Principal Inspection Report

Structure Name: Cloddach Bridge

Structure No: C2E/20

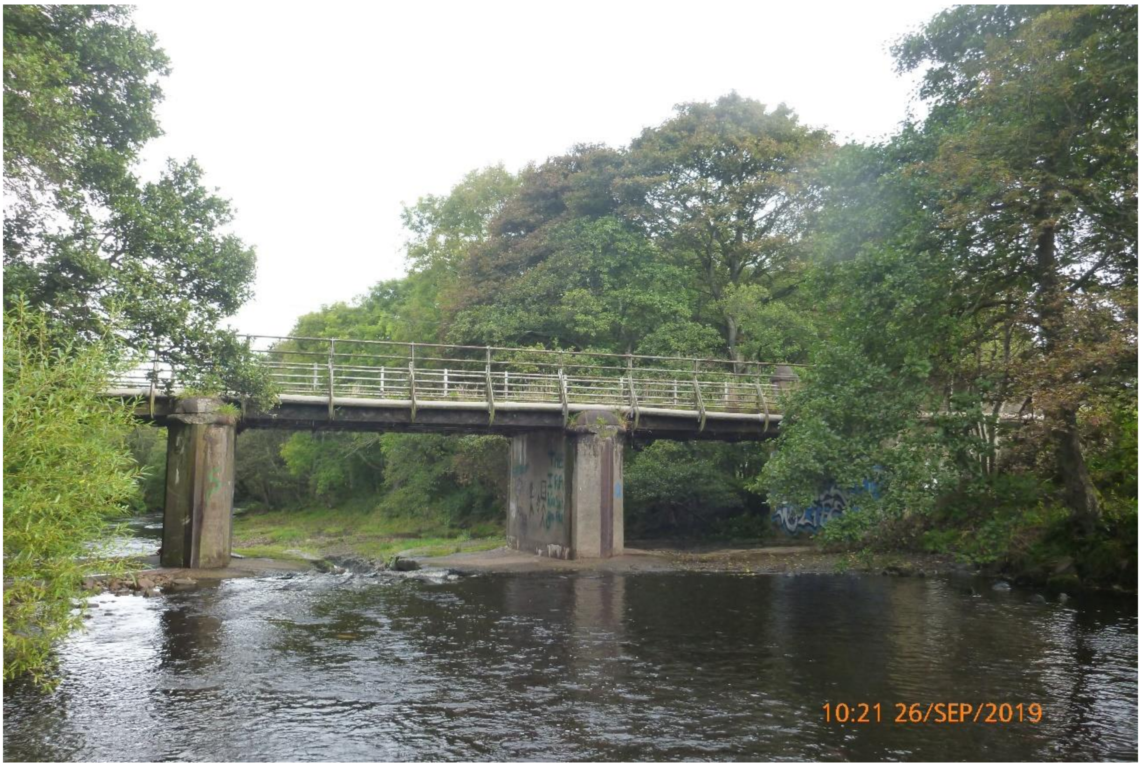
Location	Cloddach
Inspection date	26/09/2019

Bridge Condition Indicators	
BCI ave	BCI crit
55.14	22.12

Summary

Cloddach Bridge is a three span bridge over the River Lossie. The bridge is constructed of steel beams acting compositely with jack arched insitu concrete deck slab. The bridge was previously reduced to 7.5 tonne limit.

The structure is generally in poor condition with significant corrosion to the steel beams. The invert has been altered and a large gorge formed which is creating scour close to the bridge piers.



Control Sheet

Project Title: Principal Inspection (PI) Report

Cloddach Bridge

Issue and Approval Schedule:

Issue 1	Name	Signature	Date
Prepared by	[redacted]	[redacted]	03 October 2019
Checked by	[redacted]		10 January 2020
Approved by	[redacted]		10 January 2020

Revision Record:

Issue	Date	Status	Description	By	Checker	Approved
2						
3						
4						
5						
6						
7						
8						

1 Table of Contents

1 Introduction

1.1 Inspection Procedures

This Principal Inspection (PI) has been undertaken in accordance with BD 63 (DMRB 3.1.4) 'The Inspection of Highway Structure's and the general advice given in the 'Inspection Manual for Highway Structures'.

1.2 Inspection Information

Inspecting Engineer:	[redacted]
Assistant(s):	[redacted]
Date(s) of Inspections:	26/09/2019
Weather Conditions:	Mild-Damp (heavy rain before inspection)
Method of Inspection:	The structure was inspected from ground level on foot and using a ladder where practicable at abutments and piers.
Areas not inspected:	Foundations and any structural elements below ground, waterproofing, concrete deck slab/jack arches and drainage.

2 Description of Structure

2.1 General Details

Cloddach Bridge is located to the west of the B9010 to the South of Elgin over the River Lossie.

Structure No:	C2E/20
Structure Name:	Cloddach Bridge
Grid Reference:	E: 320170 N:858425
Number of Spans:	3
Span Lengths:	Span 1: Approx. 7m Span 2: Approx. 7m Span 3: Approx. 7m
Skew:	0 degrees
Overall Width of Deck:	4.3m (between parapets)
Minimum Headroom:	Not Applicable
Restrictions:	7.5 tonnes
Highway Carried:	C2E
Obstacle Crossed:	River Lossie
Approx. Date of Construction:	Unknown however a date of 1905 was found on the approach wall.

2.1.1 Superstructure

- The deck comprises of seven steel beams, acting compositely with jack arched insitu concrete deck slab. There are 7 I-beams at a distance of 700mm c/c.
- It is assumed that each span is simply supported.
- The carriageway is approx. 3.9m wide and there is no verge or kerb to either side of the carriageway.

2.1.2 Substructure

- The substructure is formed of reinforced concrete with a finish to give the appearance of masonry.
- The intermediate supports have cutwaters upstream and downstream with a metal plate fixed over the upstream point.
- Foundations are unknown but are assumed to be spread footings onto the shallow bedrock.

2.1.3 Deck Ancillaries

Surfacing:	Carriageway: Asphaltic concrete surfacing. Patch repairs apparent
Expansion Joints:	No expansion joints visible.
Waterproofing:	Unknown
Parapets:	Post and Rail steel parapets with bracing. Not to current standards.
Safety Fencing:	Masonry Solid parapet on approach to bridge deck on all side. North-west approach has a timber fence that is not connected to the bridge structure.
Drainage System:	Drainage holes located at midspan of each deck at outside beams. Drainage holes at abutments
Protective System:	Paint systems to the parapet, bracing and primary beams.
Bearings:	None

2.2 Inspection History

The last Principal Inspection was carried out in 1997. General Inspections have been carried out on a yearly basis since 2013.

2.3 Assessment History

An Assessment of the structure was completed in 1996 which found the structure to have a reduced capacity of 7.5tonnes using a condition factor of 0.8 for the four outmost beams (two on the North side and two on the South side) and 0.9 for the 3 central beams.

3 Inspection Findings

3.1 Substructure

3.1.1 Foundations

The foundations are buried and therefore were not inspected. There is no evidence to suggest the foundations are not preforming satisfactorily.

3.1.2 Inverts and Aprons

The invert comprises of insitu mass concrete under the bridge. It appears the river layout has been manually altered using a small concrete weir to ensure, at low flows, the water only passes under the centre span (Photograph 23).

Under the centre span, a deep cut in the concrete invert and rock bed has been created manually or naturally. The water is very fast flowing and turbulent therefore, access could not be gained to the invert at this location. At pier 2, at the midspan side, the pier sits approximately 2m away from the cut however, the river has scoured under the bridge invert by approximately 1-1.5m. This scour was not identified during the previous PI however was reported as a defect in November 2018. It is unknown how fast the scour is progressing (Photograph 24, 25 & 26).

3.1.3 Abutments

West Abutment

The abutment has non-offensive graffiti along the full abutment face. There is a vertical crack of approximately 0.8mm width running the full height of the abutment starting at the base of the fifth beam. There is a broken crack gauge located over the crack. It is unknown when this crack gauge was placed or what the crack width was at that time of placement (Photograph 17, 18 & 19).

There is calcite staining and rust staining on the Abutment emanating from the bottom of the steel beams with damp staining apparent at the edge beams at the time of the inspection. Although the drainage holes appear clear at the Abutment there is no sign of water egress from these locations (Photograph 17 & 19).

East Abutment

The abutment has non-offensive graffiti along the full abutment face. There is algae staining and significant calcite staining coming from the soffit of the steel beams. Along the top of the Abutment there is spalling/breakout of the concrete between and under the steel beams with large aggregate visible (Photograph 20 & 21).

A large corner of the abutment at the upstream end has broken away and is lying beside the structure leaving part of the masonry safety wall partially unsupported. This is at the location where the steel parapet is fixed to the masonry approach wall. The broken off section is sufficiently large that it was unable to be moved (photograph 27 & 28).

3.1.4 Piers

The piers have graffiti along all faces. The semi-circular topping stones at the cutwaters have concrete breakout on the upstream and downstream side of both piers with sections of vegetation growing (Photograph 22)

There is a horizontal crack (0.20mm) at mid-height of pier 1, on the span 1 side, that runs along the full width of the pier.

3.1.5 Wingwalls

The wingwalls are in fair condition with some graffiti present. There is mild delamination of sections of the concrete at the base of the wingwalls at the water's edge, likely due to scour. The wingwalls all have concrete breakout at the corners (Photograph 27 & 29).

3.1.6 Approach Embankments

The West embankments shows no sign of distress. However, at the East embankment there is some mild erosion at the bottom of the abutment and wingwall (Photograph 27). Areas of Japanese knotweed and giant hogweed were noted on the West and East banks of the river, close to the structure.

3.2 Superstructure

3.2.1 Main Beams

Generally the main steel beams have significant corrosion and rusting especially on the four outmost beams (two on the North side and two on the South side) of the structure over all three spans. There is no sign of paint protection on these outside beams and there are several layers of rust build up. Therefore, the section depth of the bottom flange on the outer beams is unknown. Generally, although there was some flaking to the rusting, it was not easily removed (Photograph 10 – 16).

The inner three beams are generally in fair condition with rusting and corrosion especially at the pier and abutments ends over all three spans. It is difficult to determine if pitting has occurred to the steel due to the extent of the rusting. There is no sign of paint protection and the bottom flange of the beams had a thickness between 10-15mm, with a flange width of 155mm. All of the beams rested directly on the abutments and piers and is unknown how far they extend beyond the face.

There are three transverse bracings or ties under each span that connect beams 2 to 6. The transverse members do not continue to the outer beams. In general, all of the bracing members are corroded and rusting however are in a better condition than the main steel beams (Photograph 10, 11 & 15).

3.2.2 Deck Soffit

The corrugated steel jack arches are rusting and corroding in places especially at the steel beam connection, at the pier and abutments end and at the outmost beams. The steel is flaking in places and the depth of steel is unknown (Photograph 10, 11, 14 & 16).

The insitu concrete was not inspected however there were no signs of deformation or failure of the jack arches.

3.3 Bridge Ancillaries

3.3.1 Parapet

The parapets are formed from painted steel, post and rail, which are substandard for vehicle restraint. Generally the parapets are in fair condition with spots of paint flaking and rusting apparent on the parapet stands. There are no expansion joints along the parapets (Photograph 8, 9, 11 & 32).

There are four parapet bracing members per span that connect to beams 1 & 2, and 6 & 7 on the north and south side of the structure. The top section of the bracing members are in fair condition with minor rusting and paint flaking in places. The corrosion and rusting is concentrated at the bracing to parapet connection. The bottom sections of the bracing are heavily rusted and corroded, and the paint either ends or has worn away just before the start of these sections. There are multiple layers of patina present on the underside section of the bracing members with calcite stalactites on some members (Photograph 9, 10, 11, 14, 16, 22 & 32)

The approach walls on the East and West side of the structure are a concrete composition, finished to look like masonry. The steel bridge parapets are fixed directly into the masonry walls at both ends.

All of the approach walls have experienced cracking with areas of delamination. The North-East approach wall has evidence of a vehicle strike with crushed and cracked concrete at the corner and a large crack on the semi-circular topping stone (Photograph 33, 34 & 35)

3.3.2 Approach Barrier

There are no vehicle restraint barriers on the approach to the structure. However there is a new timber port and rail fence on the North-West side that is not attached to the bridge structure (Photograph 4).

3.3.3 Surfacing

The carriageway surfacing was generally in good condition with a few patch repairs at the edge of the bridge structure. There are no verges on the structure (Photograph 7).

3.3.4 Waterproofing

Throughout the inspection it was noted that water was dripping from the bridge deck, especially at the two outermost beams. There were calcite stalactites throughout the structure, especially concentrated at the three North-most beams along all three spans, indicating long term water ingress through the bridge deck.

3.3.5 Drainage system

The existing concrete drainage channels that run along the edge of the bridge deck, between the carriageway and the parapets, are blocked and filled with debris and vegetation. Each span has a drainage outlet on either side of the deck at approximately midspan. Although water was seen dripping from these drainage holes on further investigation they were blocked up (Photograph 5,6,7,8 & 16)

3.3.6 Services

There is a pipe attached to the South side of the structure. The pipe is bolted to the approach walls and attached to the parapet upstands using two bracket connections. The connections are in good condition with no rusting (Photograph 3, 9, 22, 31 & 32).

To the North of the structure there is an overhead telecoms cable over the river. This continues underground at the bridge embankments. The cable is well above head height and is not attached to the structure (Photograph 30).

4 Conclusions

4.1 Substructure

Although cracking was noted on the abutments and piers (0.8mm crack on the West abutment) there was very little delamination and in general they are in fair condition. The crack in the West abutment was recorded in the 1995 PI and it is evident that a crack gauge was placed over the crack in the past. However, the crack gauge had since broken off and there are no crack width's previously recorded therefore it is unknown if the crack has spread or increased in width. If this crack is getting bigger it could be an indication that settlement of the abutment is occurring.

At the middle span of the structure it is apparent that the river is scouring beneath the bridge invert especially towards the East side. Currently the piers are not showing any signs of settlement or distress, however the rock bed appears relatively soft with a bed of sand and pebbles. It is unknown how quickly the rate of scour is occurring.

The embankment at the East abutment is showing signs of erosion leaving parts of the wingwall corner exposed.

At all of the abutments corners, concrete has spalled and or broken away. At the West abutment at the upstream side a large corner of concrete has broken off leaving the masonry parapet wall partially unsupported at the section where it connects to the steel parapet. This poses a safety risk and there is an increased risk of the wall / parapet failing if struck by a vehicle.

4.2 Superstructure

The main beams are generally in poor condition with significant rusting and corrosion, especially to the outermost beams. The flange depth of the corroded beams could not be obtained however the inner beam had an average depth of 10mm. It is unknown the original thickness of the flanges however the assessment completed in 1996 used a flange depth of 15mm. This indicates that the beams have reduced in section by approximately a third. The condition of the web and upper flanges within the deck are a hidden detail and are therefore unknown, however the outside beams have experienced corrosion across all exposed faces.

4.3 Drainage System

The drainage gully is in poor condition with vegetation growth along the entire structure on both sides of the carriageway. Although the drainage holes through the deck appear unobstructed with small amounts of water able to drip through the blockage of the drainage gully stops the drainage system working as required.

5 Recommendations

5.1 Substructure

It is recommended that the scour to the bridge invert at the centre span is monitored and the rate of scour determined. If the scour extends closer to the pier it is recommended that works are undertaken to protect the piers from scour.

It is recommended that the crack on the East abutment is monitored and the crack width recorded to determine if settlement of the abutment is occurring.

It is recommended that the broken corner of the East abutment is repaired to provide support to the masonry approach wall and the embankment at the East abutment is monitored to limit scour and / slipping of the embankment.

5.2 Superstructure

It is recommended that the beams are grit blasted and cleaned of rusting and corrosion to allow a detailed thickness test to be completed on all structural members. A revised assessment should be completed to determine the current capacity of the structure and the beams painted to protect against future corrosion.

If significant section loss has occurred, it is recommended that the bridge is closed or the deck is replaced.

5.3 Drainage System

It is recommended that the drainage gullies next to the carriageway are cleared out and the vegetation removed to limit future water seepage through the deck and onto the main beams.

5.4 Parapet

It is recommended that the parapets are grit blasted and repainted to protect against corrosion.

5.5 Load Capacity Review

A Load Capacity Review (not a full structural assessment) has now been undertaken of the steel deck beams. An assessment of the beams was undertaken in 1993 indicating 7.5Tonne capacity. A weight limit was enacted at 17Tons in 2001 and lowered to 7.5Tonnes in 2002.

Corrosion on the beams has increased significantly in the intervening 26 years since the assessment

DL Applied Moment	LL Applied Moment	Total Moment	Resistance When New	With Condition Factor = 0.6	With Condition Factor = 0.5
54.25 kNm	141.74 kNm	196.00 kNm	M_R=174.49 kNm LL =120.74 kNm	M_R=104.70 kNm LL = 50.44 kNm	M_R= 87.24 kNm LL = 32.99 kNm

Traffic flows on the bridge are Low The road surface is considered Good

Load Rating	Reduction Factor for HA	LL Applied HA Moment	Utilisation at Cond Fact 1.0	Utilisation at Cond Fact 0.6	Utilisation at Cond Fact 0.5
40/44 T	0.76	107.72 kNm	**89.2%**	**213.6%**	**326.5%**
26T	0.75	106.31 kNm	**88.0%**	**210.8%**	**322.2%**
18T	0.58	82.21 kNm	**68.1%**	**163.0%**	**249.2%**
Gp 1 FE	0.49	69.45 kNm	**57.5%**	**137.7%**	**210.5%**
7.5T	0.31	43.94 kNm	**36.4%**	**87.1%**	**133.2%**
Gp2 FE	0.25	35.44 kNm	**29.4%**	**70.3%**	**107.4%**
3.0T	0.20	28.35 kNm	**23.5%**	**56.2%**	**85.9%**

The bridge has previously been judged to have a condition factor of approximately 0.6. This gave utilisation of 87.1% at 7.5Tonnes, reflecting the current 7.5 Tonne weight limit. However, as the protective system has completely failed, the current rate of deterioration of the steel main beams is high. The condition factor will shortly be at condition factor 0.5, so any weight limit changes should take this into account, as it will be some months before a permanent change to the TRO is implemented.

Furthermore, the road surface is now showing signs of wear and weathering and without intervention will likely become poor in the relatively short term. The bridge is therefore also to be considered with a Low Traffic / Poor Surface.

Traffic flows on the bridge are Low The road surface is considered Poor

Load Rating	Reduction Factor for HA	LL Applied HA Moment	Utilisation at Cond Fact 1.0	Utilisation at Cond Fact 0.6	Utilisation at Cond Fact 0.5
40/44 T	0.91	128.98 kNm	**106.8%**	**255.6%**	**391.0%**
26T	0.89	126.15 kNm	**104.5%**	**250.0%**	**382.4%**
18T	0.70	99.22 kNm	**82.2%**	**196.7%**	**300.8%**
Gp 1 FE	0.49	69.45 kNm	**57.5%**	**137.7%**	**210.5%**
7.5T	0.37	52.44 kNm	**43.4%**	**104.0%**	**159.0%**
Gp2 FE	0.25	35.44 kNm	**29.4%**	**70.3%**	**107.4%**
3.0T	0.20	28.35 kNm	**23.5%**	**56.2%**	**85.9%**

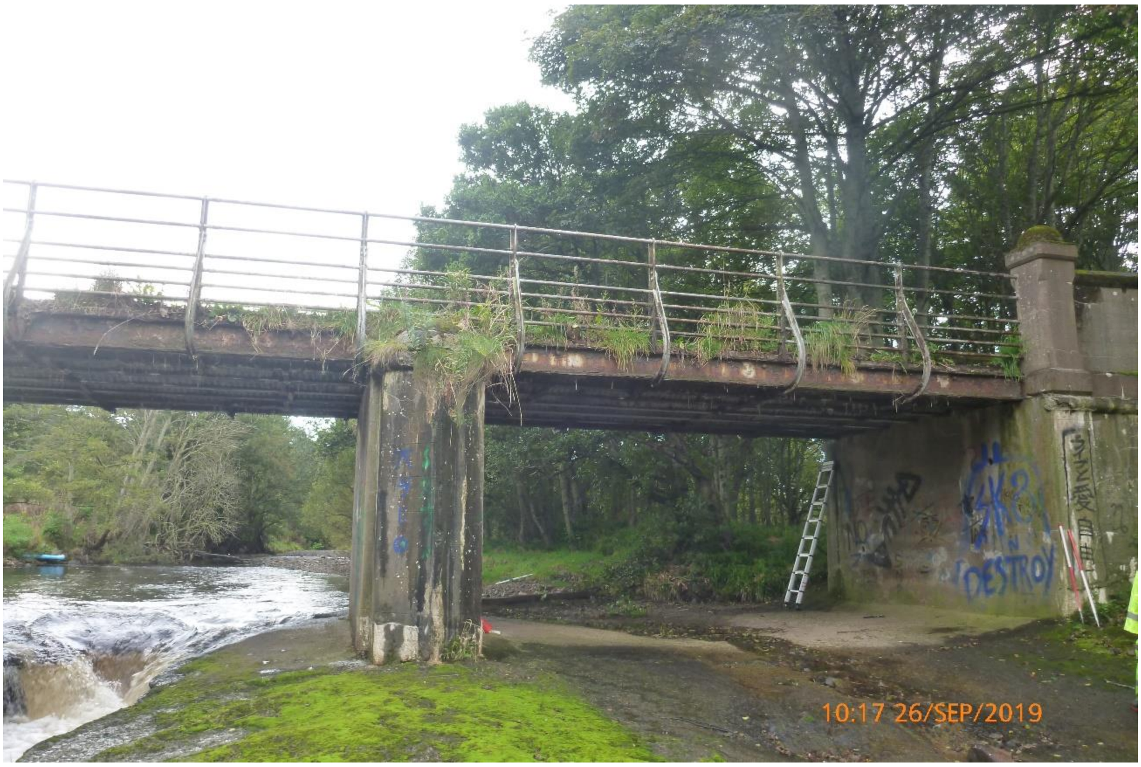
With slight further deterioration of the surfacing, the utilisation at 7.5Tonnes will be 104.0%, i.e. a failure and the bridge will have only 3.0Tonne capacity plus group 1 Fire Engines.

With the anticipated further deterioration of the main beams, with or without further deterioration of the road surface, the utilisation at group 1 FE will be 107.4%, i.e. a failure and the bridge will have a capacity of only 3.0Tonnes. **As such it is recommended that a 3.0Tonne Limit is required.**

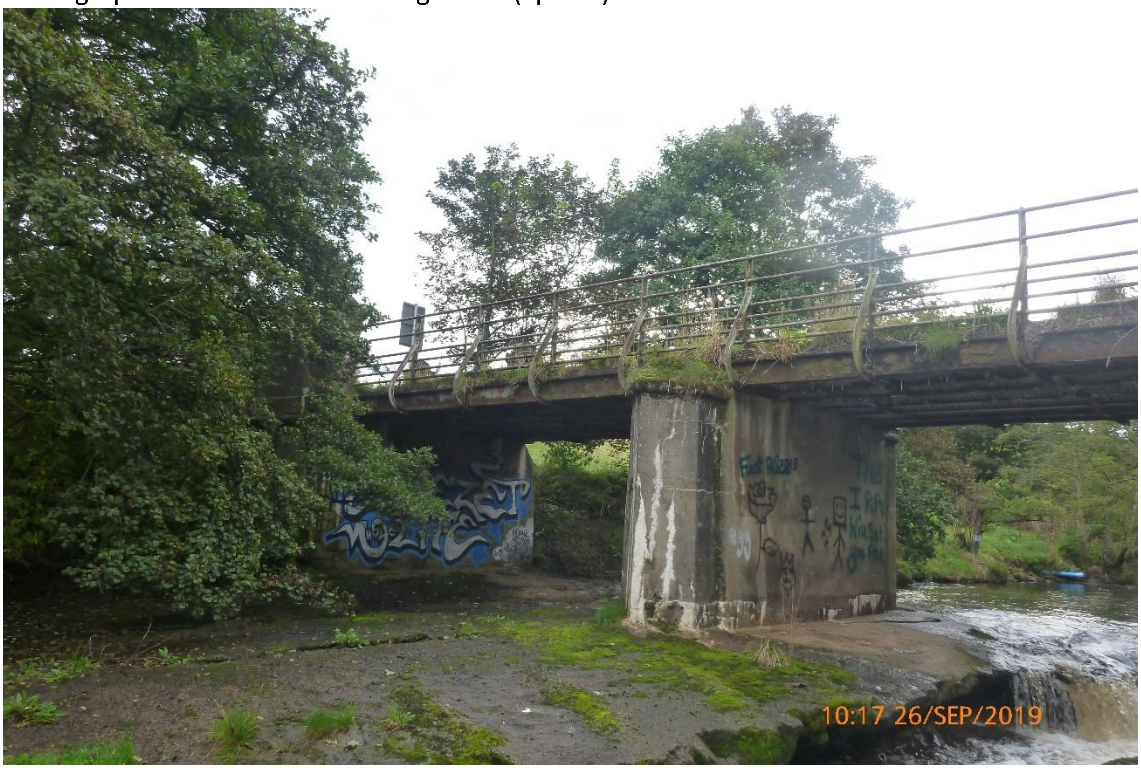
Given that the existing 7.5Tonne weight limit suffers frequent abuse by heavy agricultural vehicles, and that the route is also regularly used by 3.5Tonne vans and 4x4 traffic it is anticipated that the 3.0Tonne weight limit will need to be supplemented by a width restriction to preclude the majority of vehicles over 3.0Tonnes. **As such it is recommended that a 2.0m Width Restriction is required.**

The alternative to the combined 3.0Tonne and 2.0m limits would be to close the bridge to motorised traffic, and restrict its use to pedestrians and cycles only.

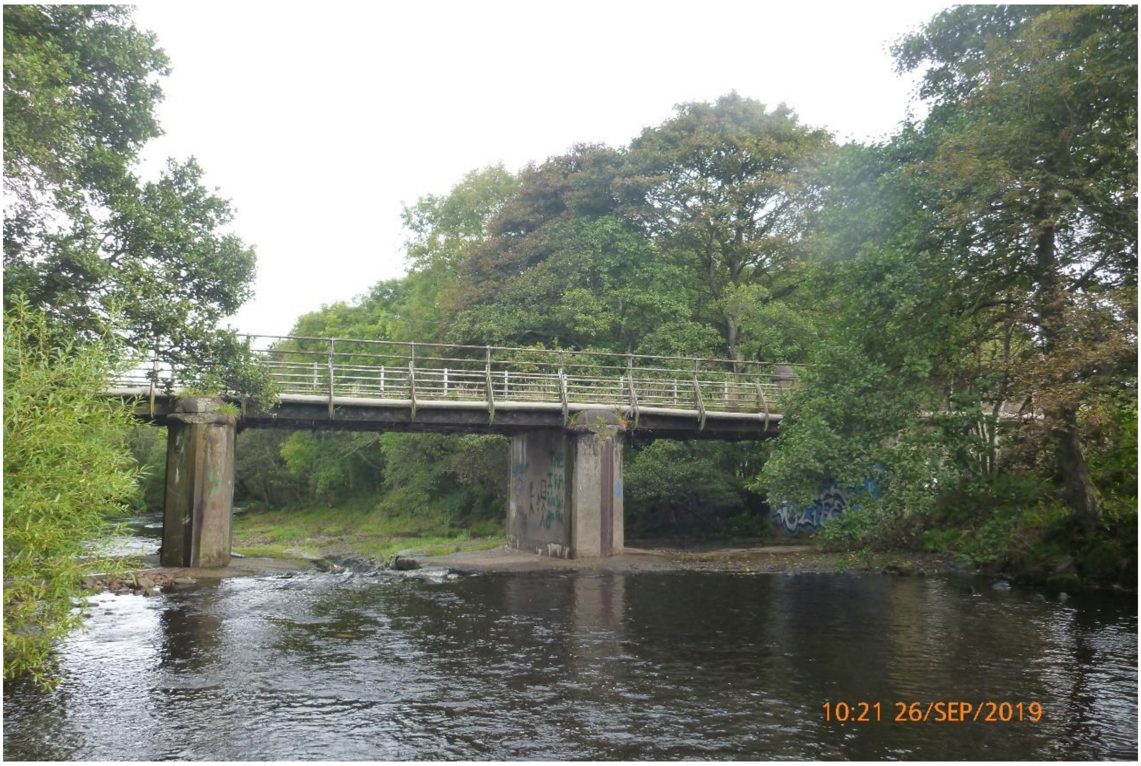
6 Appendix A – Photographs



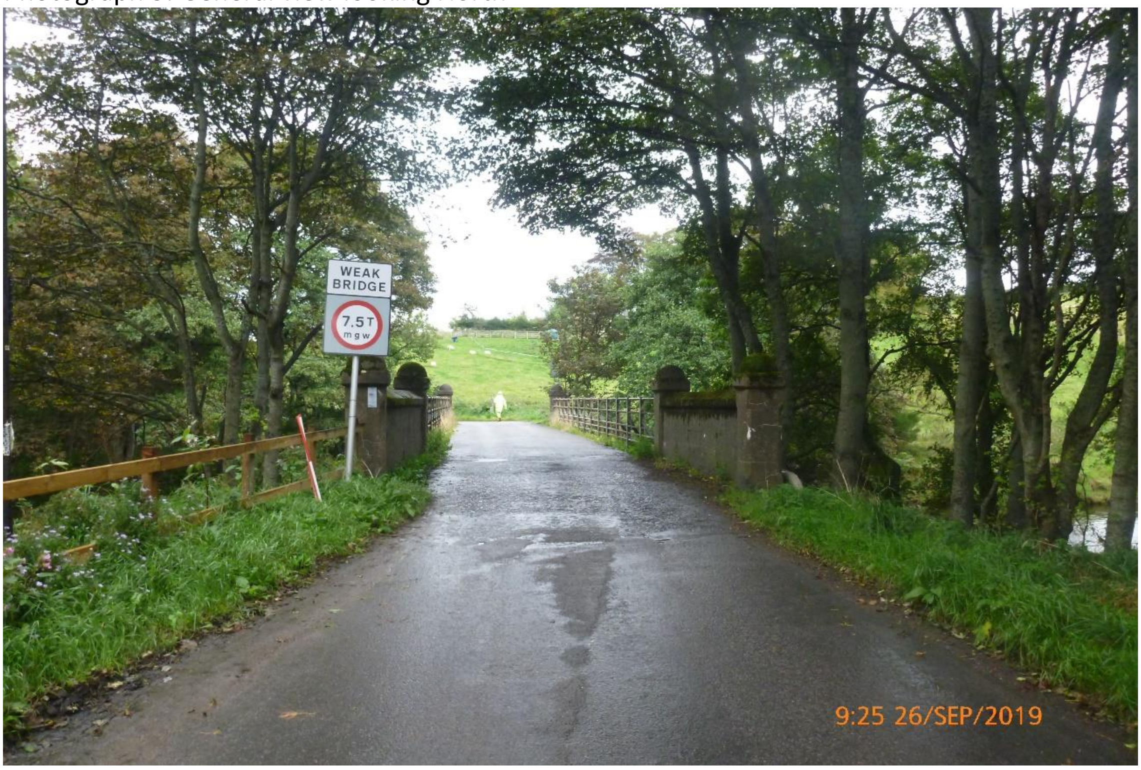
Photograph 1: General view looking South (Span 1)



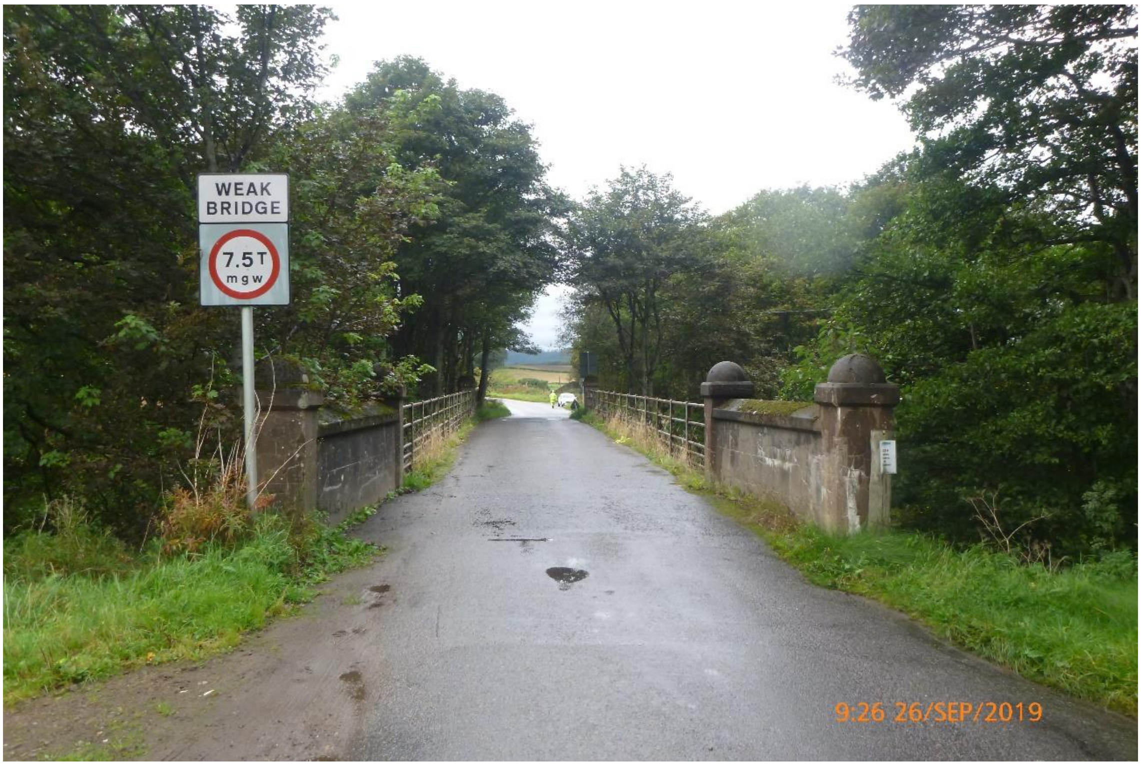
Photograph 2: General View Looking East



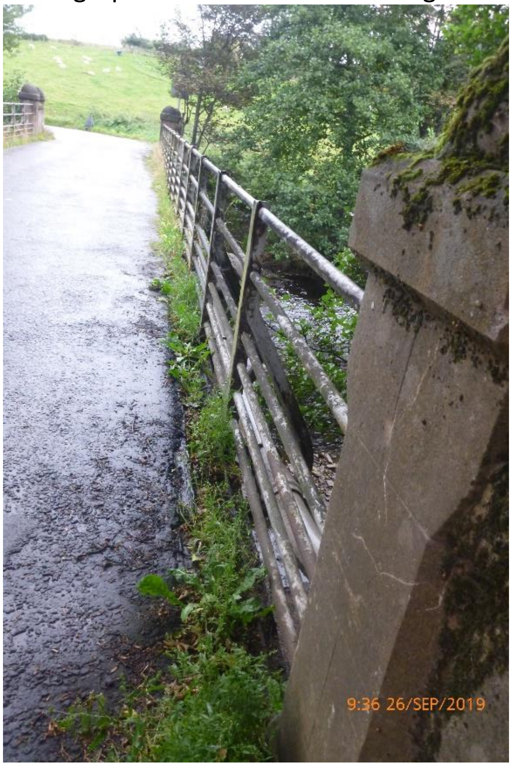
Photograph 3: General view looking North



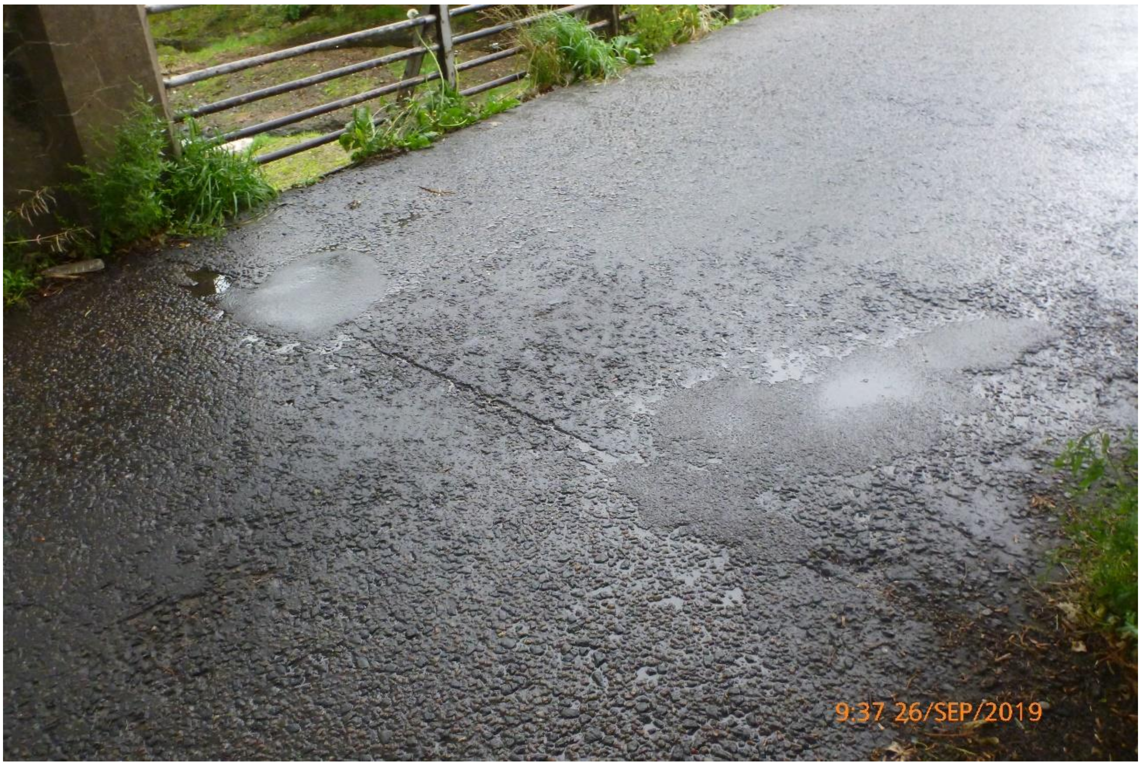
Photograph 4: General View Looking East



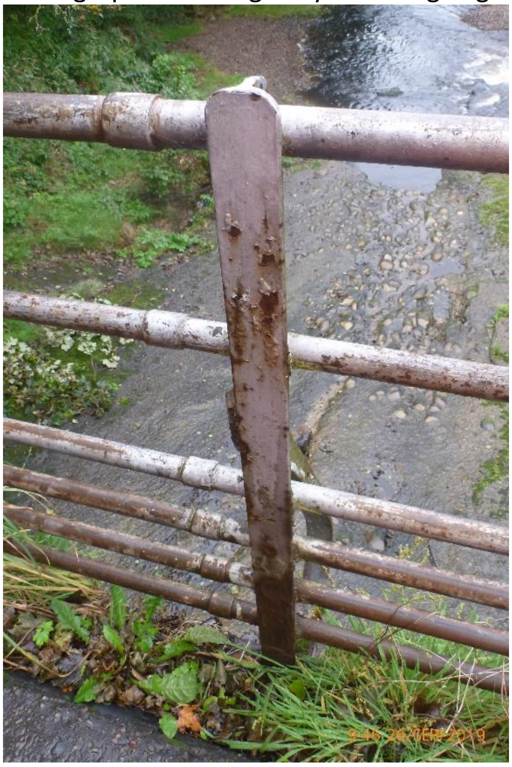
Photograph 5: General View Looking West.



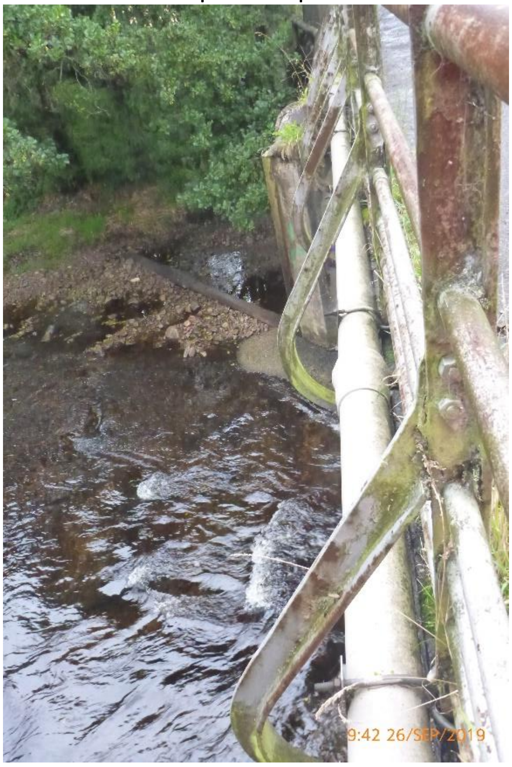
Photograph 6: Vegetation growing at edge of carriageway with no verge.



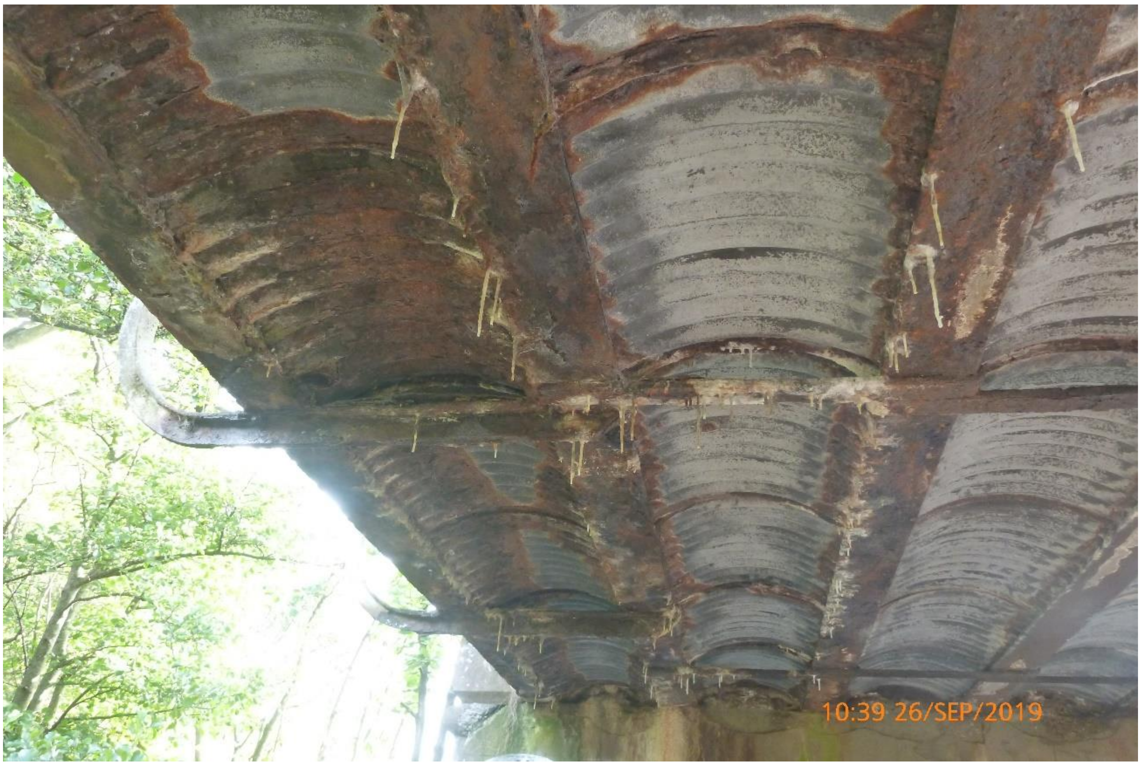
Photograph 7: Carriageway surfacing in good condition with minor patch repairs. No Joint visible.



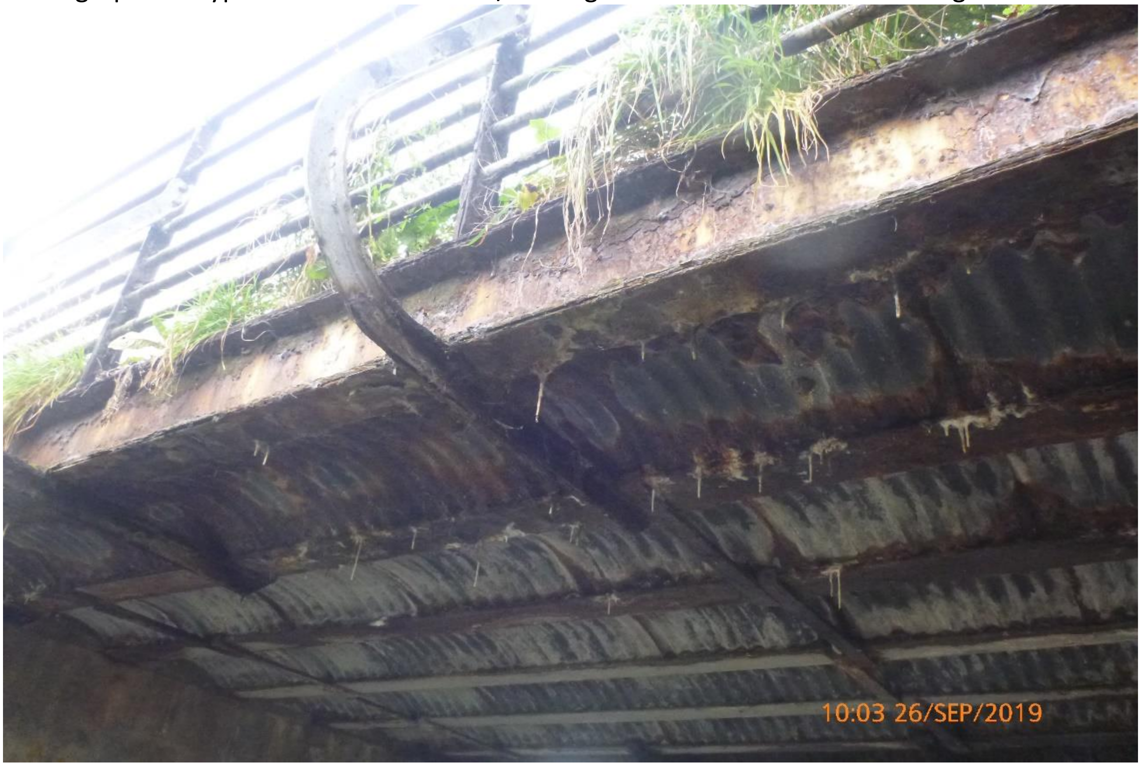
Photograph 8: Typical section of parapet corrosion.



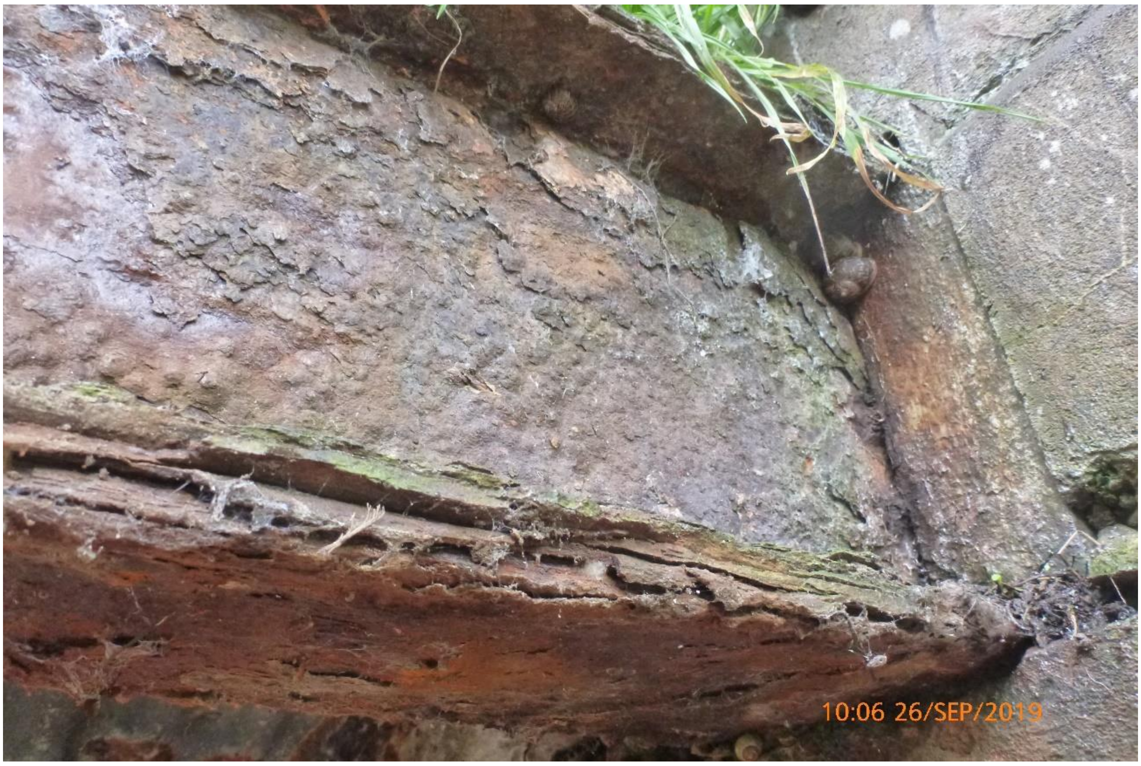
Photograph 9: View of pipeline passing through parapet bracing members on the South side.



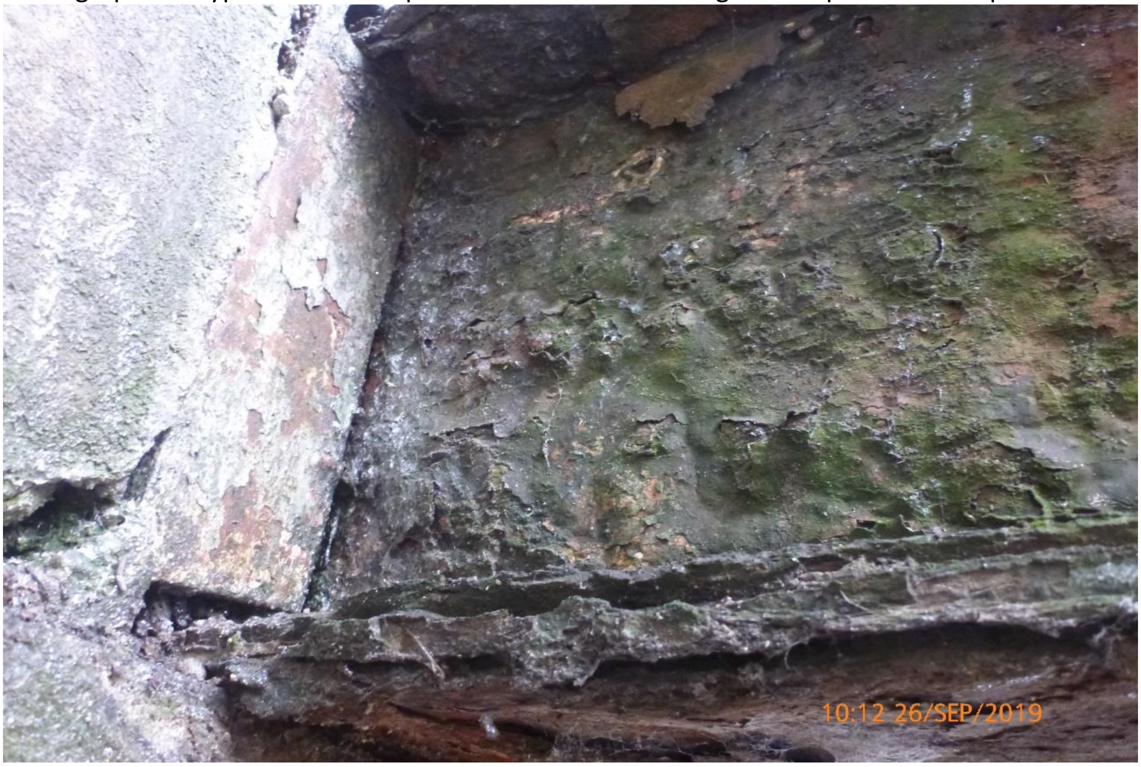
Photograph 10: Typical view of corrosion / rusting and calcite stalactites on bridge invert.



Photograph 11: Typical view of corrosion to outside beams and corrosion to bottom of bracing members.

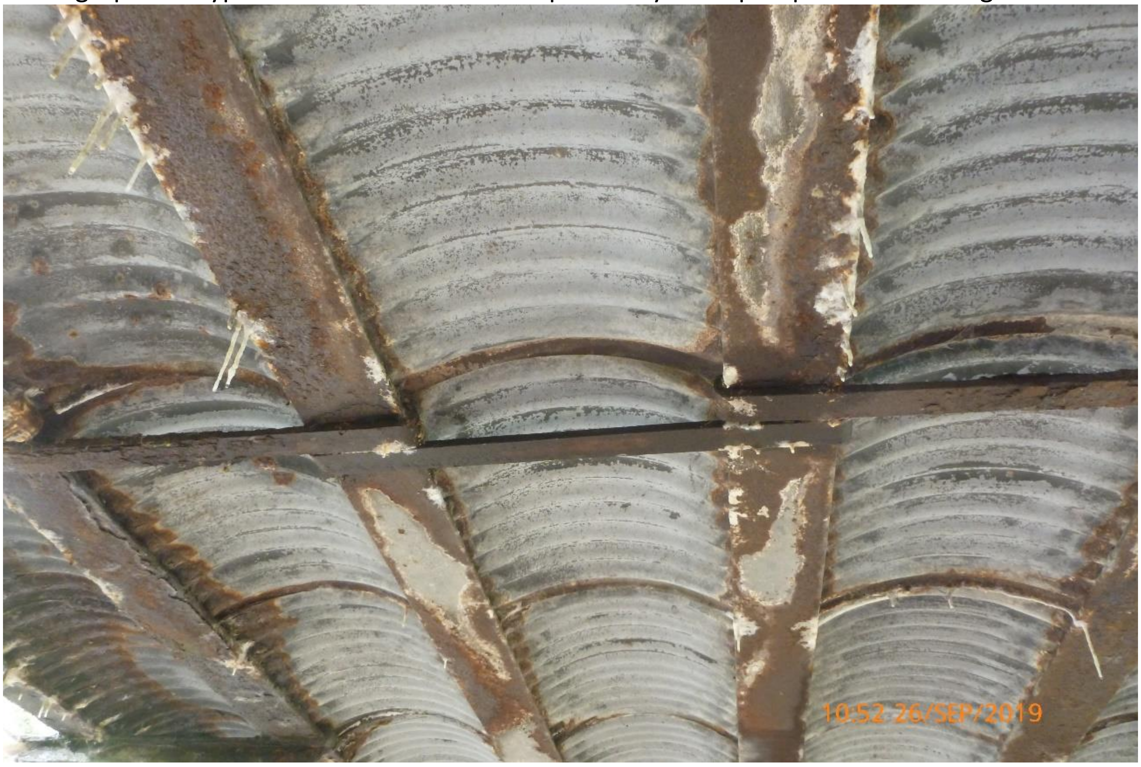


Photograph 12: Typical view of exposed beams faces with significant patina build up.

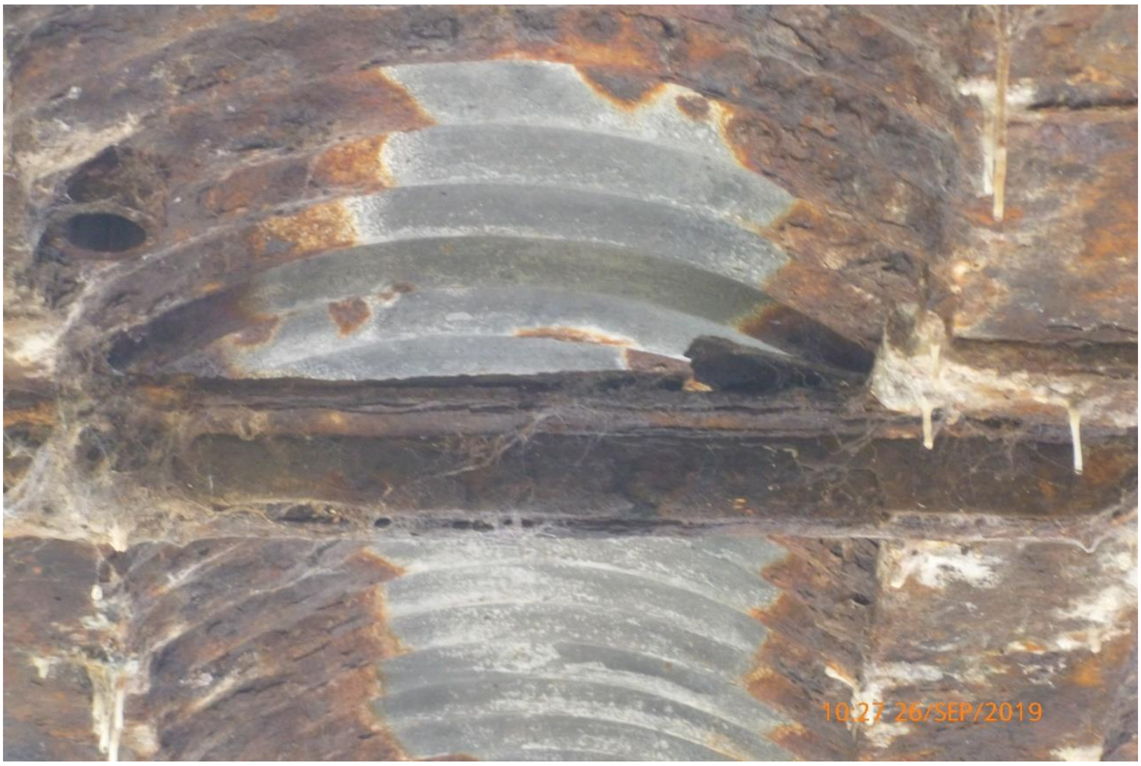


Photograph 13: Typical view of exposed beams faces with significant patina build up.

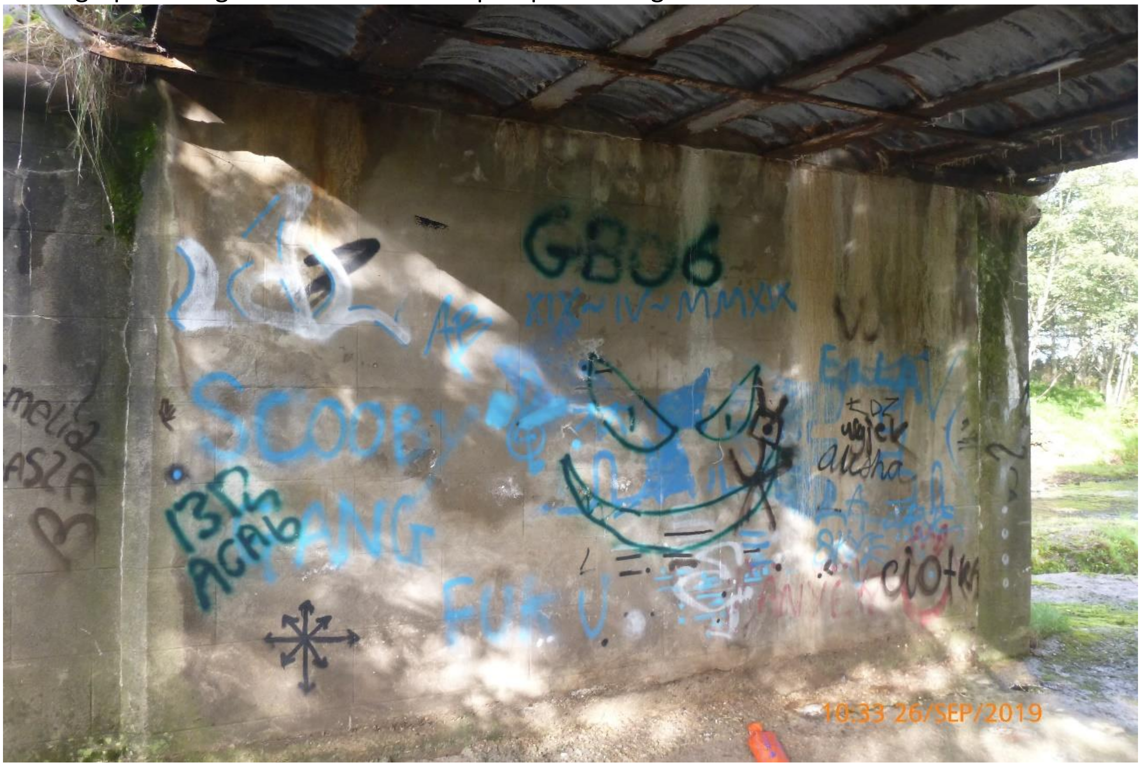
Photograph 14: Typical view of corrosion and patina layers at parapet cross bracing.



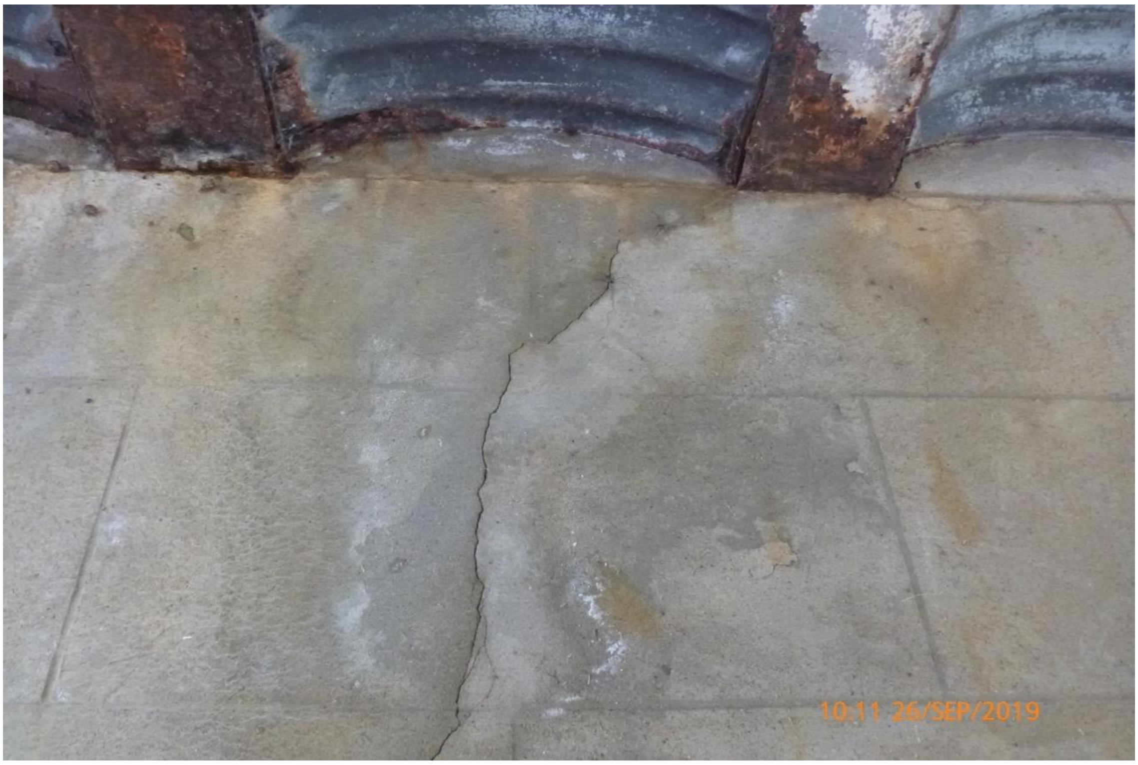
Photograph 15: Typical view of transverse bracing members.



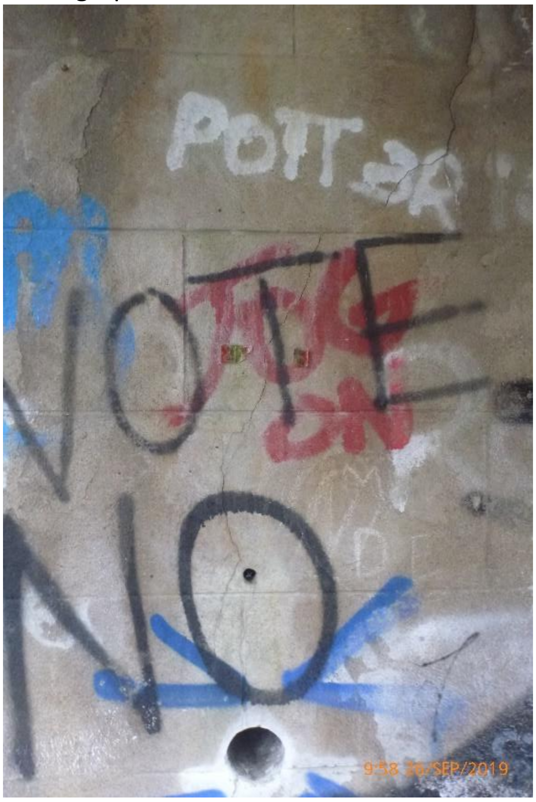
Photograph 16: Significant corrosion to parapet bracing member.



Photograph 17: Example of graffiti present on all abutment and pier faces.

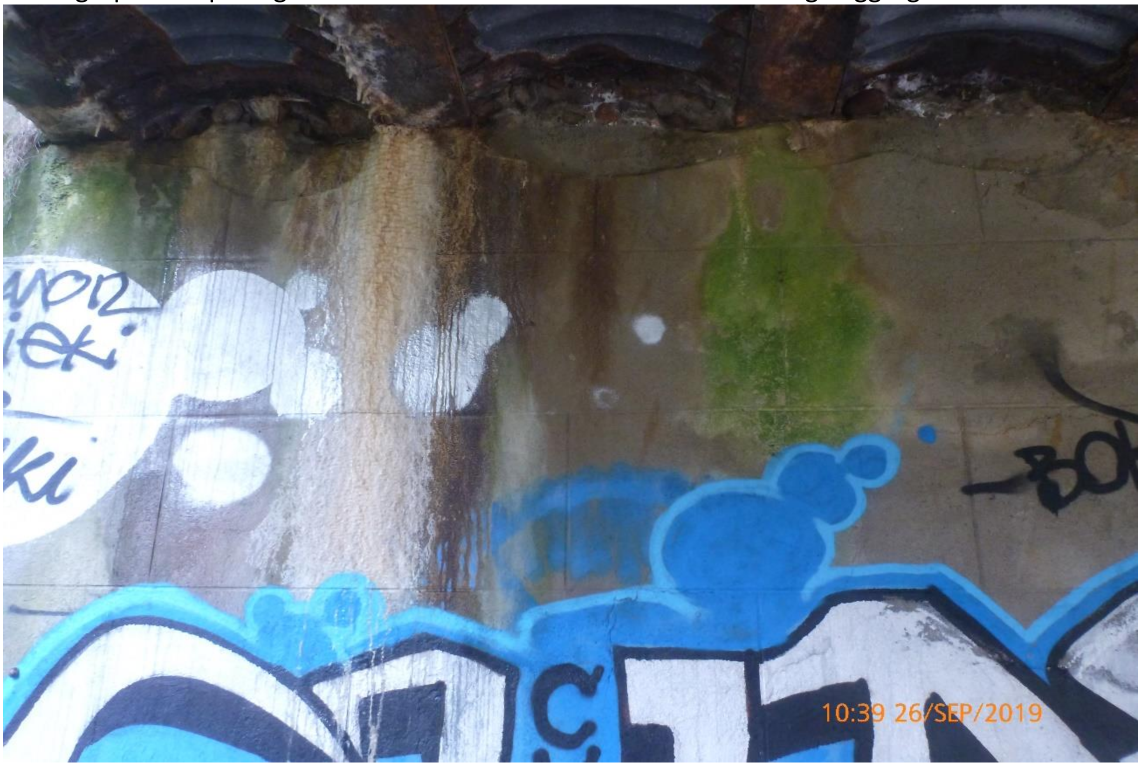


Photograph 18: Vertical Crack on West Abutment starting from beam (0.8mm).

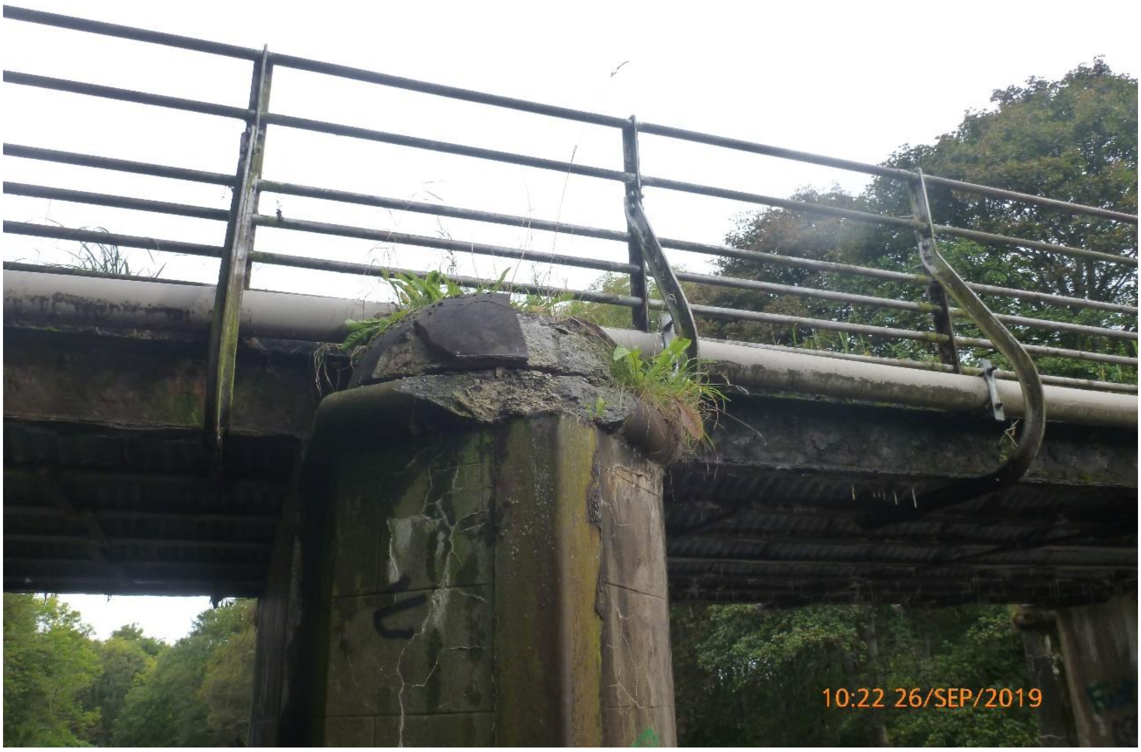


Photograph 19: Vertical crack on West Abutment, with broken crack gauge (0.8mm)

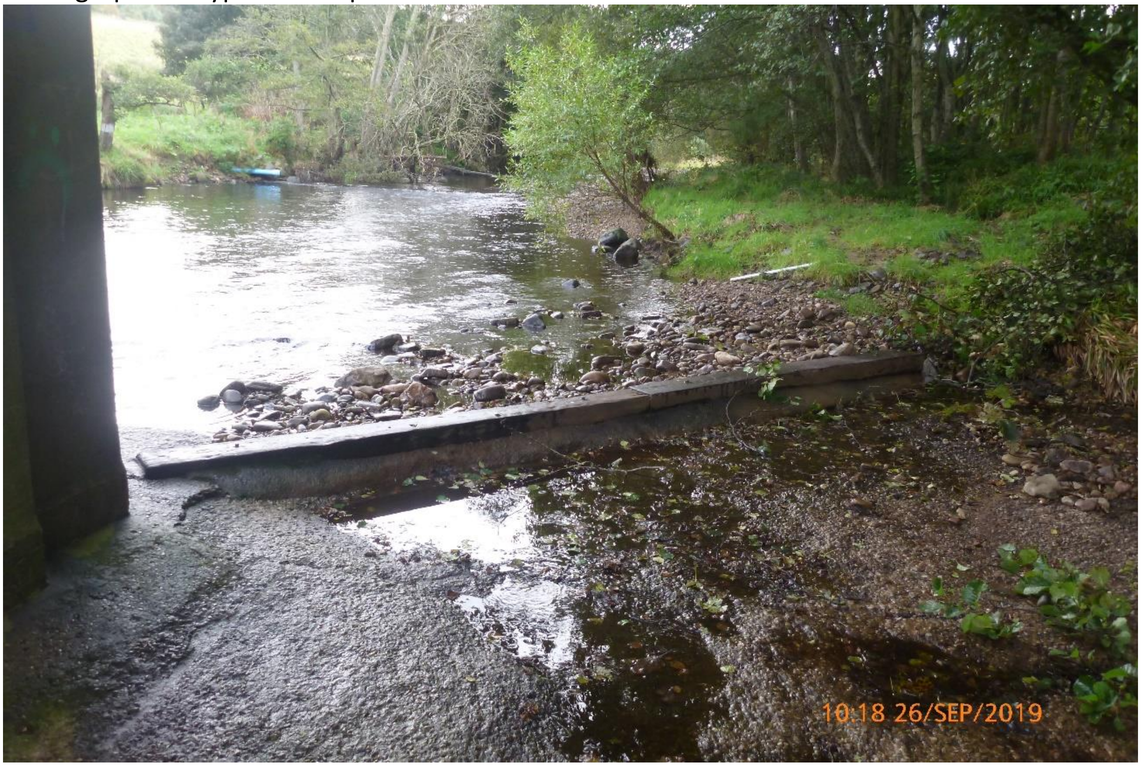
Photograph 20: Spalling of concrete between and under beams. Alrge aggregate sizes visible



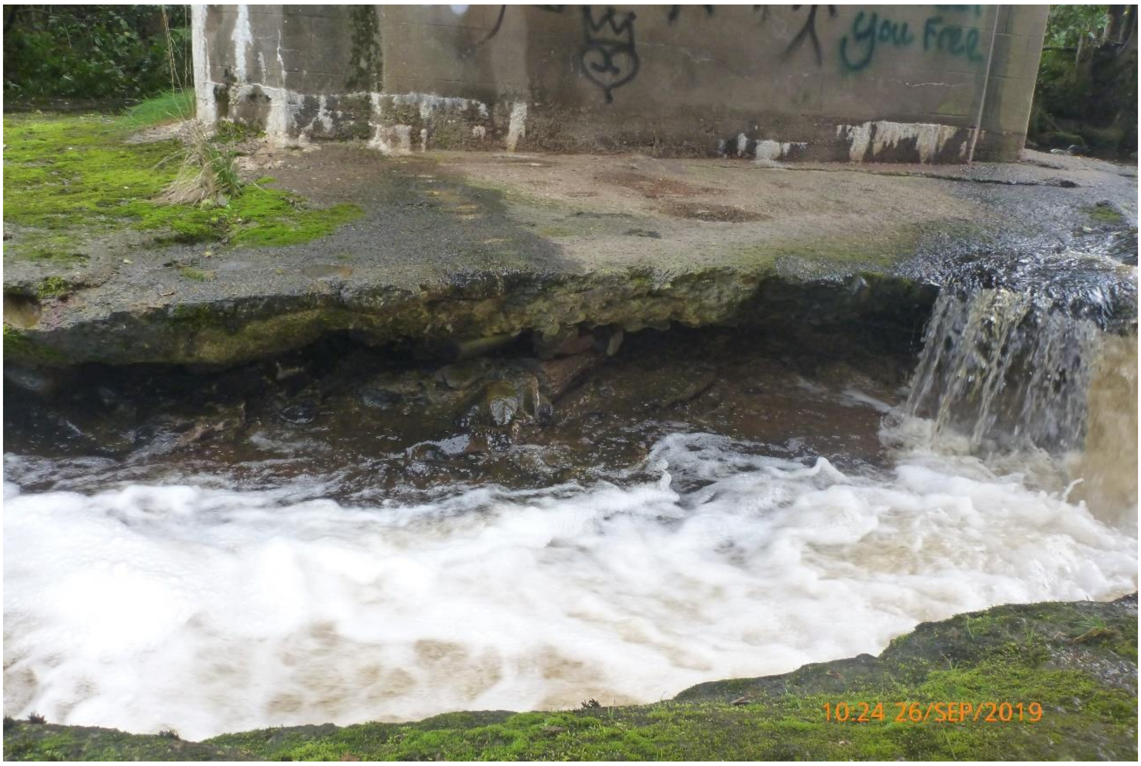
Photograph 21: Typical example of significant calcite build up on Abutment and algae staining.



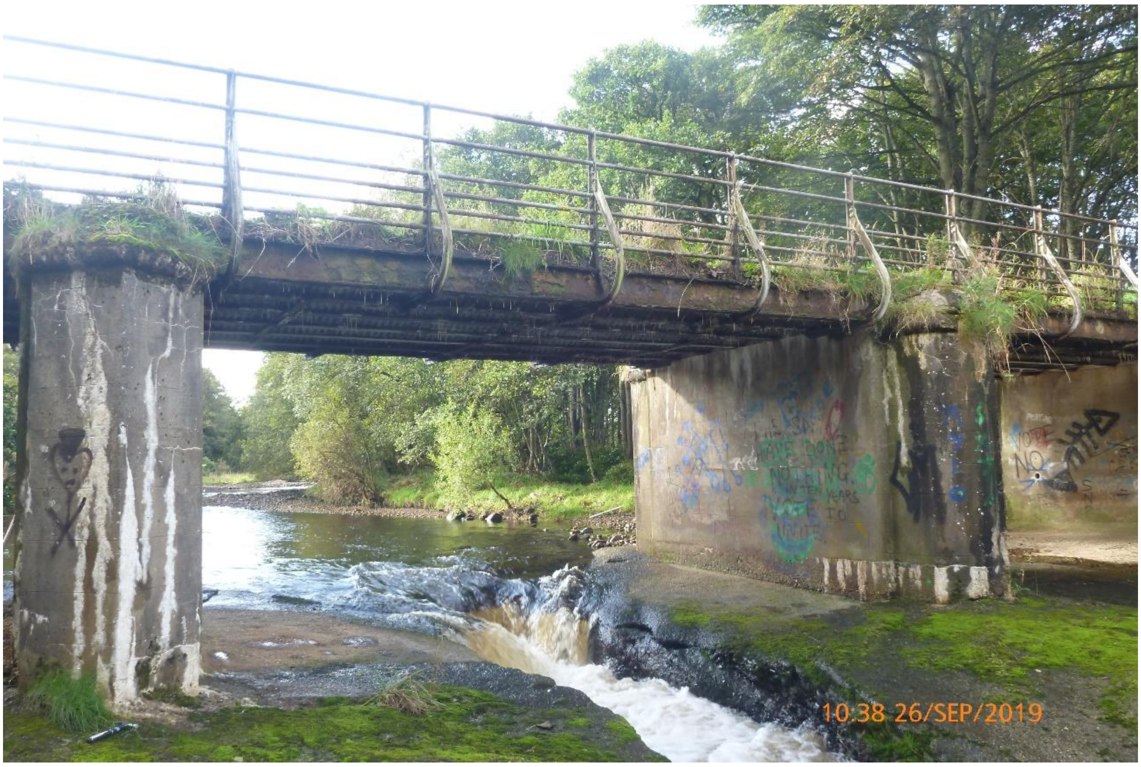
Photograph 22: Typical example of concrete break out at cutwater.



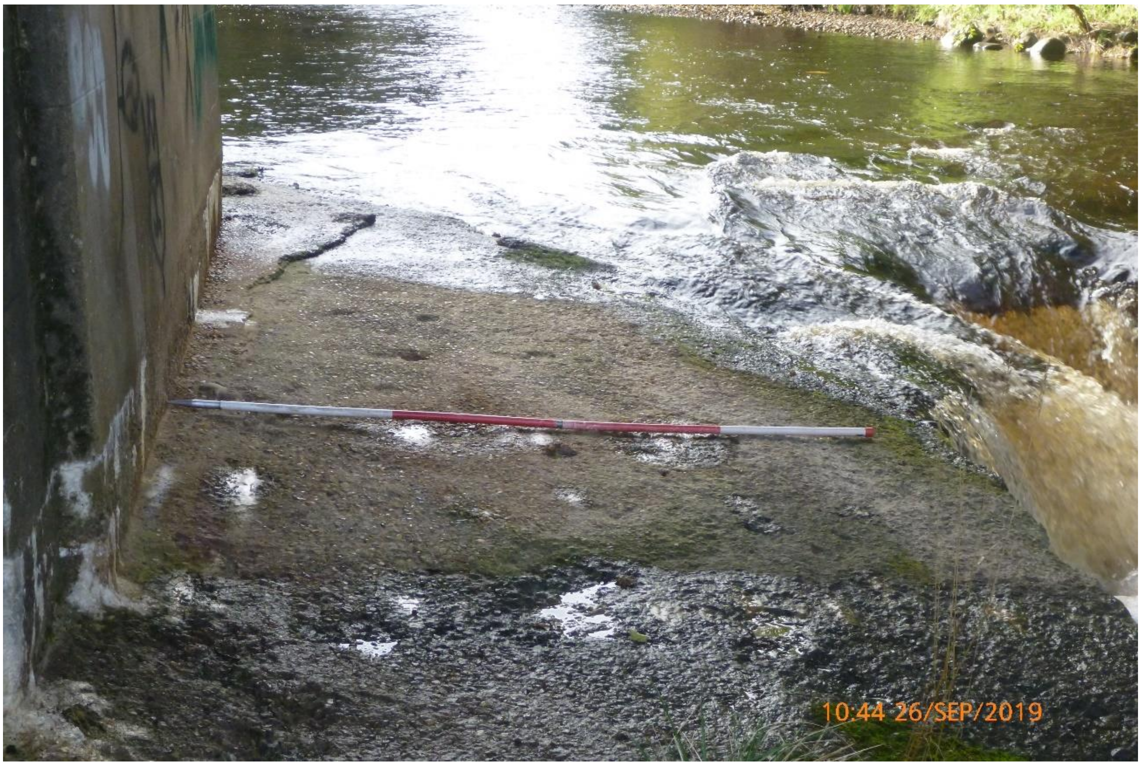
Photograph 23: River training works at upstream of Span 1.



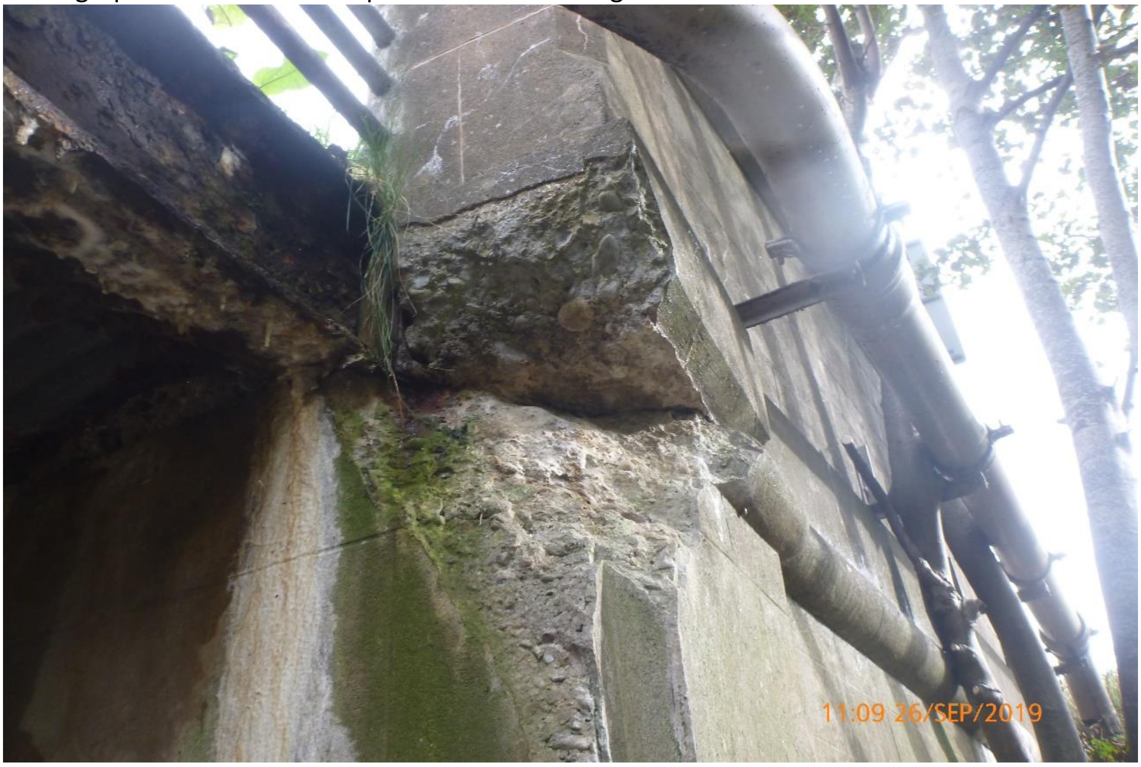
Photograph 24: Scour of bridge invert at centre span. Visible scour extending beneath invert on East side.



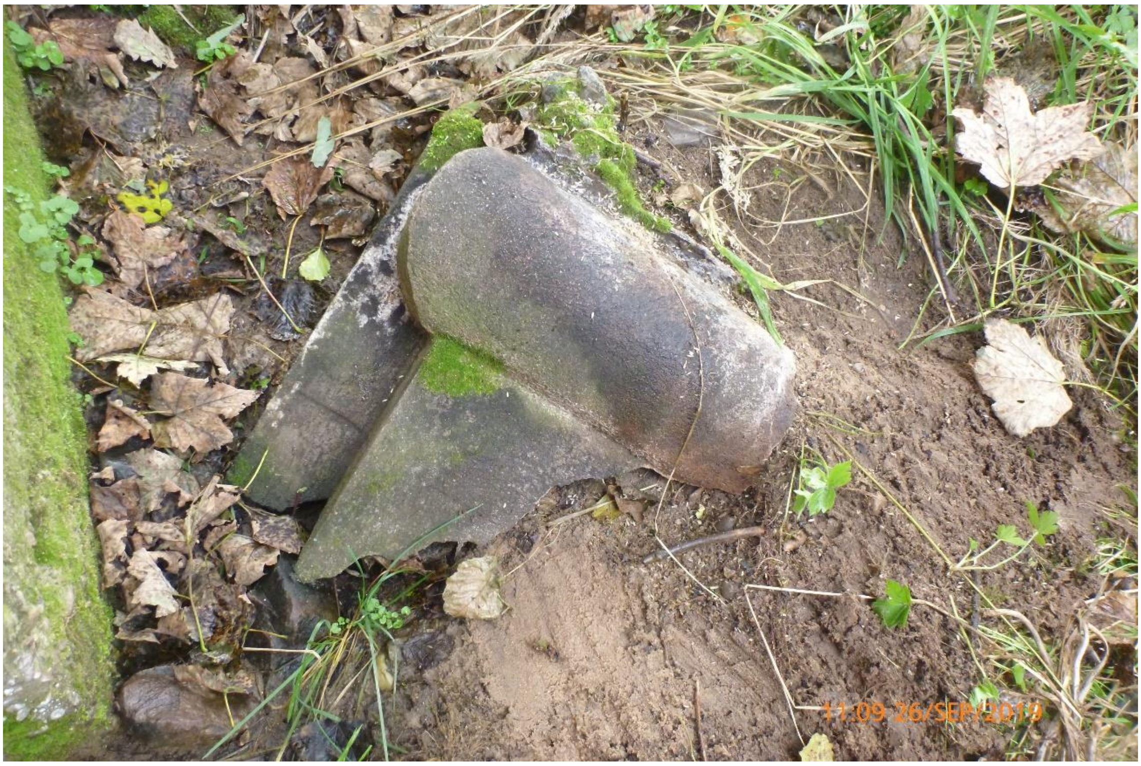
Photograph 25: General view looking South at centre span with invert scour.



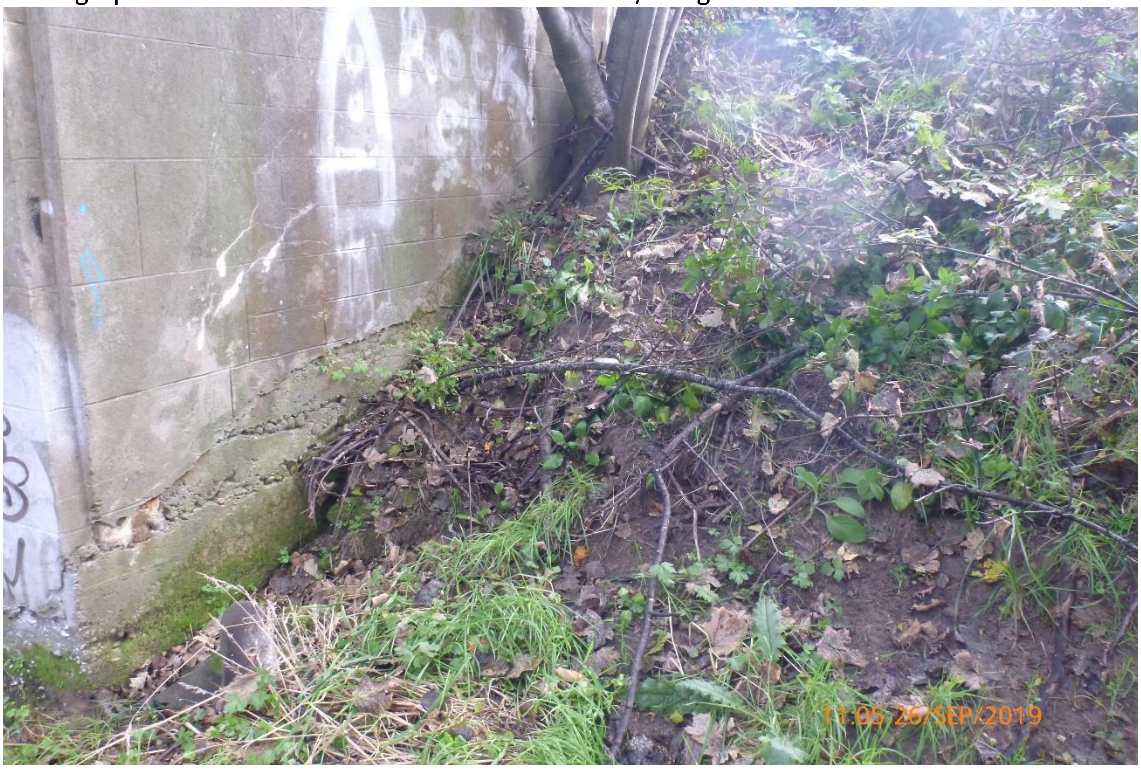
Photograph 26: distance from pier face to scour edge.



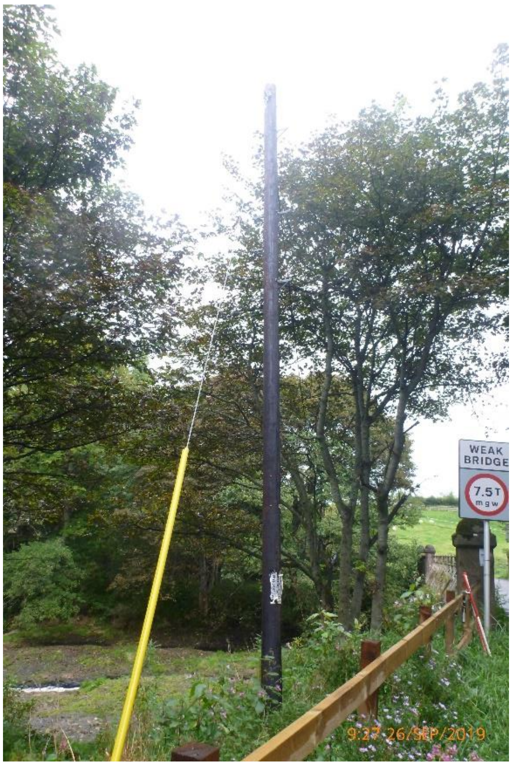
Photograph 27: Concrete breakout at East abutment / wingwall.



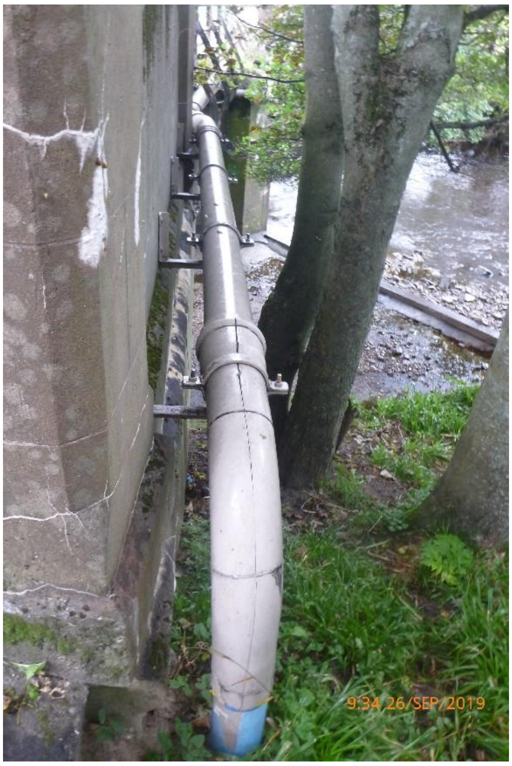
Photograph 28: Concrete breakout at East abutment / wingwall



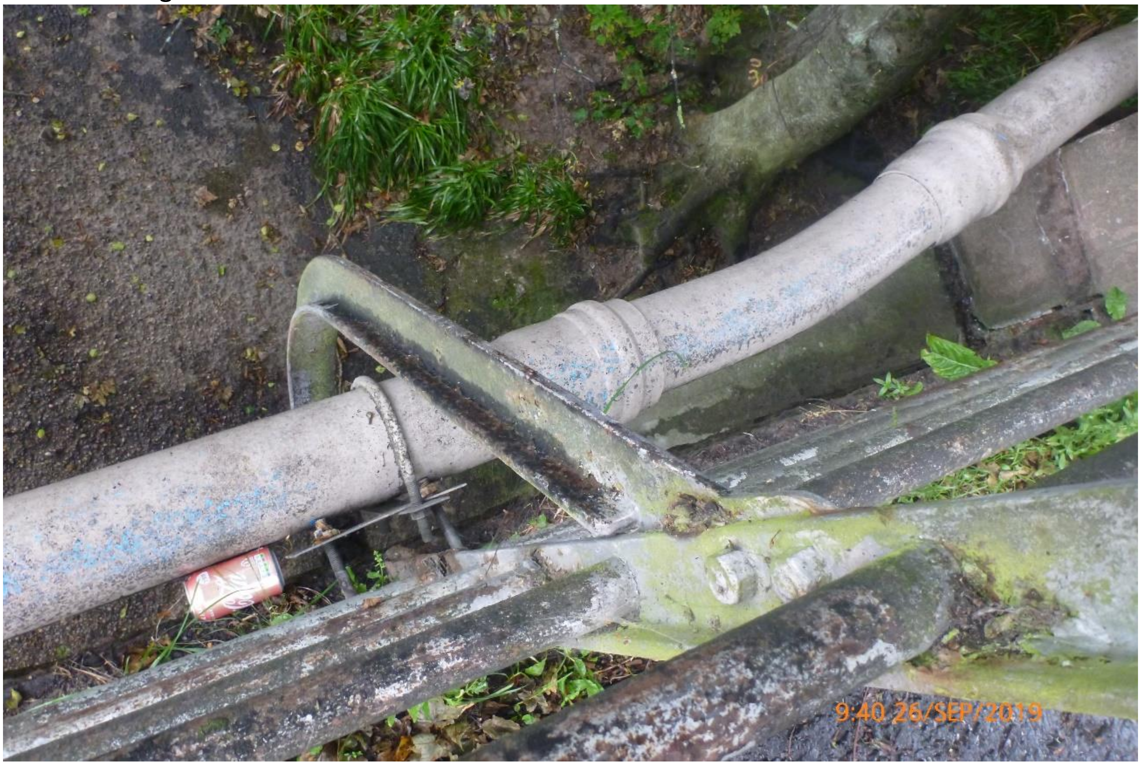
Photograph 29: Minor scour to embankment and wingwall (South-East).



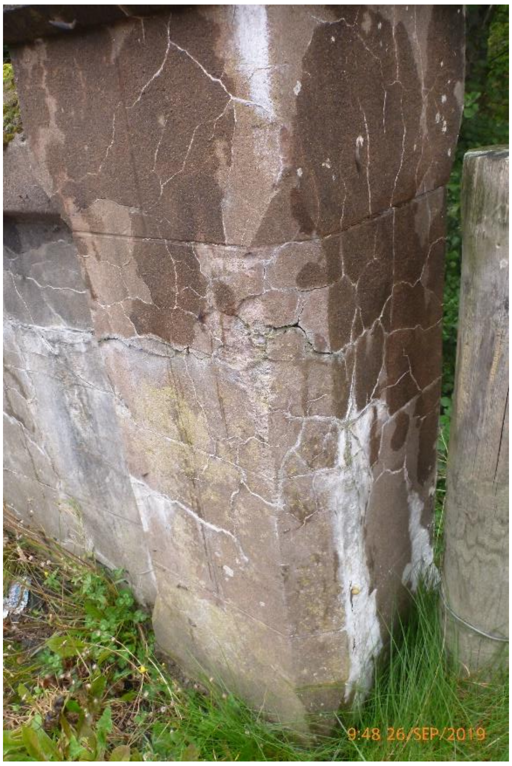
Photograph 30: Overhead telecoms cable to North of bridge.



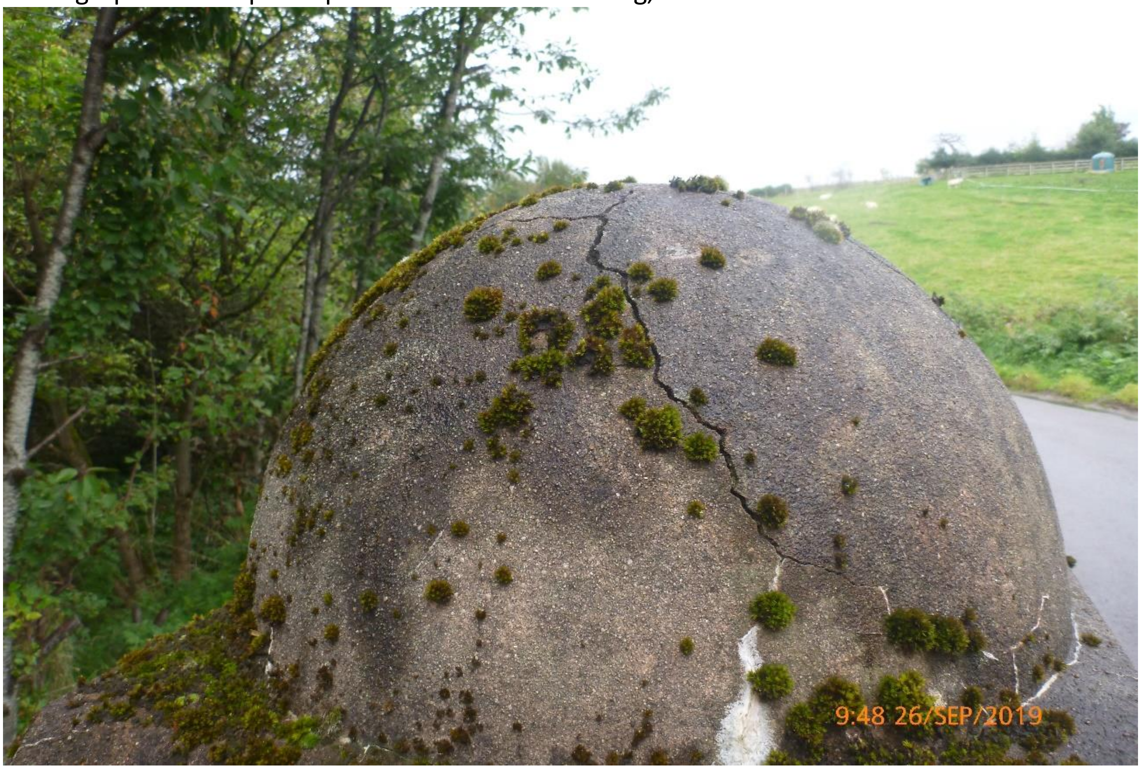
Photograph 31: Pipeline attached to South of structure.



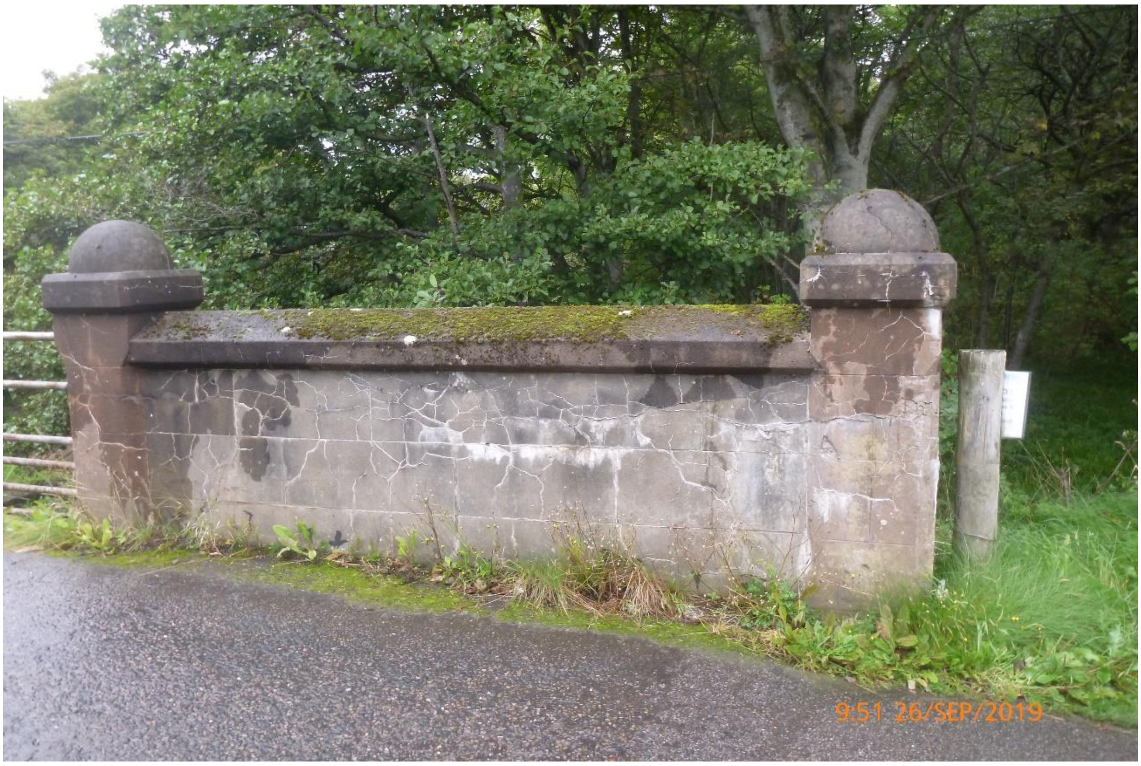
Photograph 32: Pipeline connection to bridge parapets.



Photograph 33: Parapet impact and concrete crushing, North-East.



Photograph 34: Cracking of Wingwall parapet topping stone (North-East)



Photograph 35: Typical condition of parapet with cracking and crazing.