was noted to the upper hanger connection and split pin to a hanger on the west side north back-stay chains (Figure 174). A close-up of this defect is in Figure 175.

• Paint loss and minor corrosion was noted to the upper hanger connection and split pin to a hanger on the west side north back-stay chains (Figure 176).

• Small areas of surface corrosion were noted to the chain saddles, roller bearing baths and bracing on the north tower. Figure 182 shows this defect on the north face of the north tower. Figure 183 shows the north side of the east saddle and Figure 184 shows the south side of the east saddle.

• Small areas of surface corrosion were noted to the chain saddles, roller bearing baths and bracing on the north tower. Several areas of corrosion to access ladder which is no longer in use (Figure 185).

• Paint loss, minor corrosion and rust-staining was noted to the upper hanger connection and split pin to a northern hanger on the central east catenary chains (Figure 186) and another typical example on Figure 187.

• Paint loss, minor corrosion and some rust-staining was noted to the upper hanger connection and split pin to a hanger on the central east catenary chains (Figure 188). A general view looking north from the south tower is shown in Figure 189 and a general view looking south from the north tower is within Figure 190.

• Paint loss, minor corrosion and rust-staining was noted to tie strands on the central east catenary chains, just north of mid-span drop links (Figure 191) and mid-span drop links (Figure 192).

• Paint loss, minor corrosion and rust-staining was noted to tie strands on the central east catenary chains, just south of the mid-span drop links (Figure 193).

• Paint loss, corrosion and rust-staining was noted to articulating parts of the upper hanger connection the 18th hanger north of the south tower on the central east catenary chains (Figure 194) and the 6th hanger in this section (Figure 195) with a close-up within Figure 196.

A general view looking south at the upper chains to the central east section of the catenary chains and upper north face of the south tower is shown within Figure 197 and the upper south face of the south tower and south east back-stay chains is shown within Figure 198. A general view looking south along the inner face of the south east back-stay chains and south bridge building is shown in Figure 200. Minor algae and water staining were noted to the inner face of the south west back-stay chains is shown in Figure 201.

• Rust staining from metallic debris was trapped beneath paintwork to the outer face of the south west back-stay chain just before the 1st hanger (Figure 202). A general view looking along the north outside face of the south west back-stay chains is shown within Figure 203.

18. Finishes: substructure elements

There were no finishes to any substructure element on this bridge.

19. Finishes: parapets/safety fences

This element covers the areas of the edge handrails that were visible from the footways. The outer edge and lower areas - because they co-exist with generally deeper corrosion and were also inspected by the roped access teams are contained within element 6 Cantilever. The defects to these elements are as follows:

• Numerous small areas of full depth paint loss was noted throughout the handrail parapet paint system, particularly to rails and lower ends of the vertical infill bars (Figure 62, Figure 63, Figure 64, Figure 65).

6. Access/walkways/gantries

There were no access walkways or gantries on this bridge,

7. Handrail/Parapet/Safety Fences

There were 1.55m high steel pedestrian guardrails along the extreme east and west edges of the bridge. These guardrails were two rail and post type with vertical infill bars with an upper continuous steel rail along the top. The main longitudinal suspended truss forms a physical barrier between the carriageway and walkways and the footway sides of the truss have two continuous steel rails forming the inner pedestrian guardrail. Mortared limestone pilasters, topped with stone coping, form the four corners of the bridge. The pedestrian guardrails and approach rails connect either side of these pilasters to form a continuous edge protection system.

In addition to the main pedestrian guardrails to either sides of the footways, there were short lengths of steel rail and posts guardrail with vertical infill bars to the central raised carriageway verges approaching either side of the north and south towers. There were also lattice infil guardrails surrounding the confined pits to the north back-stay anchor block arrangements. These pits were located between the east and west footways and the central carriageway. The defects to these elements are as follows:

- 30mm outward displacement was noted to the south west pilaster coping (Figure 66).

- Several small and discrete areas of corrosion and minor section loss was noted to the east and west parapets, mainly to connections and rail joints (Figure 67, Figure 68, Figure 69).

- Failure of the holding down bolt arrangement was located to the south west inner pedestrian guardrail (Figure 70).

- Severe impact damage was noted to the central reservation guardrail to the south of the north tower and south of north tower (Figure 71, Figure 72).

- Section loss from corrosion was noted to the west handrail at the south tower (Figure 73).

- Small areas of full depth section loss from corrosion was noted to the inner west guardrail at 23m north of the south tower (Figure 74, Figure 75, Figure 76).

- Corrosion, which was severe in places, and full depth section loss was noted throughout typically to the west handrail at 64m north of the south tower. It is thought that corroded areas are more prevalent where rails meet and have been site butt welded prior to painting (Figure 101).

- Deep pitting corrosion was noted to the upper west parapet rail, 52m from the south end of the main span (Figure 115).

24. Carriageway surfacing

The carriageway surfacing material consisted of hand laid mastic asphalt. The defects to this element were as follows:

- Minor wear and regular narrow transverse cracking was noted along the carriageways (Figure 77)
- A 3mm wide transverse crack and 200mm x 300mm x 250mm deep pot holes was noted to the surfacing above the north abutment (Figure 78, Figure 79).

25. Footway/verge/footbridge surfacing

The footway surfacing was generally in good condition throughout, but the following defects were recorded:

- Sections of full depth paint loss and moderate corrosion was noted to the verge steel kerbs on the approaches to the towers (Figure 80).
- Several wide cracks and a 100mm diameter x 40mm deep pothole was located in the east footway at 35m north of the north abutment (Figure 81, Figure 82, Figure 83).

26. Invert/river bed

The Menai Strait forms the invert to this bridge. All pier and abutment bases were exposed at Spring Low Tide and were inspected at this time for scour and other defects by a specialist dive team. The dive survey report is contained within Appendix C. The summary of this dive report is that these elements were largely in good condition with no significant scour, stonework defects or mortar loss to their joints or the bed-rock on which they are founded. There was no obstruction noted to the sea bed and the invert was free-flowing.

27. Aprons

There were no aprons to this bridge.

28. Fenders/cutwaters/collision protection

There were no fenders/cutwaters or collision protection to this bridge.

29. River training works

There were no river training works to this bridge.

30. Revetment/batter paving

There was no revetment or batter paving to this bridge.

31. Wing walls

Curved, concaved mortared limestone wingwalls project from the earth embankments at the four corners of the bridge. The condition was generally good but defects to these elements were as follows:

- Ivy was located to lower parts of all the four corner wing walls (Figure 84, Figure 85, Figure 86, Figure 87, Figure 88).

32. Retaining walls

There were short mortared limestone retaining walls supporting the north west and north east embankments above Beach Road. This element was generally in good condition with no significant defect.

33. Embankments

Vegetated earth embankments were located at the four corners of the bridge. Vegetation on the embankments was cut back during the inspection phase, revealing the earth beneath. The embankments appeared to be stable with no obvious sign of slump, slide, depression, scour or other type of slope failure.

34. Machinery

There was no machinery to this bridge.

35. Approach rails/barrier walls

Due to the form of construction, there were no vehicular approach rails to this bridge. There are steel edged raised central reservation approaches to the two towers and their condition is covered within element 25 Footway/verge surfacing.

The pedestrian guardrails continue beyond the four stone pilasters on all four corners of the bridge. These elements were generally in good condition, but some durability defects are covered within element 21 Finishes – parapet/safety fences.

8. Signs

Road signs to the north end of the bridge consisted of 'cycleway' and 'slippery road' warning signs and 'tourist information' signs were generally in good condition and securely mounted to a lighting column. Road signs to the north and south tower approaches consisted of 'single carriageway' information signs and tower arch 'height' warning signs which were generally in good condition and securely mounted. It should be noted that the height of the arch springers, where the old tie bars have been cut, gave a slightly higher headroom clearance than the 4.7m stated on the signs.

Road signs to the south end of the bridge consisted of **'speed camera'**, '30mph' speed limit and tower arch 'height and width' limit warning signs which were generally in good condition and securely mounted to a suitable galvanised steel column. It should be noted that the tower arches measure 2.5m wide between the steel kerb faces and 3.06m wide at 2.0m **above carriageway level. The 'width' warning signs state** a 2.6m maximum width.

9. Lighting

Street lighting mounted on columns were in good condition but during night time inspections it was noted that several of the carriageway lighting units, located along the inner faces of the truss, were not illuminated and appeared to be broken (Figure 22). Other defects were as follows:

- A broken lighting unit was noted to the east transverse arch of north tower (Figure 89).

38. Services

Various unknown services were carried across the Menai Strait on this bridge. Some services appeared to be electric and communications cables and some are suspended transversely below the deck at the north and south ends of the main span. The defects to these elements were as follows:

- **Corrosion and section loss** were noted to the edges of a west manhole cover 6m south of the south tower (Figure 90).
- **Corrosion and section loss** was noted to the edges of an unknown services box to the south of the north tower (Figure 91).
- **Corrosion and full**-depth section loss was noted to angle sections which project laterally beyond the lower west face of the main truss at 144m from the south end of the main span (Figure 122).

5. Summary and Recommendations

5.1 The bridge was generally in fair condition overall. The main suspended span was mainly in poor to fair condition scoring near **the 'fair' criteria** for average BCI indicators and scoring **'poor' in the critical BCI indicator due to several defects to critical structural members.** This report and associated BCI forms group the main suspension components, such as back-stay chains, within main span 5 as they essentially support main span 5. This means that several defects which apparently occur remotely from span 5 are accounted for within the BCI for span 5. The seven approach spans were generally in good condition scoring just near **the 'good' criteria for critical BCI indicators** and near **the 'good' indicators**.

5.2 Suggested remedial works and monitoring recommendations for the main suspended span (Span 5), towers and suspension elements are outlined below:

SPAN 5

High Priority

- Prepare, inspect, measure and repaint the localised paint loss, corrosion and minor section loss to the 34no (17no each side) square drop link bar lower portion. Consider replacing drop links which have revealed more than 5% section loss. Paint the small

areas of paint loss and surface corrosion to lower tie bars particularly to the east side at 21m north of the north tower.

Medium Priority

- Remove loose paint and surface corrosion to further inspect several small areas of paint loss and surface corrosion noted throughout the east and west longitudinal trusses. Most of the paint loss/corrosion areas are to truss element ends, nodes and discrete pockets where water collects due to the intricate detail around rivet heads and where several plates meet and intersect particularly at 90m north of the south tower where the corrosion is 1-2mm deep in places. Also remove loose paint and surface corrosion to further inspect paint loss and corrosion to northern anchor block bolt group arrangement. Note these costs are for defective paint abrasion, inspection and possible patch repair work, for associated re-painting recommendations and costs see section 19.
- Remove loose paint and surface corrosion to further inspect areas of generally 1-2mm depth of corrosion to several areas throughout the transverse beams suspended from the deck longitudinal truss. Bolt and rivet heads were generally less corroded but bolt/rivet heads at 150m north of the south end were 80% corroded to 2mm deep with some isolated areas measured up to 3mm deep. Areas around where services cut through at the south end and lower flange plates were more corroded up to 2mm deep. Assumed roped/movable suspended gantry costs are covered within defect 1.1 costs.
- Prepare, Inspect and re-paint the several areas of paint loss and corrosion which were widespread throughout the deck soffit plates.
- Prepare, inspect and repaint the several small areas of paint loss and surface corrosion throughout the east and west cantilevers. Most of the paint loss/corrosion areas are at the cantilever connection where several plates meet and intersect. Prepare, inspect and repaint the several small areas of deeper corrosion to the cantilevers, 1-2mm deep particularly at 90m in from the south tower where there is 8mm delamination to the upright.
- Prepare and repaint the several areas of full depth paint loss, minor corrosion and rust staining to the truss rivets throughout the main span.
- Prepare and repaint the moderate areas of paint loss and minor corrosion to the inside faces of the upper truss members. typical to east side 15m south of the north tower.
- Prepare and repaint the full depth paint loss and moderate corrosion to electrical boxes within the east and west trusses, above deck, at mid span.
- Prepare, inspect and repaint the several small areas of paint loss throughout the hangers, typical to 2nd north west hanger.
- Prepare and repaint the several areas of localised paint loss and minor corrosion to the remaining areas, not specifically specified above, throughout the main span soffit. Closely Inspect the bolts and rivets holding the transverse beams, which are suspended beneath the main truss, once all surrounding paint has been removed.
- Replace the impact damaged holding down bolt arrangement to the south west inner pedestrian guardrail to the central reservation at the south of the north tower.
- Replace the severe impact damage to the central reservation guardrail to the south of the north tower and north of the south tower.
- Replace the affected length of full depth section loss to the inner west guardrail at 23m north of the south tower.
- Replace the affected length of rail suffering from section loss to the west handrail at 64m north of the south tower.

Low Priority

- Repair the several small areas of deep mortar loss throughout the piers, particularly to springer points.
- Prepare, inspect and repaint the several small areas of paint loss to the north and south chain brace stiffeners.
- Prepare, inspect and repaint the numerous small areas of full depth paint loss to the parapet paint system, particularly to the rails and lower ends of the vertical infill bars.
- Prepare, inspect and repaint the several small and discrete areas of corrosion and minor section loss throughout the east and west parapets, mainly to the post connections and horizontal rail joints.
- Replace the affected lengths of upper pedestrian handrail suffering from severe section loss which is most severe to the west handrail around the south tower.
- Prepare and repaint the sections of full depth paint loss and moderate corrosion to the verge steel kerbs on the inner approaches to the tower arches.
- Replace the broken lighting unit to the east transverse arch of the north tower.
- Replace the manhole cover which is suffering corrosion and section loss to the edges of a west manhole cover at 6m south of the south tower.
- Replace the services box which is suffering corrosion and section loss to the edges, located to the south of the north tower.

Overall Monitoring Recommendations

- Monitor the possible vehicle impact damage to the east 4th hanger south of the south tower. Defects included a bent lower section and paint loss to cable.
- Monitor the small areas of paint loss, minor corrosion and rust staining throughout the centre span truss members, particularly the bolts, rivets and plate ends. This monitoring regime should include all areas not remedied by abrasion, inspection, steelwork repairs and re-paining.
- Monitor the small areas of failed paint and resulting rust staining to several upper and lower hanger lugs throughout the upper truss members. This monitoring regime should include all areas not remedied by abrasion, inspection, steelwork repairs and re-paining.
- Monitor the small areas of chipped outer paint and rust staining particularly throughout the west truss.
- Monitor the several small areas of delamination and shallow spalling throughout the east and west spandrel panels at the next inspection
- Monitor the minor wear and regular narrow transverse cracking along the carriageways. Note that this defect is more prevalent to the approach spans carriageway surfacing, particularly to the north approach.
- Monitor the minor paint loss and corrosion to the north and south chain braces above the carriageway, particularly the north transverse chain brace mainly to bolt heads.

5.3 Suggested remedial works and monitoring recommendations for the north and south masonry approach arches are outlined below:

SPAN 1

High Priority

- Repair the several areas of spalling and exposed rebar to soffit of cantilevered footway particularly to the west of spans 1-4 and to a lesser extent to several areas throughout. Danger of falling masonry.

Medium Priority

- There are no medium priority defects for this span.

Low Priority

- Repoint the several small areas of deep mortar loss to joints primarily throughout the lower third of both towers above deck level, particularly to lower east face of south tower and east side of span 7 springers and to joints throughout the arches, typically around the springer points.
- Repair the several small areas of deep mortar loss throughout the north abutment particularly to the west side face where it adjoins the north west wing wall.
- Repair the several small areas of deep mortar loss throughout the piers, particularly to springer points.
- Prepare, inspect and repaint the numerous small areas of full depth paint loss to the parapet paint system, particularly to the rails and lower ends of the vertical infill bars.
- Prepare, inspect and repaint the several small and discrete areas of corrosion and minor section loss throughout the east and west parapets, mainly to the post connections and horizontal rail joints.
- Seal the 3mm wide transverse crack and repair the 200mm x 300mm x 25mm deep pot holes to surfacing above the north abutment.
- Seal the several wide cracks and repair the 100mm diameter x 40mm deep pothole in the east footway at 35m north of the north abutment.
- Remove the ivy growing to the lower parts of northern wing walls.

SPAN 2

High Priority

- Repair the several areas of spalling and exposed rebar to soffit of cantilevered footway particularly to the west of spans 1-4 and to a lesser extent to several areas throughout. Danger of falling masonry.

Medium Priority

- There are no medium priority defects for this span.

Low Priority

- Repoint the several small areas of deep mortar loss to joints primarily throughout the lower third of both towers above deck level, particularly to lower east face of south tower and east side of span 7 springers and to joints throughout the arches, typically around the springer points.
- Repair the several small areas of deep mortar loss throughout the piers, particularly to springer points.
- Prepare, inspect and repaint the numerous small areas of full depth paint loss to the parapet paint system, particularly to the rails and lower ends of the vertical infill bars.
- Prepare, inspect and repaint the several small and discrete areas of corrosion and minor section loss throughout the east and west parapets, mainly to the post connections and horizontal rail joints.

SPAN 3

High Priority

- Repair the several areas of spalling and exposed rebar to soffit of cantilevered footway particularly to the west of spans 1-4 and to a lesser extent to several areas throughout. Danger of falling masonry.

Medium Priority

- There are no medium priority defects for this span.

Low Priority

- Repoint the several small areas of deep mortar loss to joints primarily throughout the lower third of both towers above deck level, particularly to lower east face of south tower and east side of span 7 springers and to joints throughout the arches, typically around the springer points.
- Repair the several small areas of deep mortar loss throughout the piers, particularly to springer points.
- Prepare, inspect and repaint the numerous small areas of full depth paint loss to the parapet paint system, particularly to the rails and lower ends of the vertical infill bars.
- Prepare, inspect and repaint the several small and discrete areas of corrosion and minor section loss throughout the east and west parapets, mainly to the post connections and horizontal rail joints.

SPAN 4

High Priority

- Repair the several areas of spalling and exposed rebar to soffit of cantilevered footway particularly to the west of spans 1-4 and to a lesser extent to several areas throughout. Danger of falling masonry.

Medium Priority

- There are no medium priority defects for this span.

Low Priority

- Repoint the several small areas of deep mortar loss to joints primarily throughout the lower third of both towers above deck level, particularly to lower east face of south tower and east side of span 7 springers and to joints throughout the arches, typically around the springer points.
- Repair the several small areas of deep mortar loss throughout the piers, particularly to springer points.
- Prepare, inspect and repaint the numerous small areas of full depth paint loss to the parapet paint system, particularly to the rails and lower ends of the vertical infill bars.
- Prepare, inspect and repaint the several small and discrete areas of corrosion and minor section loss throughout the east and west parapets, mainly to the post connections and horizontal rail joints.
- Prepare and repaint the sections of full depth paint loss and moderate corrosion to the verge steel kerbs on the inner approaches to the tower arches.
- Replace the broken lighting unit to the east transverse arch of the north tower.

SPAN 6

High Priority

- There are no high priority defects for this span.

Medium Priority

- There are no medium priority defects for this span.

Low Priority

- Repoint the several small areas of deep mortar loss to joints primarily throughout the lower third of both towers above deck level, particularly to lower east face of south tower and east side of span 7 springers and to joints throughout the arches, typically around the springer points.
- Repair the several small areas of deep mortar loss throughout the piers, particularly to springer points.
- Prepare, inspect and repaint the numerous small areas of full depth paint loss to the parapet paint system, particularly to the rails and lower ends of the vertical infill bars.
- Prepare, inspect and repaint the several small and discrete areas of corrosion and minor section loss throughout the east and west parapets, mainly to the post connections and horizontal rail joints.
- Prepare and repaint the sections of full depth paint loss and moderate corrosion to the verge steel kerbs on the inner approaches to the tower arches.
- Replace the manhole cover which is suffering corrosion and section loss to the edges of a west manhole cover at 6m south of the south tower.

SPAN 7

High Priority

- There are no high priority defects for this span.

Medium Priority

- There are no medium priority defects for this span.

Low Priority

- Repoint the several small areas of deep mortar loss to joints primarily throughout the lower third of both towers above deck level, particularly to lower east face of south tower and east side of span 7 springers and to joints throughout the arches, typically around the springer points.
- Repair the several up to 350mm x 350mm areas of delamination and spalling with exposed rebar to the west concrete upper spandrel panels above arch 7 (span 7). Monitor the several small areas of delamination and shallow spalling throughout the east and west spandrel panels at the next inspection.
- Repair the several small areas of deep mortar loss throughout the piers, particularly to springer points.
- Prepare, inspect and repaint the numerous small areas of full depth paint loss to the parapet paint system, particularly to the rails and lower ends of the vertical infill bars.
- Prepare, inspect and repaint the several small and discrete areas of corrosion and minor section loss throughout the east and west parapets, mainly to the post connections and horizontal rail joints.

SPAN 8

High Priority

- Repair the several areas of spalling and exposed to soffit of cantilevered footway to north side of span 8 and to a lesser extent throughout. Danger of falling masonry.

Medium Priority

- There are no medium priority defects for this span.

Low Priority

- Repoint the several small areas of deep mortar loss to joints primarily throughout the lower third of both towers above deck level, particularly to lower east face of south tower and east side of span 7 springers and to joints throughout the arches, typically around the springer points.
- Repair the several small areas of deep mortar loss throughout the piers, particularly to springer points.
- Unblock the blocked highway gully to the south west access road.
- Prepare, inspect and repaint the numerous small areas of full depth paint loss to the parapet paint system, particularly to the rails and lower ends of the vertical infill bars.
- Reposition the 30mm displacement to the south west pilaster coping and repoint.
- Prepare, inspect and repaint the several small and discrete areas of corrosion and minor section loss throughout the east and west parapets, mainly to the post connections and horizontal rail joints.
- Remove the ivy growing to the lower parts of all four wing

  walls. **Overall Monitoring Recommendations**
- Monitor the several small areas of efflorescence, stalactites and damp staining to the tower roadway transverse arches.
- Monitor the small area of slight dripping through the north west carriageway arch intrados.
- Monitor the several small areas of delamination and shallow spalling throughout the east and west spandrel panels at the next inspection.

ATKINS

Appendix A – Bridge Inspection Pro forma

BRIDGE INSPECTION

Superficial	General	X	Principal	Special		Form 1 of 8 for this bridge
Inspector:	[redacted]	Date	07-Nov-2019 to 10- Dec 2020	Next Inspection Type:	GI	Next Inspection Due Financial Year: 2021/22
Bridge Name:	Menai Bridge			Bridge Ref/No:	A5	Road Ref/No: A5
Structures Function:	above:	A5 carriageway	below:	Menai Strait		Maintaining Authority: UK Highways
Map Ref:	-	O.S.E	255677	O.S.N	371404	
Spans 1 of 8	Width (m) 11.38	Length (m)	16.002	Area (m^2)	182.1	
All above ground elements inspected?	Yes X	No	Photographs? Yes x	No		
Number of Construction forms in Bridge/Span:		BCS crit	78.88	BCS ave	81.00	

Bridge Type Code:

Primary deck element form	Table 2	Solid arch	1
Primary deck element material	Table 4	Stone	L
Secondary deck element form	Table 3	No transverse beams	20
Secondary deck element material	Table 4	No secondary element	P

Set	No	Element Description	S	Ex	Def	W	P	Cost	Comments / remarks
Deck elements	1	Primary deck element (Table 2)	2	B	3.2	R	L		Refer to multiple defects page.
	2	Secondary deck element/s: Transverse beams							
	3	Secondary deck element/s: Element from Table 3							
	4	Half joints							
	5	Tie beam/rod							
	6	Parapet beam or cantilever	2	C	2.1	R	H		Several areas of spalling and exposed rebar to soffit of cantilevered footway particularly to the west of spans 1-4 and to a lesser extent throughout.
	7	Deck bracing							
Load-bearing Substructure	8	Foundations	1	A					Good condition based on no obvious settlement or scour related defects.
	9	Abutments (incl arch springing)	3	B	3.2	R	L		Several small areas of deep mortar loss to the north abutment particularly to lower west face.
	10	Spandrel wall / head wall	1	A					No significant defect.
	11	Pier / Column	2	B	3.2	R	L		Several small areas of deep mortar loss throughout the piers, particularly to springer points.
	12	Cross head / capping beam							
	13	Bearings							
	14	Bearing shelf / plinth							
Durability elements	15	Superstructure drainage	1	A					Drain holes clear.
	16	Substructure drainage							
	17	Waterproofing	1	A					No significant defect.
	18	Movement / expansion joints							
	19	Finishes: deck elements							
	20	Finishes: substructure elements							
	21	Finishes: parapets/safety fences	5	C	4.1	P	L		Numerous small areas of full depth paint loss to parapet paint system, particularly to rails and lower ends of vertical infill bars.
Safety elements	22	Access / walkways / gantries							
	23	Handrail / parapets / safety fences	2	C	Other	R	L		Refer to multiple defects page.
	24	Carriageway surfacing	2	B	9.2	R	L		3mm wide transverse crack and 200mm x 300mm x 250mm deep pot holes to surfacing above north abutment.
	25	Footway / verge / footbridge surfacing	5	C	4.1	P	L		Several wide cracks and 100mm diameter x 40mm deep pothole in east footway 35m north of the north abutment.
Other bridge elements	26	Invert / river bed	1	A					No obstruction or significant scour.
	27	Aprons							
	28	Fenders / cutwaters / collision prot'n							
	29	River training works							
	30	Revetment / batter paving							
	31	Wing walls	3	C	5.2	R	L		Ivy to lower parts of northern wing walls.
	32	Retaining walls	1	A					Retaining wall below north abutment in good condition.
	33	Embankments	1	A					Stable.
	34	Machinery							
Ancillary elements	35	Approach rails / barriers / walls	1	A					Secure.
	36	Signs	1	A					Good condition.
	37	Lighting	1	A					No obvious defects.
	38	Services	1	A					No obvious defects.

S - severity, Ex - extent, Def - defect
W - work required, P - work priority

Inspection date: 07-Nov-2019 to 10-Dec 2020

1 of 2 pages

MULTIPLE DEFECTS

Element No.	Defect 1			Defect 2			Defect 3			Comments
	S	Ex	Def	S	Ex	Def	S	Ex	Def	
1	2	B	3.2	2	B	3.2				Defect 1: several small areas of deep mortar loss to joints throughout both towers. typical to lower east face of south tower and generally the lower third above road deck level. Defect 2: several small areas of deep mortar loss to joints throughout the arches, typically around the springer points.
23	2	B	1.1	2	B	1.1				Defect 1: several small and discrete areas of corrosion and minor section loss to east and west parapets, mainly to connections and rail joints. Defect 2: corrosion to several areas of the parapet top rails, posts and, to a lesser extent, the lower rail and panel infill bars.

INSPECTOR'S COMMENTS

This span was generally in fair to good condition. The 7No limestone masonry approach spans were generally in fair to good condition but with a high priority defect as follows: Wide areas of spalling and exposed rebar were noted to the soffit of the cantilevered footway particularly to the west of spans 1-4 and along the southern approach walkway cantilevers, particularly to north side of span 8 and to a lesser extent throughout the remaining walkway cantilever soffits. Lower priority defects, related to several small areas of mortar loss to joints, were noted throughout the approach arches. There were also numerous small areas of full depth paint loss and minor corrosion to the parapet system, particularly to rails and lower ends of vertical infill bars throughout.

Name	[redacted]	Signed	[redacted]	Date	21 January 2020

ENGINEER'S COMMENTS

This span is in fair to good condition with some high priority defects evident to the walkway cantilever soffits. These defects require remedial works within the next financial year to ensure that the bridge remains safe for use and fit for purpose. There are also several lower priority defects, such as areas of mortar loss and minor vegetation growth throughout, which should also be remedied in a timely manner so as not to incur greater costs in the future.

Name	[redacted]	Signed	[redacted]	Date	February 3, 2020

WORK REQUIRED

Ref. No	Suggested Remedial Work	Priority	Estimated Cost	Action/Work ordered
1.1 & 1.2	Repoint the several small areas of deep mortar loss to joints primarily throughout the lower third of both towers above deck level, particularly to lower east face of south tower and east side of span 7 springers and to joints throughout the arches, typically around the springer points.	L		
6	Repair the several areas of spalling and exposed rebar to soffit of cantilevered footway particularly to the west of spans 1-4 and to a lesser extent to several areas throughout. Danger of falling masonry.	H		
9	Repair the several small areas of deep mortar loss throughout the north abutment particularly to the west side face where it edjoins the north west wing wall.	L		
11	Repair the several small areas of deep mortar loss throughout the piers, particularly to springer points.	L		
21	Prepare, inspect and repaint the numerous small areas of full depth paint loss to the parapet paint system, particularly to the rails and lower ends of the vertical infill bars.	L		
23	Prepare, inspect and repaint the several small and discrete areas of corrosion and minor section loss throughout the east and west parapets, mainly to the post connections and horizontal rail joints.	L		
24	Seal the 3mm wide transverse crack and repair the 200mm x 300mm x 25mm deep pot holes to surfacing above the north abutment.	L		
25	Seal the several wide cracks and repair the 100mm diameter x 40mm deep pothole in the east footway at 35m north of the north abutment.	L		
31	Remove the ivy growing to the lower parts of northern wing walls.	L		

BRIDGE INSPECTION

Superficial	General X	Principal	Special		Form	2 of 8	for this bridge
Inspector:	[redacted]	Date	07-Nov-2019 to 10- Dec 2020	Next Inspection Type: GI	Next Inspection Due Financial Year:	2021/22	
Bridge Name:	Menai Bridge	Bridge Ref/No:	A5		Road Ref/No:	UK Highways	
Structures Function:	above:	A5 carriageway	below:	Menai Strait	Maintaining Authority:	STW	
Map Ref:	-	O.S.E	255677	O.S.N 371404	Bridge Type Code: Primary deck element form	Table 2 Solid arch	1
Spans 2 of 8	Width (m) 11.38	Length (m)	16.002	Area (m²) 182.1	Primary deck element material	Table 4 Stone	L
All above ground elements inspected?	Yes X No	Photographs?	Yes X No		Secondary deck element form	Table 3 No transverse beams	20
Number of Construction forms in Bridge/Span:	BCS crit	78.88	BCS ave	84.95	Secondary deck element material	Table 4 No secondary element	P

Set	No	Element Description		S	Ex	Def	W	P	Cost	Comments / remarks
Deck elements	1	Primary deck element (Table 2)		2	B	3.2	R	L		Refer to multiple defects page.
	2	Secondary deck element/s	Transverse beams							
	3		Element from Table 3							
	4	Half joints								
	5	Tie beam/rod								
	6	Parapet beam or cantilever		2	C	2.1	R	H		Several areas of spalling and exposed rebar to soffit of cantilevered footway particularly to the west of spans 1-4 and to a lesser extent throughout.
	7	Deck bracing								
Load-bearing Substructure	8	Foundations		1	A					Good condition based on no obvious settlement or scour related defects.
	9	Abutments (incl arch springing)								
	10	Spandrel wall / head wall		2	B	2.1	N			Monitor the several small areas of delamination and shallow spalling throughout the east and west spandrel panels.
	11	Pier / Column		2	B	3.2	R	L		Several small areas of deep mortar loss throughout the piers, particularly to springer points.
	12	Cross head / capping beam								
	13	Bearings								
	14	Bearing shelf / plinth								
Durability elements	15	Superstructure drainage		1	A					No obvious defects.
	16	Substructure drainage								
	17	Waterproofing		1	A					No significant defect.
	18	Movement / expansion joints								
	19	Finishes: deck elements								
	20	Finishes: substructure elements								
	21	Finishes: parapets/safety fences		5	C	4.1	P	L		Numerous small areas of full depth paint loss to parapet paint system, particularly to rails and lower ends of vertical infill bars.
Safety elements	22	Access / walkways / gantries								
	23	Handrail / parapets / safety fences		2	C	Othr	R	L		Refer to multiple defects page.
	24	Carriageway surfacing		2	B	9.2	N			Monitor the minor wear and regular narrow transverse cracking along the carriageways.
	25	Footway / verge / footbridge surfacing		1	A					No significant defect.
Other bridge elements	26	Invert / river bed		1	A					No obstruction or significant scour.
	27	Aprons								
	28	Fenders / cutwaters / collision prot'n								
	29	River training works								
	30	Revetment / batter paving								
	31	Wing walls								
	32	Retaining walls								
	33	Embankments								
	34	Machinery								
Ancillary elements	35	Approach rails / barriers / walls								
	36	Signs		1	A					Good condition
	37	Lighting		1	A					No obvious defects.
	38	Services		1	A					No obvious defects.

S - severity, Ex - extent, Def - defect
W - work required, P - work priority

Inspection date: 07-Nov-2019 to 10-Dec 2020

1 of 2 pages

MULTIPLE DEFECTS

Element No.	Defect 1			Defect 2			Defect 3			Comments
	S	Ex	Def	S	Ex	Def	S	Ex	Def	
1	2	B	3.2	2	B	3.2				Defect 1: several small areas of deep mortar loss to joints throughout both towers. typical to lower east face of south tower and generally the lower third above road deck level. Defect 2: several small areas of deep mortar loss to joints throughout the arches, typically around the springer points.
23	2	B	1.1	2	B	1.1				Defect 1: several small and discrete areas of corrosion and minor section loss to east and west parapets, mainly to connections and rail joints. Defect 2: corrosion to several areas of the parapet top rails, posts and, to a lesser extent, the lower rail and panel infill bars.

INSPECTOR'S COMMENTS

This span was generally in fair to good condition. The 7No limestone masonry approach spans were generally in fair to good condition but with a high priority defect as follows: Wide areas of spalling and exposed rebar were noted to the soffit of the cantilevered footway particularly to the west of spans 1-4 and along the southern approach walkway cantilevers, particularly to north side of span 8 and to a lesser extent throughout the remaining walkway cantilever soffits. Lower priority defects, related to several small areas of mortar loss to joints, were noted throughout the approach arches. There were also numerous small areas of full depth paint loss and minor corrosion to the parapet system, particularly to rails and lower ends of vertical infill bars throughout.

Name	[redacted]	Signed	[redacted]	Date	21 January 2020

ENGINEER'S COMMENTS

This span is in fair to good condition with some high priority defects evident to the walkway cantilever soffits. These defects require remedial works within the next financial year to ensure that the bridge remains safe for use and fit for purpose. There are also several lower priority defects, such as areas of mortar loss and minor vegetation growth throughout, which should also be remedied in a timely manner so as not to incur greater costs in the future.

Name	[redacted]	Signed	[redacted]	Date	February 3, 2020

WORK REQUIRED

Ref. No	Suggested Remedial Work	Priority	Estimated Cost	Action/Work ordered
1.1 & 1.2	Repoint the several small areas of deep mortar loss to joints primarily throughout the lower third of both towers above deck level, particularly to lower east face of south tower and east side of span 7 springers and to joints throughout the arches, typically around the springer points.	L		
6	Repair the several areas of spalling and exposed rebar to soffit of cantilevered footway particularly to the west of spans 1-4 and to a lesser extent to several areas throughout. Danger of falling masonry.	H		
11	Repair the several small areas of deep mortar loss throughout the piers, particularly to springer points.	L		
21	Prepare, inspect and repaint the numerous small areas of full depth paint loss to the parapet paint system, particularly to the rails and lower ends of the vertical infill bars.	L		
23	Prepare, inspect and repaint the several small and discrete areas of corrosion and minor section loss throughout the east and west parapets, mainly to the post connections and horizontal rail joints.	L		

BRIDGE INSPECTION

Superficial	General X	Principal	Special
Form 3 of 8 for this bridge			

Inspector:	[redacted]	Date	07-Nov-2019 to 10- Dec 2020
Next Inspection Type:	GI	Next Inspection Due Financial Year:	2021/22
Bridge Name:	Menai Bridge	Bridge Ref/No:	A5
Road Ref/No:	A5	Maintaining Authority:	UK Highways
Structures Function: above:	A5 carriageway	below:	Menai Strait
Map Ref:	-	O.S.E	255677
O.S.N	371404		
Spans	3 of 8	Width (m)	11.35
Length (m)	16.002	Area (m^2)	182.1
All above ground elements inspected?	Yes X No	Photographs?	Yes X No
Number of Construction forms in Bridge/Span:		BCS crit 78.88	BCS ave 84.95

Bridge Type Code:

Primary deck element form		
Table 2	Solid arch	1
Primary deck element material		
Table 4	Stone	L
Secondary deck element form		
Table 3	No transverse beams	20
Secondary deck element material		
Table 4	No secondary element	P

Set	No	Element Description	S	Ex	Def	W	P	Cost	Comments / remarks
Deck elements	1	Primary deck element (Table 2)	2	B	3.2	R	L		Refer to multiple defects page.
	2	Secondary deck element/s – Transverse beams							
	3	Secondary deck element/s – Element from Table 3							
	4	Half joints							
	5	Tie beam/rod							
	6	Parapet beam or cantilever	2	C	2.1	R	H		Several areas of spalling and exposed rebar to soffit of cantilevered footway particularly to the west of spans 1-4 and to a lesser extent throughout.
	7	Deck bracing							
Load-bearing Substructure	8	Foundations	1	A					Good condition based on no obvious settlement or scour related defects.
	9	Abutments (incl arch springing)							
	10	Spandrel wall / head wall	2	B	2.1	N			Monitor the several small areas of delamination and shallow spalling throughout the east and west spandrel panels.
	11	Pier / Column	2	B	3.2	R	L		Several small areas of deep mortar loss throughout the piers, particularly to springer points.
	12	Cross head / capping beam							
	13	Bearings							
	14	Bearing shelf / plinth							
Durability elements	15	Superstructure drainage	1	A					No obvious defects.
	16	Substructure drainage							
	17	Waterproofing	1	A					No significant defect.
	18	Movement / expansion joints							
	19	Finishes: deck elements							
	20	Finishes: substructure elements							
	21	Finishes: parapets/safety fences	5	C	4.1	P	L		Numerous small areas of full depth paint loss to parapet paint system, particularly to rails and lower ends of vertical infill bars.
Safety elements	22	Access / walkways / gantries							
	23	Handrail / parapets / safety fences	2	C	Other	R	L		Refer to multiple defects page.
	24	Carriageway surfacing	2	B	9.2	N			Monitor the minor wear and regular narrow transverse cracking along the carriageways.
	25	Footway / verge / footbridge surfacing	1	A					No significant defect.
Other bridge elements	26	Invert / river bed	1	A					No obstruction or significant scour.
	27	Aprons							
	28	Fenders / cutwaters / collision prot'n							
	29	River training works							
	30	Revetment / batter paving							
	31	Wing walls							
	32	Retaining walls							
	33	Embankments							
	34	Machinery							
Ancillary elements	35	Approach rails / barriers / walls							
	36	Signs	1	A					No obvious defects.
	37	Lighting	1	A					No obvious defects.
	38	Services	1	A					No obvious defects.

S - severity, Ex - extent, Def - defect
W - work required, P - work priority

Inspection date: 07-Nov-2019 to 10-Dec 2020

1 of 2 pages

MULTIPLE DEFECTS

Element No.	Defect 1			Defect 2			Defect 3			Comments
	S	Ex	Def	S	Ex	Def	S	Ex	Def	
1	2	B	3.2	2	B	3.2				Defect 1: several small areas of deep mortar loss to joints throughout both towers. typical to lower east face of south tower and generally the lower third above road deck level. Defect 2: several small areas of deep mortar loss to joints throughout the arches, typically around the springer points.
23	2	B	1.1	2	B	1.1				Defect 1: several small and discrete areas of corrosion and minor section loss to east and west parapets, mainly to connections and rail joints. Defect 2: corrosion to several areas of the parapet top rails, posts and, to a lesser extent, the lower rail and panel infill bars.

INSPECTOR'S COMMENTS

This span was generally in fair to good condition. The 7No limestone masonry approach spans were generally in fair to good condition but with a high priority defect as follows: Wide areas of spalling and exposed rebar were noted to the soffit of the cantilevered footway particularly to the west of spans 1-4 and along the southern approach walkway cantilevers, particularly to north side of span 8 and to a lesser extent throughout the remaining walkway cantilever soffits. Lower priority defects, related to several small areas of mortar loss to joints, were noted throughout the approach arches. There were also numerous small areas of full depth paint loss and minor corrosion to the parapet system, particularly to rails and lower ends of vertical infill bars throughout.

Name	[redacted]	Signed	[redacted]	Date	21 January 2020

ENGINEER'S COMMENTS

This span is in fair to good condition with some high priority defects evident to the walkway cantilever soffits. These defects require remedial works within the next financial year to ensure that the bridge remains safe for use and fit for purpose. There are also several lower priority defects, such as areas of mortar loss and minor vegetation growth throughout, which should also be remedied in a timely manner so as not to incur greater costs in the future.

Name	[redacted]	Signed	[redacted]	Date	February 3, 2020

WORK REQUIRED

Ref. No	Suggested Remedial Work	Priority	Estimated Cost	Action/Work ordered
1.1 & 1.2	Repoint the several small areas of deep mortar loss to joints primarily throughout the lower third of both towers above deck level, particularly to lower east face of south tower and east side of span 7 springers and to joints throughout the arches, typically around the springer points.	L		
6	Repair the several areas of spalling and exposed rebar to soffit of cantilevered footway particularly to the west of spans 1-4 and to a lesser extent to several areas throughout. Danger of falling masonry.	H		
11	Repair the several small areas of deep mortar loss throughout the piers, particularly to springer points.	L		
21	Prepare, inspect and repaint the numerous small areas of full depth paint loss to the parapet paint system, particularly to the rails and lower ends of the vertical infill bars.	L		
23	Prepare, inspect and repaint the several small and discrete areas of corrosion and minor section loss throughout the east and west parapets, mainly to the post connections and horizontal rail joints.	L		

BRIDGE INSPECTION

Superficial	General	X	Principal	Special	Form 4 of 8 for this bridge

Inspector:	[redacted]	Date:	07-Nov-2019 to 10- Dec 2020	Next Inspection Type:	GI
Next Inspection Due Financial Year:	2021/22				
Bridge Name:	Menai Bridge			Bridge Ref/No:	A5
Road Ref/No:	A5				
Structures Function:		above:	All carriageway	below:	Menai Strait
Maintaining Authority:	UK Highways				
Map Ref:	-	O.S.E	256677	O.S.N	371484

Spans	4	of	8	Width (m)	11.38	Length (m)	16.002	Area (m²)	182.1

All above ground elements inspected?	Yes	X	No	Photographs? Yes	X	No

Number of Construction forms in Bridge/Span:		BCS crit	78.88	BCS ave	79.42

Bridge Type Code:

Primary deck element form		
Table 2	Solid arch	1
Primary deck element material		
Table 4	Stone	L
Secondary deck element form		
Table 3	No transverse beams	20
Secondary deck element material		
Table 4	No secondary element	P

Set	No	Element Description		S	Ex	Def	W	P	Cost	Comments / remarks
Deck elements	1	Primary deck element (Table 2)		2	B	3.2	R	L		Refer to multiple defects page.
	2	Secondary deck element/s	Transverse beams							
	3		Element from Table 3							
	4	Half joints								
	5	Tie beam/rod								
	6	Parapet beam or cantilever		2	C	2.1	R	H		Several areas of spalling and exposed rebar to soffit of cantilevered footway particularly to the west of spans 1-4 and to a lesser extent throughout.
	7	Deck bracing								
Load-bearing Substructure	8	Foundations		1	A					Good condition based on no obvious settlement or scour related defects.
	9	Abutments (incl arch springing)								
	10	Spandrel wall / head wall		2	B	2.1	N			Monitor the several small areas of delamination and shallow spalling throughout the east and west spandrel panels.
	11	Pier / Column		2	B	3.2	R	L		Several small areas of deep mortar loss throughout the piers, particularly to springer points.
	12	Cross head / capping beam								
	13	Bearings								
	14	Bearing shelf / plinth								
Durability elements	15	Superstructure drainage		1	A					No obvious defects.
	16	Substructure drainage								
	17	Waterproofing		2	B	14.1	N			Monitor slight dripping through north west tower arch.
	18	Movement / expansion joints								
	19	Finishes: deck elements								
	20	Finishes: substructure elements								
	21	Finishes: parapets/safety fences		5	C	4.1	P	L		Numerous small areas of full depth paint loss to parapet paint system, particularly to rails and lower ends of vertical infill bars.
Safety elements	22	Access / walkways / gantries								
	23	Handrail / parapets / safety fences		2	C	Other	R	L		Refer to multiple defects page.
	24	Carriageway surfacing		2	B	9.2	N			Monitor the minor wear and regular narrow transverse cracking along the carriageways.
	25	Footway / verge / footbridge surfacing		5	C	M	P	L		Sections of full depth paint loss and moderate corrosion to the verge steel kerbs on the approaches to the towers.
Other bridge elements	26	Invert / river bed		1	A					No obstruction or significant scour.
	27	Aprons								
	28	Fenders / cutwaters / collision prot'n								
	29	River training works								
	30	Revetment / batter paving								
	31	Wing walls								
	32	Retaining walls								
	33	Embankments								
	34	Machinery								
Ancillary elements	35	Approach rails / barriers / walls								
	36	Signs		1	A					Good condition
	37	Lighting		2	B	Other	C	L		Broken lighting unit to east transverse arch of north tower.
	38	Services		1	A					No obvious defects.

S - severity, Ex - extent, Def - defect
W - work required, P - work priority

Inspection date: 07-Nov-2019 to 10-Dec 2020

MULTIPLE DEFECTS

Element No.	Defect 1			Defect 2			Defect 3			Comments
	S	Ex	Def	S	Ex	Def	S	Ex	Def	
1	2	B	3.2	2	B	3.2				Defect 1: several small areas of deep mortar loss to joints throughout both towers. typical to lower east face of south tower and generally the lower third above road deck level. Defect 2: several small areas of deep mortar loss to joints throughout the arches, typically around the springer points.
23	2	B	1.1	2	B	1.1				Defect 1: several small and discrete areas of corrosion and minor section loss to east and west parapets, mainly to connections and rail joints. Defect 2: corrosion to several areas of the parapet top rails, posts and, to a lesser extent, the lower rail and panel infill bars.

INSPECTOR'S COMMENTS

This span was generally in fair to good condition. The 7No limestone masonry approach spans were generally in fair to good condition but with a high priority defect as follows: Wide areas of spalling and exposed rebar were noted to the soffit of the cantilevered footway particularly to the west of spans 1-4 and along the southern approach walkway cantilevers, particularly to north side of span 8 and to a lesser extent throughout the remaining walkway cantilever soffits. Lower priority defects, related to several small areas of mortar loss to joints, were noted throughout the approach arches. There were also numerous small areas of full depth paint loss and minor corrosion to the parapet system, particularly to rails and lower ends of vertical infill bars throughout.

Name	[redacted]	Signed	[redacted]	Date	21 January 2020

ENGINEER'S COMMENTS

This span is in fair to good condition with some high priority defects evident to the walkway cantilever soffits. These defects require remedial works within the next financial year to ensure that the bridge remains safe for use and fit for purpose. There are also several lower priority defects, such as areas of mortar loss and minor vegetation growth throughout, which should also be remedied in a timely manner so as not to incur greater costs in the future.

Name	[redacted]	Signed	[redacted]	Date	February 3, 2020

WORK REQUIRED

Ref. No	Suggested Remedial Work	Priority	Estimated Cost	Action/Work ordered
1.1 & 1.2	Repoint the several small areas of deep mortar loss to joints primarily throughout the lower third of both towers above deck level, particularly to lower east face of south tower and east side of span 7 springers and to joints throughout the arches, typically around the springer points.	L		
6	Repair the several areas of spalling and exposed rebar to soffit of cantilevered footway particularly to the west of spans 1-4 and to a lesser extent to several areas throughout. Danger of falling masonry.	H		
11	Repair the several small areas of deep mortar loss throughout the piers, particularly to springer points.	L		
21	Prepare, inspect and repaint the numerous small areas of full depth paint loss to the parapet paint system, particularly to the rails and lower ends of the vertical infill bars.	L		
23	Prepare, inspect and repaint the several small and discrete areas of corrosion and minor section loss throughout the east and west parapets, mainly to the post connections and horizontal rail joints.	L		
25	Prepare and repaint the sections of full depth paint loss and moderate corrosion to the verge steel kerbs on the inner approaches to the tower arches.	L		
37	Replace the broken lighting unit to the east transverse arch of the north tower.	L		

BRIDGE INSPECTION

Superficial	General	X	Principal		Special		Form 5 of 8 for this bridge

Inspector:	[redacted]	Date	07-Nov-2019 to 10- Dec 2020	Next Inspection Type:	GI
Next Inspection Due Financial Year:	2021/22				
Bridge Name:	Menai Bridge			Bridge Ref/No:	A5 Menai
Road Ref/No:	A5				
Structures Function:		above:	A5 carriageway	below:	Menai Strait
Maintaining Authority:	UK Highways				
Map Ref:	-	O.S.E	255877	O.S.N	371484
Spans	5 of 8	Width (m)	11.38	Length (m)	176.75
Area (m²)	2011.4				
All above ground elements inspected?	Yes X	No		Photographs?	Yes X No
Number of Construction forms in Bridge/Span:		BCS crit	55.48	BCS ave	70.53

Bridge Type Code:

Primary deck element form		17
Table 2	Cable stayed / suspension	
Primary deck element material		E
Table 4	Steel	
Secondary deck element form		36
Table 3	Other (transverse beams)	
Secondary deck element material		E
Table 4	Steel	

Set	No	Element Description		S	Ex	Def	W	P	Cost	Comments / remarks
Deck elements	1	Primary deck element (Table 2)		3	C	1.1	R	M		Refer to multiple defects page.
	2	Secondary deck element/s	Transverse beams	3	B	M	P	M		Refer to multiple defects page.
	3		Element from Table 3	2	B	1.1	P	M		Several areas of paint loss and corrosion were widespread throughout the deck soffit plates.
	4	Half joints								
	5	Tie beam/rod		3	C	M	P	H		Refer to multiple defects page.
	6	Parapet beam or cantilever		2	B	M	R	M		Refer to multiple defects page.
	7	Deck bracing		2	B	4.1	N			Monitor minor paint loss and corrosion to the north and south chain braces particularly the north transverse chain brace mainly to bolt heads.
Load-bearing Substructure	8	Foundations		1	A					Good condition based on no obvious settlement or scour related defects.
	9	Abutments (incl arch springing)								
	10	Spandrel wall / head wall		2	B	2.1	N			Several small areas of delamination and shallow spalling throughout the east and west spandrel panels.
	11	Pier / Column		2	B	3.2	R	L		Several small areas of deep mortar loss throughout the piers, particularly to springers.
	12	Cross head / capping beam		1	A					No obvious sign of defect.
	13	Bearings								Obscured by the small gap between the corbelled bearing shelf and end transverse deck beams.
	14	Bearing shelf / plinth								Obscured by the small gap between the corbelled bearing shelf and end transverse deck beams.
Durability elements	15	Superstructure drainage		1	A					Regular 25mm dia. drain holes along east and west kerblines were clear of debris and functional
	16	Substructure drainage								
	17	Waterproofing		2	B	14.1	N			Minor water staining throughout possibly from atmosphere.
	18	Movement / expansion joints								
	19	Finishes: deck elements		5	C	M	P	M		Refer to multiple defects page.
	20	Finishes: substructure elements								
	21	Finishes: parapets/safety fences		5	C	4.1	P	L		Numerous small areas of full depth paint loss to parapet paint system, particularly to rails and lower ends of vertical infill bars.
Safety elements	22	Access / walkways / gantries								
	23	Handrail / parapets / safety fences		5	B	M	R	M		Refer to multiple defects page.
	24	Carriageway surfacing		2	B	9.2	N			Monitor the minor wear and regular narrow transverse cracking along the carriageway.
	25	Footway / verge / footbridge surfacing		5	C	M	P	L		Sections of full depth paint loss and moderate corrosion to the verge steel kerbs on the approaches to the towers.
Other bridge elements	26	Invert / river bed		1	A					No obstruction or significant scour.
	27	Aprons								
	28	Fenders / cutwaters / collision prot'n								
	29	River training works								
	30	Revetment / better paving								
	31	Wing walls								
	32	Retaining walls								
	33	Embankments								
	34	Machinery								
Ancillary elements	35	Approach rails / barriers / walls								
	36	Signs		1	A					Height sign value is lower than actual headroom beneath tower arches.
	37	Lighting		2	B	Other	C	L		Broken lighting unit to east transverse arch of north tower.
	38	Services		4	C	M	R	L		Refer to multiple defects page.

S - severity, Ex - extent, Def - defect
W - work required, P - work priority

Inspection date: 07-Nov-2019 to 10-Dec 2020

MULTIPLE DEFECTS										
Element No.	Defect 1			Defect 2			Defect 3			Comments
	S	Ex	Def	S	Ex	Def	S	Ex	Def	
1	2	C	1.1	3	B	1.1				Defect 1: several small areas of paint loss and surface corrosion were noted throughout the east and west longitudinal trusses located between the footways and carriageway. Most of the paint loss/corrosion areas are to truss element nodes and discrete pockets where water collects due to the intricate detail around rivet heads and where several plates meet and intersect. Also, paint loss and corrosion to northern anchor block bolt group arrangement. Defect 2: several small areas of deeper corrosion to the truss, 1-3mm deep particularly at 90m in from the south tower.
2	2	B	14.1	3	B	1.1				Defect 1: monitor several small areas of efflorescence, stalactites and damp staining to the tower transverse arches. Defect 2: generally 1-2mm depth of corrosion to several areas throughout the transverse beams suspended from the deck longitudinal truss. Bolt and rivet heads were generally less corroded but bolt/rivet heads at 150m north of the south end were 80% corroded to 2mm deep with some isolated areas measured up to 3mm deep. Areas around where services cut through at the south end and lower flange plates were more corroded up to 2mm deep.
5	3	C	1.2	2	B	1.1				Defect 1: localised paint loss, corrosion and minor section loss to the 34no (17no each side) square drop link bar lower portion. Defect 2: small areas of paint loss and surface corrosion to lower tie bars particularly to the east side at 21m north of the north tower.
6	2	C	1.1	3	B	1.1				Defect 1: several small areas of paint loss and surface corrosion were noted throughout the east and west cantilevers located between the footways and carriageway. Most of the paint loss/corrosion areas are at the cantilever connection where several plates meet and intersect. Defect 2: several small areas of deeper corrosion to the cantilevers, 1-2mm deep particularly at 90m in from the south tower where there is 8mm delamination to the upright.
19	4	B	4.1	3	B	4.1	5	C	4.1	Defect 1: monitor the small areas of paint loss, minor corrosion and rust staining throughout the centre span truss members, particularly the bolts, rivets and plate ends. Defect 2: monitor the small areas of failed paint and resulting rust staining to the lower hanger lugs. Defect 3: several areas of full depth paint loss, minor corrosion and rust staining to the truss rivets throughout.
19	3	B	4.1	4	B	4.1	3	B	4.1	Defect 4: monitor the small areas of failed paint and resulting rust staining to the upper hanger lugs. Defect 5: moderate areas of paint loss and minor corrosion to the inside faces of the upper truss members. typical to east side 15m south of north tower. Defect 6: monitor the small areas of chipped paint and rust staining throughout the west truss.
19	5	B	4.1	5	B	4.1	4	B	4.1	Defect 7: full depth paint loss and moderate corrosion to electrical box to west side at mid span. Defect 8: several small areas of paint loss to hangers, typical to 2nd north west hanger. Defect 9: several small areas of paint loss to north chain brace.
19	5	B	4.1							Defect 10: numerous areas of full depth paint loss and minor corrosion throughout the truss, both above and below the deck, typically appearing at nodes where plates intersect or join.
23	4	B	1.2	2	B	1.2	5	B	Other	Defect 1: small areas of full depth section loss to inner west guardrail at 23m north of south tower. Defect 2: several small and discrete areas of corrosion and minor section loss to east and west parapets, mainly to connections and rail joints. Defect 3: failure of holding down bolt arrangement to south west inner pedestrian guardrail.
23	5	C	13.1	3	B	1.2	4	B	1.2	Defect 4: severe impact damage to the central reservation guardrail to the south of the north tower and north of the south tower. Defect 5: section loss to west handrail at south tower. Defect 6: small areas of full depth section loss to inner west guardrail at 23m north of south tower.
23	5	C	13.1	3	B	1.1				Defect 7: section loss to west handrail 64m north of south tower. Defect 8: corrosion to several areas of the parapet top rails, posts and, to a lesser extent, the lower rail and panel infill bars.
25	5	C	4.1	3	B	9.4				Defect 1: sections of full depth paint loss and moderate corrosion to the verge steel kerbs on the approaches to the towers. Defect 2: several wide cracks and 100mm diameter x 40mm deep potholes in east footway 35m north of the north abutment.
38	3	B	1.2	4	C	1.2				Defect 1: corrosion and section loss to the edges of a west manhole cover 6m south of the south tower. Defect 2: corrosion and section loss to the edges of services box to the south of the north tower.

			INSPECTOR'S COMMENTS				
	This span was generally in fair condition. The central suspended steel truss was generally in fair condition with some areas requiring urgent remedial work. The catenary chains: back-stay and fore-stay were in good condition as were the cable hangers and their respective lug/pin connections. The main defects were located to the underside of the deck and these included numerous, separate areas of full depth paint loss and corrosion with some elements suffering from section loss which would affect their structural load carrying capacity. These defective areas were typical throughout the underside of the deck and they affect the underside of the main truss, the transverse beams and some of their connection bolts/rivets, steel deck plate permanent formwork supporting the reinforced concrete deck longitudinal stiffeners, the under-deck surfaces of the walkway cantilevers and some pedestrian guardrail post connections. It was noted that defects to these elements were more severe at beam ends and where they meet other structural components. These areas are more exposed, and they allow salt water to collect and pond respectively. Other main defects included paint loss, corrosion and significant section loss to the square section steel drop link tie bars occupying the central third of the main suspended span where they pass through and connect with the upper elements of the east and west main longitudinal trusses by use of bolts to the threaded end section of the drop links.					
Name		[redacted]	Signed	[redacted]		Date	21 January 2020
			ENGINEER'S COMMENTS				
	This span is in fair condition with some high priority defects to structural components, particularly to the central tie links and throughout the underside of the main suspended span. These defects require remedial works within the next financial year to ensure that the bridge remains safe for use and fit for purpose. There are also several medium and low priority defects which should also be remedied in a timely manner so as not to incur greater costs in the future.					
Name		[redacted]	Signed	[redacted]		Date	February 3, 2020

WORK REQUIRED				
Ref. No	**Suggested Remedial Work**	**Priority**	**Estimated Cost**	**Action/Work ordered**
1.1 & 1.2	Remove loose paint and surface corrosion to further inspect several small areas of paint loss and surface corrosion noted throughout the east and west longitudinal trusses. Most of the paint loss/corrosion areas are to truss element ends, nodes and discrete pockets where water collects due to the intricate detail around rivet heads and where several plates meet and intersect particularly at 90m north of the south tower where the corrosion is 1-2mm deep in places. Also remove loose paint and surface corrosion to further inspect paint loss and corrosion to northern anchor block bolt group arrangement. Note these costs are for defective paint abrasion, inspection and possible patch repair work, for associated re-painting recommendations and costs see section 19.	M		
2	Remove loose paint and surface corrosion to further inspect areas of generally 1-2mm depth of corrosion to several areas throughout the transverse beams suspended from the deck longitudinal truss. Bolt and rivet heads were generally less corroded but bolt/rivet heads at 150m north of the south end were 80% corroded to 2mm deep with some isolated areas measured up to 3mm deep. Areas around where services cut through at the south end and lower flange plates were more corroded up to 2mm deep. Assumed roped/movable suspended gantry costs are covered within defect 1.1 costs.	M		
3	Prepare, inspect and re-paint the several areas of paint loss and corrosion which were widespread throughout the deck soffit plates.	M		
5.1 & 5.2	Prepare, inspect, measure and repaint the localised paint loss, corrosion and minor section loss to the 34no (17no each side) square drop link bar lower portion. Consider replacing drop links which have revealed more than 5% section loss. Paint the small areas of paint loss and surface corrosion to lower tie bars particularly to the east side at 21m north of the north tower.	H		
6.1 & 6.2	Prepare, inspect and repaint the several small areas of paint loss and surface corrosion throughout the east and west cantilevers. Most of the paint loss/corrosion areas are at the cantilever connection where several plates meet and intersect. Prepare, inspect and repaint the several small areas of deeper corrosion to the cantilevers, 1-2mm deep particularly at 90m in from the south tower where there is 6mm delamination to the upright.	M		
11	Repair the several small areas of deep mortar loss throughout the piers, particularly to springer points.	L		
19	Prepare and repaint the several areas of full depth paint loss, minor corrosion and rust staining to the truss rivets throughout the main span.	M		
19.2	Prepare and repaint the moderate areas of paint loss and minor corrosion to the inside faces of the upper truss members. typical to east side 15m south of the north tower.	M		
19.3	Prepare and repaint the full depth paint loss and moderate corrosion to electrical boxes within the east and west trusses, above deck, at mid span.	M		
19.4	Prepare, inspect and repaint the several small areas of paint loss throughout the hangers, typical to 2nd north west hanger.	M		
19.5	Prepare, inspect and repaint the several small areas of paint loss to the north and south chain brace stiffeners.	L		
19.6	Prepare and repaint the several areas of localised paint loss and minor corrosion to the remaining areas, not specified above, throughout the main span soffit. Closely inspect the bolts and rivets holding the transverse beams, which are suspended beneath the main truss, once all surrounding paint has been removed.	M		
21	Prepare, inspect and repaint the numerous small areas of full depth paint loss to the parapet paint system, particularly to the rails and lower ends of the vertical infill bars.	L		
23	Prepare, inspect and repaint the several small and discrete areas of corrosion and minor section loss throughout the east and west parapets, mainly to the post connections and horizontal rail joints.	L		
23.2	Replace the impact damaged holding down bolt arrangement to the south west inner pedestrian guardrail to the central reservation at the south of the north tower.	M		
23.3	Replace the severe impact damage to the central reservation guardrail to the south of the north tower and north of the south tower.	M		
23.4	Replace the affected lengths of upper pedestrian handrail suffering from severe section loss which is most severe to the west handrail around the south tower.	L		
23.5	Replace the affected length of full depth section loss to the inner west guardrail at 23m north of the south tower.	M		
23.6	Replace the affected length of rail suffering from section loss to the west handrail at 64m north of the south tower.	M		
25	Prepare and repaint the sections of full depth paint loss and moderate corrosion to the verge steel kerbs on the inner approaches to the tower	L		
37	Replace the broken lighting unit to the east transverse arch of the north tower.	L		
38	Replace the manhole cover which is suffering corrosion and section loss to the edges of a west manhole cover at 6m south of the south tower.	L		
38.2	Replace the services box which is suffering corrosion and section loss to the edges, located to the south of the north tower.	L		

BRIDGE INSPECTION

Superficial | General X | Principal | Special | Form 6 of 8 for this bridge

Inspector: [redacted] | Date: 07-Nov-2019 to 10- Dec 2020 | Next Inspection Type: GI | Next Inspection Due Financial Year: 2021/22

Bridge Name: Menai Bridge | Bridge Ref/No: A5 | Road Ref/No: A5

Structures Function: | above: A5 carriageway | below: Menai Strait | Maintaining Authority: UK Highways

Map Ref: - | O.S.E 255677 | O.S.N 371404

Spans 6 of 6 | Width (m) 11.38 | Length (m) 16.002 | Area (m²) 152.1

All above ground elements inspected? Yes X No | Photographs? Yes X No

Number of Construction forms in Bridge/Span: | BCS crit 81.00 | BCS ave 80.46

Bridge Type Code:

Primary deck element form	Table 2	Solid arch 1
Primary deck element material	Table 4	Stone L
Secondary deck element form	Table 3	No transverse beams 20
Secondary deck element material	Table 4	No secondary element P

Set	No	Element Description	S	Ex	Def	W	P	Cost	Comments / remarks
Deck elements	1	Primary deck element (Table 2)	2	B	3.2	R	L		Refer to multiple defects page.
	2	Secondary deck element/s: Transverse beams							
	3	Secondary deck element/s: Element from Table 3							
	4	Half joints							
	5	Tie beam/rod							
	6	Parapet beam or cantilever	2	B	2.1				Several areas of spalling and exposed rebar to soffit of cantilevered footway throughout.
	7	Deck bracing							
Load-bearing Substructure	8	Foundations	1	A					Good condition based on no obvious settlement or scour related defects.
	9	Abutments (incl arch springing)							
	10	Spandrel wall / head wall	2	B	2.1	N			Monitor the several small areas of delamination and shallow spalling throughout the east and west spandrel panels.
	11	Pier / Column	2	B	3.2	R	L		Several small areas of deep mortar loss throughout the piers, particularly to springer points.
	12	Cross head / capping beam							
	13	Bearings							
	14	Bearing shelf / plinth							
Durability elements	15	Superstructure drainage	1	A					No obvious defects.
	16	Substructure drainage							
	17	Waterproofing	1	A					No significant defect.
	18	Movement / expansion joints							
	19	Finishes: deck elements							
	20	Finishes: substructure elements							
	21	Finishes: parapets/safety fences	5	C	4.1	P	L		Numerous small areas of full depth paint loss to parapet paint system, particularly to rails and lower ends of vertical infill bars.
Safety elements	22	Access / walkways / gantries							
	23	Handrail / parapets / safety fences	2	C	Other	R	L		Refer to multiple defects page.
	24	Carriageway surfacing	2	B	9.2	N			Monitor the minor wear and regular narrow transverse cracking along the carriageways.
	25	Footway / verge / footbridge surfacing	5	C	M	P	L		Sections of full depth paint loss and moderate corrosion to the verge steel kerbs on the approaches to the towers.
Other bridge elements	26	Invert / river bed	1	A					No obstruction or significant scour.
	27	Aprons							
	28	Fenders / cutwaters / collision prot'n							
	29	River training works							
	30	Revetment / batter paving							
	31	Wing walls							
	32	Retaining walls							
	33	Embankments							
	34	Machinery							
Ancillary elements	35	Approach rails / barriers / walls							
	36	Signs	1	A					No defects
	37	Lighting	1	A					No obvious defects.
	38	Services	4	C	1.1	R	L		Corrosion and section loss to the edges of a west manhole cover at 8m south of the south tower.

S - severity, Ex - extent, Def - defect
W - work required, P - work priority

Inspection date: 07-Nov-2019 to 10-Dec 2020

MULTIPLE DEFECTS

Element No.	Defect 1			Defect 2			Defect 3			Comments
	S	Ex	Def	S	Ex	Def	S	Ex	Def	
1	2	B	3.2	2	B	3.2				Defect 1: several small areas of deep mortar loss to joints throughout both towers. typical to lower east face of south tower and generally the lower third above road deck level. Defect 2: several small areas of deep mortar loss to joints throughout the arches, typically around the springer points.
23	2	B	1.1	2	B	1.1				Defect 1: several small and discrete areas of corrosion and minor section loss to east and west parapets, mainly to connections and rail joints. Defect 2: corrosion to several areas of the parapet top rails, posts and, to a lesser extent, the lower rail and panel infill bars.

INSPECTOR'S COMMENTS

This span was generally in fair to good condition. The 7No limestone masonry approach spans were generally in fair to good condition but with a high priority defect as follows: Wide areas of spalling and exposed rebar were noted to the soffit of the cantilevered footway particularly to the west of spans 1-4 and along the southern approach walkway cantilevers, particularly to north side of span 8 and to a lesser extent throughout the remaining walkway cantilever soffits. Lower priority defects, related to several small areas of mortar loss to joints, were noted throughout the approach arches. There were also numerous small areas of full depth paint loss and minor corrosion to the parapet system, particularly to rails and lower ends of vertical infill bars throughout.

Name	[redacted]	Signed	[redacted]	Date	21 January 2020

ENGINEER'S COMMENTS

This span is in fair to good condition with some high priority defects evident to the walkway cantilever soffits. These defects require remedial works within the next financial year to ensure that the bridge remains safe for use and fit for purpose. There are also several lower priority defects, such as areas of mortar loss and minor vegetation growth throughout, which should also be remedied in a timely manner so as not to incur greater costs in the future.

Name	[redacted]	Signed	[redacted]	Date	February 3, 2020

WORK REQUIRED

Ref. No	Suggested Remedial Work	Priority	Estimated Cost	Action/Work ordered
1.1 & 1.2	Repoint the several small areas of deep mortar loss to joints primarily throughout the lower third of both towers above deck level, particularly to lower east face of south tower and east side of span 7 springers and to joints throughout the arches, typically around the springer points.	L		
11	Repair the several small areas of deep mortar loss throughout the piers, particularly to springer points.	L		
21	Prepare, inspect and repaint the numerous small areas of full depth paint loss to the parapet paint system, particularly to the rails and lower ends of the vertical infill bars.	L		
23	Prepare, inspect and repaint the several small and discrete areas of corrosion and minor section loss throughout the east and west parapets, mainly to the post connections and horizontal rail joints.	L		
25	Prepare and repaint the sections of full depth paint loss and moderate corrosion to the verge steel kerbs on the inner approaches to the tower arches.	L		
38	Replace the manhole cover which is suffering corrosion and section loss to the edges of a west manhole cover at 6m south of the south tower.	L		

BRIDGE INSPECTION

Superficial	General X	Principal	Special		Form	7 of 8	for this bridge
Inspector: [redacted]	Date	07-Nov-2019 to 10- Dec 2020	Next Inspection Type:	GI	Next Inspection Due Financial Year:	2021/22	
Bridge Name:	Menai Bridge	Bridge Ref/No:	A5		Road Ref/No:	A5	
Structures Function:	above: A5 carriageway	below:	Menai Strait		Maintaining Authority:	UK Highways	
Map Ref:	-	O.S.E	255677	O.S.N	371404		
Spans 7 of 8	Width (m) 11.38	Length (m)	16.002	Area (m²)	182.1		
All above ground elements inspected?	Yes X No	Photographs?	Yes X No				
Number of Construction forms in Bridge/Span:	BCS crit	81.00	BCS ave	83.30			

Bridge Type Code:

Primary deck element form	Table 2	Solid arch	1
Primary deck element material	Table 4	Stone	L
Secondary deck element form	Table 3	No transverse beams	20
Secondary deck element material	Table 4	No secondary element	P

Set	No	Element Description		S	Ex	Def	W	P	Cost	Comments / remarks
Deck elements	1	Primary deck element (Table 2)		2	B	3.2	R	L		Refer to multiple defects page.
	2	Secondary deck element/s	Transverse beams							
	3		Element from Table 3							
	4	Half joints								
	5	Tie beam/rod								
	6	Parapet beam or cantilever		2	B	2.1	N			Several areas of minor spalling throughout.
	7	Deck bracing								
Load-bearing Substructure	8	Foundations		1	A					Good condition based on no obvious settlement or scour related defects.
	9	Abutments (incl arch springing)								
	10	Spandrel wall / head wall		3	B	2.1	R	L		Refer to multiple defects page.
	11	Pier / Column		2	B	3.2	R	L		Several small areas of deep mortar loss throughout the piers, particularly to springer points.
	12	Cross head / capping beam								
	13	Bearings								
	14	Bearing shelf / plinth								
Durability elements	15	Superstructure drainage		1	A					No obvious defects.
	16	Substructure drainage								
	17	Waterproofing		1	A					No significant defect.
	18	Movement / expansion joints								
	19	Finishes: deck elements								
	20	Finishes: substructure elements								
	21	Finishes: parapets/safety fences		5	C	4.1	P	L		Numerous small areas of full depth paint loss to parapet paint system, particularly to rails and lower ends of vertical infill bars.
Safety elements	22	Access / walkways / gantries								
	23	Handrail / parapets / safety fences		2	C	[illegible]	R	L		Refer to multiple defects page.
	24	Carriageway surfacing		2	B	8.2	N			Monitor the minor wear and regular narrow transverse cracking along the carriageways.
	25	Footway / verge / footbridge surfacing		1	A					No significant defect.
Other bridge elements	26	Invert / river bed		1	A					No obstruction or significant scour.
	27	Aprons								
	28	Fenders / cutwaters / collision prot'n								
	29	River training works								
	30	Revetment / batter paving								
	31	Wing walls								
	32	Retaining walls								
	33	Embankments								
	34	Machinery								
Ancillary elements	35	Approach rails / barriers / walls								
	36	Signs		1	A					No obvious defects.
	37	Lighting		1	A					No obvious defects.
	38	Services		1	A					No obvious defects.

S - severity, Ex - extent, Def - defect
W - work required, P - work priority

Inspection date: 07-Nov-2019 to 10-Dec 2020

1 of 2 pages

MULTIPLE DEFECTS

Element No.	Defect 1			Defect 2			Defect 3			Comments
	S	Ex	Def	S	Ex	Def	S	Ex	Def	
1	2	B	3.2	2	B	3.2				Defect 1: several small areas of deep mortar loss to joints throughout both towers. typical to lower east face of south tower and generally the lower third above road deck level. Defect 2: several small areas of deep mortar loss to joints throughout the arches, typically around the springer points.
10	3	B	2.1	2	B	2.1				Defect 1: several up to 350mm x 350mm areas of delamination and spalling with exposed rebar to the west spandrel panels above arch 7 (span 7). Defect 2: several small areas of delamination and shallow spalling throughout the east and west spandrel panels.
23	2	B	1.1	2	B	1.1				Defect 1: several small and discrete areas of corrosion and minor section loss to east and west parapets, mainly to connections and rail joints. Defect 2: corrosion to several areas of the parapet top rails, posts and, to a lesser extent, the lower rail and panel infill bars.

INSPECTOR'S COMMENTS

This span was generally in fair to good condition. The 7No limestone masonry approach spans were generally in fair to good condition but with a high priority defect as follows: Wide areas of spalling and exposed rebar were noted to the soffit of the cantilevered footway particularly to the west of spans 1-4 and along the southern approach walkway cantilevers, particularly to north side of span 8 and to a lesser extent throughout the remaining walkway cantilever soffits. Lower priority defects, related to several small areas of mortar loss to joints, were noted throughout the approach arches. There were also numerous small areas of full depth paint loss and minor corrosion to the parapet system, particularly to rails and lower ends of vertical infill bars throughout.

Name	[redacted]	Signed	[redacted]	Date	21 January 2020

ENGINEER'S COMMENTS

This span is in fair to good condition with some high priority defects evident to the walkway cantilever soffits. These defects require remedial works within the next financial year to ensure that the bridge remains safe for use and fit for purpose. There are also several lower priority defects, such as areas of mortar loss and minor vegetation growth throughout, which should also be remedied in a timely manner so as not to incur greater costs in the future.

Name	[redacted]	Signed	[redacted]	Date	February 3, 2020

WORK REQUIRED

Ref. No	Suggested Remedial Work	Priority	Estimated Cost	Action/Work ordered
1.1 & 1.2	Repoint the several small areas of deep mortar loss to joints primarily throughout the lower third of both towers above deck level, particularly to lower east face of south tower and east side of span 7 springers and to joints throughout the arches, typically around the springer points.	L		
10	Repair the several up to 350mm x 350mm areas of delamination and spalling with exposed rebar to the west concrete upper spandrel panels above arch 7 (span 7). Monitor the several small areas of delamination and shallow spalling throughout the east and west spandrel panels at the next inspection.	L		
11	Repair the several small areas of deep mortar loss throughout the piers, particularly to springer points.	L		
21	Prepare, inspect and repaint the numerous small areas of full depth paint loss to the parapet paint system, particularly to the rails and lower ends of the vertical infill bars.	L		
23	Prepare, inspect and repaint the several small and discrete areas of corrosion and minor section loss throughout the east and west parapets, mainly to the post connections and horizontal rail joints.	L		

ATKINS

BRIDGE INSPECTION

Superficial	General X	Principal	Special		Form	8 of 8	for this bridge
Inspector: [redacted]	Date	07-Nov-2019 to 10- Dec 2020	Next Inspection Type:	GI	Next Inspection Due Financial Year:	2021/22	
Bridge Name:	Menai Bridge	Bridge Ref/No:	A5		Road Ref/No:	A5	
Structures Function:	above: A5 carriageway	below:	Menai Strait		Maintaining Authority:	UK Highways	
Map Ref:	-	O.S.E 255677	O.S.N 371404		Bridge Type Code: Primary deck element form	Table 2: Solid arch	1
Spans	8 of 8	Width (m) 11.38	Length (m) 16.002	Area (m²) 182.1	Primary deck element material	Table 4: Stone	L
All above ground elements inspected?	Yes X No	Photographs?	Yes X No		Secondary deck element form	Table 3: No transverse beams	20
Number of Construction forms in Bridge/Span:		BCS crit 78.88	BCS ave	81.97	Secondary deck element material	Table 4: No secondary element	P

Set	No	Element Description		S	Ex	Def	W	P	Cost	Comments / remarks
Deck elements	1	Primary deck element (Table 2)		2	B	3.2	R	L		Refer to multiple defects page.
	2	Secondary deck element/s	Transverse beams							
	3		Element from Table 3							
	4	Half joints								
	5	Tie beam/rod								
	6	Parapet beam or cantilever		2	C	2.1	R	H		Several areas of spalling and exposed to soffit of cantilevered footway to north side of span 8 and to a lesser extent throughout.
	7	Deck bracing								
Load-bearing Substructure	8	Foundations		1	A					Good condition based on no obvious settlement or scour related defects.
	9	Abutments (incl arch springing)		1	A					No obvious defects.
	10	Spandrel wall / head wall		2	B	2.1	N			Monitor the several small areas of delamination and shallow spalling throughout the east and west spandrel panels.
	11	Pier / Column		2	B	3.2	R	L		Several small areas of deep mortar loss throughout the piers, particularly to springer points.
	12	Cross head / capping beam								
	13	Bearings								
	14	Bearing shelf / plinth								
Durability elements	15	Superstructure drainage		4	B	8.1	R	L		Highway gully blocked to south west access road.
	16	Substructure drainage								
	17	Waterproofing		1	A					No significant defect.
	18	Movement / expansion joints								
	19	Finishes: deck elements								
	20	Finishes: substructure elements								
	21	Finishes: parapets/safety fences		5	C	4.1	P	L		Numerous small areas of full depth paint loss to parapet paint system, particularly to rails and lower ends of vertical infill bars.
Safety elements	22	Access / walkways / gantries								
	23	Handrail / parapets / safety fences		2	C	Other	R	L		Refer to multiple defects page.
	24	Carriageway surfacing		2	B	9.2	N			Monitor the minor wear and regular narrow transverse cracking along the carriageways.
	25	Footway / verge / footbridge surfacing		1	A					No obvious defects.
Other bridge elements	26	Invert / river bed		1	A					No obstruction or significant scour.
	27	Aprons								
	28	Fenders / cutwaters / collision prot'n								
	29	River training works								
	30	Revetment / batter paving								
	31	Wing walls		3	C	5.2	R	L		Ivy to lower parts of southern wing walls.
	32	Retaining walls								
	33	Embankments		1	A					Stable and southern embankments had been de-vegetated at later inspections.
	34	Machinery								
Ancillary elements	35	Approach rails / barriers / walls		1	A					Secure.
	36	Signs		1	A					Height sign value is lower than actual headroom beneath tower arches.
	37	Lighting		1	A					No obvious defects.
	38	Services		1	A					No obvious defects.

S - severity, Ex - extent, Def - defect
W - work required, P - work priority

Inspection date: 07-Nov-2019 to 10-Dec 2020

1 of 2 pages

MULTIPLE DEFECTS

Element No.	Defect 1			Defect 2			Defect 3			Comments
	S	Ex	Def	S	Ex	Def	S	Ex	Def	
1	2	B	3.2	2	B	3.2				Defect 1: several small areas of deep mortar loss to joints throughout both towers. typical to lower east face of south tower and generally the lower third above road deck level. Defect 2: several small areas of deep mortar loss to joints throughout the arches, typically around the springer points.
23	2	B	3.7	2	B	1.1	2	B	1.1	Defect 1: 30mm displacement to south west pilaster coping. Defect 2: several small and discrete areas of corrosion and minor section loss to east and west parapets, mainly to connections and rail joints. Defect 3: corrosion to several areas of the parapet top rails, posts and, to a lesser extent, the lower rail and panel infill bars.

INSPECTOR'S COMMENTS

This span was generally in fair to good condition. The 7No limestone masonry approach spans were generally in fair to good condition but with a high priority defect as follows: Wide areas of spalling and exposed rebar were noted to the soffit of the cantilevered footway particularly to the west of spans 1-4 and along the southern approach walkway cantilevers, particularly to north side of span 8 and to a lesser extent throughout the remaining walkway cantilever soffits. Lower priority defects, related to several small areas of mortar loss to joints, were noted throughout the approach arches. There were also numerous small areas of full depth paint loss and minor corrosion to the parapet system, particularly to rails and lower ends of vertical infill bars throughout.

Name	[redacted]	Signed	[redacted]	Date	21 January 2020

ENGINEER'S COMMENTS

This span is in fair to good condition with some high priority defects evident to the walkway cantilever soffits. These defects require remedial works within the next financial year to ensure that the bridge remains safe for use and fit for purpose. There are also several lower priority defects, such as areas of mortar loss and minor vegetation growth throughout, which should also be remedied in a timely manner so as not to incur greater costs in the future.

Name	[redacted]	Signed	[redacted]	Date	February 3, 2020

WORK REQUIRED

Ref. No	Suggested Remedial Work	Priority	Estimated Cost	Action/Work ordered
1.1 & 1.2	Repoint the several small areas of deep mortar loss to joints primarily throughout the lower third of both towers above deck level, particularly to lower east face of south tower and east side of span 7 springers and to joints throughout the arches, typically around the springer points.	L		
6	Repair the several areas of spalling and exposed to soffit of cantilevered footway to north side of span 8 and to a lesser extent throughout.. Danger of falling masonry.	H		
11	Repair the several small areas of deep mortar loss throughout the piers, particularly to springer points.	L		
15	Unblock the blocked highway gully to the south west access road.	L		
21	Prepare, inspect and repaint the numerous small areas of full depth paint loss to the parapet paint system, particularly to the rails and lower ends of the vertical infill bars.	L		
23	Reposition the 30mm displacement to the south west pilaster coping and repoint.	L		
23.1	Prepare, inspect and repaint the several small and discrete areas of corrosion and minor section loss throughout the east and west parapets, mainly to the post connections and hortzontal rail joints.	L		
31	Remove the Ivy growing to the lower parts of all four wing walls.	L		

Appendix B – Photographs

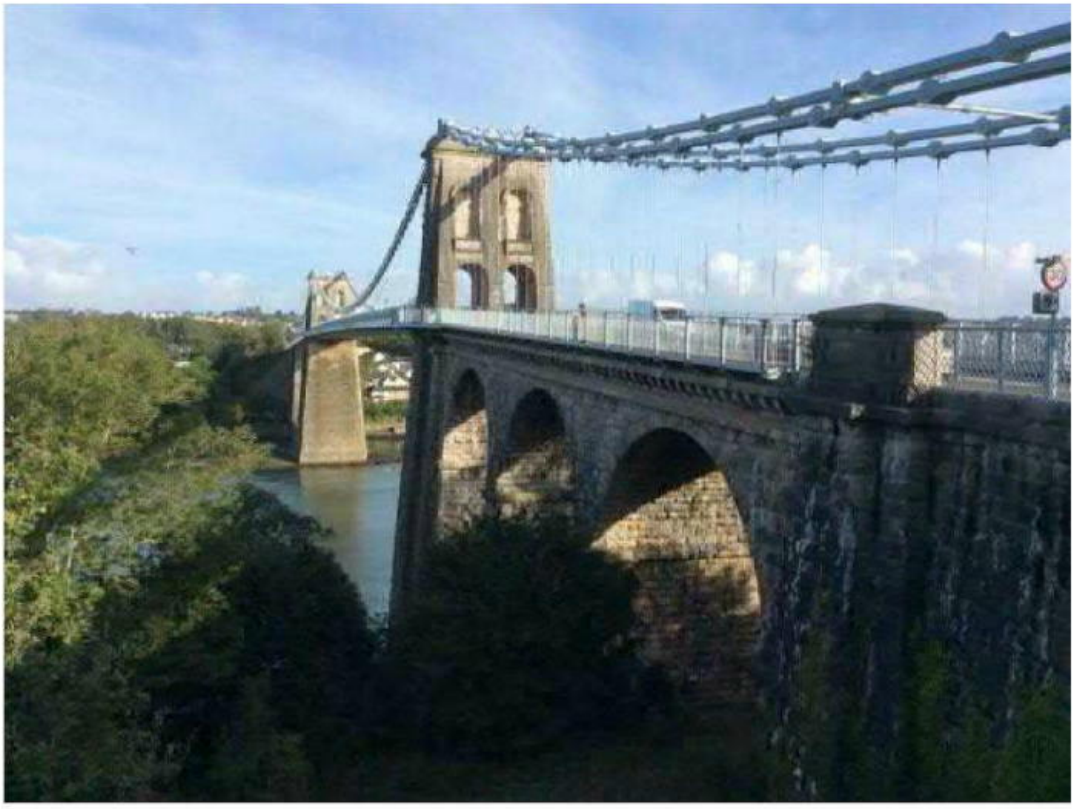


Figure 1: GA Photo - west elevation

Figure 2: GA Photo – looking north from the bridge masters building

Figure 3: GA Photo - south anchor building

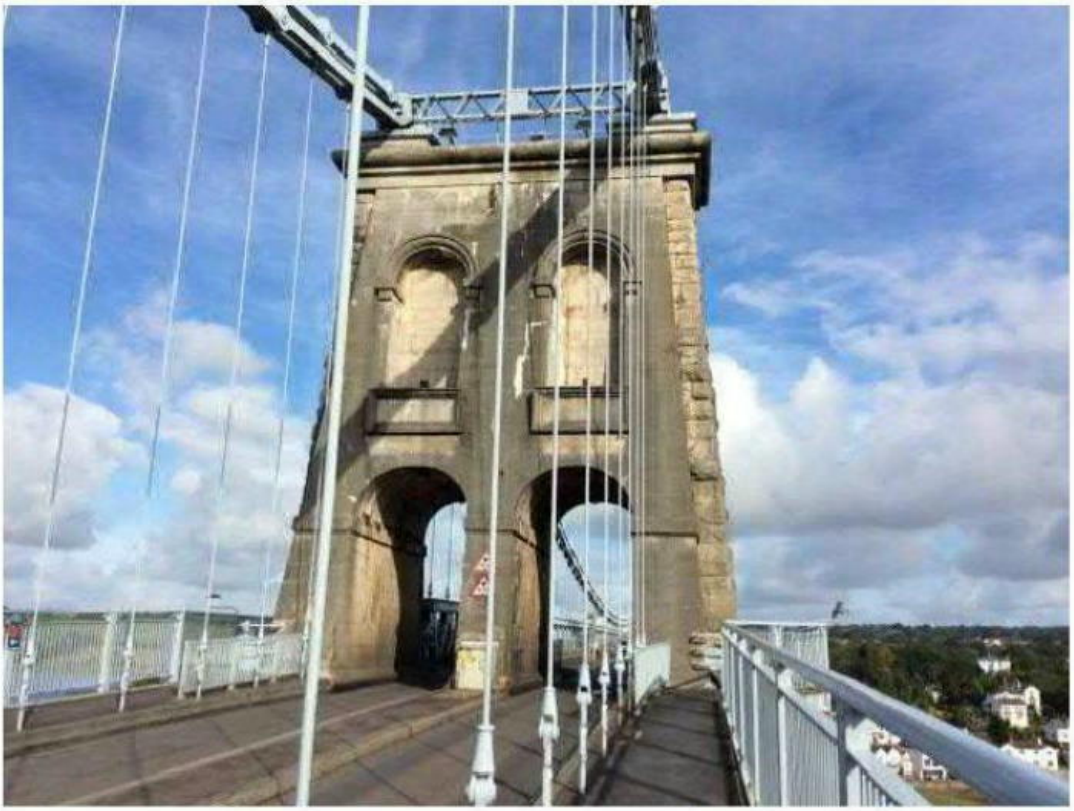


Figure 4: GA Photo - south face of south tower

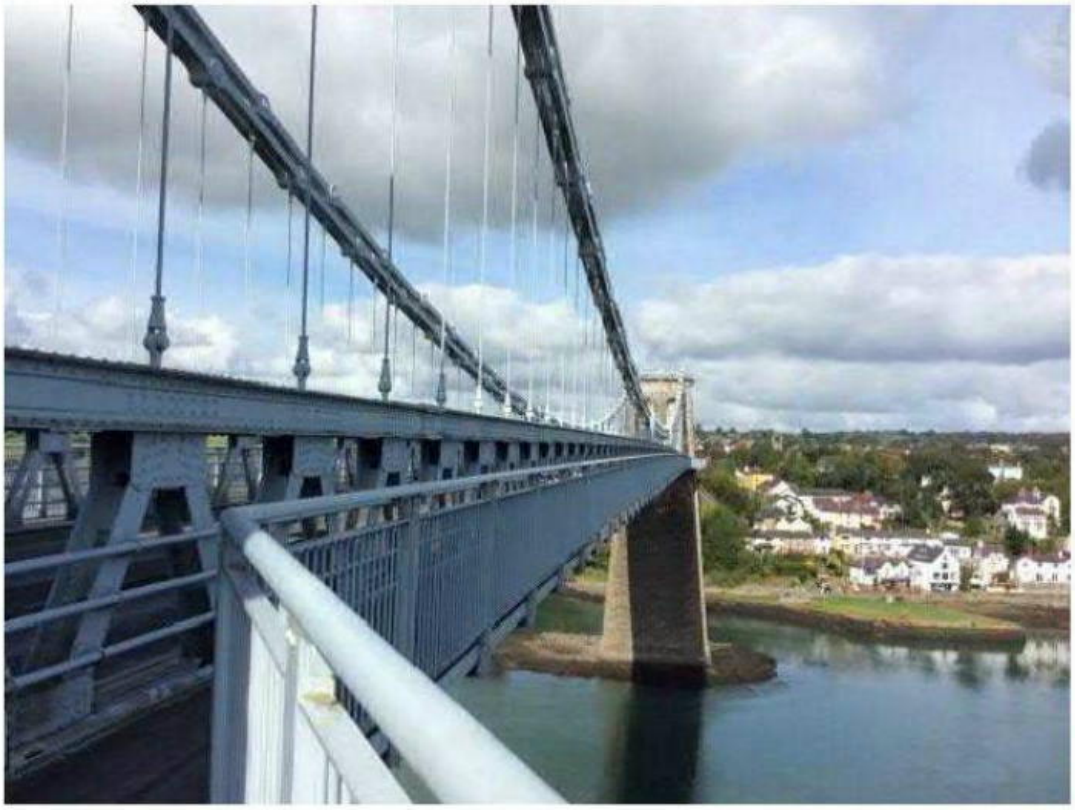


Figure 5: GA Photo - looking north along east side of main span

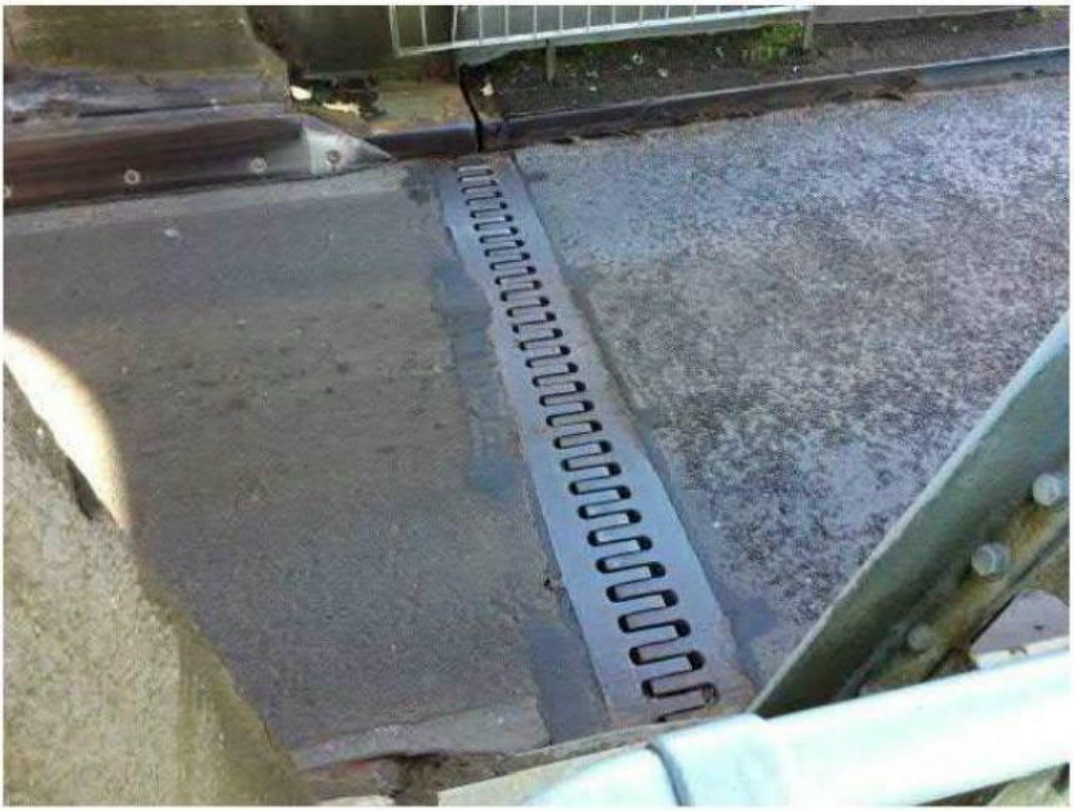


Figure 6: GA Photo - south west comb expansion joint

Figure 7: GA Photo - north face of south tower

Figure 8: GA Photo - north east comb expansion joint

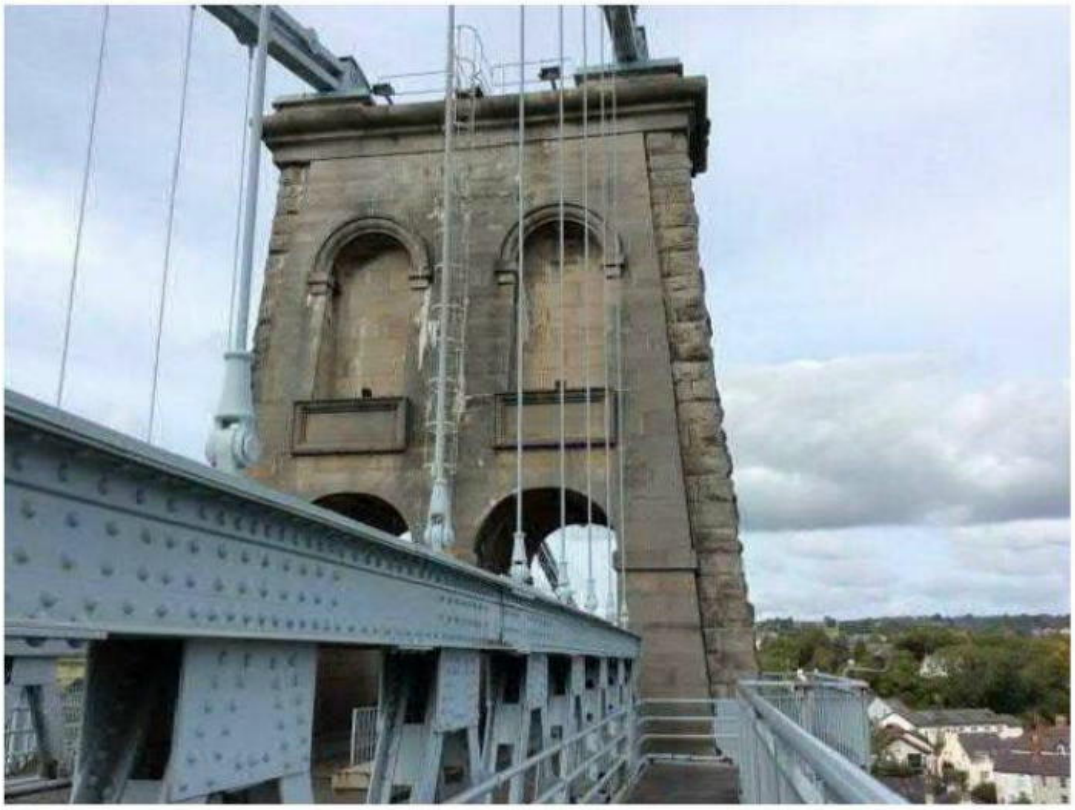


Figure 9: GA Photo - south face of north tower

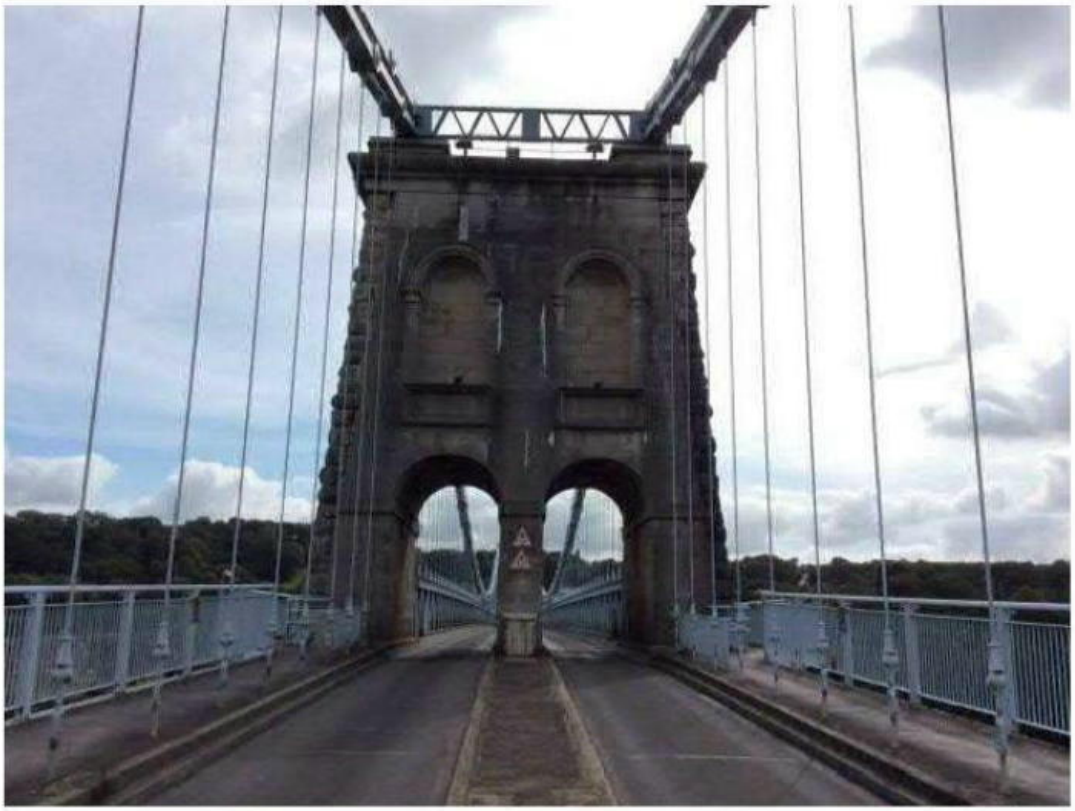


Figure 10: GA Photo - north face of north tower

Figure 11: GA Photo - north east back stay anchor

Figure 12: GA Photo - looking south

Figure 13: GA Photo - Intrados of south span 8 showing typical good condition of arches

Figure 14: GA Photo - span 7 from north

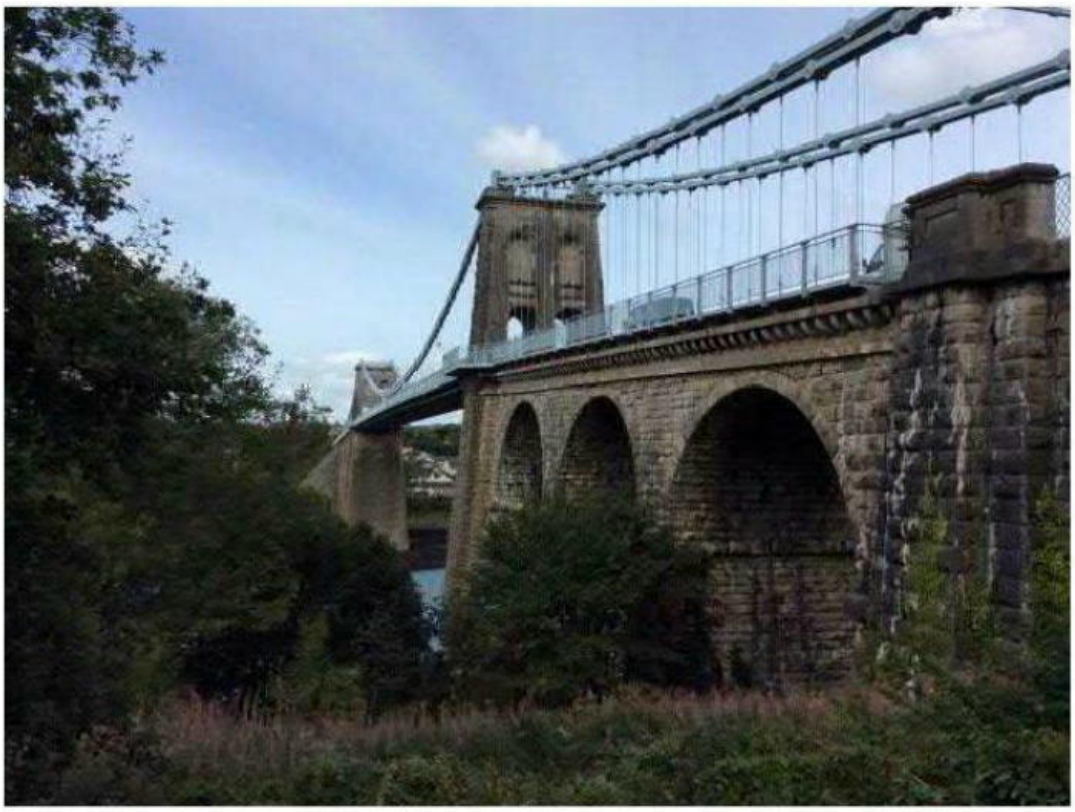


Figure 15: GA Photo - west elevation

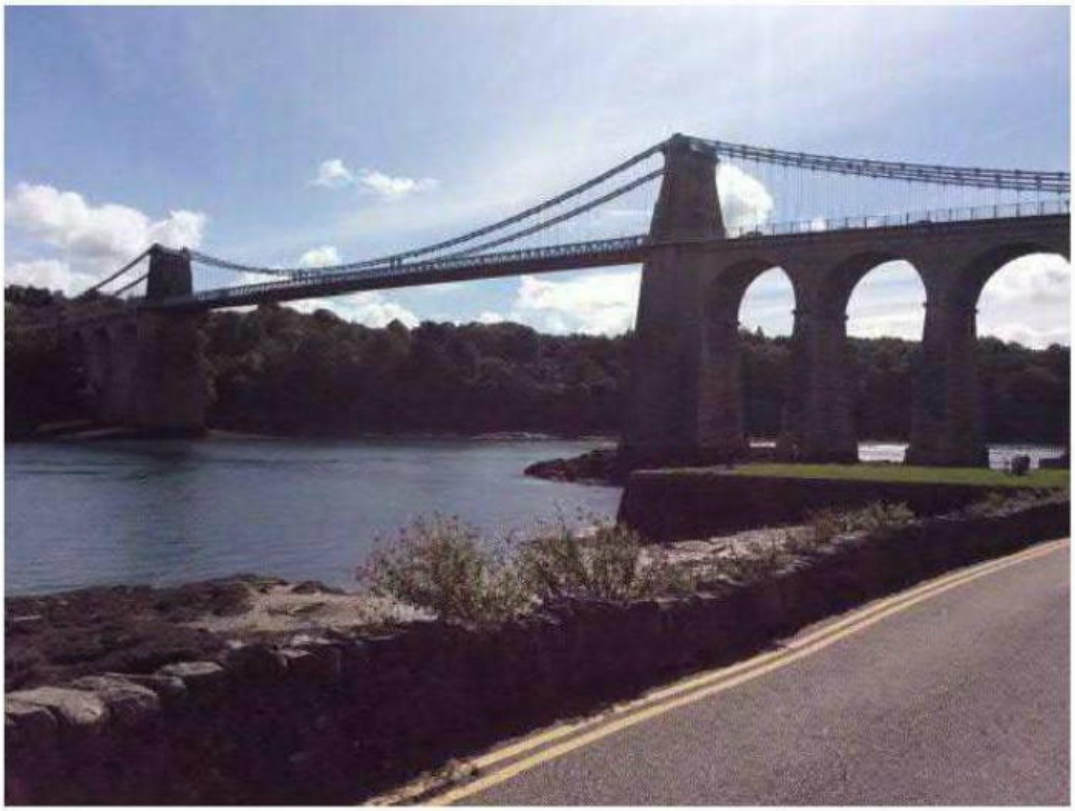


Figure 16: GA Photo - east elevation

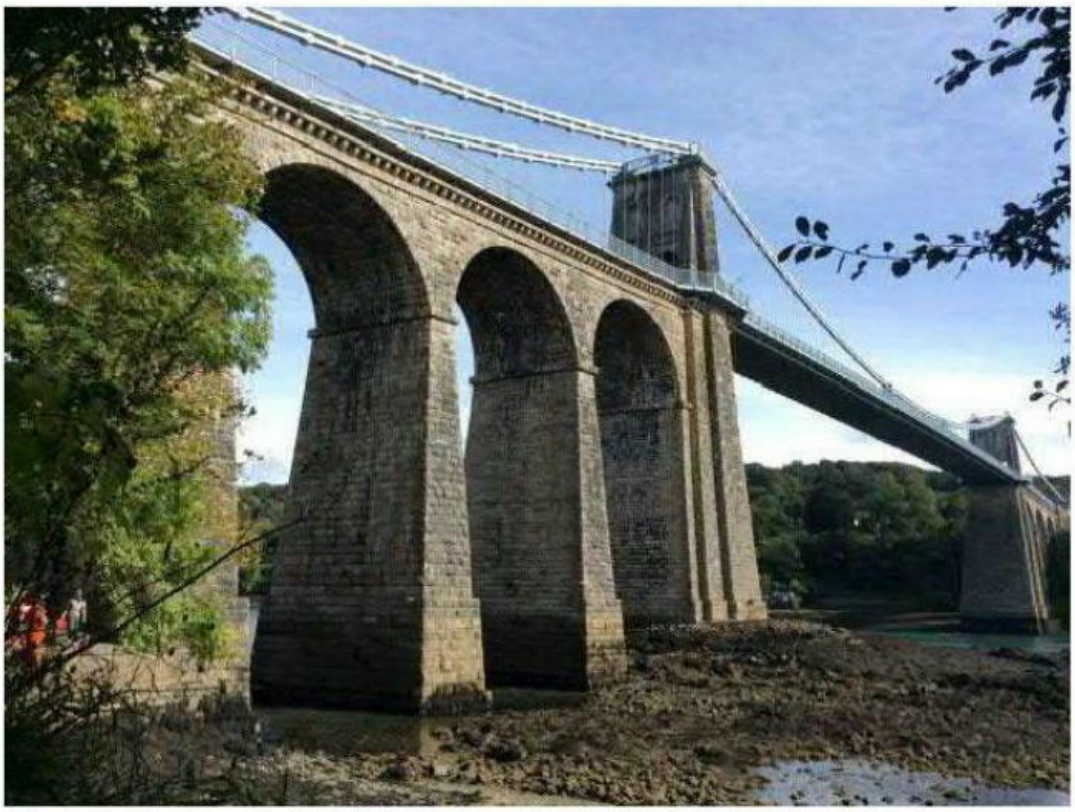


Figure 17: GA Photo - west elevation

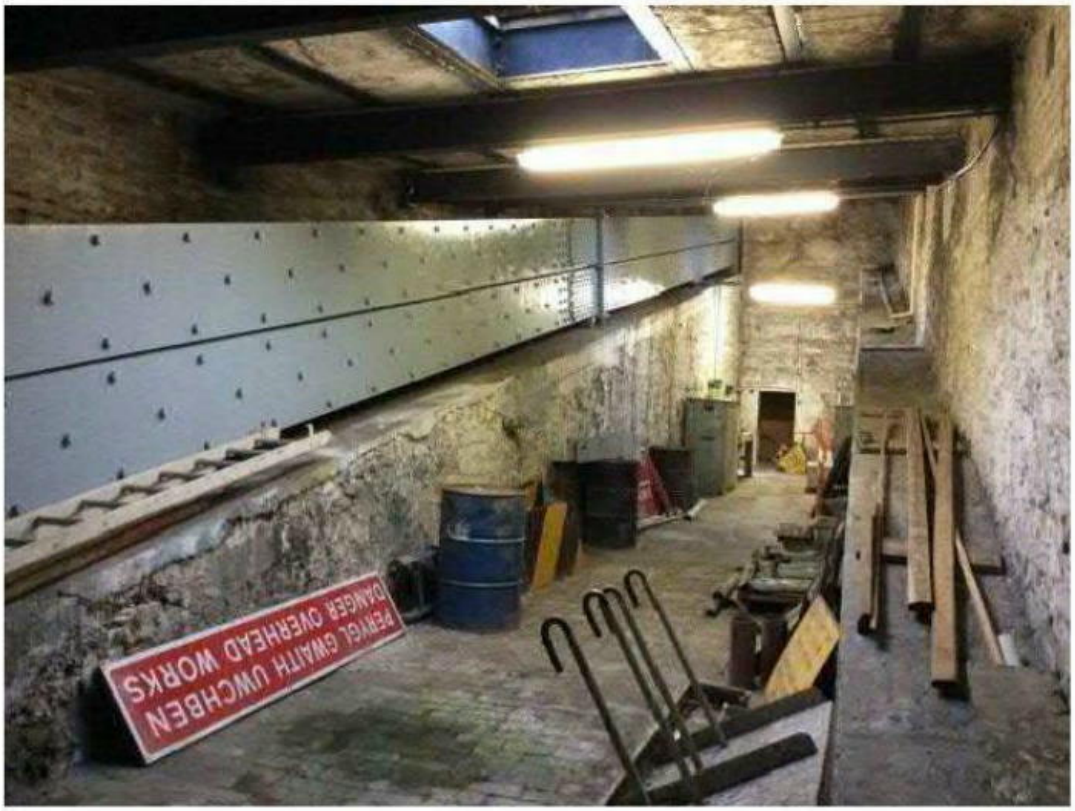


Figure 18: GA Photo - south west back stay

Figure 19: GA Photo - south west back stay

Figure 20: GA Photo - south east back stay

Figure 21: GA Photo - looking south along east truss

Figure 22: GA Photo - looking south along west truss

Figure 23: GA Photo - looking north along east truss

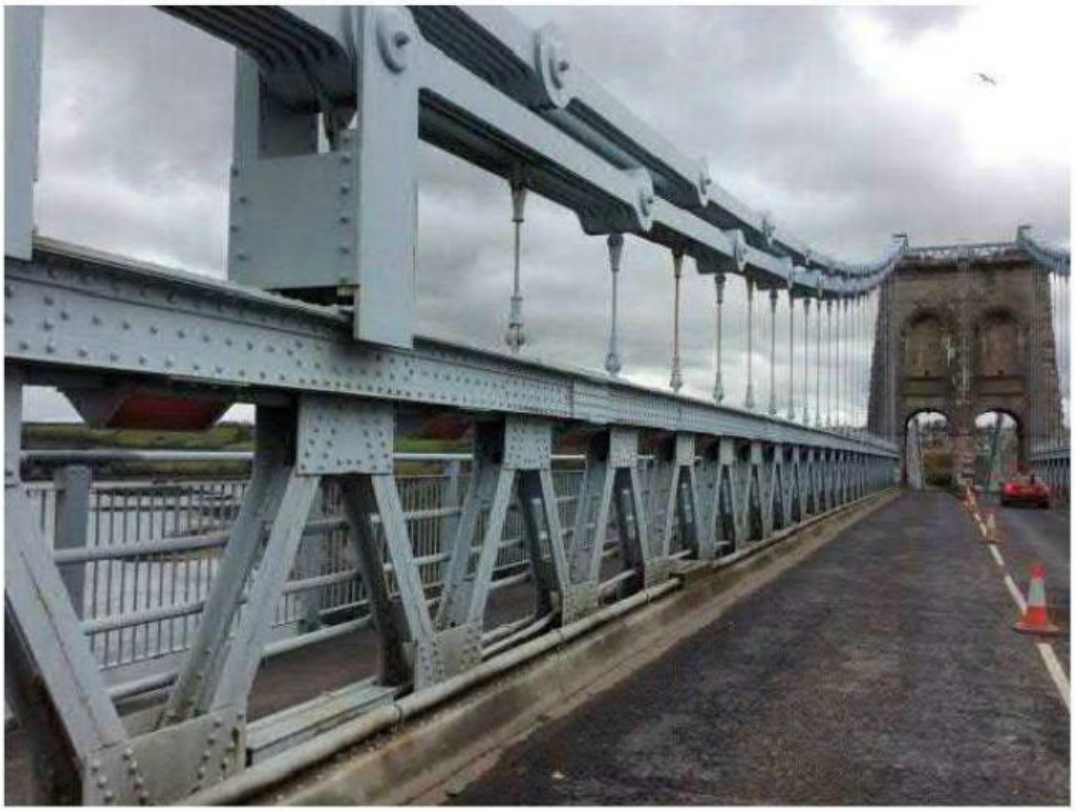


Figure 24: GA Photo - looking north along west truss

Figure 25: GA Photo - north west back stay anchor

Figure 26: Tie bar - monitor the possible vehicle impact damage to the east 4th hanger south of the south tower. Bent lower section and paint loss to cable

Figure 27: Primary deck element - several small areas of deep mortar loss to joints throughout both towers. typical to lower east face of south tower

Figure 28: Tie bars - localised paint loss, corrosion and minor section loss to the 34no (17no each side) square drop link bar lower portion. paint and steel flake to left. east

Figure 29: Tie bars - localised paint loss, corrosion and minor section loss to the 34no (17no each side) square drop link bar lower portion. east

Figure 30: Tie bars - localised paint loss, corrosion and minor section loss to the 34no (17no each side) square drop link bar lower portion. east

Figure 31: Tie bars - localised paint loss, corrosion and minor section loss to the 34no (17no each side) square drop link bar lower portion. west

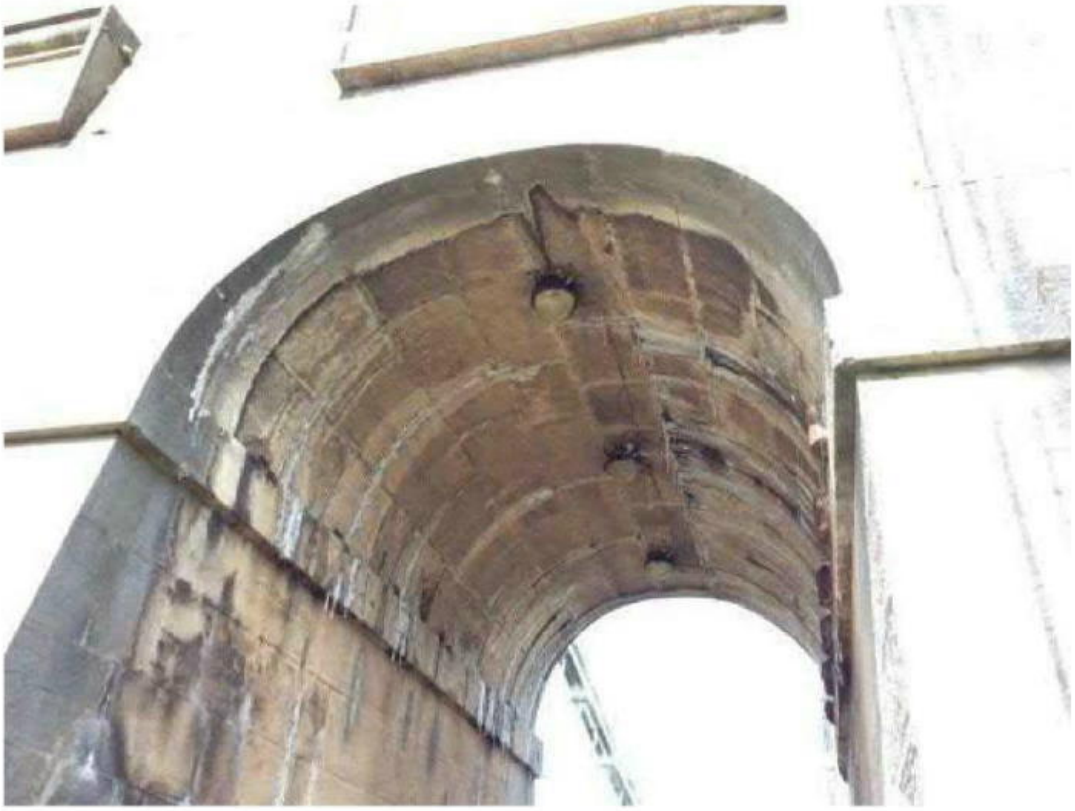


Figure 32: Secondary deck elements - Transverse beams - monitor several small areas of efflorescence, stalactites and damp staining to the tower transverse arches. typical to south east arch intrados

Figure 33: Bracing - Transverse beams - monitor minor paint loss and corrosion to north transverse chain brace mainly to bolt heads

Figure 34: Bracing - Transverse beams - minor paint loss and corrosion to north transverse chain brace mainly to bolt heads

Figure 35: Tie beam/rod - monitor the small areas of paint loss and surface corrosion to lower tie bars particularly to the east at 21m north of north tower

Figure 36: Tie beam/rod – close up of the small areas of paint loss and surface corrosion to lower tie bars particularly to the east at 21m north of north tower

Figure 37: Parapet beam or cantilever - wide areas of spalling and exposed rebar to soffit of cantilevered footway to the west of spans 1-4

Figure 38: Parapet beam or cantilever - wide areas of spalling and exposed rebar to soffit of cantilevered footway to the west of spans 1-4

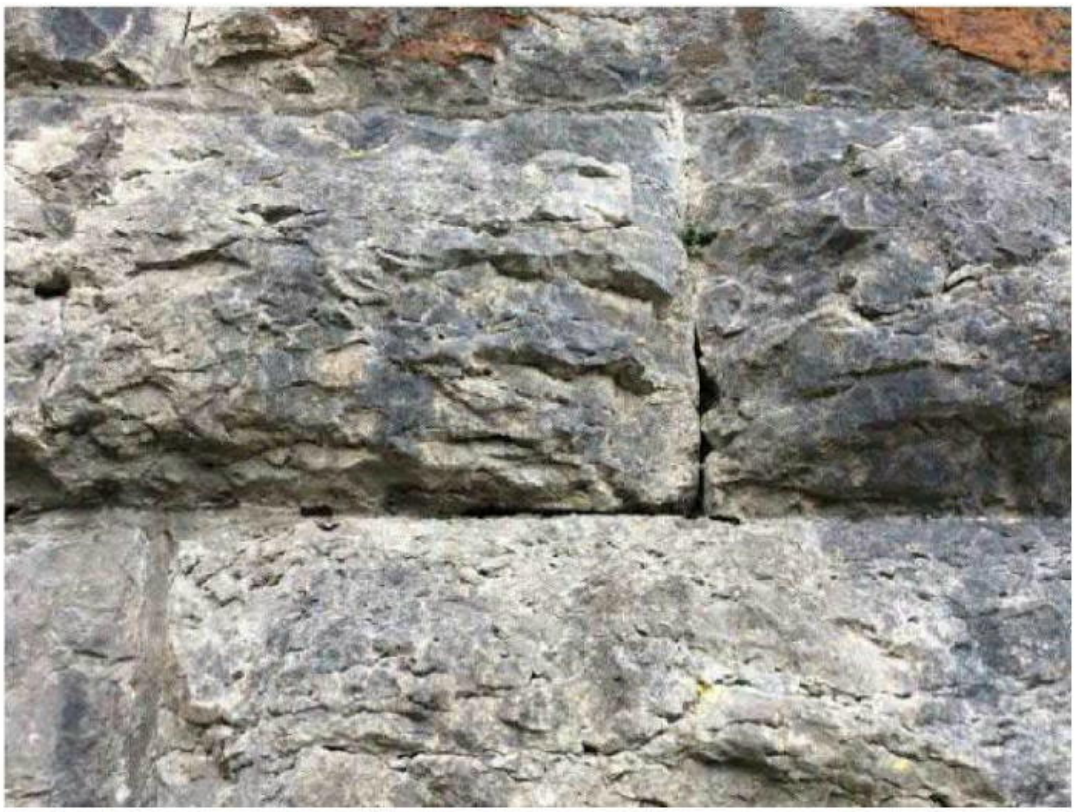


Figure 39: Abutments (incl arch springing) - several small areas of deep mortar loss to the north abutment particularly to west face

Figure 40: Abutments (incl arch springing) - several small areas of deep mortar loss to the north abutment east face

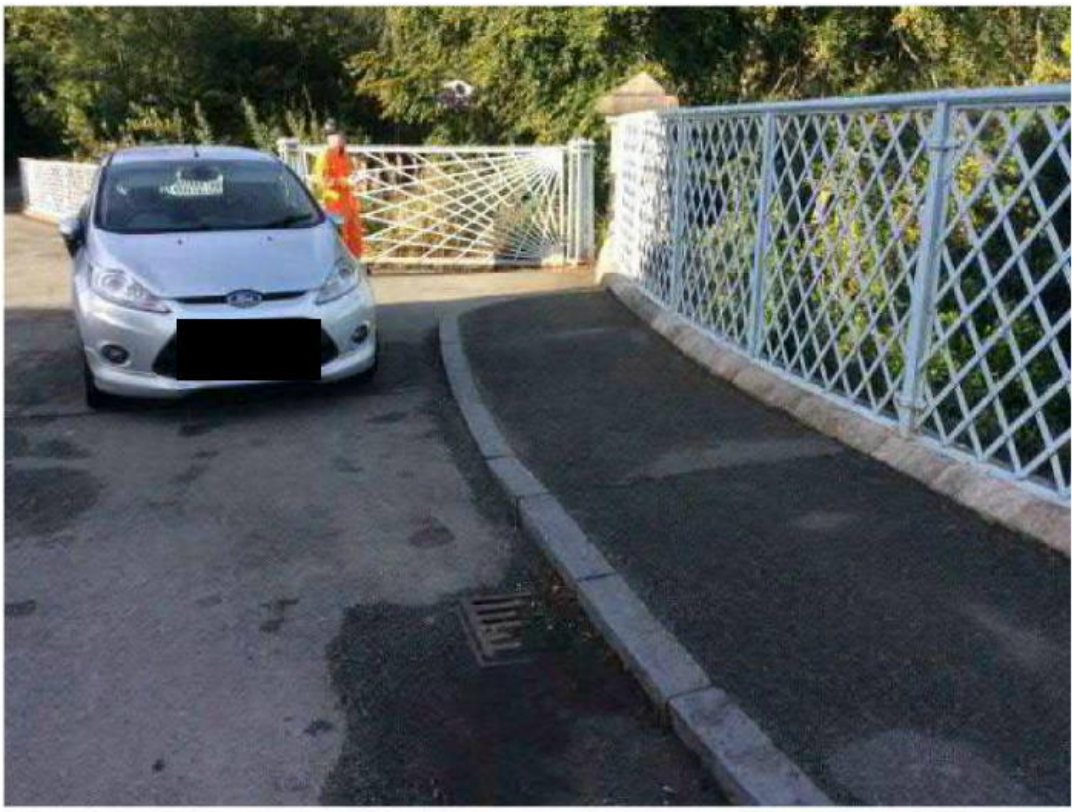


Figure 41: Superstructure drainage - gully blocked to south west access road

Figure 42: Waterproofing - monitor slight dripping through north west arch

Figure 43: Finishes: deck elements - monitor to small areas of paint loss, minor corrosion and rust staining throughout the centre span truss members, particularly the bolts, rivets and plate ends. east side 4m north of south tower

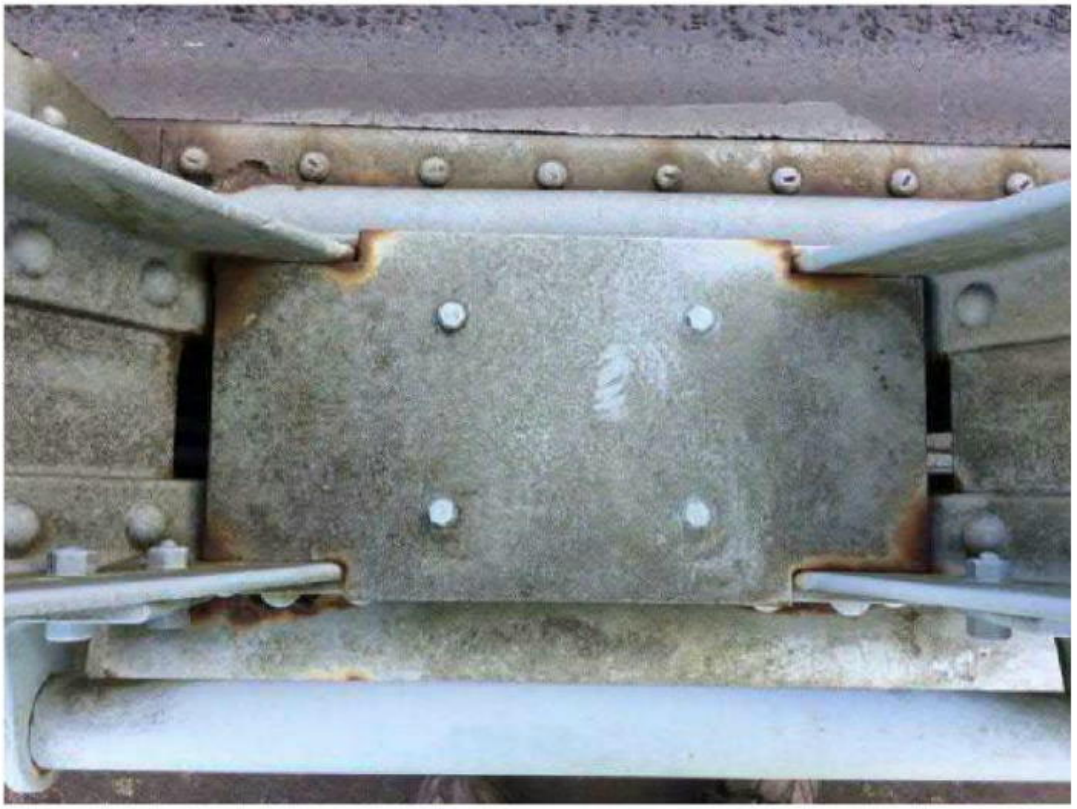


Figure 44: Finishes: deck elements - monitor to small areas of paint loss, minor corrosion and rust staining throughout the centre span truss members, particularly the bolts, rivets and plate ends. east side 4m north of south tower

Figure 45: Finishes: deck elements - monitor the small areas of failed paint and resulting rust staining to the lower hanger lugs. typical to east side 28m north of south tower

Figure 46: Finishes: deck elements - monitor the small areas of failed paint and resulting rust staining to the lower hanger lugs. typical to east side 22m north of north tower

Figure 47: Finishes: deck elements - several areas of full depth paint loss, minor to moderate corrosion and rust staining to the lighting electrical box at mid span

Figure 48: Finishes: deck elements - rust staining to the chain link underside at east mid span

Figure 49: Finishes: deck elements - several areas of full depth paint loss, minor corrosion and rust staining to the truss rivets throughout

Figure 50: Finishes: deck elements - monitor the small areas of failed paint and resulting rust staining to the upper hanger lugs. typical at east side just north of mid span

Figure 51: Finishes: deck elements - monitor the small areas of failed paint and resulting rust staining to the upper hanger lugs. typical at east side 30m north of north tower

Figure 52: Finishes: deck elements - moderate areas of paint loss and minor corrosion to the inside faces of the upper truss members. typical to east side 15m south of north tower

Figure 53: Finishes: deck elements - moderate areas of paint loss and minor corrosion to the inside faces of the upper truss members. typical to west at 35m north of south tower

Figure 54: Finishes: deck elements - monitor the small areas of chipped paint and rust staining throughout the west truss

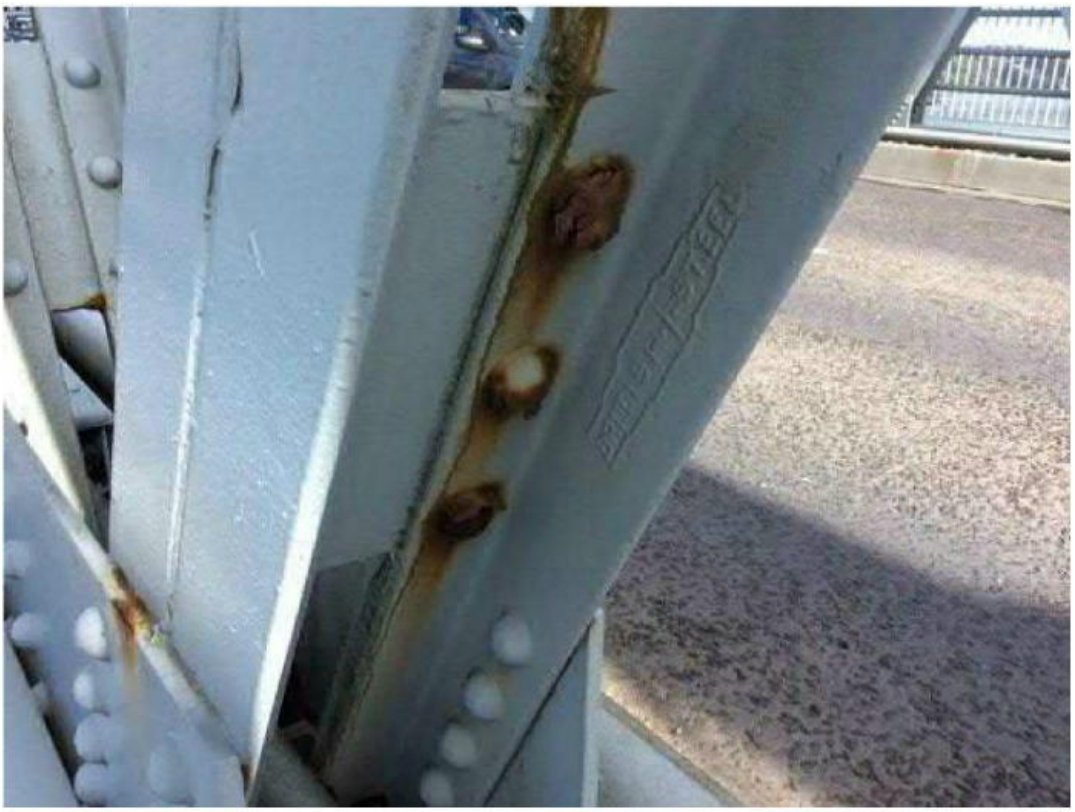


Figure 55: Finishes: deck elements - chipped paint and rust staining to rivets on the west truss. 35m north of south tower

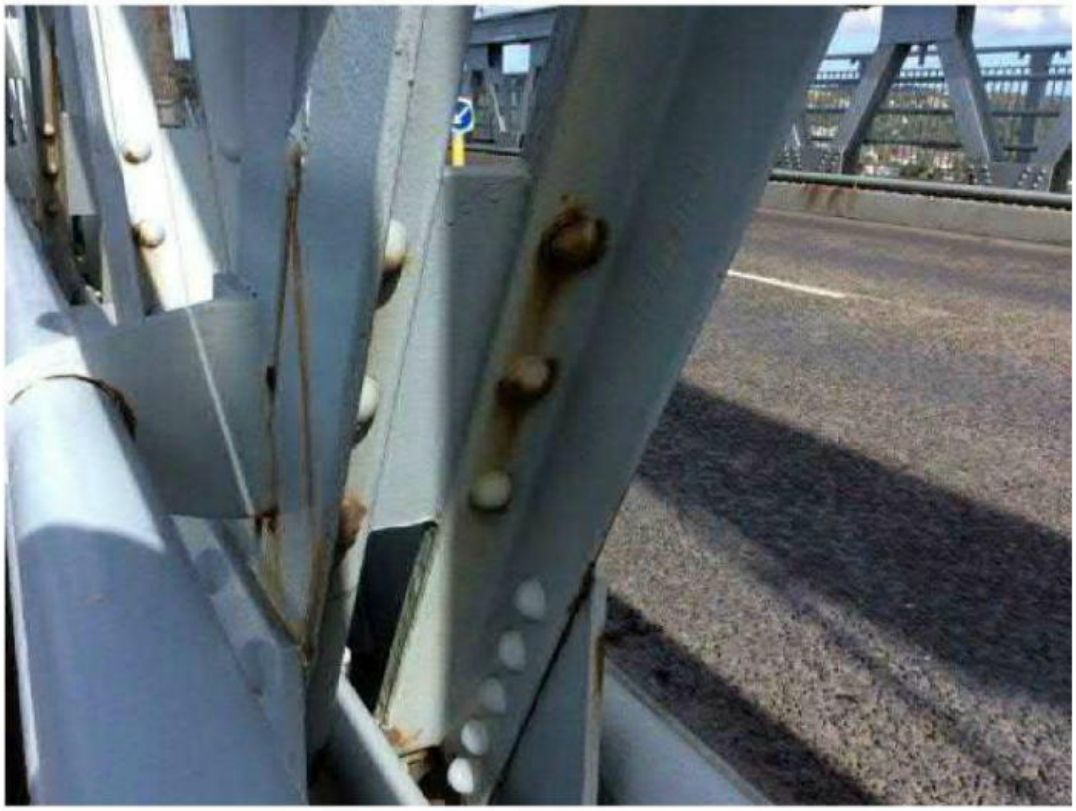


Figure 56: Finishes: deck elements - chipped paint and rust staining to rivets on the west truss. 20m south of north tower

Figure 57: Finishes: deck elements - full depth paint loss and moderate corrosion to electrical box to west side at mid span

Figure 58: Finishes: deck elements - full depth paint loss and moderate corrosion to electrical box to west side at mid span

Figure 59: Finishes: deck elements - several small areas of paint loss to hangers, typical to 2nd north west hanger

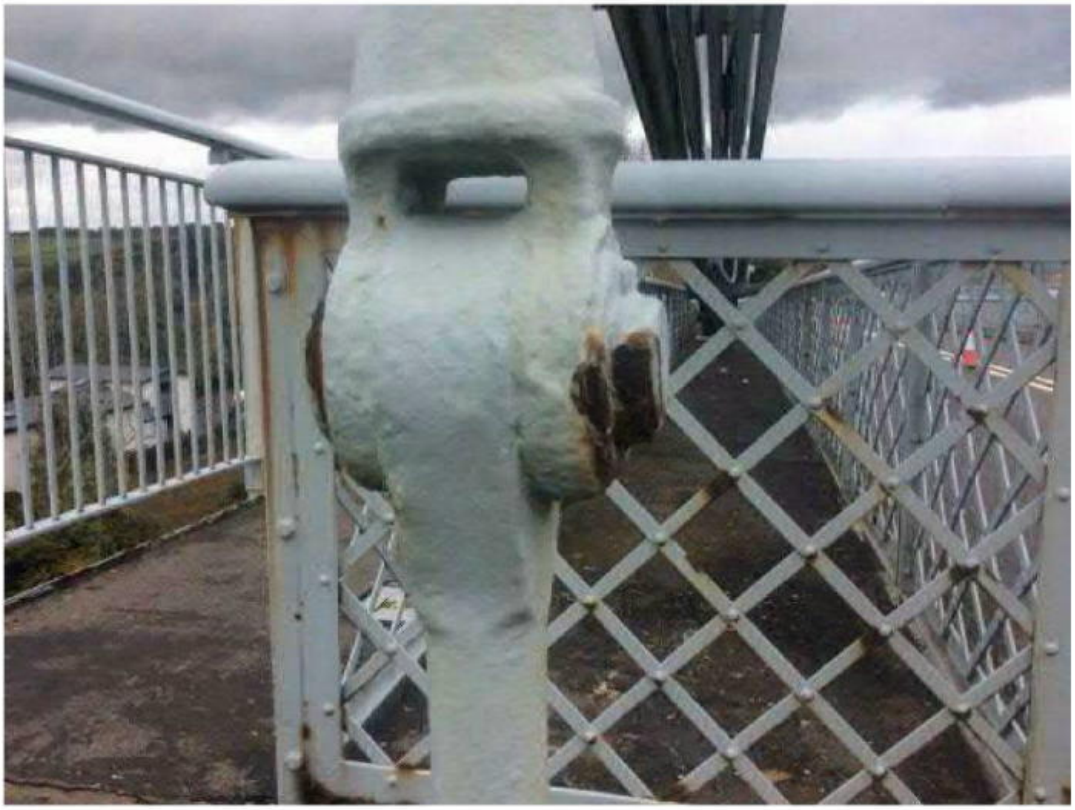


Figure 60: Finishes: deck elements - several small areas of paint loss to hangers, typical to 1st north west hanger

Figure 61: Finishes: deck elements - several small areas of paint loss to north chain brace

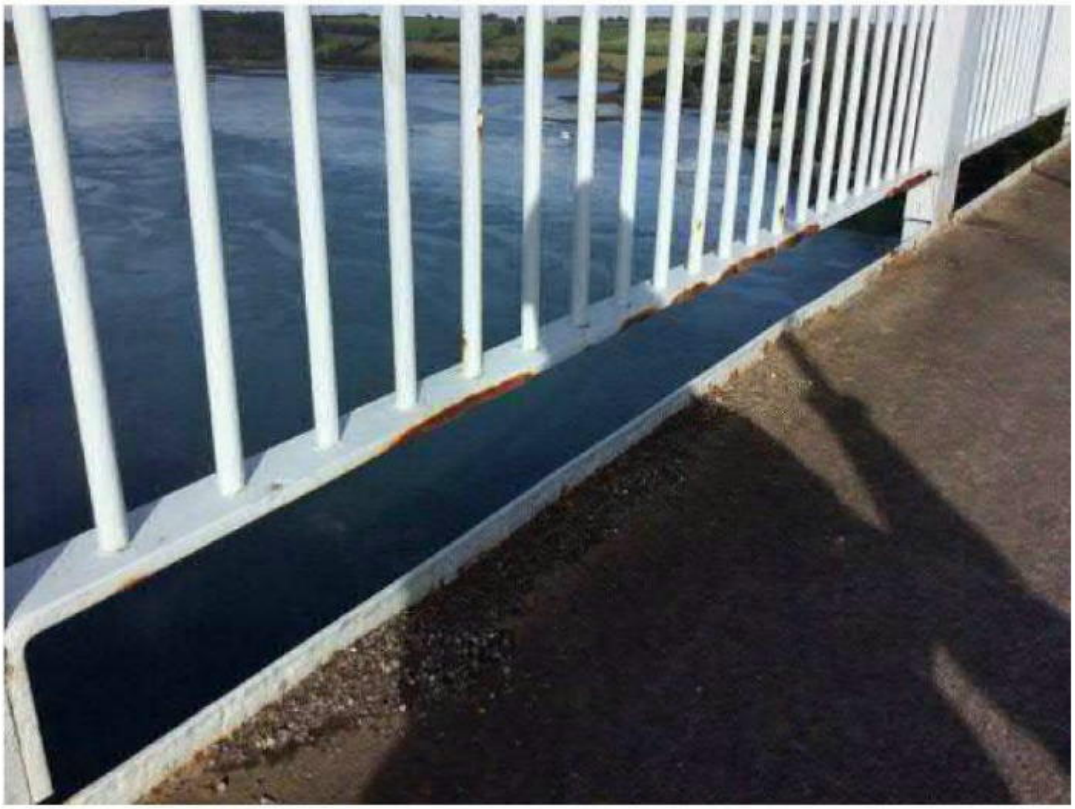


Figure 62: Finishes: parapets/safety fences - numerous small areas of full depth paint loss to parapet paint system, particularly to rails and lower ends of vertical infill bars. typical to west parapet 10m south of south tower

Figure 63: Finishes: parapets/safety fences - paint loss and corrosion with evidence of recent repair weld to east parapet adjacent the south tower

Figure 64: Finishes: parapets/safety fences - paint loss and corrosion to west parapet at north end

Figure 65: Finishes: parapets/safety fences - numerous small areas of full depth paint loss to parapet paint system, particularly to north back stay guardrails where there is also full depth section loss

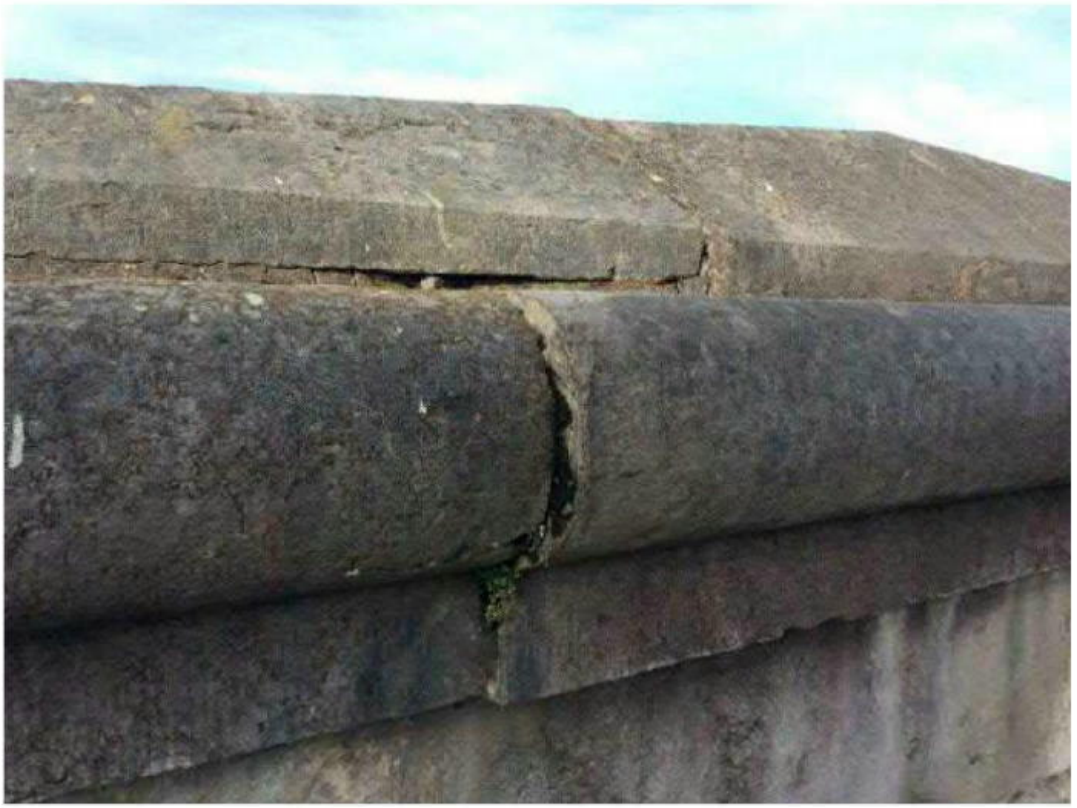


Figure 66: Handrail / parapets / safety fences - 30mm displacement to south west pilaster coping

Figure 67: Handrail / parapets / safety fences - several small and discrete areas of corrosion and minor section loss to east and west parapets. west side, south pilaster

Figure 68: Handrail / parapets / safety fences - example of paint loss and surface corrosion to parapet top rail joints at south end of west parapet

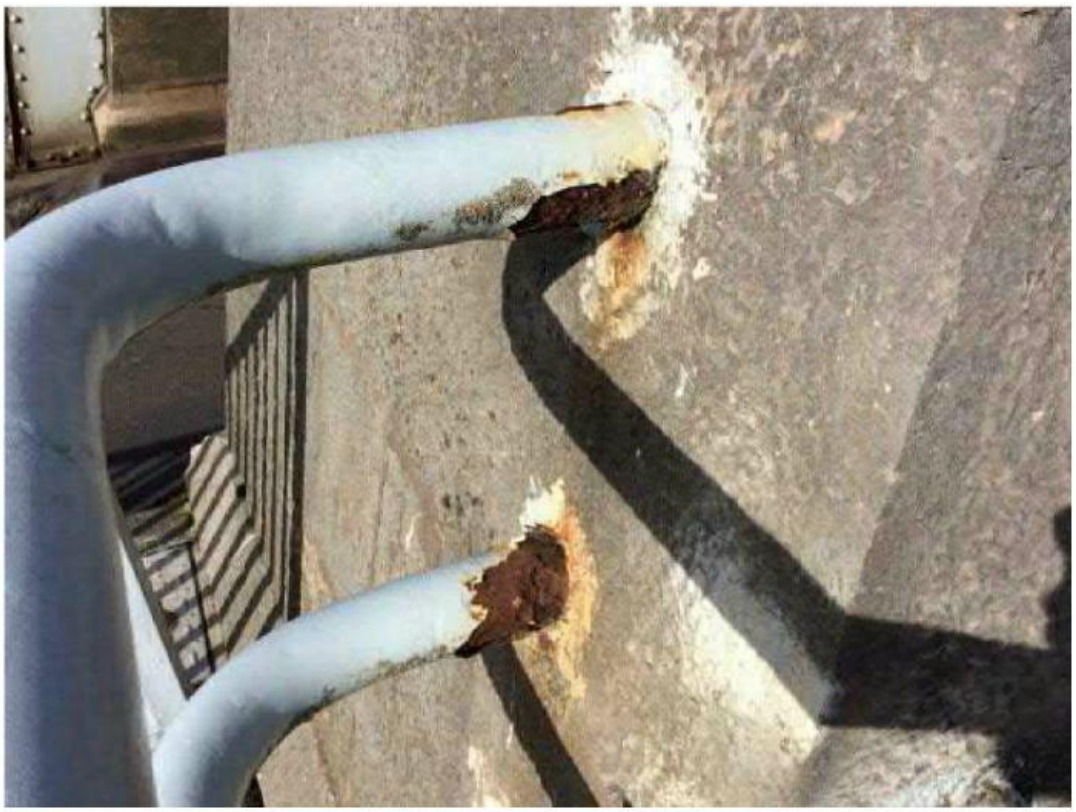


Figure 69: Handrail / parapets / safety fences - paint loss and corrosion to inner parapet to east side of south tower

Figure 70: Handrail / parapets / safety fences - failure of holding down bolt arrangement to south west inner pedestrian guardrail

Figure 71: Handrail / parapets / safety fences - severe impact damage to the central reservation guardrail to the south of the north tower

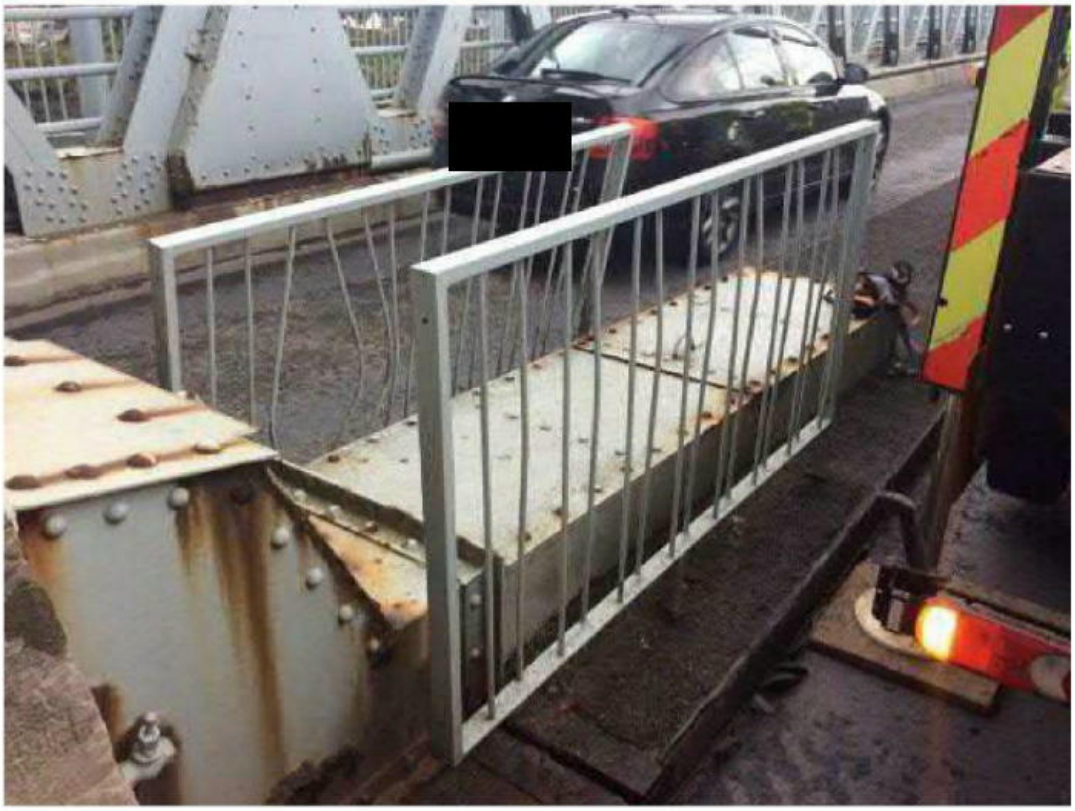


Figure 72: Handrail / parapets / safety fences - severe impact damage to the central reservation guardrail to the south of north tower

Figure 73: Handrail / parapets / safety fences - section loss to west handrail at south tower

Figure 74: Handrail / parapets / safety fences - small areas of full depth section loss to inner west guardrail at 23m north of south tower

Figure 75: Handrail / parapets / safety fences - small areas of full depth section loss to inner west guardrail at 23m north of south tower

Figure 76: Handrail / parapets / safety fences - small areas of full depth section loss to inner west guardrail at 34m south of north tower

Figure 77: Carriageway surfacing - monitor the minor wear and regular narrow transverse cracking along the carriageway. typical to south of south tower

Figure 78: Carriageway surfacing - 3mm wide transverse crack to surfacing above north abutment

Figure 79: Carriageway surfacing - 3mm wide transverse crack to surfacing above north abutment

Figure 80: Footway / verge / footbridge surfacing - sections of full depth paint loss and moderate corrosion to the verge steel kerbs on the approaches to the towers. typical at 6m south of north tower

Figure 81: Footway / verge / footbridge surfacing - several wide cracks and 100mm diameter x 40mm deep pothole in east footway 35m north of the north abutment

Figure 82: Footway / verge / footbridge surfacing - several wide cracks and 100mm diameter x 40mm deep pothole in east footway 35m north of the north abutment

Figure 83: Footway / verge / footbridge surfacing - several wide cracks and 100mm diameter x 40mm deep pothole in east footway 35m north of the north abutment

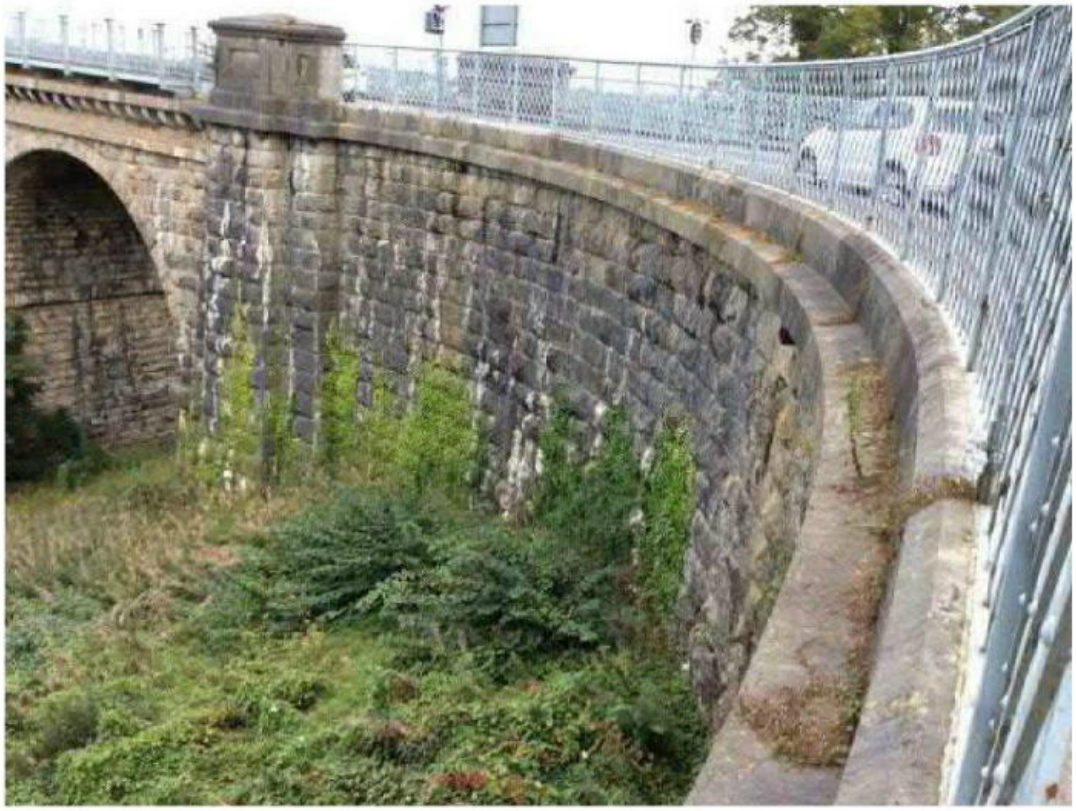


Figure 84: Wing walls - ivy to lower parts of south west wing wall

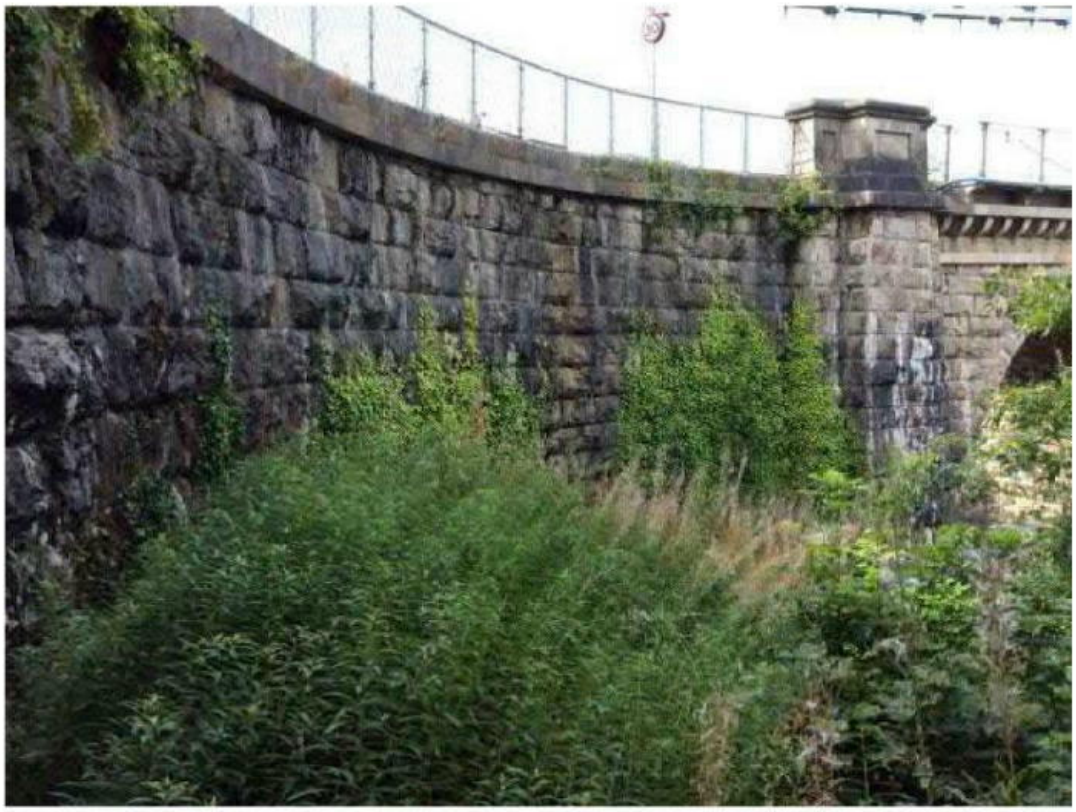


Figure 85: Wing walls - ivy to lower parts of north end of south east wing wall

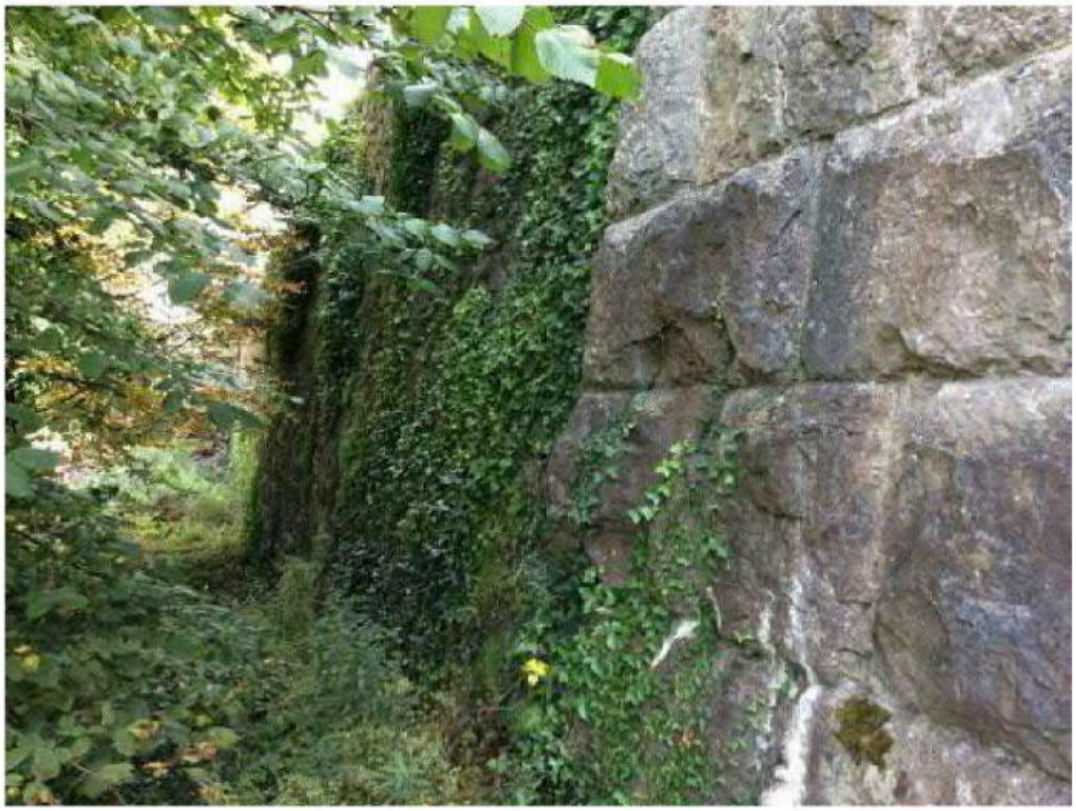
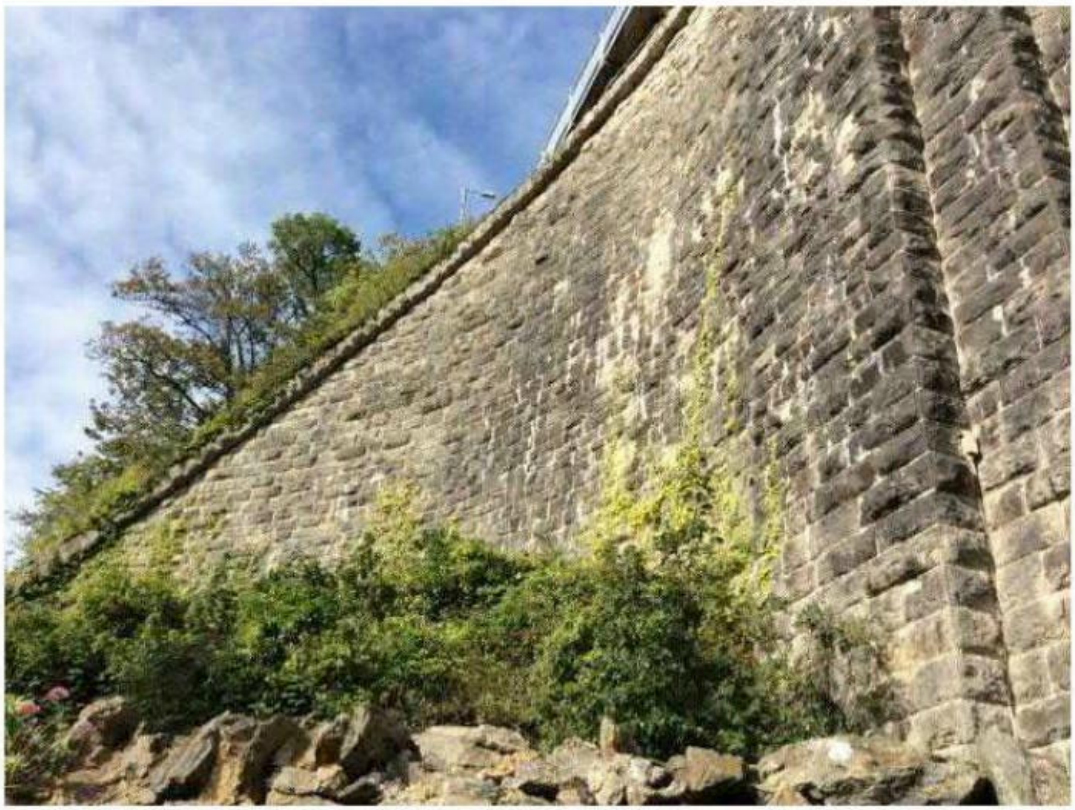


Figure 86: Wing walls - ivy to lower parts of south end of south east wing wall



87: Wing wa ing wall

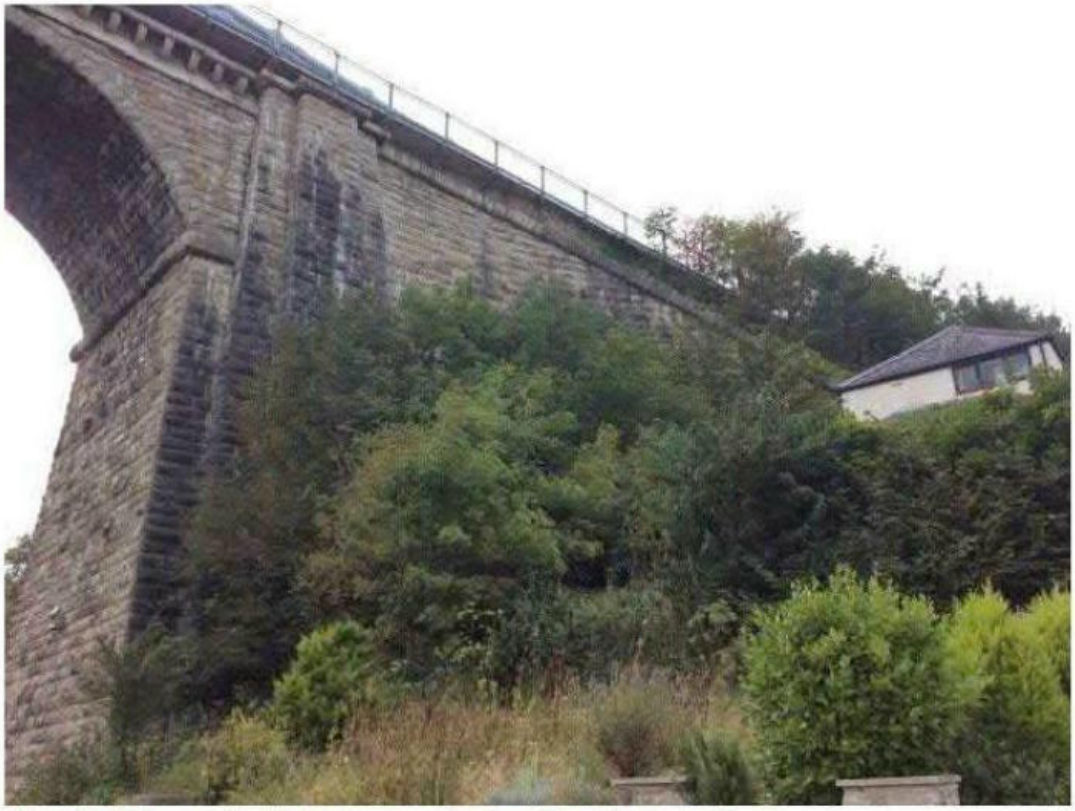


Figure 88: Wing walls - ivy to lower parts of north east wing wall

Figure 89: Lighting - broken lighting unit to east transverse arch of north tower

Figure 90: Services - corrosion and section loss to the edges of a west manhole cover 6m south of the south tower

Figure 91: Services - corrosion and section loss to the edges of services box to the south of the north tower

Figure 92: North anchor block – west face of the west back-stay anchor arrangement generally in good condition with minor algae

Figure 93: North anchor block – looking south along the inside, east face of the west back-stay anchor arrangement bolt group. Several small areas of minor to moderate paint loss and corrosion to bolt heads. Also, vegetation growing from silting/ponding to the base.

Figure 94: North anchor block – looking north along the inside, east face of the west back-stay anchor arrangement bolt group where it meets the buried concrete anchor block. Several small areas of minor to moderate paint loss and corrosion to bolt heads

Figure 95: North anchor block – north face of the east back-stay anchor arrangement generally in good condition but with minor cracking to the short retaining wall supporting the east footpath

Figure 96: North anchor block – very minor cracking and algae to the south face of the east anchor block

Figure 97: North anchor block – minor rust staining and debris surrounding last chain links near the east anchor block

Figure 98: North anchor block – corrosion and rust staining beneath the south end of the east anchor block strands

Figure 99: North anchor block – algae to and debris beneath the west face of the east anchor block strands

Figure 100: North anchor block – algae to the concrete plinth near the east anchor block

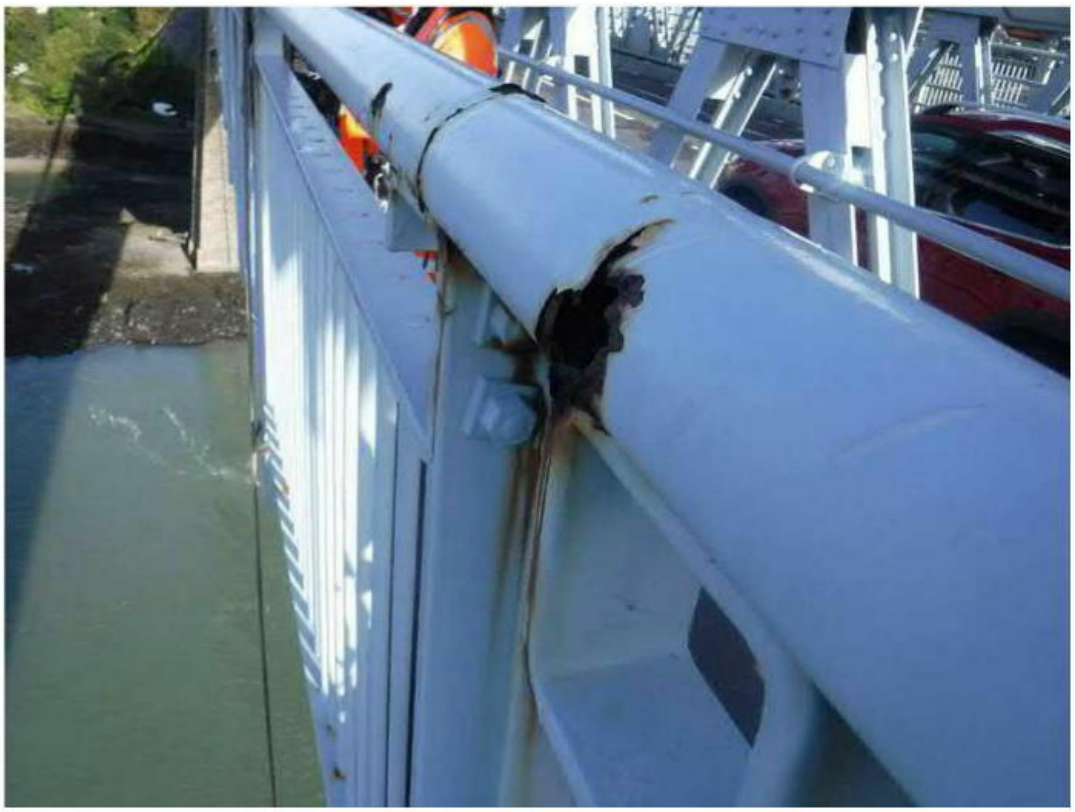


Figure 101: Parapet – corrosion and full depth section loss to west handrail at 64m north of south tower

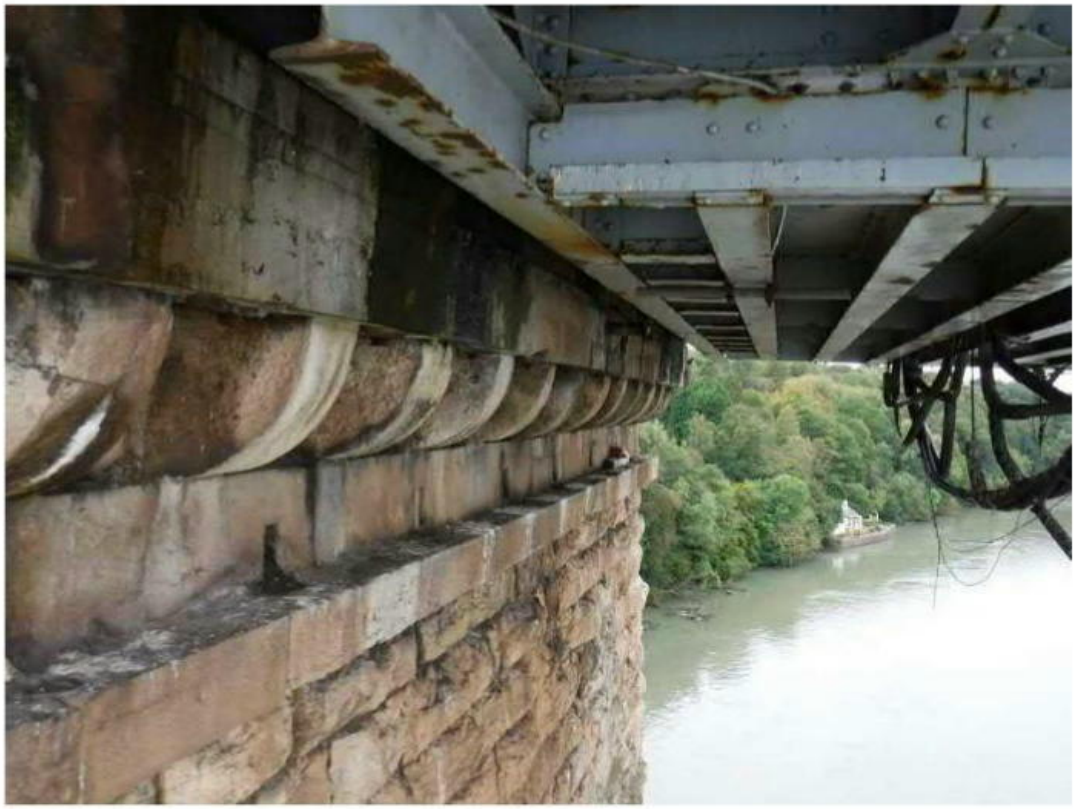


Figure 102: secondary deck – typical paint loss and corrosion to south end of main span (bearings obscured behind southernmost transverse beam)

Figure 103: secondary deck – typical paint loss and corrosion to south east end of main span (areas of previous painting visible to beam ends)

Figure 104: secondary deck – typical paint loss and corrosion to south west end of main span transverse beams and longitudinal stiffeners

Figure 105: secondary deck – typical paint loss and corrosion to soffit of west footpath cantilever to south tower. Note flaking paint where the concrete soffit has been incorrectly painted

Figure 106: secondary deck – typical paint loss and corrosion to south west end of main span, 1m from south end

Figure 107: Bearings – typical paint loss and corrosion to south pin/comb bearing, south end

Figure 108: cantilever – typical paint loss and corrosion to south end of main span west walkway soffit, 8m from south

Figure 109: secondary deck – typical paint loss and corrosion to south end of main span west walkway soffit, 17.5m from south

Figure 110: secondary deck – typical paint loss and corrosion to main span lower west elevation, 27m from south

Figure 111: secondary deck – general photo looking south at typical paint loss and corrosion throughout main span soffit, 37m from south

Figure 112: secondary deck – typical paint loss and corrosion to lower west face of truss, 37m from south

Figure 113: secondary deck –looking east at typical paint loss and corrosion to deck soffit, 46.5m from south

Figure 114: secondary deck –deep pitting corrosion and full depth section loss to lower edge beam flange, 52m from south

Figure 115: parapet – deep pitting corrosion to upper west parapet rail, 52m from south

Figure 116: secondary deck – looking east at typical paint loss and corrosion to deck soffit, 66m from south

Figure 117: secondary deck – looking east at typical paint loss and corrosion to lower west face of main truss and walkway cantilever, 80.5m from south

Figure 118: secondary deck – looking east at typical paint loss and corrosion to transverse beam edges, longitudinal stiffeners and bolts, 85.5m from south (around mid-span)

Figure 119: secondary deck – looking east at typical paint loss and corrosion to transverse beam edges, longitudinal stiffeners and bolts, 90.5m from south (around mid-span)

Figure 120: secondary deck – close-up of paint loss and corrosion to west walkway cantilever, gusset plate and rivet heads, 117.5m from south

Figure 121: secondary deck – close-up of paint loss and corrosion to west walkway cantilever flange end and rivet heads, 121.5m from south

Figure 122: secondary deck – close-up of paint loss and total section loss from corrosion to angle sections beyond lower west face of truss, 144m from south

Figure 123: secondary deck – close-up of paint loss and corrosion to walkway soffit, 149m from south

Figure 124: secondary deck – paint loss and corrosion to west face of lower truss, upper flanges of transverse beams and walkway soffit, 149m from south

Figure 125: secondary deck – paint loss and corrosion to west face of lower truss, upper flanges of walkway cantilever and rust-staining to bearing shelf, north end

Figure 126: secondary deck – paint loss and corrosion to west face of lower truss, transverse beams and deck soffit plates, north end

Figure 127: secondary deck – paint loss and corrosion to deck soffit plates where service ducts penetrate, north end

Figure 128: secondary deck – flaking paint, paint loss and corrosion to steelwork repair panel to the lower east face of the parapet, 8m from south end

Figure 129: secondary deck – minor corrosion to transverse beam east end, 12.5m from south end

Figure 130: secondary deck – typical condition of outer lower truss and cantilevers looking south from east side, 12.5m from south end

Figure 131: secondary deck – paint loss and corrosion to east end of transverse beam and riveted plates, 17.5m from south end

Figure 132: parapet – typical paint loss and corrosion to the base of the east parapet infill bars, 27m from south end

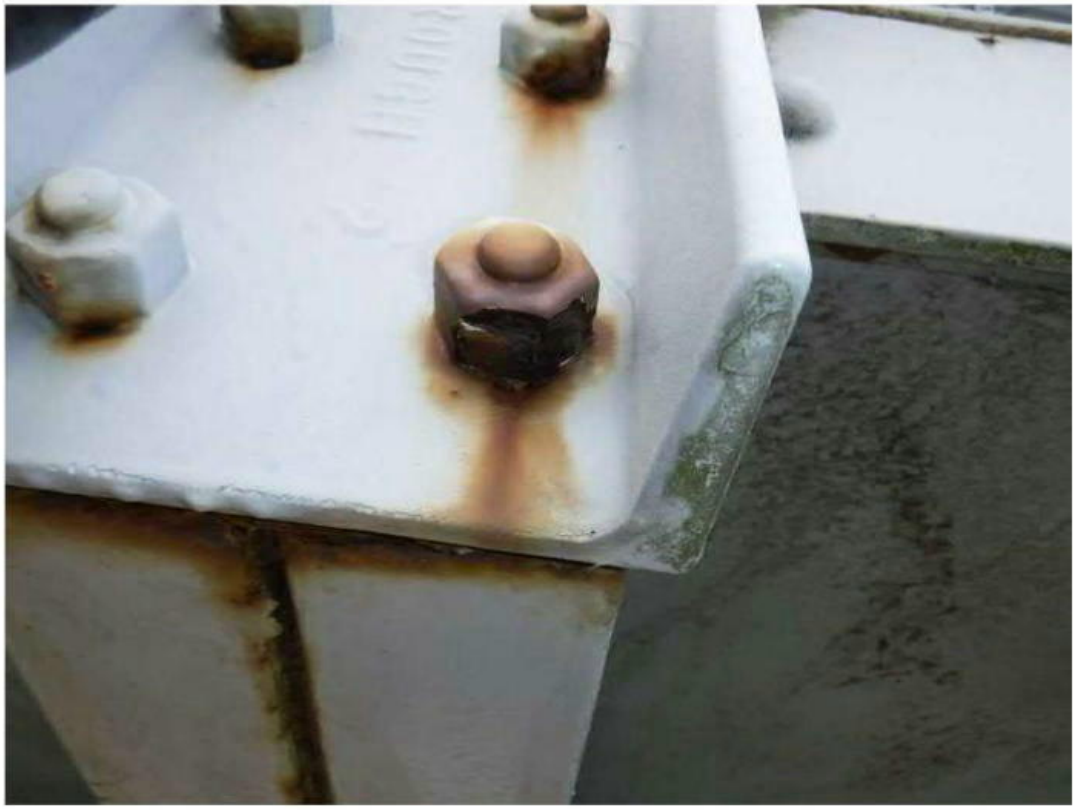


Figure 133: parapet – typical paint loss, corrosion and rust staining to the base of the east parapet post, 41m from south end

Figure 134: parapet – looking north at typical paint loss, corrosion and rust staining to the outer face ends of the east parapet posts, 58.5m from south end

Figure 135: secondary deck – typical paint loss and corrosion throughout transverse beams and longitudinal stiffeners, 71m from south

Figure 136: secondary deck – typical paint loss and corrosion to throughout transverse beams and longitudinal stiffeners, 85.5m from south (around mid-span)

Figure 137: secondary deck – paint loss and corrosion to bolt heads to inside face of east edge beam, 112.5m from south

Figure 138: secondary deck – expanding foam and compressible fibre board to lower outer east face of east edge beam, 126m from south

Figure 139: secondary deck – paint loss and corrosion to outer east end of cantilever, 139.5m from south

Figure 140: secondary deck – close-up of paint loss and corrosion to outer east end of cantilever, 139.5m from south

Figure 141: secondary deck –paint loss and corrosion to several areas throughout lower truss and transverse beams, 139.5m from south

Figure 142: secondary deck –suspended service ducts to north end with paint loss and corrosion to several areas throughout transverse beams, 149m from south

Figure 143: secondary deck – general view looking south, 153.5m from south

Figure 144: secondary deck – paint loss and corrosion to lower outer truss face, cantilever, gusset and bolt heads, 153.5m from south

Figure 145: secondary deck – minor water staining to upper south face of pier 5

Figure 146: secondary deck – extensive surface corrosion to north main span bearings on pier 5

Figure 147: Waterproofing – minor damp staining and efflorescence to south abutment

Figure 148: Waterproofing – minor damp staining and efflorescence throughout south end of arch span 7.

Figure 149: Piers – very minor damp staining and efflorescence throughout south face of pier 7 (span 7).

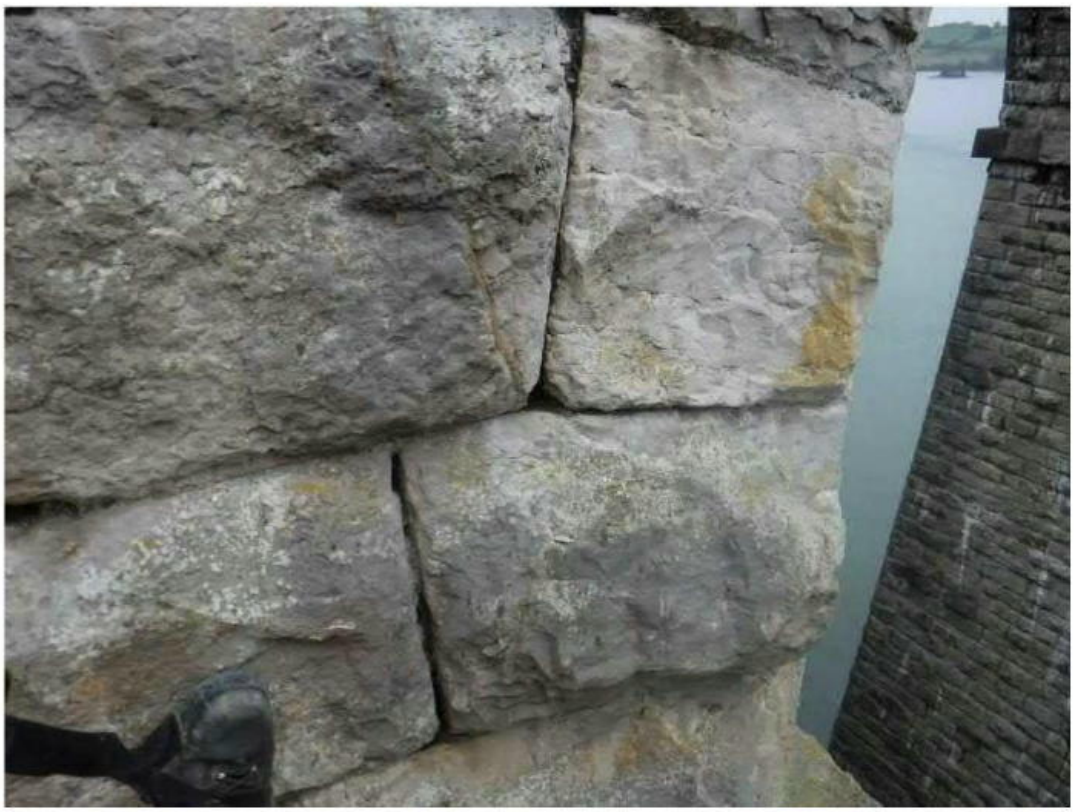


Figure 150: primary deck element – several small areas of deep mortar loss to joints throughout the arches. Typical area around the east side, above south springer of arch 7 (span 7).

Figure 151: primary deck element – several small areas of deep mortar loss to joints throughout the arches. Typical area around the east side, at south springer of arch 7 (span 7) where vegetation is starting to take hold.

Figure 152: Edge beam/cantilever – several small areas of spalling and exposed rebar to the west walkway soffit above arch 7 (span 7).

Figure 153: Spandrels – several areas of up to 350mm x 350mm of delamination and spalling with exposed rebar to the west spandrel panels above arch 7 (span 7).

Figure 154: Parapet cantilever – approximately 800mm diameter x 40mm deep spalling with exposed rebar to the west walkway soffit above the cantilever off span 7.

Figure 155: Parapet cantilever – several areas of typically 100mm x 50mm x 20mm deep delamination and spalling with exposed rebar to the east walkway soffit of span 8 (south span). Previously repaired areas also visible.

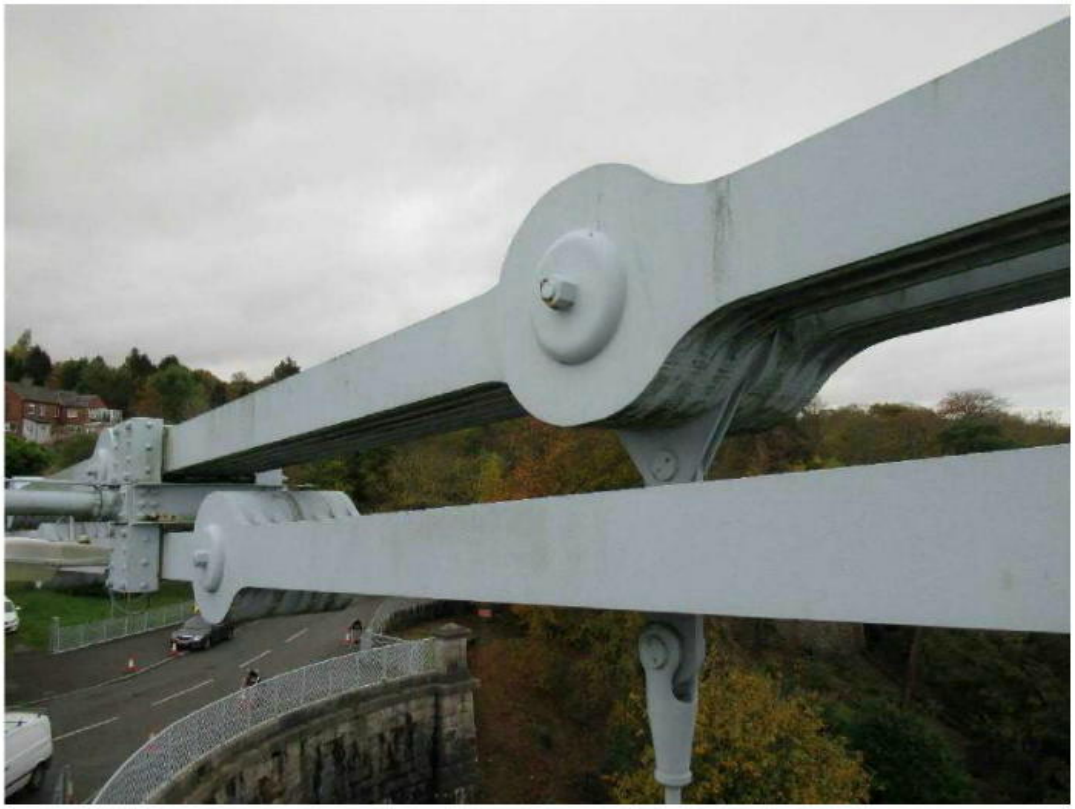


Figure 156: Primary deck element – looking south along south west back-stay chains and transverse brace connection. Generally, in good condition.

Figure 157: Primary deck element – looking south along south west back-stay chains and transverse brace connection. Generally, in good condition.

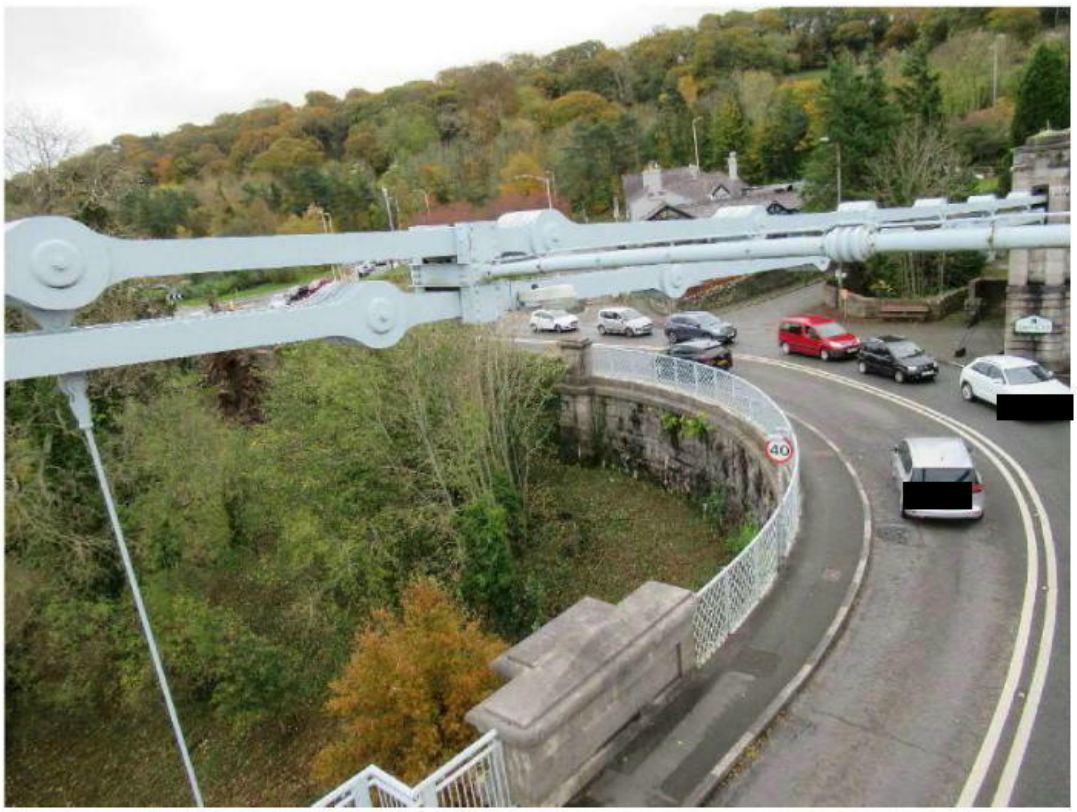


Figure 158: Primary deck element – looking south along south east back-stay chains and transverse brace connection. Generally, in good condition.

Figure 159: Primary deck element – upper hanger connection to south hanger to lower south west back-stay chains. Structurally, in good condition with minor water-staining.

Figure 160: Tie bar – paint loss and minor corrosion to upper hanger connection to 19th hanger on the south west back-stay chains. Structurally, in good condition.

Figure 161: Tie bar – paint loss and minor corrosion with rust-staining to upper hanger connection to a southern hanger on the central west catenary chains.

Figure 162: Tie bar – paint loss and minor corrosion with rust-staining to upper hanger connection to a southern hanger on the central west catenary chains.

Figure 163: Tie bar – paint loss and minor corrosion with rust-staining to upper hanger connection to a southern hanger on the central west catenary chains.

Figure 164: Tie bar – paint loss and minor corrosion with rust-staining to upper hanger connection to a southern hanger on the central west catenary chains.

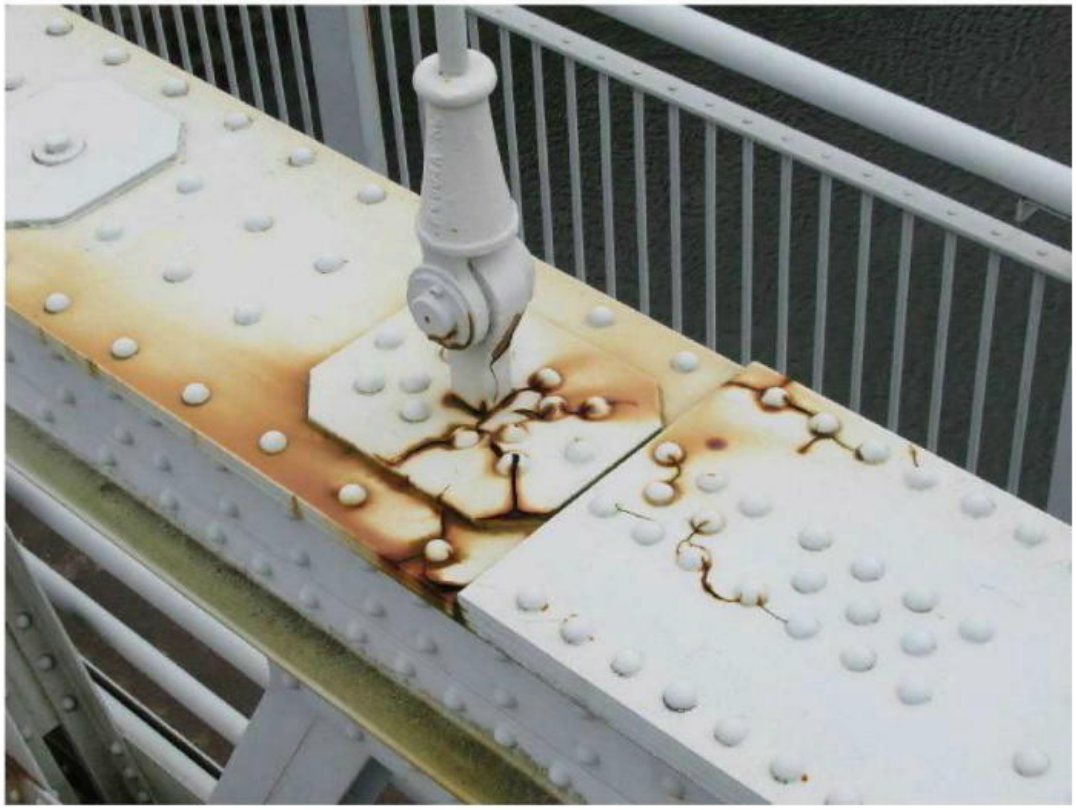


Figure 165: Finishes – paint loss and minor corrosion with rust-staining to lower hanger connection to a hanger on the central west catenary chains.

Figure 166: Primary deck element – paint loss and minor corrosion with rust-staining to mid-span drop link on the central west catenary chains.

Figure 167: Primary deck element – minor paint loss and minor corrosion to lower chain near mid-span on the central west catenary chains.

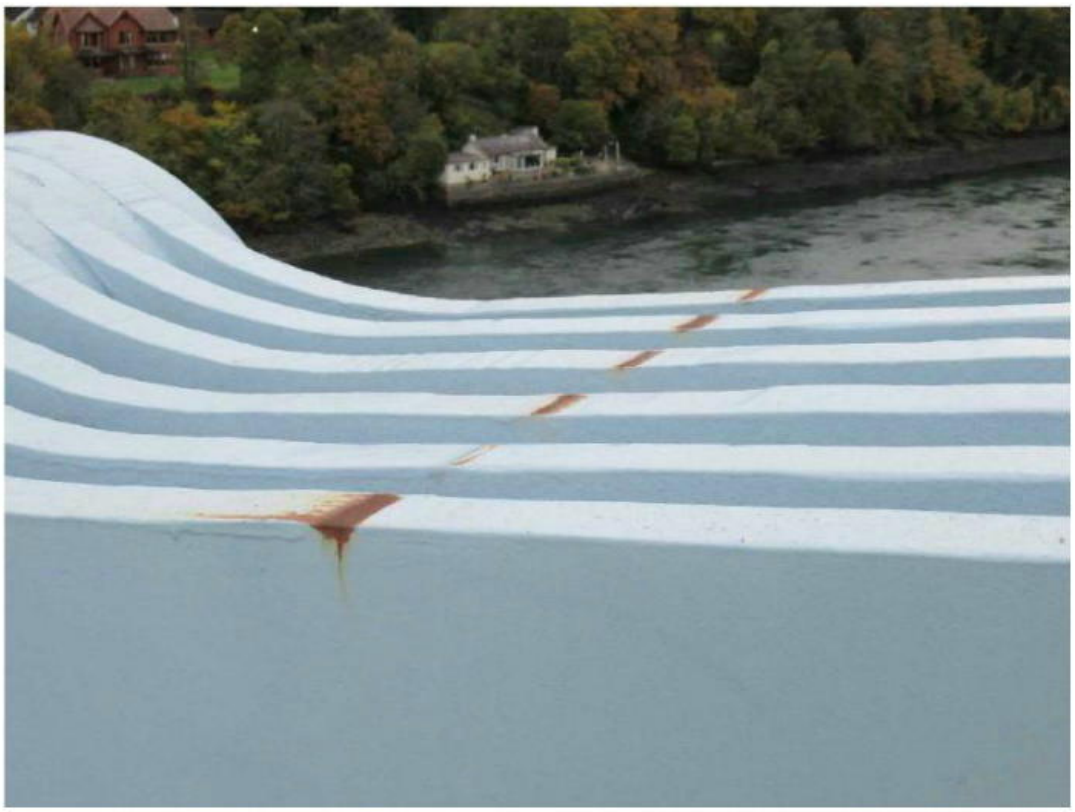


Figure 168: Primary deck element – band of minor paint loss and minor corrosion to upper chain near mid-span on the central west catenary chains.

Figure 169: Primary deck element – small areas of surface corrosion to west chain saddle on the south tower.

Figure 170: Primary deck element – close-up of small areas of surface corrosion to west chain saddle on the south tower, south face.

Figure 171: Bracing – small areas of surface corrosion to chain bracing on the south tower saddles, north face.

Figure 172: Primary deck element – close-up of small areas of surface corrosion to west chain saddle on the south tower, north face.

Figure 173: Primary deck element – small areas of surface corrosion to east chain saddle and to the roller bearing bath on the south tower.

Figure 174: Primary deck element – paint loss and minor corrosion to upper hanger connection and split pin to a hanger on the west side north back-stay chains.

Figure 175: Primary deck element – close-up of the paint loss and minor corrosion to upper hanger connection and split pin to a hanger on the west side north back-stay chains.

Figure 176: Primary deck element – paint loss and minor corrosion to upper hanger connection and split pin to a hanger on the west side north back-stay chains.

Figure 177: Deck bracing – looking north along north back-stay chains and transverse brace connection. Generally, in good condition with some minor surface corrosion.

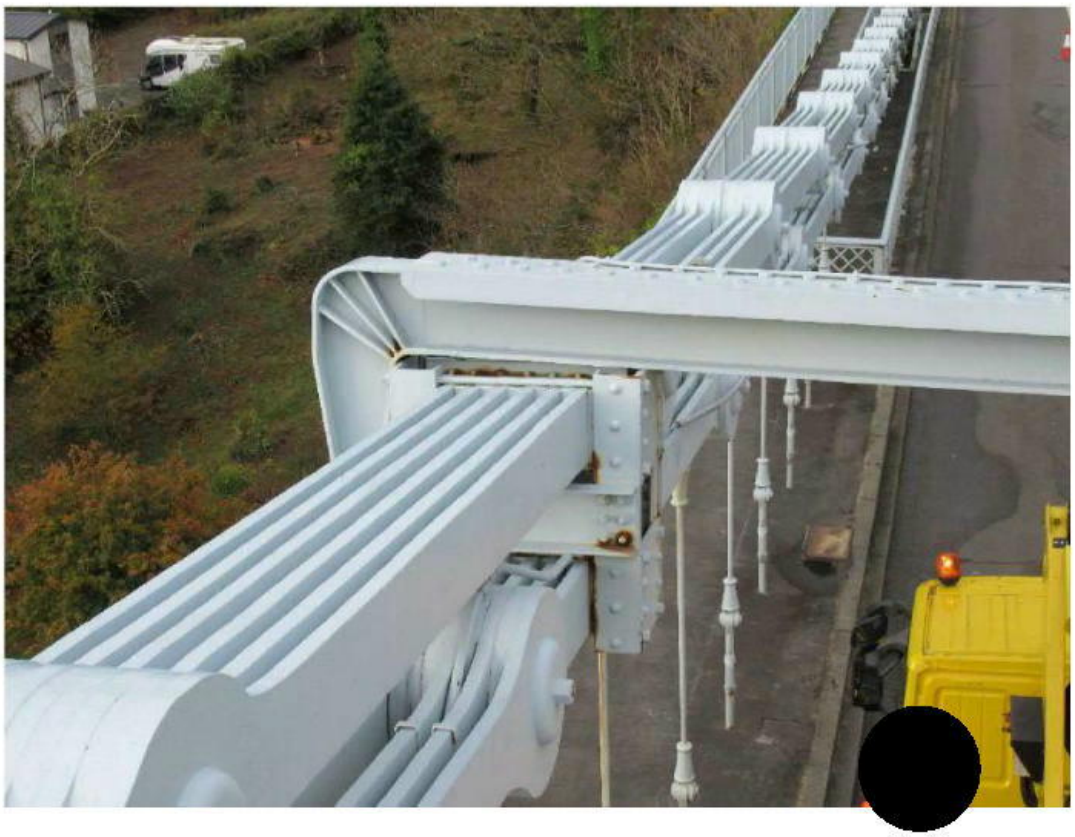


Figure 178: Deck bracing – west side of north back-stay transverse brace connection. Generally, in good condition with some minor surface corrosion.

Figure 179: Deck bracing – east side of north back-stay transverse brace connection. Generally, in good condition with some minor surface corrosion.

Figure 180: Tie bars – paint loss and minor corrosion to upper hanger connection and split pin to a hanger on the east side north back-stay chains.

Figure 181: Tie bars – flaking paint loss and minor corrosion with rust-staining to upper tie cable on the east side north back-stay chains.

Figure 182: Primary deck element – small areas of surface corrosion to chain saddles, roller bearing baths and bracing on the north tower. Several areas of water-staining and efflorescence to the north face of the north pier.

Figure 183: Primary deck element – small areas of surface corrosion to north side of the east chain saddle and to the roller bearing bath on the north tower.

Figure 184: Primary deck element – small areas of surface corrosion to south side of the east chain saddle and to the roller bearing bath on the north tower.

Figure 185: Bracing – small areas of surface corrosion to chain saddles, roller bearing baths and bracing on the north tower. Several areas of corrosion to access ladder which is no longer in use.

Figure 186: Primary deck element – paint loss, minor corrosion and rust-staining to upper hanger connection and split pin to a hanger on the central east catenary chains.

Figure 187: Primary deck element – paint loss, minor corrosion and rust-staining to moving parts of the upper pin to a hanger on the central east catenary chains.

Figure 188: Primary deck element – paint loss, minor corrosion and some rust-staining to upper hanger connection and split pin to a hanger on the central east catenary chains.

Figure 189: Primary deck element – general view looking north from the south tower.

Figure 190: Primary deck element – general view looking south from the north tower.

Figure 191: Tie bar – paint loss, minor corrosion and rust-staining to tie strands on the central east catenary chains, just north of mid-span drop links.

Figure 192: Tie bar – paint loss, corrosion and rust-staining to mid-span drop links.

Figure 193: Tie bar – paint loss, minor corrosion and rust-staining to tie strands on the central east catenary chains, just south of mid-span drop links.

Figure 194: Primary deck element – paint loss, corrosion and rust-staining to articulating parts of the upper hanger connection the 18th hanger north of south tower on the central east catenary chains.

Figure 195: Primary deck element – paint loss, corrosion and rust-staining to articulating parts of the upper hanger connection the 6th hanger north of south tower on the central east catenary chains.

Figure 196: Primary deck element – close-up of paint loss, corrosion and rust-staining to articulating parts of the upper hanger connection the 6th hanger north of south tower on the central east catenary chains.

Figure 197: Primary deck element – looking south at upper chain to central east section of catenary chains and upper north face of south tower.

Figure 198: Primary deck element – upper south face of south tower and south east back-stay chains.

Figure 199: Bracing – looking south along outer face of south east back-stay chains and transverse brace connection. Generally, in good condition with small areas of minor corrosion.

Figure 200: Primary deck element – looking south along inner face of south east back-stay chains and south bridge building.

Figure 201: Primary deck element – minor algae and water staining to inner face of south west back-stay chains.

Figure 202: Primary deck element – rust staining from metallic debris trapped beneath paintwork to outer face of south west back-stay chain just before 1st hanger.

Figure 203: Primary deck element – looking north along outside face of south west back-stay chains.

Appendix C – Dive Survey Report

UK Diving Services

Menai Suspension Bridge

Underwater Bridge Pier Inspection Report

Date of Inspection: **1st October 2019**

Location: Menai Strait, Anglesey

Prepared by:

UK Diving Services Ltd

[redacted]

UK Diving Services

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UK Diving Services

Introduction

A general condition and scour survey of the Menai Suspension Bridge pier bases was carried out by UK Diving Services on 1st October 2019. The underwater survey was carried out by a UK HSE dive team, working on behalf of Atkins Global, to assess the structure in accordance with the scope outlined below.

Scope of Works

The scope of works will include:

- Condition survey of the underwater elements of the bridge piers 1-6.
- Survey of the sea bed to determine bed profile, and location of any scouring.
- Produce suitable report detailing the results of the inspection.

Structure Information

Name: Menai Suspension Bridge

Location: Menai Strait, Anglesey

Causeway: A55

Structure Type: World's first wrought iron and stone suspension bridge consisting of 8 spans

Structure:

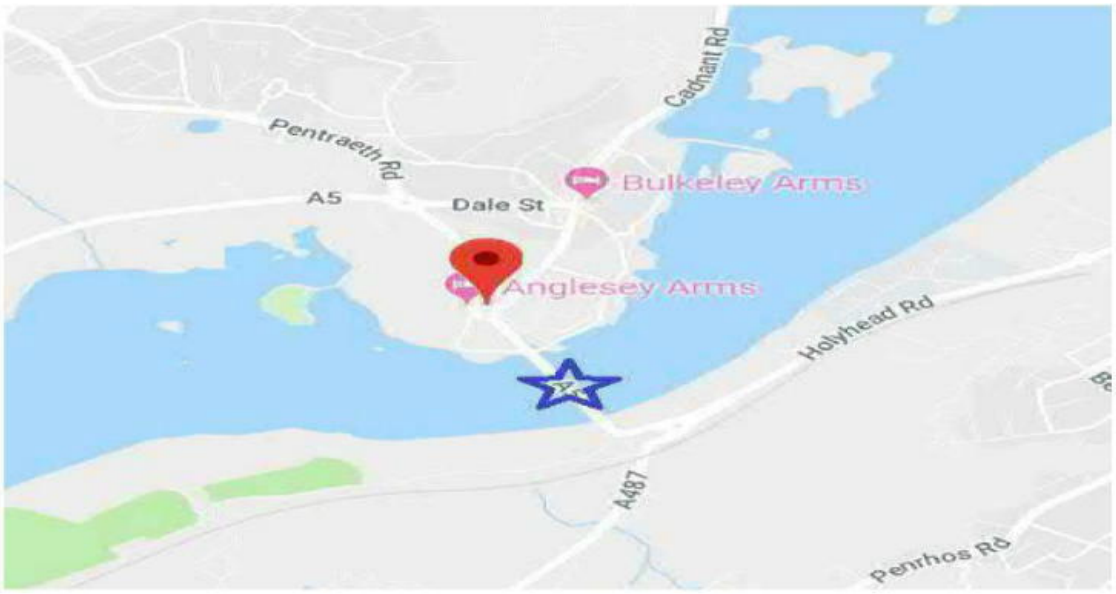
Piers	7 (6 in water)
Abutments	2
Spans	8

Orientation:

North	Anglesey
South	North Wales

UK Diving Services

Location



Inspection Conditions

Diver/Inspector: [redacted]
Company: [redacted]
Supervisor:
Temperature: 9 °c
Light: Overcast
Water Visibility: <50mm
Flow speed: 1-6kt
Equipment: Surface supplied diving equipment on site:

- KM 27 Dive Helmet
- KMB 18 Dive Helmet
- Compressed Air from LP source with HP backup
- 2-way communication system
- Diving suits
- Measuring Equipment: Sight Staff, Rules, Tapes etc.
- Rigid Probes
- Underwater Lighting
- Safety Boat with 10hp Mercury outboard
- IR and Low-light Camera

Inspection Conclusion

Overall Structure Condition: GOOD 7

On visual inspection of the submerged elements the general overall structure is assessed as **GOOD 7.**

All in water pier bases were fully exposed on the spring low tide allowing for full visual Inspection In dry conditions. Tidal windows were short. The rock bed levels on the east side of piers 1,2 and 3 are generally between 800mm and 1200mm lower than the levels on the west side. This is mostly because of the natural gradient of the surrounding seabed across the structure. There are some localised areas where the stones have built up against the piers. Equally there are some very small areas where rocks have scoured away creating small crab pools on the pier corners of piers 2 & 3. These small areas of scour are relatively insignificant as they only measure 200-300mm in depth, though they should be monitored at next inspection so they do not worsen and threaten the integrity of the structure.
The retaining wall between piers 4 & 3 on the east side does have some partial collapse but generally remains mostly intact. Pier 4 is founded onto natural raised bedrock and is therefore exposed for longer durations than the adjacent piers and has less marine vegetation growing on it.
At pier 5 on the north side there are several small stone blocks scattered In front of the pier that may have originally been part of a small wall/plinth acting as a scour protection measure.
The shoreline gradient is some 3m higher on the south side of pier 5 and approximately 2m higher on the south side of pier 6 and is considered the natural lay of the seabed.
The masonry stones within the tidal zone on all piers (1-6) are in good condition with little or no damage. The stones are heavily covered in marine vegetation and small barnacles.
The seabed is mostly small to medium sized rocks covered with extensive marine vegetation and small sharp barnacles. These provide a bonding mechanism preventing excessive movement during high tidal flows.
There was no evidence of undermining along any of the piers and all should be considered GOOD condition.

Recommendations

1. Consider repairs to retaining wall between piers 3 & 4
2. Investigate further the loose stonework adjacent pier 5 on the north side

Component Rankings

Component	Ranking
Piers 1-6	7

Inspection Scoring Key

N	Not applicable
9	Excellent condition
8	Very good condition – no problems noted
7	Good condition – some minor problems
6	Satisfactory condition – minor deterioration of structure
5	Fair condition – Consider repairing/improving
4	Poor condition – Can be used but needs repairing in near future
3	Serious condition – Can be used but repairs must be immediate
2	Critical condition - should not be used till repairs made
1	Imminent failure - un-repairable - NOT TO BE USED

Report

Fig 01: General view of piers 4-1 on the east side looking west – All piers are in good condition – some small scour pools approx. 300mm deep on average – Retaining wall between piers 3 & 4 has some loose stone work - No undermining to piers

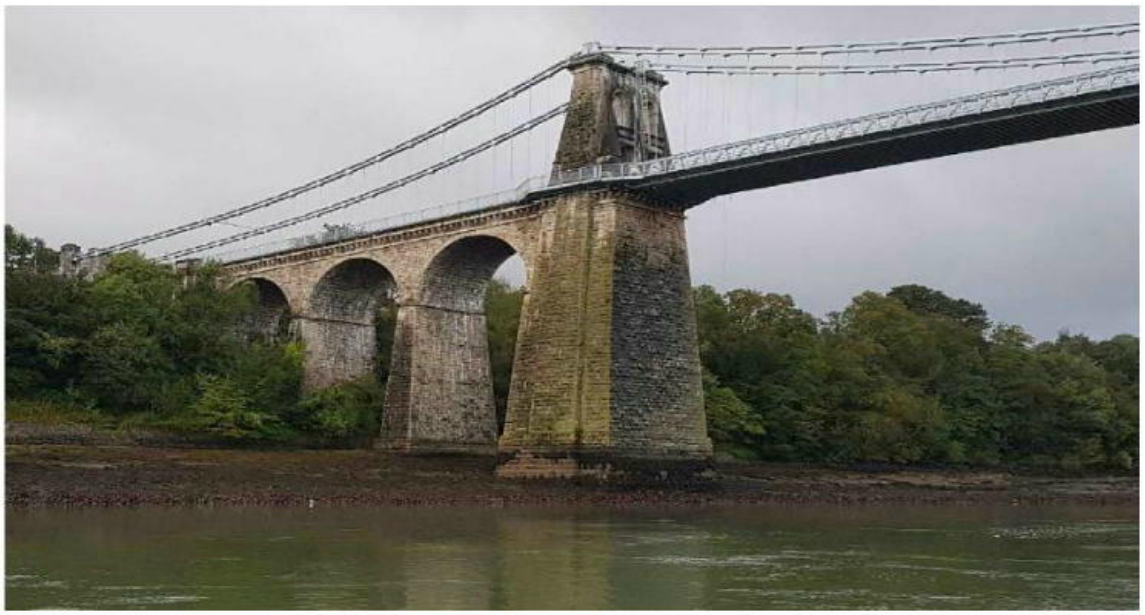


Fig 02: General view of piers 5 & 6 on the east side looking west – Both piers are in good condition – Some loose stone work laying on the sea bed immediately in front of pier 5 on the north side - Possibly part of a small plinth/wall which acted as an anti scour measure to protect the pier – No undermining

Pier 1

Fig 03: Bed levels at the eastern corner are approx. 800mm lower than the west side. Yellow line is location of measured distance X on pier 1 south face (refer appendix A for measurements) -- No undermining - Good condition

Fig 04: Pier 1 on east side looking west - Natural sloping gradient slopes 2.5m across the pier elevation - Yellow line is location of measured distance Y (refer appendix A for measurements) - No undermining - Good condition

Fig 05: Pier 1 on west side looking east - Natural sloping gradient slopes 2.5-3.0m across the pier elevation – Small crab pool to the south 200-300mm depth - No undermining - Good condition

Pier 2

Fig 06: Pier 2 on east side looking west – Bed levels on the east are slightly lower than the west side mostly due to natural lay of the seabed – Some crab pools from minor scour 200-300mm depth – No undermining or significant scour to the structure – Good condition

Fig 07: Pier 2 on the north side looking south from pier 1 – Bed levels are approx. 1m lower on the east side with small scour pools of 200-300mm depth – These are not thought to be threatening the integrity of the structure though should be monitored at next inspection – No undermining – Good condition

Fig 08: Pier 2 on the west side looking east – Small crab pool to the south 200-300mm depth - No undermining - Good condition

Fig 09: Pier 2 east end - Small crab pool 200-300mm depth – No undermining - Good condition

Pier 3

Fig 10: Pier 3 on the east side looking west – crab pool 300-400mm deep – Bed levels at the east end are approx. 1-1.2m lower than the west end - No undermining - Good condition – The retaining wall adjacent the east side of the pier has become messy and appears to have some section loss when compared to the wall further along

Fig 11: Pier 3 on the west side looking east - The sea bed here is exposed bed rock - No undermining - Good condition

Fig 12: Pier 3 on the south side looking NW - The sea bed here is exposed bed rock - No undermining - Good condition

Fig 13: Looking westward the retaining wall between piers 4 & 3 on the east side - The wall is missing several stones and appears to worsen as the wall moves around to the north side.

Pier 4

Fig 14: Pier 4 west face while looking east - This pier is on raised bedrock with no issues – Bed levels are 600-700mm lower on the south face compared to the north – No undermining – Good condition

Fig 15: Pier 4 south face looking east – Less marine vegetation due to longer exposure during tide cycle - No undermining – Good condition

Fig 16: Pier 4 NE corner – Exposed bedrock - Good condition – No undermining

Fig 17: Pier 4 SE corner – good condition – no undermining

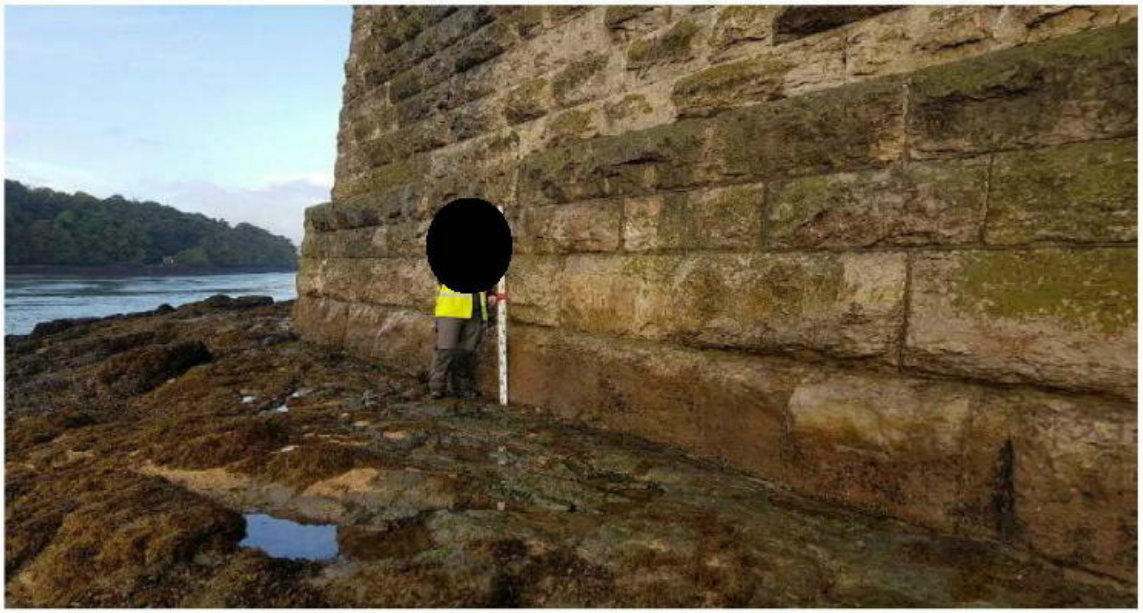


Fig 18: South face of pier 4 looking west – No undermining – Good condition

Fig 19: South face of pier 4 looking north – No undermining – Good condition

Pier 5

Fig 20: Pier 5 north face low tide cycle – Exposed remainder of small wall in front of pier otherwise Good condition – No undermining

Fig 21: Pier 5 north face low spring tide – Loose stones laying on the sea bed immediately in front of the pier. It is possible these were originally a plinth or small wall protecting the pier base. Otherwise pier is in good condition with no undermining

Fig 22: Pier 5 NW corner – Loose stones laying on sea bed appear to have originally formed a small plinth or wall otherwise good condition with no undermining

Fig 23: Pier 5 NE corner – Again loose stones laying on sea bed may have originally formed a small plinth or wall otherwise pier is in good condition with no undermining

Fig 24: Pier 5 east face looking west – Good condition - No undermining

Fig 25: Pier 5 south and east faces looking NW – Good condition - No undermining

Fig 26: Pier 5 west face looking east – Good condition - No undermining

Pier 6

Fig 27: Pier 6 north face looking south – Good condition - No undermining

Fig 28: Pier 6 east face looking west – Good condition - No undermining

Fig 29: Pier 6 west face looking east – Good condition - No undermining

APPENDIX A

Pier	Length X	Width Y
1	16400mm	6100mm
2	16500mm	6740mm
3	16500mm	6000mm
4	16900mm	14750mm
5	18000mm	15220mm
6	14920mm	5500mm

Limitations

UK Diving Services Ltd has prepared this report for the sole use of the client. Where field investigations are carried out, these have been restricted to a level of detail required to meet the stated objectives of the services. The results of any measurements taken may vary spatially or with time and further confirmatory measurements may need to be taken.

The methodology adopted and the sources of information used by UK Diving Services Ltd in providing its services are outlined in this report. The work described in this report was undertaken on the date stated on the first page of this report and is based on the conditions encountered and the information available at that time. The scope of this Report and the services are accordingly factually limited by these circumstances.

Where assessments of works or costs identified in this Report are made, such assessments are based upon the information available at the time and where appropriate are subject to further investigations or information which may become available.

The recommendations and conclusions contained in it are based upon information provided by others and upon the assumption that all relevant information has been provided by those parties from whom it has been requested and that such information is accurate. Information obtained by UK Diving Services Ltd has not been independently verified by UK Diving Services Ltd, unless otherwise stated in the report
Statements within this report are based on based on reasonable assumptions and by their nature involve risks and uncertainties that could cause actual results to differ from true measurements. UK Diving Services Ltd specifically does not guarantee any of the information within this report.

Appendix D – Principal Bridge Inspection Interval Risk Assessment

Structure Name:	Menai Bridge		Structure Key:	A5 Menai Bridge
A - BRIDGES & LARGE CULVERTS	**Criteria Number**	**Criteria**	**Attribute**	**Risk Score**
A1 Structure Type	A.1.1	Structural form	Not Known / Other	0
	A.1.2	Constituent material	Not Known / Other	0
	A.1.3	Age of the structure	25 years +	0
	A.1.4	Headroom	Greater than 'Minimum Maintained Headroom'	1
	A.1.5	Span	Greater than 25m	0
A2 Environment	A.2.1	Exposure	Severe (Marine Environment)	PII to remain at 6 years
	A.2.2	Scour	Scour Susceptible (Scour Risk Rating of 1-4)	PII to remain at 6 years
	A.2.3	Flooding	Low Risk (structure is adjacent to / over waterway with low likelihood of flood damage)	0
A3 Inspection / Assessment	A.3.1	Level of visual accessibility during a General Inspection	Certain parts of the structure not visible from a distance (including the use of binoculars)	0
	A.3.2	Likelihood of latent defects going unnoticed during a Principal Inspection	High likelihood of latent defects occurring without any visible secondary effects	0
	A.3.3	Assessment	Not Known	0
A4 Condition	A.4.1	Condition - Inspector's opinion	Fair	2
	A.4.2	Condition Performance Indicator (Average Score)	Fair (65-80)	2
	A.4.3	Condition Performance Indicator (Critical Element Score)	Fair (65-80)	2
	A.4.4	Signs of Concrete Deterioration including TSA, AAR, ASR and ACR	No	3
A5 Consequences	A.5.1	Applied loading	Full Highway Loading	1
	A.5.2	Route supported	A road	2
	A.5.3	Obstacle crossed	Other / Not Known	0
	A.5.4	Potential failure mode	Brittle Failure (Concrete, masonry, timber)	0

Note: "PII to remain at 6 Years" means that irrespective of the final adjusted risk score the nature of the attribute requires the interval between Principal Inspections to be 6 Years

Assessment Risk	Actual	Maximum possible Risk Score	Weighting %	Adjusted Risk Score
Structure Score	1	13	25	1.9
Environment Score	-	11	20	-
Inspection Score	0	11	15	0.0
Condition Score	9	16	15	8.4
Consequence Score	3	14	25	5.4
			Total Risk Score	15.7

Comments and Recommendation for PI Interval

The risk, in accordance with BD 63/07 and IAN 171, with support spreadsheet states that the PBI interval cannot be extended beyond 8 years.

	Name	Signature	Date
Prepared	[redacted]	[redacted]	[redacted]
Authorised	[redacted]	[redacted]	[redacted]
TAA Agreement			